Chapter 9
Proposed Voluntary Agreements

9.1 Introduction

On March 29, 2022, the State Water Resources Control Board (State Water Board) received a Memorandum of Understanding Advancing a Term Sheet for the Voluntary Agreements to Update and Implement the Bay-Delta Water Quality Control Plan, and Other Related Actions (MOU; hereafter referred to as the VA Term Sheet) (see Appendix G1 for a copy of the VA Term Sheet). The VA Term Sheet included signatories from state and federal agencies, local water agencies, private companies, and a non-profit mutual benefit corporation (collectively referred to in the VA documents as "Parties," "public water agencies," or "PWAs"). The Parties submitted the VAs as a proposed alternative for updating the Water Quality Control Plan for the San Francisco Bay-Sacramento/San Joaquin Delta (Bay-Delta Plan) to achieve reasonable protection of fish and wildlife beneficial uses in the regions covered by the VAs (VA tributaries). The State Water Board received updates to the VA Term Sheet in August 2022 and November 2022 to include additional parties and VA components. As described further below, there were also further developments following this date that affect the overall VA proposal, or may in the future.

The VAs include a combination of proposed flow and non-flow habitat restoration measures on a portion of the Sacramento/Delta tributaries over 8 years (with the intent to extend the term), including varying amounts of increased flows, depending on water year type, and non-flow habitat restoration actions targeted at improving spawning and rearing capacity for juvenile salmonids, estuarine species, and other native fish and wildlife. The proposed VA flows are intended to be additive to the Delta outflows required by State Water Board Decision 1641 (D-1641) and resulting from the 2019 Biological Opinions (collectively "2019 BiOps condition") though the VAs acknowledge that the BiOps may change. The flow and non-flow habitat actions are proposed as implementation measures for an existing and proposed new water quality objective in the Bay-Delta Plan. Specifically, the VAs propose: 1) a new narrative objective to achieve the viability of native fish populations; and 2) to provide the participating parties' share, during implementation of the VAs, to contribute to achieving the existing Narrative Salmon Protection Objective, and propose doing so by 2050. The VAs also include proposed governance and science programs to direct flows and habitat restoration, conduct assessments, and develop strategic plans and annual reports.

The State Water Board is considering the proposed VAs as a possible path forward for updating the Bay-Delta Plan. Some components are currently under development and will require consideration of public input on the draft Staff Report and peer review of the Scientific Basis Report Supplement. The proposed VAs identify that there will be a regulatory pathway that would exist in parallel with the VA implementation pathway. The staff-proposed regulatory pathway under the VA alternative would apply to non-VA parties and could apply to VA parties in the event that the VAs are discontinued. This approach would integrate the proposed VAs and portions of the proposed Plan amendments discussed in Chapter 5, *Proposed Changes to the Bay-Delta Plan for the Sacramento/Delta* in the following way. The Bay-Delta Plan water quality objectives for fish and wildlife beneficial uses for the Sacramento River/Delta tributary flows would be updated to add the narrative viability objective proposed by the VA Parties instead of the narrative and numeric objectives discussed as the proposed Plan amendments in Chapter 5, which include an inflow objective of 55% of unimpaired flow, with an adaptive range of flows between 45% and 65% of unimpaired flow (numeric flow range) in the Sacramento River, its tributaries, and the three Delta eastside tributaries, the Mokelumne, Cosumnes, and Calaveras Rivers, as well as an associated narrative cold water habitat objective and inflow based Delta outflows that would require required inflows as outflows. The Bay-Delta Plan program of implementation for Sacramento River/Delta tributary inflows would be amended to require that either the proposed VA flow and non-flow habitat restoration actions are achieved in any region covered by a VA, consistent with that approved VA or, for any Sacramento River/Delta tributary flow region not covered by an approved VA, or where a VA is discontinued, the numeric flow range (inflows), inflow-based Delta outflows, and cold water habitat provisions described in Chapter 5 must be maintained.

Because the State Water Board received the proposed VAs after much of this Staff Report had been prepared, the proposed VAs are analyzed separately in this chapter. The environmental analysis for the proposed Plan amendments and other project alternatives is provided in Chapter 7, *Environmental Analysis*.

This chapter includes a general description of the proposed VAs. Additional details regarding the VAs are included in Appendix G, including the final draft Scientific Basis Report in support of the VAs that is being submitted to independent peer review. In addition, the components of the VA proposal that have been submitted to date are also included, including the VA Term Sheet and appendices, draft VA Strategic Plan, draft VA Governance Program, and draft VA Science Plan. In addition to these components of the VAs, by the end of the year, the VA parties are planning to submit the following additional draft documents: draft Global Agreement, draft Enforcement Agreements, draft Implementing Agreements; draft Quantitative Flow Accounting Approach; draft Funding Plan; and draft Systemwide Governance Committee Charter.

This chapter provides the environmental analysis of the proposed VAs, including evaluation of the potentially significant, less-than-significant, and beneficial environmental effects of the proposed VAs. This chapter also identifies mitigation measures that could avoid or reduce potentially significant impacts of the VA proposal. This chapter relies on the environmental analysis presented in Chapter 7, *Environmental Analysis*, where possible for efficiency and to avoid redundancy. The economic effects of the proposed VAs are also evaluated in this chapter. This chapter evaluates the effects of potential VA flow contributions from the lower San Joaquin River on Delta outflows, but it does not evaluate environmental impacts on the lower San Joaquin River and its tributaries. The analyses presented are not intended to support possible updates to the portions of the Bay-Delta Plan covering the lower San Joaquin River, which could incorporate lower San Joaquin River VAs, and would be subject to a separate process and subsequent analysis. The State Water Board commenced a process for considering possible updates to the Bay-Delta Plan for the Tuolumne River in 2023. While Merced River parties have submitted a VA, the Merced River parties are not currently signatories to the VA Term Sheet. In the event the Merced River VA is included in the VA Term Sheet, it would be evaluated similar to the Tuolumne River VA, as would also be the case if a VA is developed for the Stanislaus River.

This chapter also provides the environmental and economic analysis for a flow protection modular alternative (Alternative 6a, Protection of Voluntary Agreement Flows Alternative) that could be adopted in combination with the proposed VAs. The Flow Protection modular alternative is a possible mechanism for protecting the VA flows from diversion by other water users and ensuring that the 2019 BiOps condition base upon which the VA flows are intended to be additive is not reduced. Additional discussion of the Flow Protection modular alternative is provided below in Section 9.9, *Modular Alternatives for Proposed VAs*.

9.2 Background

The State Water Board has responsibility and authority for addressing flow and other operations that contribute to water quality impairments but recognizes that additional tools to improve ecological conditions can be brought to bear through actions by other agencies, including voluntary agreements. On December 12, 2018, through State Water Board Resolution No. 2018-0059 (State Water Board 2018), the State Water Board adopted amendments to the Bay-Delta Plan and a Final Substitute Environmental Document (SED) establishing updated flow objectives on the Lower San Joaquin River, including its three eastside tributaries, the Stanislaus, Tuolumne, and Merced Rivers (collectively "LSJR"), revised southern Delta salinity objectives, and programs of implementation to achieve the revised objectives. Resolution No. 2018-0059 acknowledged the State Water Board's awareness of ongoing negotiations between interested stakeholders and various other state agencies to achieve voluntary agreements to implement the Plan amendments and identified that robust voluntary agreements could help inform and expedite implementation of LSJR flow objectives and provide durable solutions in the Bay-Delta watershed while also providing reasonable protections for fish and wildlife. Through Resolution No. 2018-0059, the State Water Board encouraged stakeholders to continue to work together to reach voluntary agreements that incorporate a mix of flow and non-flow habitat measures that meet or exceed the new and revised water quality objectives and protect fish and wildlife beneficial uses, and to present those voluntary agreements to the State Water Board for its review as soon as feasible.

At the December 12, 2018 State Water Board meeting, the California Department of Water Resources (DWR) and California Department of Fish and Wildlife (CDFW), two departments under the California Natural Resources Agency (CNRA), also presented information on voluntary agreements and the contours of a potential Delta watershed-wide agreement. Resolution 2018-0059 discussed that additional work is necessary to develop an enforceable agreement, join additional parties, analyze the agreement and how it interacts with the Bay-Delta Plan, and assess what changes may be necessary to the Bay-Delta Plan for the agreement to serve as an implementation mechanism to reasonably protect fish and wildlife beneficial uses in applicable portions of the Bay-Delta watershed, while providing a suitable regulatory implementation pathway.

Since 2018, several federal, state, and local agencies, and other parties, developed the proposed VAs that are analyzed in this chapter. In February 2020, the Secretaries of the CNRA and California Environmental Protection Agency (CalEPA), together with DWR and CDFW, presented a Framework of Voluntary Agreements to Update and Implement the Bay-Delta Water Quality Control Plan (CNRA and CalEPA 2020) that discussed possible increases in flows, non-flow habitat improvements, and governance and science programs to facilitate adaptive management. The 2020 framework identified that additional work would be needed to finalize the proposed VAs and submit the proposal to the State Water Board. As discussed above, in March 2022, the State Water Board received the VA Term Sheet. Subsequently, the State Water Board received updates to the VA Term Sheet in August 2022 and November 2022 to include additional parties. Consistent with State Water Board Resolution 2018-0059, the State Water Board is considering the proposed VAs as an approach that could provide a possible path forward for updating the Bay-Delta Plan.

State Water Board staff in coordination with staff from DWR and CDFW also prepared a Draft *Scientific Basis Report Supplement in Support of proposed Voluntary Agreements for the Sacramento River, Delta, and Tributaries Update to the San Francisco Bay/Sacramento-San Joaquin Delta Water Quality Control Plan* (Scientific Basis Report Supplement) to document the science supporting the proposed provisions included in the proposed VAs (see Appendix G2). This report is a VA-specific supplement to the 2017 *Scientific Basis Report in Support of possible New and Modified Requirements for Inflows from the Sacramento River and its Tributaries and Eastside Tributaries to the Delta, Delta Outflows, Cold Water Habitat, and Interior Delta Flows* (2017 Scientific Basis Report) (^SWRCB 2017), which describes the science supporting possible Sacramento/Delta updates to the Bay-Delta Plan that were proposed prior to receipt of VAs. As discussed in Chapter 12, *Public Participation*, the State Water Board made the Draft Scientific Basis Report Supplement available for public comment and held a public workshop on January 19, 2023. Following receipt of public comments, the draft was revised in response to public comments and a final Draft Scientific Basis Report Supplement was developed for peer review pursuant to the requirements of California Public Health and Safety Code (section 57004).

9.3 Description of the Proposed Voluntary Agreements

This section provides a description of the proposed VAs. The proposed VAs include a combination of assets (Table 9.3-1) over 8 years (with the possibility of extension), including varying amounts of increased flows on certain tributaries, depending on water year type, and non-flow habitat restoration actions targeted at improving spawning and rearing capacity for juvenile salmonids and other native fishes.

Table 9.3-1. Proposed VA Assets as Modeled

	Flows (thousand acre-feet) by Water Year Type					Restoration (acres)		
Location	C	D	BN	AN	W	Spawning	Instream Rearing	Floodplain
Sacramento		100	100	100		113.5	137.5	20,000
American[1]	30	40	10	10		25	75	
Yuba		50	50	50			50	100
Feather		60	60	60		15	5.25	1,655
Putah[2]	7	6	6	6		1.4		
Mokelumne (by Mokelumne Water Year Type)[3]		5	5	7			1	25
Delta		125*	125*	175*				5,227.5**
PWA Fixed Price Purchases	3	63.5	84.5	99.5	27			
PWA Market Price Purchases		50	60	83				
Permanent State Water purchases	65	108	9	52	123			

	Flows (thousand acre-feet) by Water Year Type					Restoration (acres)		
Location	C	D	BN	AN	W	Spawning	Instream Rearing	Floodplain
Friant (by San Joaquin Water Year Type)[4]		0-50	0-50	0-50				
Tuolumne (by San Joaquin Water Year Type)	37	62	78	27				

Flow assets are proposed to be additive to the Delta outflows resulting from State Water Board Revised Water Right Decision 1641 (D-1641) and implementation of the 2019 Biological Opinions for operations of the State Water Project and Central Valley Project.
C = Critical, D = Dry, BN = Below Normal, AN = Above Normal, W = Wet, * = foregone exports, ** = includes tidal wetland habitat. Blank cells indicate no proposed assets in that category. Water Year Types are based on Sacramento Valley Index unless otherwise noted.
[1] These flows would be implemented in three out of eight years of the VA in AN, BN, D, or C years.
[2] Flow contributions would be from modified operations and not protected as Delta outflow. Discussions for these VAs are still underway.
[3] Flow contributions would be from modified operations and not protected as Delta outflow. Discussions for these VAs are still underway. Mokelumne VA reflects updated volumes from the Mokelumne VA Term Sheet addendum (August 2022); Mokelumne VA based on Joint Settlement Agreement water year types.
[4] Flow contributions were intended to result from foregone recapture of up to 50 TAF of San Joaquin River Restoration Program flows provided based on San Joaquin Water Year Type. The Friant parties have withdrawn from providing VA flows at the time of this writing and future participation is uncertain.

The flow and non-flow physical restoration actions are proposed as implementation measures for an existing and new narrative water quality objective in the Bay-Delta Plan. Specifically, the VAs propose: 1) a new narrative objective to achieve the viability of native fish populations; and 2) to provide the participating parties' share, during implementation of the VAs, to contribute to achieving the existing Narrative Salmon Protection Objective by 2050.

The VAs propose an 8-year term and a set of flow and non-flow physical habitat actions (also referred to in the VA Term Sheet as "assets"), in selected tributaries, flood bypasses, and the Delta. The assets for which there are specific existing commitments included in the VA Term Sheet are summarized in Table 9.3-1 and described in more detail in the subsections below. Flow assets are expected to be concentrated in January through June, with some flexibility outside of this period, as indicated by the VA Strategic Plan included in Appendix G, with more limited flow assets also planned for fall months (Mokelumne and Putah systems). Priority months include April through May, and priority water year types include Dry, Below Normal, and Above Normal water years. Flows during these time periods and water year types are intended to benefit spawning and rearing habitats for salmonids in the VA tributaries and provide benefits for native estuarine species such as longfin smelt.

Proposed physical habitat restoration actions are intended to target spawning and rearing capacity for juvenile salmonids, as well as other native fishes. Tributary physical restoration actions are meant to restore spawning and rearing habitats sufficient to support approximately 25% of the offspring of the salmon doubling goal populations for each tributary. Restoration is also intended to improve regional aquatic food supply and improve connectivity between the in-channel and the new and existing floodplains. The VA Parties intend that achievement of non-flow restoration action acreage amounts would be calculated as additive to existing physical conditions as of December 2018. As stated in the VAs, implementation of non-flow restoration actions "by Parties after

[December 2018], but prior to the execution of the VAs, will be considered as contributing towards implementation of the Narrative Salmon Objective and Narrative Viability Objective." Where appropriate, non-flow restoration actions are intended to be integrated with and complementary to VA flow assets.

The proposed VAs include a proposed Governance Program that would "direct flows and habitat restoration, conduct assessments, develop strategic plans and annual reports, implement a science program, and hire staff and contractors" (^Voluntary Agreements Parties 2022). This Governance Program anticipates a Systemwide Governance Committee to oversee overall coordination of the VA Program, and Tributary/Delta Governance Entities that would oversee implementing the agreements for which that entity is responsible. The VA Science Program is proposed to "(A) inform decision-making by the Systemwide Governance Committee, Tributary/Delta Governance Entities, and VA Parties; (B) track and report progress relative to the metrics and outcomes stated in Appendix 4; (C) reduce management-relevant uncertainty; and (D) provide recommendations on adjusting management actions to the Systemwide Governance Committee, Tributary/Delta Governance Entities and VA Parties" (^Voluntary Agreements Parties 2022). The framework for the VA Science Program is proposed to be collaboratively developed by the VA Parties in coordination with the State Water Board.

The VA Parties propose that in the eighth year of the VAs, the State Water Board would consider the reports, analyses, information, and data from the VA Science Program, as well as recommendations from the VA Governance Committee and the Delta Independent Science Board (ISB) to decide the future of the VA program. The VA Parties propose that if the VAs are substantially achieving the stated objectives, the VAs would continue without any substantial modification in terms or, if the VAs are expected to achieve the stated objectives with some modifications, the VAs could continue implementation with substantive modifications in terms. However, if the VAs are not expected to achieve the stated objectives, then either 1) new agreements may be negotiated or 2) the State Water Board would use its regulatory authorities to implement the Bay-Delta Plan (Voluntary Agreements Parties 2022). This regulatory implementation pathway would also apply on non-VA tributaries.

9.3.1 Components of Proposed Voluntary Agreements

This section provides a summary of the supporting documentation for the proposed VAs that are provided in Appendix G. The supporting documentation for the proposed VAs is referred to collectively as the VA proposal or VA package.

Appendix G1 contains the current VA proposal, dated September 2023. The current VA proposal includes the draft Strategic Plan for the Proposed Agreements to Support Healthy Rivers and Landscapes (Strategic Plan), VA Term Sheet (dated November 2022), draft VA Governance Program, and draft Science Plan. The VA Term Sheet states of the draft Strategic Plan, "The VA Parties will propose an initial Strategic Plan for approval in the update to the Bay-Delta Plan, along with other elements of the VAs. The plan will provide multi-year guidance for the implementation of flow and other measures, set priorities to guide the Science Program, and establish reporting procedures related to implementation and effects." The VA Term Sheet, dated November 2022, identifies the proposed VA assets, including flow and non-flow habitat restoration measures. The proposed VA assets are outlined in Appendices 1 and 2 of the VA Term Sheet. As described in the VA Term Sheet, the draft VA Governance Program, "will be established to direct Systemwide Measures, make recommendations regarding the deployment of Tributary/Delta Measures, conduct assessments, update the strategic plan, develop annual reports, implement a systemwide science program, and hire staff and contractors, consistent with applicable provisions of the VA." The VA Term Sheet identifies that "The VAs include formation of a VA Science Program, guided by the VA Science Committee. The VA Science Program is a coordinated collective of tributary- and Delta-focused monitoring and research programs relevant to understanding the outcomes of VA implementation that has several high-level functions."

Appendix G2 is a copy of the final draft Scientific Basis Report Supplement, dated September 2023. The final draft Scientific Basis Report Supplement documents the science supporting the proposed provisions included in the VAs and is being submitted for external peer review pursuant to the requirements of California Public Health and Safety Code section 57004, which requires that the scientific basis of any statewide plan, basin plan, plan amendment, guideline, policy, or regulation undergo external scientific peer review before adoption. Following peer review, the report may be further revised.

In addition to these components of the VAs, by the end of the year, the VA parties are planning to submit the following additional documents: draft Global Agreement, draft Enforcement Agreements, draft Implementing Agreements; draft Quantitative Flow Accounting Approach; draft Funding Plan; and draft Systemwide Governance Committee Charter.

9.3.2 Narrative Viability Objective and Narrative Salmon Objective

The VAs propose that the State Water Board update the Bay-Delta Plan to include a new narrative viability objective as well as a combination of voluntary flow and non-flow habitat restoration actions that would provide the participating parties' share, during implementation of the VAs, to contribute to achieving the Narrative Salmon Objective by 2050 (^Voluntary Agreements Parties 2022).

The existing Narrative Salmon Protection Objective (also referred to as the salmon doubling objective) states:

> *Water quality conditions shall be maintained, together with other measures in the watershed, sufficient to achieve a doubling of natural production of chinook salmon from the average production of 1967-1991, consistent with the provisions of State and federal law.*

The proposed Narrative Viability Objective states:

> *Maintain water quality conditions, including flow conditions in and from tributaries and into the Delta, together with other measures in the watershed, sufficient to support and maintain the natural production of viable native fish populations. Conditions and measures that reasonably contribute toward maintaining viable native fish populations include, but may not be limited to, (1) flows that support native fish species, including the relative magnitude, duration, timing, temperature, and spatial extent of flows, and (2) conditions within water bodies that enhance spawning, rearing, growth, and migration in order to contribute to improved viability. Indicators of viability include population abundance, spatial extent, distribution, structure, genetic and life history diversity, and productivity. Flows provided to meet this objective shall be managed in a manner to avoid causing significant adverse impacts to fish and wildlife beneficial uses at other times of the year.*

9.3.3 Tributary Assets

Tributary assets described below include flow and non-flow assets negotiated as of November 10, 2022, and outlined in Appendices 1 and 2 of the VA Term Sheet (^Voluntary Agreements Parties 2022). Flow assets would be additive to the 2019 BiOps condition, and would vary according to the Water Year Type. These flows would generally be provided in January through June, but the timing varies by tributary system and flows may be shaped in timing and seasonality to test biological hypotheses and to respond to hydrologic conditions. Such shaping is proposed to occur through the Governance Program (Section 9 of the VA Term Sheet) subject to the Implementing Agreements and applicable regulatory requirements. A portion of the volumes of water described below are proposed to be managed with a priority of providing increased flows in the months of April and May in Dry, Below Normal, and Above Normal water years to replicate average outflow resulting from the Inflow/Export ratio in the 2009 NMFS BiOp as modeled (^NMFS 2009).

As described in the draft Strategic Plan, flow assets would be deployed in accordance with a "flexibility bracket" defined for each tributary system, CVP/SWP Export Reductions, and the PWA Water Purchase Program. The flexibility brackets indicate, by Water Year Type, the range of the percent of total water-year VA flows to be provided in each month, along with identification of a default distribution. The VA Term Sheet describes the total flow assets for each system that would be provided in each water year while the flow flexibility brackets identify how the flows may be deployed across specified months. The VA Parties indicate that the flexibility brackets will allow VA governance entities to optimize provision of VA Flow Measures for the benefit of native fish; test hypotheses in areas of uncertainty, thus informing adaptive management of flow measures; and, enable operators to work within operational and hydrological constraints of each system. The draft VA Strategic Plan included in Appendix G includes additional information.

Flows made available through reservoir reoperations would be subject to accounting procedures approved by the State Water Board. An assessment based on the accounting procedures would be developed (pursuant to Section 8.4 of the VA Term Sheet) and conducted prior to year 8 of the VAs to determine if the flows described below were provided, on average, by water year type to help to inform if the VAs should be continued, should be modified, or whether the regulatory pathway should be implemented. Off-ramps for flows during Critical years would be subject to real-time conditions including storage forecasts for cold water pool preservation, but flows described below reflect average critical year contributions over the term of the VAs. The habitat restoration measures described below would be additive to physical conditions and regulatory requirements existing as of December 2018, when the State Water Board adopted Resolution 2018-0059. Implementation of such measures by Parties after that date, but prior to execution of the VAs, would be considered as contributing toward implementation of the Narrative Salmon Protection Objective and Narrative Viability Objective. The non-flow habitat restoration described below represents the non-flow habitat restoration commitments from Appendix 2 of the VA Term Sheet.

Table 9.3-2 identifies the minimum additive contribution to physical habitat restoration, in acres and by general location, committed in the VA Term Sheet, within the proposed 8-year VA term. These efforts include activities to increase spawning habitat, instream rearing habitat and floodplain habitat, including levee setbacks, breaches, side-channel improvements, and other improvements based on site-specific objectives. Proposed projects are intended to provide habitat at a frequency, magnitude, and duration necessary to produce biological benefits for species such as fall-run Chinook salmon through improved quality and quantity of rearing and spawning habitat. The VA Parties could pursue additional non-flow habitat improvement actions (e.g., removal of barriers or invasive aquatic weeds), if they determine that such actions would contribute toward meeting the objectives of the VAs.

Table 9.3-2. Summary of VA Tributary Habitat Restoration Commitments by Habitat Type and Watershed

Watershed	Spawning (acres)	Instream Rearing (acres)	Floodplain Rearing (acres)
Sacramento River	113.5	137.5	-
Sutter Bypass, Butte Sink, and Colusa Basin	-	-	20,000
Feather River	15	5.25	1,655
Yuba River	-	50	100
American River	25	75	-
Mokelumne River	-	1	25
Putah Creek	1.4	-	-

Source: Voluntary Agreements Parties 2022.

9.3.3.1 Sacramento River

The VAs propose both flow and non-flow habitat restoration for the Sacramento River. Flow assets for the Sacramento River have been identified as 100 thousand acre-feet (TAF) in Dry, Below Normal, and Above Normal years. No assets are identified for Wet Years. Appendix 1 to the VA Term Sheet identified 2 TAF of flow assets in Critical Years and 102 in Dry years. However, commitments for Critical Years are not part of the VA Term Sheet and only commitments for 100 TAF in Dry years are part of the VA Term Sheet. Physical habitat assets proposed for the Sacramento River includes restoration of 137.5 acres of instream habitat and 113.5 acres of spawning habitat. Physical habitat assets proposed for the Sacramento River include restoration of 137.5 acres of instream habitat and 113.5 acres of spawning habitat.

No direct flow assets are proposed for the flood basins. While Sutter Bypass inundation is expected to increase with the VAs, changes in flow in the Sutter Bypass would primarily be due to changes in operation of the Tisdale Weir notch, rather than direct effects of VA flow assets. Physical habitat restoration for three flood basins (Sutter Bypass, Butte Sink, and Colusa Basin) would allow more frequent inundation of 20,000 acres of flood basin habitat and 20,000 acres of land for fish food production. These physical habitat improvements would be generated via modifications to Tisdale Weir and other infrastructure modifications and would be subject to analyses showing that the acreage meets suitability criteria and that the fish food production program is effective. For example, water would be pumped out onto rice fields, held for a period of time to allow fish food production (e.g., zooplankton) and then discharged to the river for the benefit of native fishes downstream. Physical habitat restoration actions on the Sacramento River will mainly focus on fish passage improvements, food production, and enhancement of rearing habitat quantity and quality.

9.3.3.2 American River

The VAs propose both flow and physical habitat restoration actions for the American River. Flow assets for the American River are proposed in Critical, Dry, Below Normal, and Above Normal years of 30, 40, 10, and 10 TAF respectively. These flows would be deployed in three out of eight years of the VA in the above year types. No additional water would be provided from the American River in Wet years. These proposed flows are contingent on "replenishment," either from upstream surface storage releases or groundwater substitution, and the proposed VA assumes $40 million will be made available to fund groundwater substitution infrastructure. In addition to flows, physical habitat restoration of 25 acres of spawning habitat and 75 acres of rearing habitat is proposed on the American River.

9.3.3.3 Yuba River

The VAs propose both flow and physical habitat restoration actions for the Yuba River. Flow assets for the Yuba River are proposed as 60 TAF in Dry, Below Normal, and Above Normal years made available through reservoir reoperations. No additional water would be provided from the Yuba River in Critical or Wet years. Physical habitat restoration for the Yuba River would include 50 acres of instream habitat and 100 acres of floodplain habitat. This constructed floodplain is anticipated to activate at 2,000 cfs.

9.3.3.4 Feather River

The VAs propose both flow and physical habitat restoration actions for the Feather River. Flow assets for the Feather River are proposed as 60 TAF in Dry, Below Normal, and Above Normal years with no additional water provided from the Feather River in Critical or Wet years. Physical habitat restoration actions for the Feather River include 5.25 acres of instream habitat, 15 acres of spawning habitat, and 1,655 acres of floodplain habitat. These actions would target instream habitat complexity and side-channel improvements.

9.3.3.5 Putah Creek

The VAs propose both flow and physical habitat restoration for Putah Creek. Flow assets are proposed for Putah Creek in Critical, Dry, Below Normal, and Above Normal years. In Critical years 7 TAF would be provided, while 6 TAF would be provided in Dry, Below Normal, and Above Normal years. No additional water is proposed for Wet years. In addition to flows, physical habitat restoration of 1.4 acres of spawning habitat would be done on Putah Creek.

9.3.3.6 Mokelumne River

The VAs propose both flow and physical habitat restoration for the Mokelumne River. Flow assets are proposed for the Mokelumne River in Dry, Below Normal, and Above Normal years of 5, 5, and 7 TAF, respectively with no additional water available in Critical or Wet Years. Flow contributions would result from modified operations and not be protected as Delta outflow, as discussions for these VAs are still underway. The Mokelumne VA flow assets are based on Joint Settlement Agreement water year types. Funding to partially support PWA water purchases would also be provided. The Mokelumne VA reflects updated volumes from the Mokelumne VA Term Sheet addendum (August 2022). In addition to flows, restoration of 1 acre of instream habitat and 25 acres of floodplain habitat would be done on the Mokelumne River. This restoration would target creation of habitat to improve rearing capacity.

9.3.3.7 San Joaquin River Watershed and Friant Contributions to Delta Outflows

This Staff Report includes a range of scenarios to evaluate the potential effects of different possible contributions to Delta outflows from the LSJR tributaries, including the Tuolumne, Stanislaus, and

Merced Rivers, as well as Friant contributions. The VA Term Sheet includes LSJR placeholder flows anticipated from the Tuolumne River, as well as the Merced and Stanislaus Rivers. However, the Tuolumne River is the only tributary that is included in the VA MOU and there are not currently commitments in the VA MOU for the remaining contributions, which would be expected to be provided from the Merced and Stanislaus Rivers. While Merced River water users recently submitted a proposed VA, it has not been incorporated into the MOU and agreed to by other VA parties at this point. The latest version of the VA Term Sheet and MOU also includes commitments from Friant to reduce recapture of San Joaquin River Restoration Program flows in the Delta. However, Friant has withdrawn from the VAs but may rejoin in the future.

Further, in 2018 the State Water Board approved updates to the Bay-Delta Plan's LSJR flow objectives and program of implementation (as well as southern Delta salinity updates) which included preparation of environmental documentation. The Board is in the process of implementing those updates through a regulation. Following which, the 2018 LSJR flow objectives will be in effect unless VAs are approved on one or more of the LSJR tributaries. The Board is moving forward with a process to consider updates to the Bay-Delta Plan's LSJR flow objectives that were approved in 2018 to consider the Tuolumne River VA through a supplemental environmental review process. On April 11, 2023, the State Water Board issued a Notice of Preparation for a staff report/substitute environmental document to enable consideration of the Tuolumne River VA. The Board is conducting a separate review of the Tuolumne River VA because it would require changes to the program of implementation for the LSJR flow objectives of the Bay-Delta Plan adopted in 2018 and because the Tuolumne River VA involves changes in the San Joaquin River watershed that is a separate watershed from the Sacramento/Delta watershed.

In order to capture the range of possible additional LSJR flows and Friant commitments that would contribute to Delta outflows under the proposed VAs, or as the result of implementation of the LSJR flow objectives adopted in 2018, a range of scenarios is evaluated in this Staff Report. While it is expected that there would be some additional flow above baseline from the LSJR that would contribute to Delta outflows under the proposed VAs or implementation of the 2018 LSJR flow objectives, or a combination of the two, a scenario that does not include any additional contributions from the LSJR or Friant is evaluated. This scenario represents a conservative low end bookend for Delta outflow purposes. In addition, a scenario that represents commitments that were included in the VA MOU at the time it was submitted is evaluated that includes commitments from the Tuolumne River and Friant to Delta outflows. This scenario represents the Delta outflows for which there were commitments of assets at the time the latest VA Term Sheet was submitted in November of 2022. This analysis provides necessary documentation to consider approval of the Friant VA if it is pursued.

In addition, while VAs for the Merced and Stanislaus River are not currently under consideration, in recognition that there will be additional Delta outflows from the Merced and Stanislaus Rivers with or without VAs, that would be protected as Delta outflow as part of the VAs, additional analyses of the benefits of these additional Delta outflows is provided. Two scenarios are evaluated that add flows from the Merced and Stanislaus River to Delta outflows including the placeholder values from the VA Term Sheet and the LSJR flow objective included as part of the 2018 update to the Bay-Delta Plan (40% of unimpaired flow from February through June). Specifically, the potential benefits to Delta outflows during the January through June time frame are evaluated in order to provide a bookend evaluation of what the total changes in Delta outflows may be under the current VAs, possible future VAs, and implementation of the 2018 LSJR flow objectives and associated program of implementation. The potential impacts of these scenarios are not evaluated in this Staff Report because these actions have been, are being, or would be evaluated separately due to the reasons described above.

9.3.4 Delta and Estuary Assets

9.3.4.1 Habitat Actions in the Delta

The VA Term Sheet proposes restoring a total of 5,227.5 acres of tidal wetland and associated floodplain habitats within the North Delta Arc and Suisun Marsh regions. These restoration projects propose to create or enhance physical habitat in the Delta, including floodplain, tidal, and riparian habitat acres, in order to restore ecological functions and improve fish passage, provide access to higher quality and quantity spawning and rearing habitat, and increase food production. The Strategic Plan states that physical habitat restoration for the Delta would be sited and designed to improve conditions for native species, including Delta smelt, longfin smelt, splittail, and salmonids.

Among the various efforts proposed for the Delta, there are approximately 10 projects identified through the VA planning process.

9.3.4.2 Forgone Exports

The SWP and CVP deliver water to numerous water users, including individuals, agencies, and mutual water companies, in the San Francisco Bay Area, San Joaquin Valley, Central Coast and Southern California. SWP and CVP deliveries from the Delta can be significantly less than contract amounts in drier years and more at other times. The VAs propose to forgo the following amounts of exports from the Delta as contributions to Delta outflow: 125 TAF in both Dry and Below Normal water year types, and 175 TAF in Above Normal water year types.

9.3.4.3 Water Purchases

The proposed VAs anticipate that approximately $925 million will be made available for water purchases with approximately $708 million provided by public funding from the state and federal governments and the remaining approximately $217 million generated by the VA Parties through a per acre-foot charge on participating SWP and CVP contractors, depending on actual deliveries. The VAs propose three water purchase programs: permanent state water purchases, fixed price water purchases, and market price water purchases.

The following amounts of flow, by water year type, are proposed for each program:

- Permanent state water purchase program: 65 TAF in Critical, 108 TAF in Dry, 9 TAF in Below Normal, 52 TAF in Above Normal, and 123 TAF in Wet years.
- PWA Water Purchase Fixed Price Program: 3 TAF in Critical, 63.5 TAF in Dry, 84.5 TAF in Below Normal, 99.5 TAF in Above Normal, and 27 TAF in Wet years. The VAs intend for this program to purchase water at a fixed price from known sellers.
- PWA Water Purchase Market Price Program: 50 TAF in Dry, 60 TAF in Below Normal, and 83 TAF in Above Normal years. This program is intended to purchase water at market rates from sellers on the water transfer market and would include updated volumes resulting from the Mokelumne VA Term Sheet addendum (August 2022).

The sources of the flow assets for the PWA Water Purchase Market Price Program and permanent state water purchases are not fully known at this time and are hereafter termed *unspecified water purchases*. Because the sources of the unspecified water purchases are not known, two different scenarios are evaluated assuming these flows are derived from inflows or from SWP/CVP export reductions as described further below. However, the tributary sources of the inflows are not evaluated since that is not known. These scenarios represent the range of possible effects of these purchases. Both of these methods would have the same effect on Delta outflows. Accordingly, different scenarios for evaluating the effects of the unspecified water purchases on Delta outflows are not needed.

9.3.5 New Water Projects (before Year 8)

In addition to the flow and non-flow habitat restoration assets discussed above, Appendix 1 (Flow Tables) of the VA Term Sheet identifies three New Water Projects. These projects are the Chino Basin, Kern Fan, and Willow Springs Conjunctive Use projects. The VA Term Sheet proposes that these projects would be funded, in part, by $370 million from Proposition 1 and phased in by Year 8. The additional flow assets anticipated from these projects are indicated in Table 9.3-3. These flow assets are not included in the description of the tributary assets and Delta and estuary assets provided in 9.3-1.

Table 9.3-3. New Water Projects (before Year 8) Identified in Appendix I of the VA Term Sheet, Thousand Acre-Feet (TAF)

New Water Projects (Before Year 8)	Critical	Dry	Below Normal	Above Normal	Wet
Chino Basin	0	50	50	0	0
Kern Fan	0	18	18	0	0
Willow Springs Conjunctive Use	0	19	29	0	0

9.3.6 Points of Comparison for VA Flow Assets

The VA Term Sheet describes VA flow assets as additive to the 2019 BiOps condition. The 2019 BiOps condition is different than the Staff Report baseline in that the 2019 BiOps condition is the theoretical assumed starting point for accounting purposes upon which VA assets would be added, rather than a reflection of current or prior existing conditions or baseline. The baseline is the primary point of comparison for evaluating the environmental impacts of the alternatives evaluated in the Staff Report. The major difference between the baseline and 2019 BiOps condition relative to exports and Delta outflows is the applicability of San Joaquin River inflow to export (I:E) constraints that apply during April and May. The I:E export limits have the effect of restricting exports and increasing Delta outflow during April and May. In the 2019 BiOps condition, exports are higher on average in January - June than the project baseline and Delta outflow is lower on average in these months.

As described in Chapter 6, *Changes in Hydrology and Water Supply*, the 2019 BiOps resulted in the removal of the I:E limits that had been included in the 2009 NMFS BiOp limiting exports by the CVP and SWP as a function of San Joaquin River flows. A similar export limit to increase spring Delta outflows was applied to SWP operations in the 2020 incidental take permit (ITP) for operation of the SWP. The new requirement limits SWP exports according to the SWP's share of the San Joaquin I:E requirement as previously defined in the NMFS 2009 BiOp, with some additional offramps that allow for somewhat greater exports in wet years. While the applicability of the I:E requirements was removed from the CVP in the 2019 BiOps, due to court orders and other actions associated with litigation on the 2019 BiOps, this component of the 2019 BiOps has not been implemented and the CVP has effectively been operating to the I:E (spring Delta outflow) requirement applied to the SWP. The BiOps are also being further updated in response to the litigation issues, including updates related to I:E/spring Delta outflows. The baseline incorporates the San Joaquin I:E limit (spring Delta outflows) as formulated in the 2020 ITP, but applied to both SWP and CVP exports since these conditions are closest to recent operations and are largely consistent with conditions that existed at the time the Notice of Preparation was issued for this project. The proposed VAs include export reductions that would account for a significant portion of the effects of I:E constraints depending on the point of reference, as discussed further below.

In addition to comparing the proposed VAs to baseline, the VA benefits are also assessed in this chapter relative to the 2008-2009 BiOps condition, which is the point of reference used for both the 2017 Scientific Basis Report and the Scientific Basis Report Supplement. The 2008-2009 BiOps condition represents the flows resulting from implementing State Water Board Revised Water Right Decision 1641 (D-1641) and the CVP and SWP BiOps issued in 2008/2009 for long-term CVP/SWP operations, as modeled. The differences between the baseline and the 2008-2009 BiOps condition are described in detail in Chapter 6, *Changes in Hydrology and Water Supply*. The major differences are changes in fall Delta outflow requirements between the BiOps, with somewhat minor differences in export constraints in wetter years and other minor differences that have little to no effect on the modeling.

Specifically, the higher fall Delta outflow conditions of the 2008 BiOp are not included in baseline in recognition that these requirements have changed and that those changes are likely to persist. Not including the higher fall Delta outflow conditions of the 2008 BiOp in baseline ensures that the water supply effects of the proposed Plan amendments and Low and High Flow alternatives are not underestimated. However, elimination of the 2008 BiOp fall Delta outflows in baseline also affects the resulting increases in Delta outflows expected under the proposed VAs compared to baseline during the winter and spring due to changes in spills and other effects. As discussed above, accounting methods for the proposed VAs are under development that will ensure that the expected increases in flows under the VAs are provided.

Figure 9.3-1 and Figure 9.3-2 show the differences between baseline, the 2008-2009 BiOps condition, and 2019 BiOps condition as modeled in SacWAM.

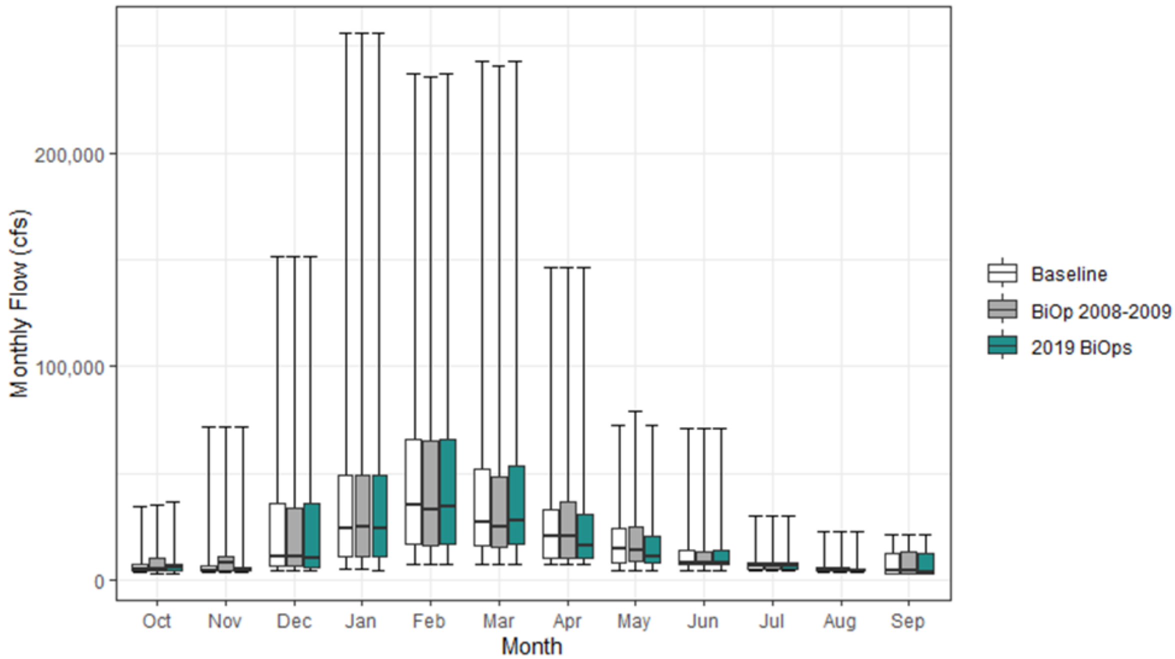


Figure 9.3-1. Monthly Delta Outflow for Baseline, the 2008–2009 BiOps Condition, and 2019 BiOps Condition

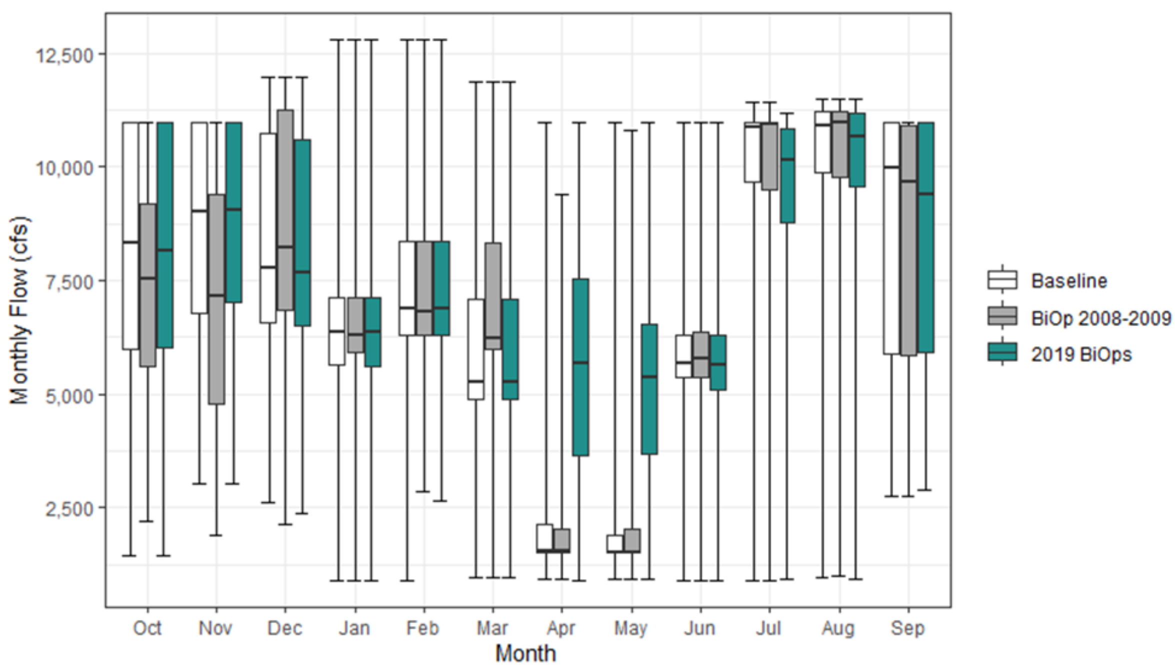


Figure 9.3-2. Monthly CVP and SWP Total South of Delta Exports for Baseline, the 2008–2009 BiOps Condition, and 2019 BiOps Condition

9.4 Regulatory Implementation Pathway

As discussed in Section 9.3, *Description of the Proposed Voluntary Agreements*, the VAs propose an 8-year term and a set of flow and physical habitat restoration actions, also called "assets," in selected tributaries, flood bypasses, and the Delta. The VAs propose that, in the eighth year of implementation, the State Water Board would consider the reports, analyses, information, and data from the VA Science Program, as well as recommendations from the VA governance committee and the Delta ISB to decide the future of the VA program. The VAs propose that if VA implementation is substantially achieving the stated objectives, the VA Parties would continue implementation of the VAs without any substantial modification in terms. If the VAs are expected to achieve the stated objectives with some modifications, the VA Parties could continue implementation with substantive modifications in terms. The VAs propose that if in year 8 the VAs are not expected to achieve the stated objectives, then either: 1) new agreements may be negotiated, or 2) the State Water Board would impose a regulatory pathway to implement the Bay-Delta Plan (Voluntary Agreements Parties 2022). This regulatory implementation pathway would also apply to non-VA parties.

As discussed previously, the State Water Board staff proposed regulatory pathway would integrate the proposed VAs and the proposed Plan amendments described in Chapter 5, *Proposed Changes to the Bay-Delta Plan for the Sacramento/Delta,* in the following way. The Bay-Delta Plan water quality objectives for fish and wildlife beneficial uses would be updated with the narrative objective proposed in the VA Term Sheet instead of the narrative and numeric objectives discussed as the proposed Plan amendments in Chapter 5, which include Sacramento/Delta tributary flows of 55% of unimpaired flow, in a range of 45% to 65% of unimpaired flow (numeric flow range) and associated Delta outflows. However, the Bay-Delta Plan program of implementation would be amended to require that either the proposed VA flow and non-flow habitat restoration actions are achieved in any region covered by a VA (in order to implement the proposed new narrative objective and contribute to the existing salmon protection objective), consistent with that approved VA or, for any Sacramento River/Delta region not covered by an approved VA, or where a VA is discontinued, the numeric flow range (inflows), inflow-based Delta outflows, and cold water habitat provisions described in Chapter 5 would be required through the program of implementation.

9.5 Changes in Hydrology and Water Supply

9.5.1 Introduction

This section describes the changes in hydrology and water supply that could occur as a result of the proposed VAs. Proposed VA physical habitat restoration actions are evaluated using a habitat model and are presented in Section 9.6, *Beneficial Environmental Effects of Proposed VAs*.

Consistent with modeling conducted for the proposed Plan amendments and Low and High Flow alternatives, the SacWAM hydrologic and system operations model was used as a tool for estimating potential changes in hydrology and water supply under the proposed VAs. Post processing of SacWAM results was also conducted for certain analyses where appropriate as described further below. The proposed VAs involve voluntary contributions of water that could be implemented in different ways that would affect hydrology and water supply, including reservoir operations, fallowing of agricultural lands, and groundwater substitution. The VA modeling includes assumptions that are generally reflective of how the proposed VAs are expected to be implemented but cannot reflect all of the numerous specific ways they could be implemented. For this reason, modeling results are intended to be used in a comparative manner, which allows for assessing the changes in system operations and resulting incremental effects between scenarios. Modeling results should not be taken as indicating the exact changes in water supply and changes in hydrology from implementation of the proposed VAs but rather should be used to indicate the general timing and trends that may occur. To help characterize the possible changes in hydrology and water supply that may occur under the VAs, a range of SacWAM results are provided in this chapter as described above and further below.

The modeling results presented in this section are focused on changes in hydrology and water supply expected from implementation of the VA flow assets identified in the VA Term Sheet, and other possible changes in LSJR flows as described above. The VA assets, however, do not fully match the volumes (volumes can be higher or lower) identified in the VA Term Sheet due to the specific details of the proposed VAs, including the theoretical accounting base upon which the VA flows are added being different than baseline and other points of reference described above, reservoir operations associated with the VAs (including changes in release patterns and issues associated with refill and spills), the dynamic nature of the modeling and other modeling assumptions, and other details associated with the VAs.

As discussed in Section 9.4, *Regulatory Implementation Pathway*, the proposed VAs identify that there will be a regulatory pathway that would apply to VA regions in the event the VAs are discontinued. The pathway is also proposed to apply to non-VA regions. The modeling results and analyses presented in this section do not separately analyze the proposed regulatory pathway because it is largely consistent with the proposed Plan amendments discussed in Chapter 5, *Proposed Changes to the Bay-Delta Plan for the Sacramento/Delta* and, as such, already analyzed in prior chapters of this Staff Report. Specifically, SacWAM modeling results for the proposed Plan amendments are presented in Chapter 6, *Changes in Hydrology and Water Supply*, and the environmental impacts and economic effects of the proposed Plan amendments are evaluated in Chapter 7, *Environmental Analysis*, and Chapter 8, *Economic Effects and Other Considerations*.

The changes in hydrology and water supply are estimated by comparing SacWAM-modeled and post processed results for the proposed VAs with results for baseline, as well as the reference condition utilized in the Scientific Basis Report Supplement for the VAs based on the 2008-2009 BiOps condition, for benefits analysis. The modeled results represent the overall estimated system changes caused by replacing one set of operations with another (see detail below and the detailed assumptions in Appendix G3a).

If the VAs were adopted, actual operations could vary to some degree from modeled outcomes presented in this section. For example, the proposed VAs include flexibility in the timing of flow assets, so streamflows and reservoir levels could deviate to some degree from modeled results. In addition, the VA Term Sheet describes flow assets that would be provided through unspecified water purchases, but the sources of water purchases are not fully known at this time.

Model results are presented throughout the section in graphical and tabular formats that facilitate comparison of the statistical properties of streamflow, reservoir storage, and water supply for the proposed VAs relative to baseline, as well as the 2008-2009 BiOps condition for certain results.

9.5.2 VA Modeling Approach

The general approach to modeling the effects of the proposed VAs on hydrology and water supply is first to simulate the 2019 BiOps condition, and then build the VA scenario from the 2019 BiOps condition. The proposed VAs include new flow commitments from the Sacramento River, American River, Feather River, Mokelumne River, Yuba River, and Putah Creek (VA tributaries) identified in Section 9.3.3, *Tributary Assets*. The VA scenario includes modified operational curves for New Bullards Bar Reservoir on the Yuba River and fallowing of land in the Sacramento and Feather River watersheds. The VA scenario also includes flow assets that would be provided through CVP/SWP export reductions identified in the VA Term Sheet. It is not expected that these export reductions would result in significant changes in upstream tributary or reservoir operations, though it is possible there could be some changes that were not modeled.

As discussed in Section 9.3, *Description of the Proposed Voluntary Agreements*, the proposed VAs also include flow assets that would be provided through water purchase programs. The sources for the PWA Water Purchase Fixed Price Program are identified and as such are modeled. However, the unspecified water purchases (PWA Water Purchase Market Price Program and permanent state water purchases) would be from unspecified willing sellers, which could include inflow sources within the Sacramento/Delta watershed or reductions in exports, both of which could result in additional Delta outflows. Because the unspecified water purchases under the proposed VAs could be provided from reductions in exports or increases in inflows, both scenarios are evaluated. Under both scenarios, the unspecified water purchases are assumed to occur during April and May to the extent possible, though those purchases could also result in flows at other times. Results are shown assuming with and without additional export reductions and with and without additional Delta inflows and associated water supply reductions from the Sacramento/Delta watershed. The scenario that assumes the unspecified water purchases are derived from inflows is referred to in the below inflow tables and graphs as “VA High Inflows.” The “VA” scenario in these tables and graphs does not include the unspecified water purchases in inflows. The scenario that assumes the unspecified water purchases are derived from reductions in exports is referred to in the below export results, as well as Old and Middle River flow results, as “VA High Export Cuts.” The “VA” scenario in these tables and graphs does not includes additional export cuts to provide for the unspecified water purchases. The VA tributary inflow analyses do not assume any additional inflows from unspecified water purchases given the unknown origin of these water purchases. The source for the unspecified water purchases does not affect the Delta outflow results so only one scenario is evaluated that includes the unspecified water purchases in Delta outflows.

In addition, as discussed above, possible conditions with and without additions to Delta outflows from the San Joaquin River, including possible contributions from Friant and the Tuolumne River are also evaluated given that Friant may not participate in the VAs and the Tuolumne River component of the VAs is being considered separately. The scenario that includes Tuolumne and Friant contributions is referred to as the “VA” scenario and the scenario that does not include these contributions is referred to as “VA w/o SJ Contributions.”

As discussed in Section 9.3, *Description of the Proposed Voluntary Agreements*, the VA Term Sheet identifies three New Water Projects that would provide for flow contributions during dry and below normal water year types. These projects are the Chino Basin, Kern Fan, and Willow Springs Conjunctive Use projects. Flow assets from these projects are not included in the SacWAM modeling of the proposed VAs because water contributions from these projects would begin towards the end of the 8-year period.

The VA scenario also includes evaluation of actions related to the Tisdale Weir. The Tisdale Weir notch is one component of the Tisdale Weir Rehabilitation and Fish Passage Project, which is intended to rehabilitate the weir to extend the design life and also provide passage for fish to the Sacramento River (DWR 2023). The VAs propose to operate the Tisdale Weir notch to increase flows into the Sutter Bypass during December through mid-March.

For purposes of benefits analysis, as discussed above, two additional scenarios are also included for evaluating January through June Delta outflows that provide a higher bookend of possible Delta outflows under the VAs in recognition that the VAs are intended to protect both VA flows as Delta outflows, as well as flows that may be provided by implementing the 2018 updated LSJR flow objectives. These two scenarios also include a factor to eliminate differences between the 2008-2009 BiOps and 2019 BiOps conditions between DWR's CalSim II systems operations modeling (included in the January 2023 Draft Scientific Basis Report Supplement) and SacWAM. CalSim II results indicate a smaller difference between these two scenarios than SacWAM. While the results are largely comparable, particularly in relation to total Delta outflows, the differences could affect the assumed expected Delta outflow benefits of the VAs so these higher end bookends include a correction factor between CalSim II and SacWAM in recognition that Delta outflows under the VAs may be somewhat higher than assumed in SacWAM when compared to the 2008-2009 BiOps condition. The accounting produced for the VAs is expected to ensure that the expected Delta outflows are realized. The first scenario assumes the remaining San Joaquin River placeholder volumes identified in the VA Term sheet above the Tuolumne River contributions are provided by the Merced and Stanislaus Rivers to Delta outflows, referred to as "VA w/Bias Correction and LSJR Placeholder." The second scenario assumes additional Delta outflows from implementation of the 2018 LSJR Flow updates to the Bay-Delta Plan on the Merced and Stanislaus Rivers (40% of unimpaired flow from February through June), referred to as "VA w/Bias Correction and 40% UF Merced & Stanislaus". Both scenarios include the Tuolumne River VA and Friant contributions, as well as other VA contributions, including unspecified water purchases.

A full list of flow requirements and more detailed descriptions of the modeling assumptions used can be found in Appendix G-3a.

9.5.3 Changes in Hydrology

9.5.3.1 Introduction

This section describes the modeled changes in flows and reservoir storage levels under the proposed VAs as compared with baseline, and for certain results relative to the 2008-2009 BiOps condition. The results below are focused on flow and reservoir storage levels for the VA tributaries, including the Sacramento River, Feather River, Yuba River, American River, Mokelumne River, and Putah Creek. Results are also provided for Delta inflows, Delta interior flows, and Delta outflows.

Reservoir storage results are presented in this section for end of April (EOA) and end of September (EOS) reservoir storage for VA tributaries. The EOA values are presented to represent storage at the end of the wet season going into the irrigation season. The EOS values were chosen to represent carryover storage because this time period is at the end of the dry season and prior to the typical onset of fall precipitation. EOS represents the initial condition for the reservoir in a new water year for both water supplies for different purposes and flood control. These results are presented using exceedance curves, which are generally used to characterize the distribution of reservoir storage volumes. Chapter 6, *Changes in Hydrology and Water Supply*, provides additional general information about the use of exceedance curves. Results are also provided in tabular format for average EOA and EOS storage conditions among all water year types, and for critical water years specifically.

Monthly streamflow results are also presented in this section. Boxplots are used to broadly characterize the distributions of monthly streamflows under the proposed VAs. Chapter 6 provides additional general information about the use of boxplots. Results are also provided below in tabular format for January-June and July-December monthly average flows, by water year type.

Overall, the SacWAM modeling results show changes in flows and minor changes in reservoir storage on VA tributaries and in the Delta. Priority years for the proposed VAs include above normal, below normal, and dry years, but there are changes in hydrology in wet and critical year types as well.

9.5.3.2 Sacramento River

Under the proposed VAs, the SacWAM modeling indicates generally slight lower storage in Shasta Reservoir under the VAs compared to baseline. Flows on the Sacramento River would increase when VA flows are provided and may decrease slightly at other times compared to baseline.

Figure 9.5-1 presents SacWAM EOA and EOS carryover storage results for Shasta Reservoir. Table 9.5-1 presents SacWAM average EOA and EOS carryover storage results for Shasta Reservoir in tabular format for all water years and critical water years. Overall, SacWAM results indicate slightly lower Shasta Reservoir storage in all but the wettest years under the VA scenario. The SacWAM results indicate that by the end of September, storage in Shasta Reservoir under the VA scenario would be closer to baseline than at the end of the spring.

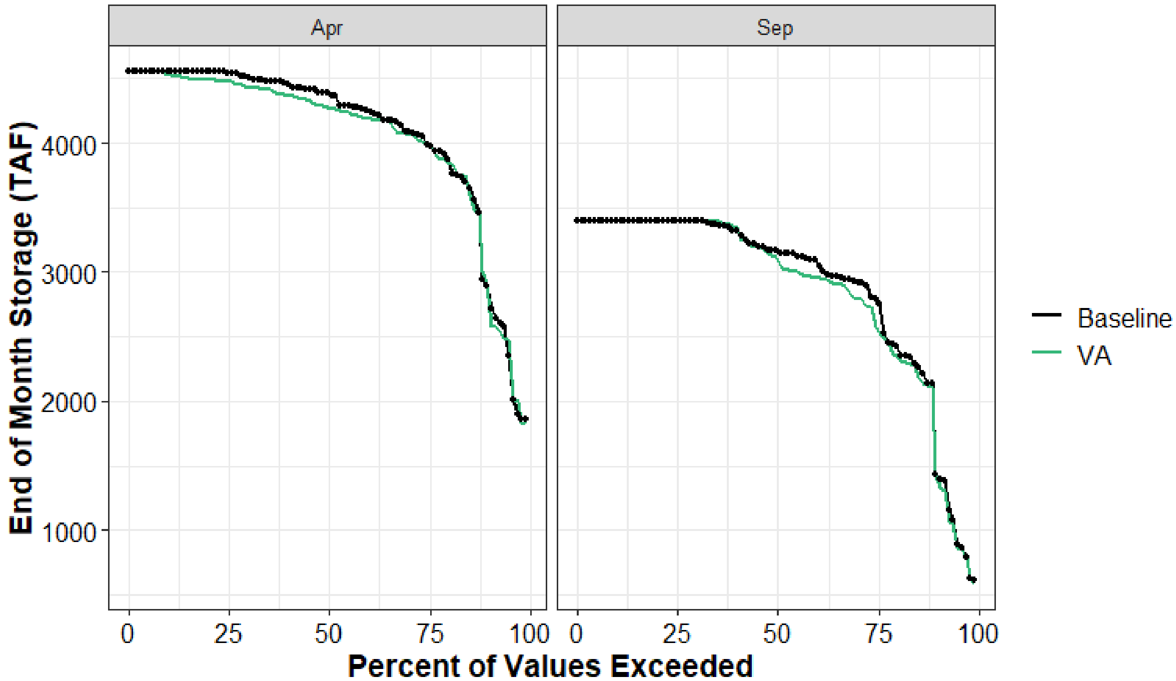


Figure 9.5-1. Change in Shasta Reservoir End of April and End of September Carryover Storage under Baseline and Proposed VAs

Table 9.5-1. Change in Shasta Reservoir Average End of Month Storage (TAF and Percent Difference) for All Years and Critical Years

Month	Water Year Type	Baseline (TAF)	Proposed VA: Change from Baseline (TAF / % change)
April	All Years	4086	-42 / (-1)
April	Critical	2882	-3 / (0)
September	All Years	2879	-38 / (-1)
September	Critical	1518	-25 / (-2)

The SacWAM modeling assumes that flow assets would be provided on the Sacramento River either as a result of Shasta Reservoir releases during the spring and associated land fallowing later in the year, or during the irrigation season timed with the actual reductions in diversions. Figure 9.5-2 presents SacWAM modeled monthly flows for the Sacramento River below Keswick Reservoir under baseline and the VA scenario. Table 9.5-2 presents January-June monthly average flows for the Sacramento River below Keswick Reservoir under baseline and the VA scenario. Table 9.5-3 presents July-December monthly average flows for the Sacramento River below Keswick Reservoir under baseline and the VA scenario. Under the VA scenario, there is an increase in flow on average during January-June and a decrease in flow on average for July-December compared to baseline. The greatest increases in flow on the Sacramento River below Keswick Reservoir in the VA scenario occur March through May, with smaller increases in July and August (Figure 9.5-2). The decreases in flows include decreases from not releasing water from storage during the irrigation season that was provided pursuant to the VAs in the spring. In above normal and below normal years, the additional VA flows are assumed to be deployed in the spring in 83% of years, and in 17% of the years they are instead assumed to be deployed in the summer based on Shasta Reservoir storage as described in the VA documents.

As described throughout this chapter, the VA flow assets are accounted for as additive to the 2019 BiOps condition, not baseline. Therefore, changes in flows presented below may be greater or less than the values in Table 9.3-1 because of other changes in system operations between the project baseline and the 2019 BiOps condition.

Figure 9.5-2 also shows that there may be decreases in flow on the Sacramento River below Keswick Reservoir at times during the fall and winter months, including under median hydrology in November and December. These effects may result from increased flood space in reservoirs and other reoperation effects in Shasta Reservoir.

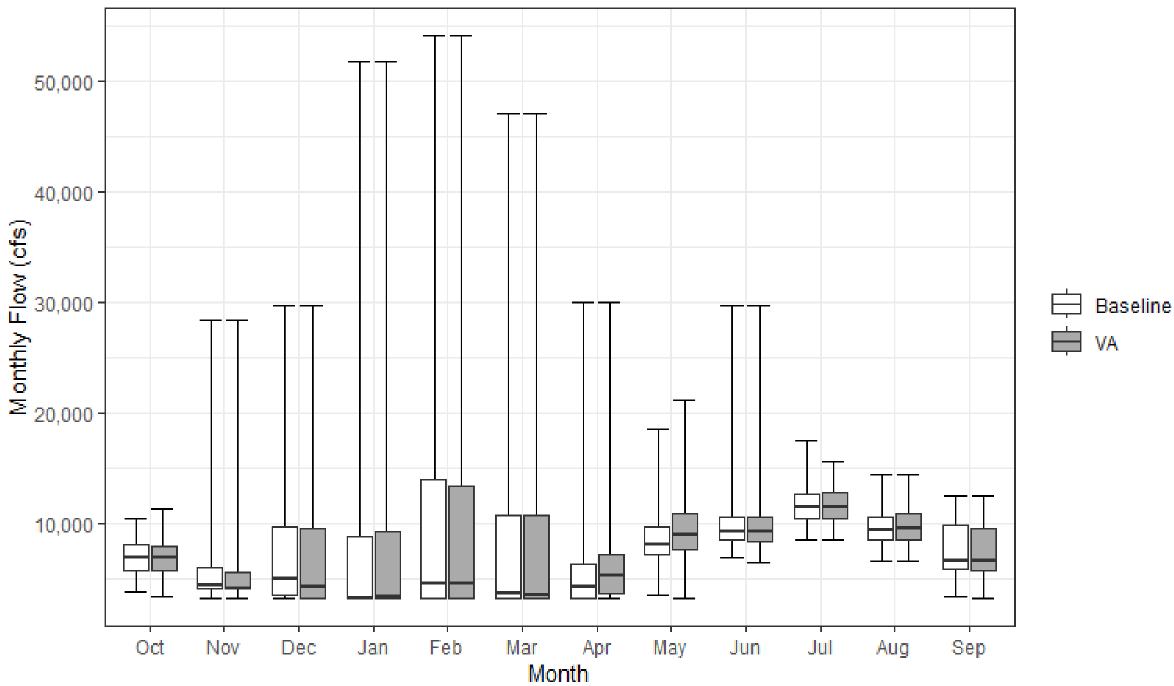


Figure 9.5-2. Monthly Streamflow of the Sacramento River below Keswick Reservoir under Baseline and Proposed VAs

Table 9.5-2. Change in January–June Monthly Average Flow of the Sacramento River below Keswick by Water Year Type (TAF/yr)

Water Year Type	Baseline	Proposed VA: Change from Baseline
C	1,998	-30
D	2,105	135
BN	2,401	103
AN	3,409	130
W	4,804	-2
All	3,122	61

Table 9.5-3. Change in July–December Monthly Average Flow of the Sacramento River below Keswick by Water Year Type (TAF/yr)

Water Year Type	Baseline	Proposed VA: Change from Baseline
C	2,446	-17
D	2,669	12
BN	2,815	-103
AN	2,994	-141
W	3,688	-40
All	3,008	-49

Figure 9.5-3 presents the model results for Sacramento River inflow (represented as the sum of the Sacramento River at Knights Landing, inflow to the Knights Landing Ridge Cut from the Colusa Basin Drain, and inflow from the Sutter Bypass) to characterize changes in flow from the Sacramento River, excluding the Feather River and its tributaries, resulting from the Sacramento River VA proposal. Summing these three flow locations provides a summary of the net change in seasonal flows from the Sacramento River above the confluence with the Feather River, and avoids confounding the effects of the Sacramento River VA proposal with the Feather and Yuba River VA proposals. Overall, these results show that Sacramento River inflow would increase on average during most water years, with the exception of critical years. The median hydrology indicates that increases would likely occur during April and May. Sacramento River inflow would also decrease on average during July-December for most water year types.

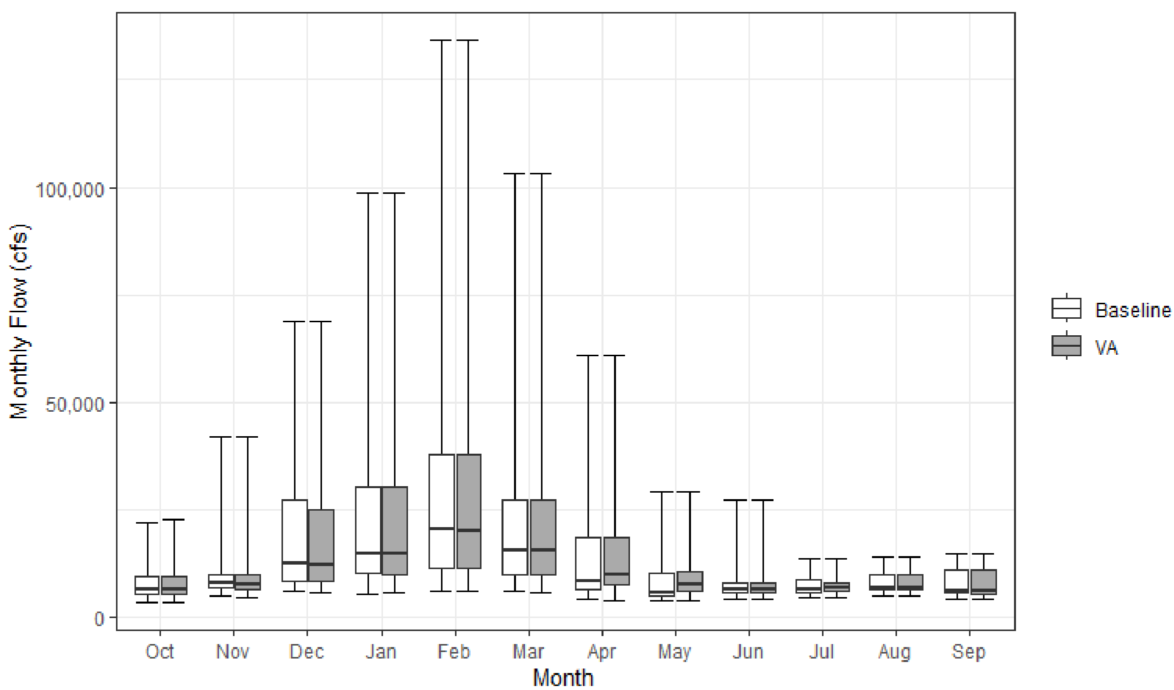


Figure 9.5-3. Sacramento River Inflow under Baseline and Proposed VAs

Table 9.5-4. Change in January–June Monthly Inflow for the Sacramento River by Water Year Type (TAF)

Water Year Type	Baseline	Proposed VA: Change from Baseline
C	2,752	-30
D	3,511	158
BN	4,676	132
AN	7,569	153
W	10,209	1
All	6,142	75

Table 9.5-5. Change in July–December Monthly Inflow for the Sacramento River by Water Year Type (TAF)

Water Year Type	Baseline	Proposed VA: Change from Baseline
C	2,207	-16
D	2,788	35
BN	2,933	-72
AN	3,615	-103
W	5,070	-38
All	3,514	-33

SacWAM flow results on the Sacramento River at Freeport follow the same general pattern as the Sacramento River below Keswick Reservoir, with increases in flow during the spring months and decreases in flow during the fall months (Figure 9.5-4, Table 9.5-6, and Table 9.5-7). The largest increases in flow would occur in March through May. The largest increase occurs in the spring of dry years where the monthly average flow at this location between January-June is 386 TAF (7%) higher than baseline (Table 9.5-6). Flows on the Sacramento River at Freeport would also decrease at times compared to baseline, and the monthly average flow at this location between July-December is 81 TAF lower than baseline.

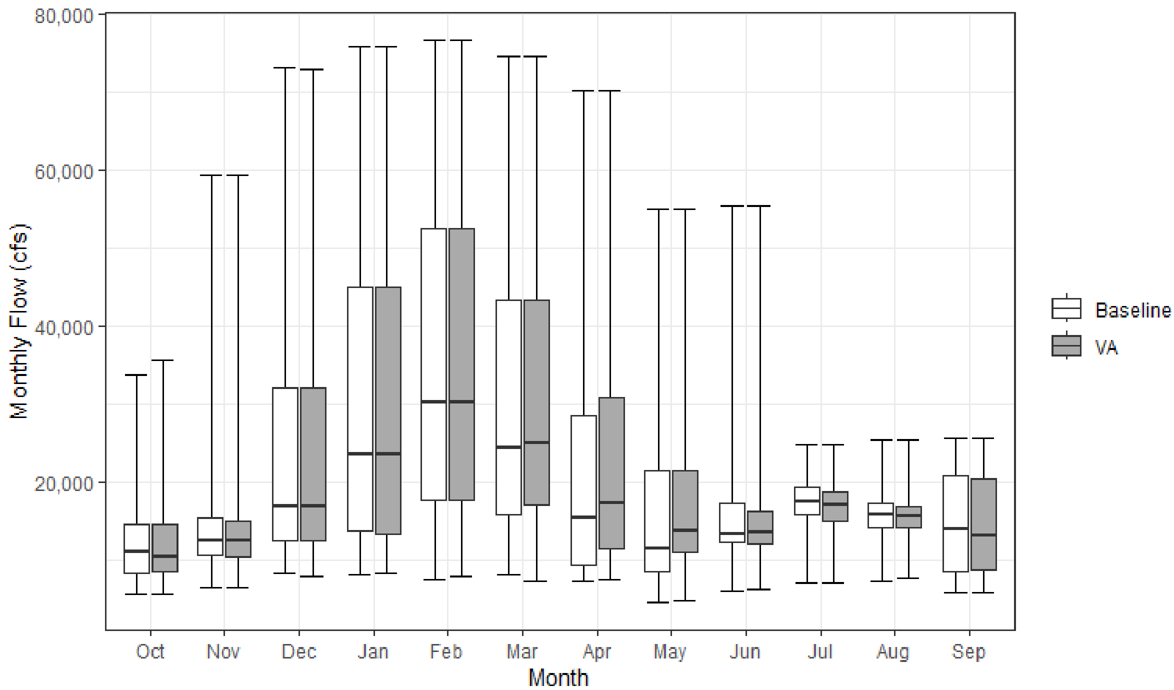


Figure 9.5-4. Monthly Streamflow for the Sacramento River at Freeport under Baseline and Proposed VAs

Table 9.5-6. Change in January–June Monthly Average Flow for the Sacramento River at Freeport by Water Year Type (TAF/yr)

Water Year Type	Baseline	Proposed VA: Change from Baseline
C	4,042	44
D	5,453	386
BN	7,415	321
AN	11,250	284
W	14,566	36
All	9,076	200

Table 9.5-7. Change in July-December Monthly Average Flow for the Sacramento River at Freeport by Water Year Type (TAF/yr)

Water Year Type	Baseline	Proposed VA: Change from Baseline
C	3,509	-14
D	5,031	-39
BN	5,597	-172
AN	6,577	-127
W	8,209	-73
All	6,045	-81

9.5.3.3 Sutter and Yolo Bypasses

The Sutter and Yolo Bypasses fill with water from local runoff, agricultural return flows, and spills from the Sacramento River during high flow events. The proposed VAs could have minor effects on agricultural return flow volumes due to land fallowing, but any resulting effects on flow in the Sutter and Yolo Bypasses would be very small. High flows on the Sacramento River are not expected to increase as a result of the proposed VAs. SacWAM modeling does not show any meaningful change to flows in the Yolo Bypass and therefore results for the Yolo Bypass are not presented in detail. However, the proposed VAs would result in additional floodplain inundation at times in the Sutter Bypass. As discussed above, the proposed VAs include infrastructure modifications to Tisdale Weir, including a notch in the Tisdale Weir. The Tisdale Weir notch is one component of the Tisdale Weir Rehabilitation and Fish Passage Project, which is intended to rehabilitate the weir to extend the design life and also provide passage for fish to the Sacramento River. The VA proposes to operate the Tisdale Weir notch to increase flows into the Sutter Bypass during December through mid-March. The proposed Tisdale Weir notch would reduce the amount of Sacramento River flow required to overtop the weir, causing higher and more frequent inundation of the Sutter Bypass. Below results are presented for the flow spilling over the Tisdale Weir and at the bottom of the Sutter Bypass.

SacWAM results indicate that the proposed VAs would increase the frequency in which the Tisdale Weir spills in the Sutter Bypass in January-March by about 25% and increase the median flows as shown in Figure 9.5-5. The largest change in flow over the Tisdale Weir is 178 TAF/mo in above normal years on average between January and June (Table 9.5-8 and Table 9.5-9).

At the downstream end of the Sutter Bypass (Sacramento Slough), a similar pattern is displayed for the VA scenario with higher median flows in the winter months (Figure 9.5-6) and little change to flows in the other months. In the July-December period, there are small reductions in the flows on average in the below normal and dry year types (Table 9.5-11) for the VA scenario due to reduced agricultural return flows from fallowing of land in the Feather River watershed.

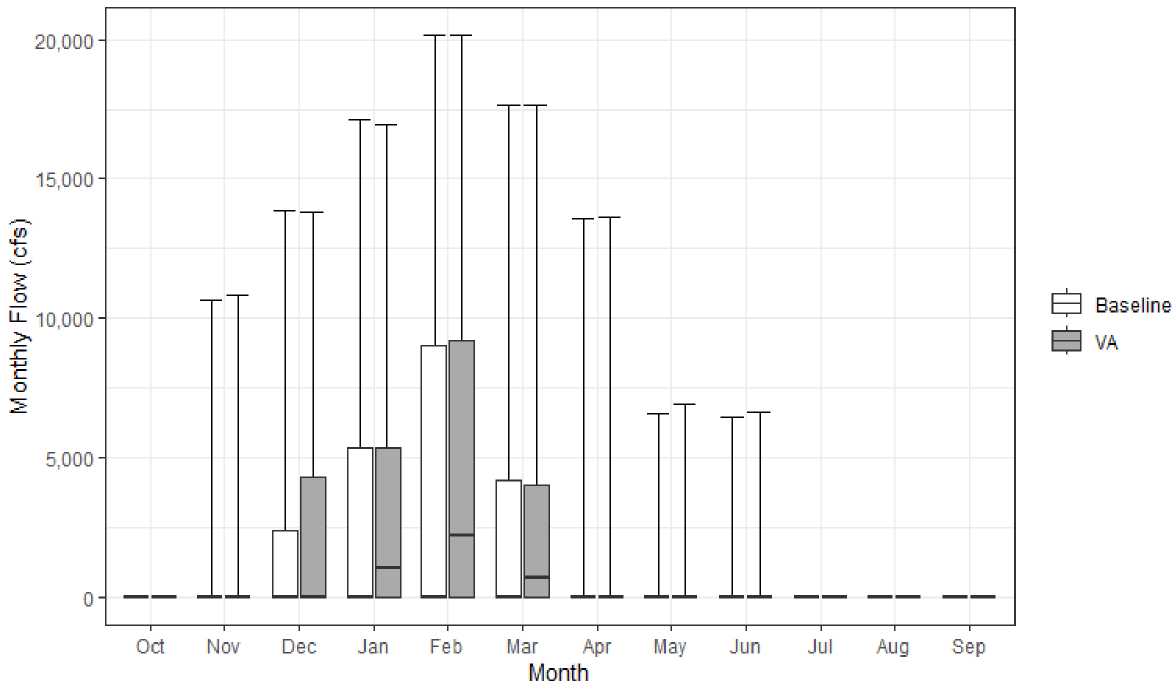


Figure 9.5-5. Monthly Streamflow over the Tisdale Weir into the Sutter Bypass under Baseline and the Proposed VAs

Table 9.5-8. Change in January–June Monthly Average Flow over the Tisdale Weir by Water Year Type (TAF/yr)

Water Year Type	Baseline	Proposed VA: Change from Baseline
C	0	44
D	96	63
BN	200	178
AN	1,027	151
W	1,618	75
All	678	96

Table 9.5-9. Change in July–December Monthly Average Flow over the Tisdale Weir by Water Year Type (TAF/yr)

Water Year Type	Baseline	Proposed VA: Change from Baseline
C	10	9
D	36	17
BN	59	6
AN	91	23
W	381	39
All	147	21

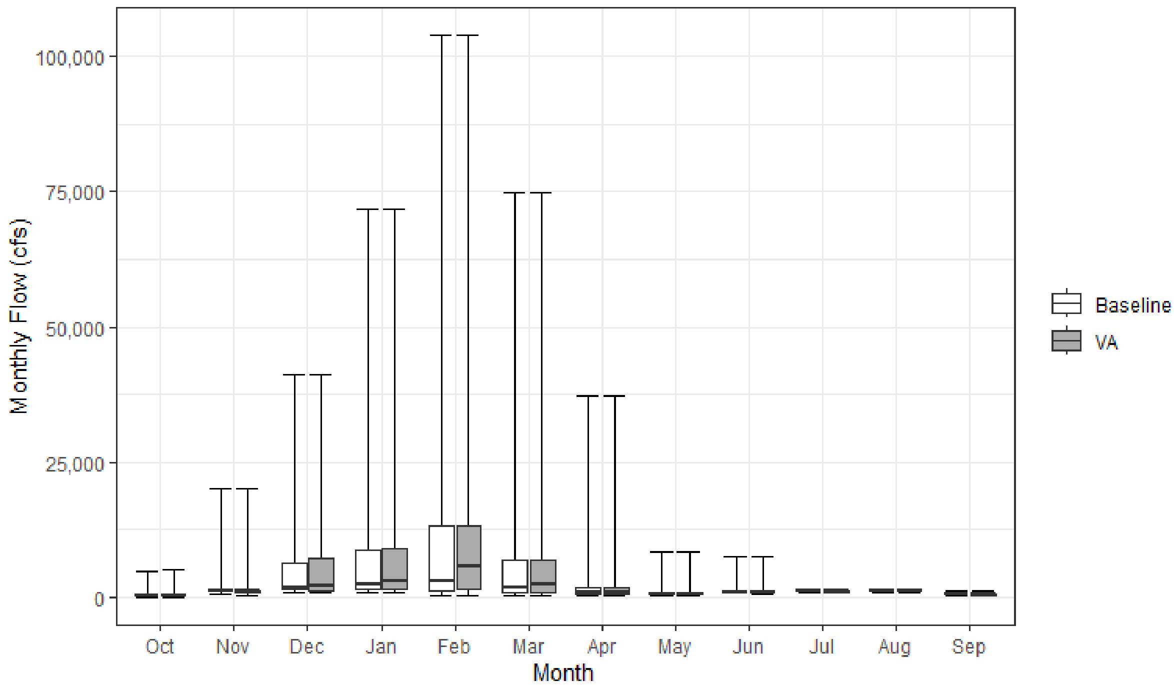


Figure 9.5-6. Monthly Streamflow at Sacramento Slough (Downstream End of Sutter Bypass) under Baseline and Proposed VA

Table 9.5-10. Change in January–June Monthly Average Flow at Sacramento Slough by Water Year Type (TAF/yr)

Water Year Type	Baseline	Proposed VA: Change from Baseline
C	376	41
D	552	42
BN	838	156
AN	2,341	144
W	4,409	81
All	1,968	88

Table 9.5-11. Change in July–December Monthly Average Flow at Sacramento Slough by Water Year Type (TAF/yr)

Water Year Type	Baseline	Proposed VA: Change from Baseline
C	333	10
D	427	-4
BN	482	-15
AN	495	3
W	1,097	23
All	632	5

9.5.3.4 Feather River

Figure 9.5-7 presents EOA and EOS carryover storage results for Oroville Reservoir. Table 9.5-12 presents average EOA and EOS carryover storage results for Oroville Reservoir in tabular format for all water years and critical water years. Overall, under the proposed VAs, EOA and EOS storage in Oroville Reservoir is very similar to baseline.

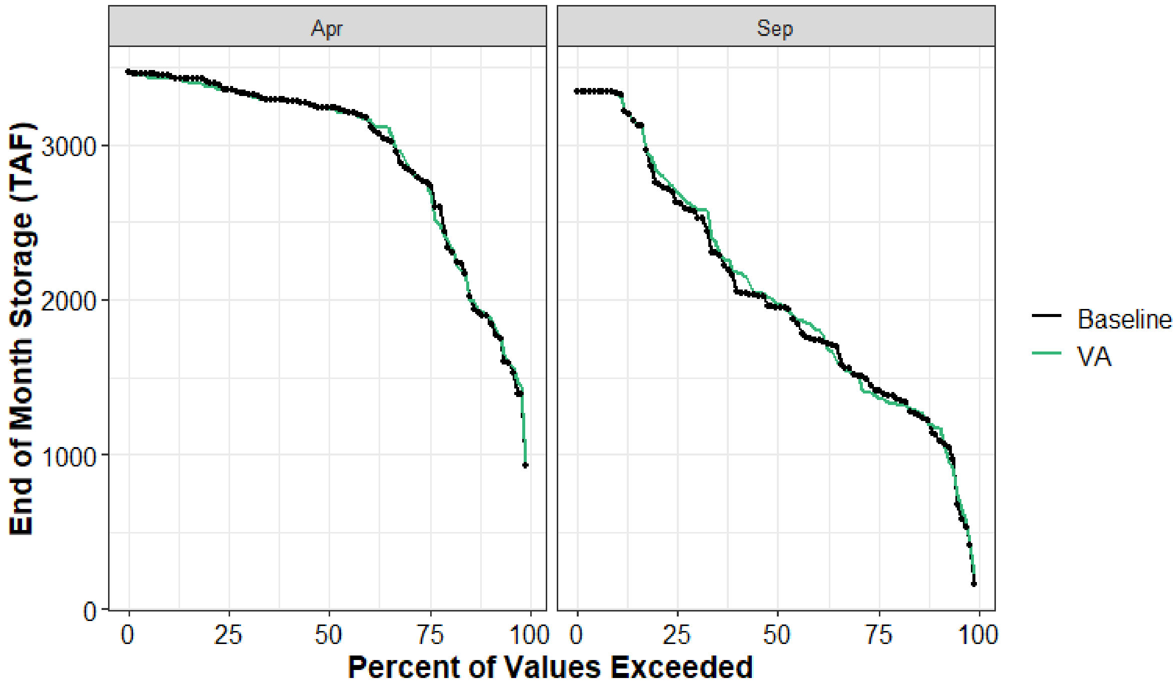


Figure 9.5-7. Oroville Reservoir End of April and End of September Carryover Storage under Baseline and Proposed VAs

Table 9.5-12. Change in Oroville Reservoir Average End of Month Storage (TAF and Percent Difference) for All Years and Critical Years

Month	Water Year Type	Baseline (TAF)	Proposed VA: Change from baseline (TAF / % change)
April	All Years	2937	1 / (0)
April	Critical	1856	31 / (2)
September	All Years	2037	21 / (1)
September	Critical	951	5 / (1)

Figure 9.5-8, Table 9.5-13, and Table 9.5-14 present results for the Feather River in the High Flow Channel under baseline and the VA scenario. Figure 9.5-9, Table 9.5-15, and Table 9.5-16 present results downstream on the Feather River above the confluence with the Sacramento River.

SacWAM results show that streamflows on the Feather River would increase during the spring for the Feather River in the High Flow Channel, which is located below the releases from Thermalito Afterbay, and above the confluence with the Sacramento River. SacWAM results also show a decrease in flows in July-December for the Feather River in the High Flow Channel and downstream for the Feather River above the Sacramento River in all water year types under the proposed VAs. The largest increase in flows on the Feather River above the confluence with the Sacramento River occurs in dry and below normal years where there is a modeled increase of about 135 TAF over the January through June period. The majority of these increases in flow originate from releases from the Thermalito Complex into the Feather River High Flow Channel. However, additional increases in flow are provided from the Yuba River watershed as described below in Section 9.5.3.5, *Yuba River*. Streamflows are not expected to change in the Low Flow Channel below Oroville Reservoir under the proposed VAs.

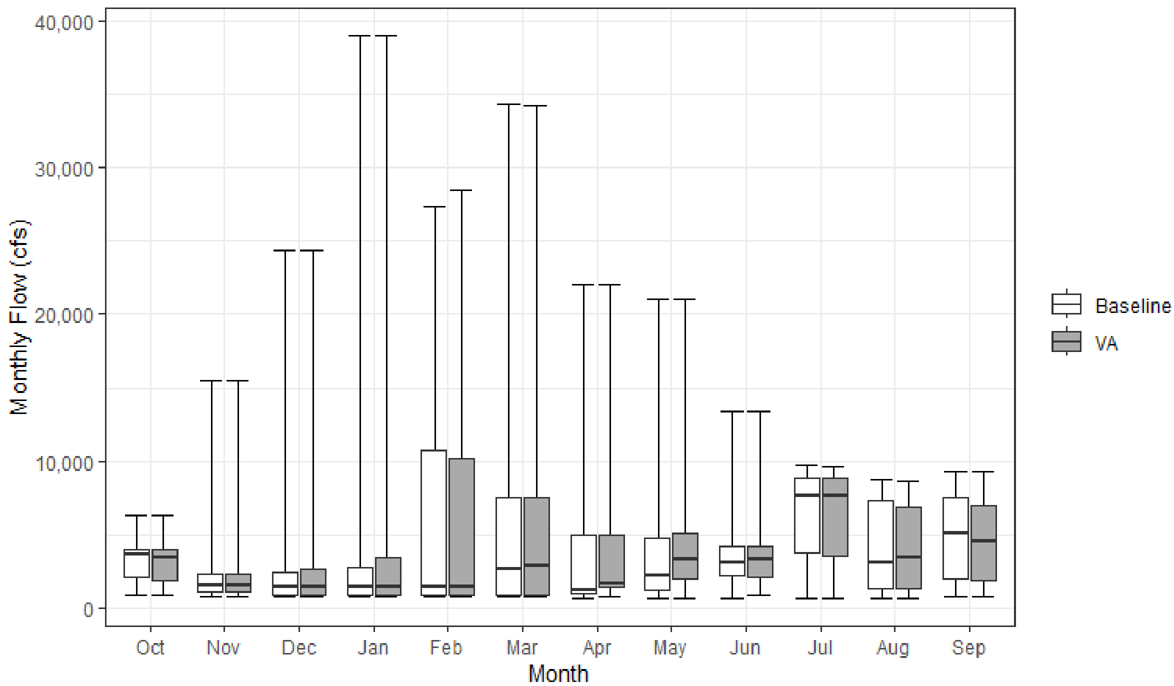


Figure 9.5-8. Monthly Streamflow for the Feather River in the High Flow Channel under Baseline and the Proposed VAs

Table 9.5-13. Change in January–June Monthly Average Flow for the Feather River in the High Flow Channel by Water Year Type (TAF/yr)

Water Year Type	Baseline	Proposed VA: Change from Baseline
C	591	11
D	635	119
BN	849	106
AN	1,609	36
W	3,530	16
All	1,664	58

Table 9.5-14. Change in July–December Monthly Average Flow for the Feather River in the High Flow Channel by Water Year Type (TAF/yr)

Water Year Type	Baseline	Proposed VA: Change from Baseline
C	875	-10
D	1,420	-42
BN	1,702	-63
AN	1,663	-6
W	1,548	-30
All	1,454	-32

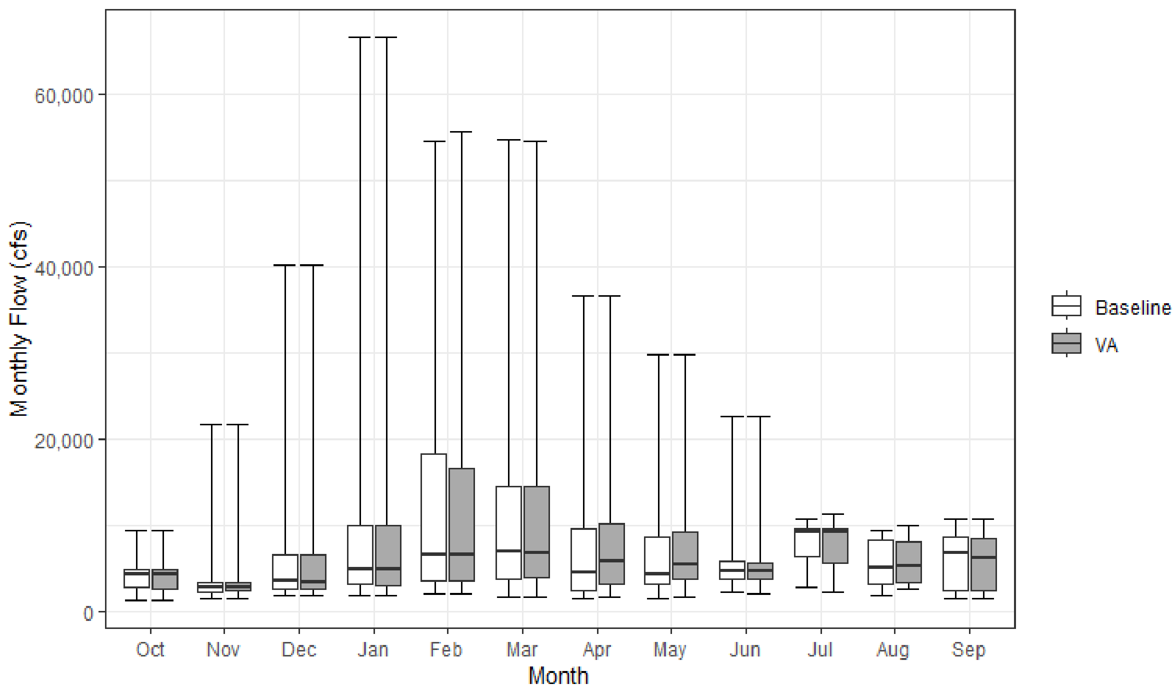


Figure 9.5-9. Instream Flows for the Feather River above the Sacramento River under Baseline and Proposed VAs

Table 9.5-15. Change in January–June Monthly Average Flow for the Feather River above the Sacramento River by Water Year Type (TAF/yr)

Water Year Type	Baseline	Proposed VA: Change from Baseline
C	1,027	1
D	1,428	137
BN	2,039	136
AN	3,483	83
W	6,115	7
All	3,151	69

Table 9.5-16. Change in July–December Monthly Average Flow for the Feather River above the Sacramento River by Water Year Type (TAF/yr)

Water Year Type	Baseline	Proposed VA: Change from Baseline
C	1,144	-14
D	1,797	-42
BN	2,126	-71
AN	2,313	-22
W	2,597	-50
All	2,059	-42

9.5.3.5 Yuba River

Figure 9.5-10 and Table 9.5-17 present EOA and EOS storage results for New Bullards Bar Reservoir. The Yuba River VA proposes to reduce storage levels in order to provide for increased flows. The SacWAM results accordingly show lower storage for New Bullards Bar Reservoir in the VA scenario compared to baseline. Changes in operations and hydrology of the Yuba River occur in about 70% of the years when storage levels in New Bullards Bar Reservoir would be lower by the end of the summer. On average, storage in New Bullards Bar is about 29 TAF (4%) lower in the VA scenario at the end of April than baseline and about 29 TAF (5%) lower at the end of September.

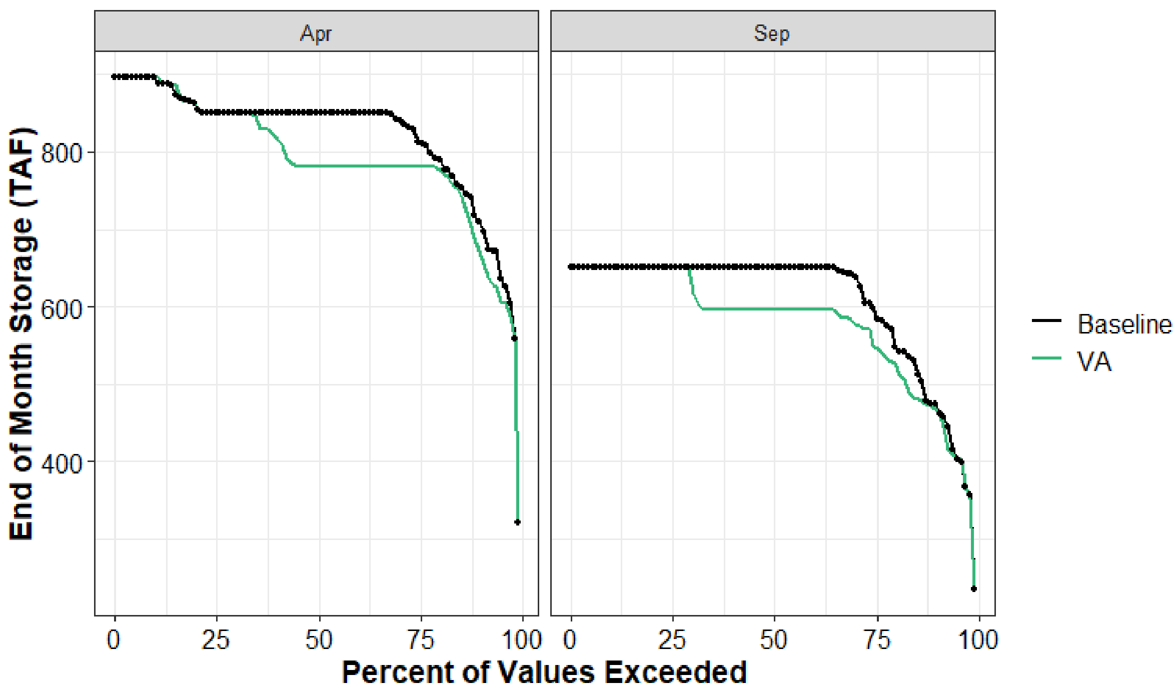


Figure 9.5-10. New Bullards Bar Reservoir End of April and End of September Carryover Storage under Baseline and Proposed VAs

Table 9.5-17. Change in New Bullards Bar Reservoir Average End of Month Storage (TAF and Percent Difference) for All Years and Critical Years

Month	Water Year Type	Baseline (TAF)	Proposed VA: Change from baseline (TAF / % change)
April	All Years	820	-29 / (-4)
April	Critical	680	-20 / (-3)
September	All Years	605	-29 / (-5)
September	Critical	478	-9 / (-2)

Figure 9.5-11 presents modeled monthly flows for the Yuba River above the confluence with the Feather River for baseline and the VA scenario. Table 9.5-18 and Table 9.5-19 present the monthly average baseline flows and changes from baseline for the VA scenario for January-June and July-December.

The reduced reservoir carryover storage target in the VA scenario for New Bullards Bar results in increased streamflow on the Lower Yuba River, primarily in April of dry through above normal year types (Figure 9.5-11). In some years, the proposed VA also results in increased flows in the later spring and summer months. The reduced carryover storage target for New Bullards Bar also has the effect of reducing the magnitude of the highest flows in the lower Yuba River during November and December because there would more storage space available to capture flows during high flow events. The SacWAM results (Table 9.5-18) also indicate that the proposed VAs would result in flow reductions in the spring of critical and wet years due to the effects of the lower reservoir operating curve on subsequent streamflows.

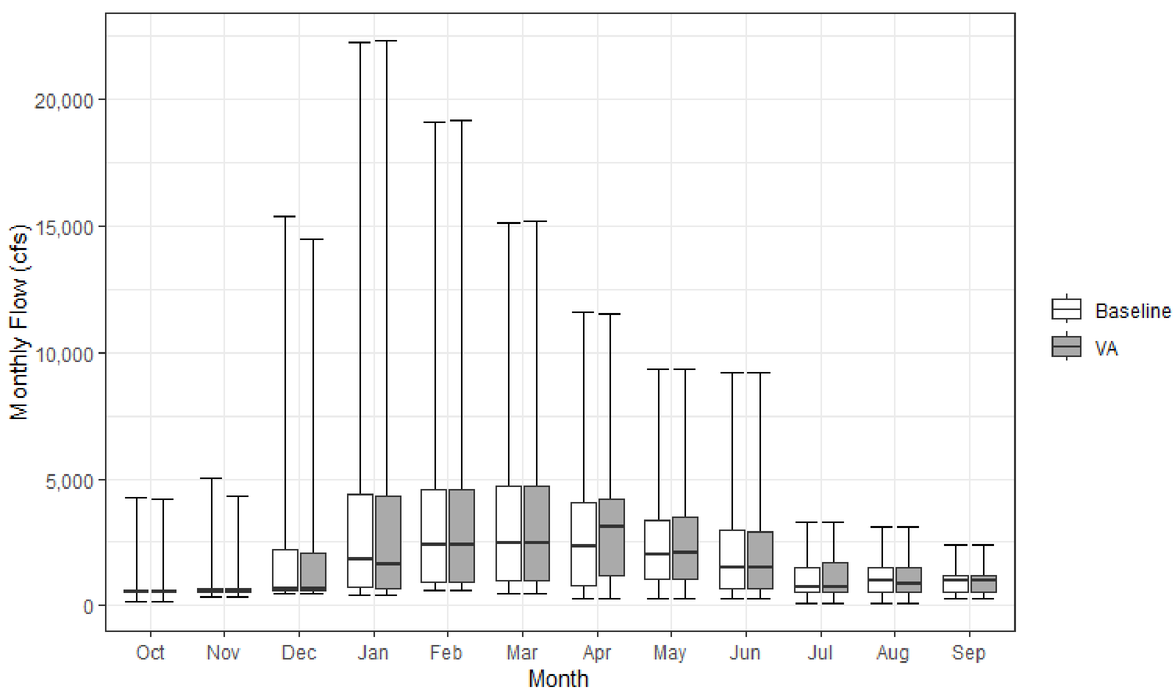


Figure 9.5-11. Monthly Streamflow for the Yuba River above the Feather River under Baseline and Proposed VAs

Table 9.5-18. Change in January–June Monthly Average Flow for the Yuba River above the Feather River by Water Year Type (TAF/yr)

Water Year Type	Baseline	Proposed VA: Change from Baseline
C	262	-10
D	483	21
BN	779	33
AN	1,268	48
W	1,947	-9
All	1,043	13

Table 9.5-19. Change in July–December Monthly Average Flow for the Yuba River above the Feather River by Water Year Type (TAF/yr)

Water Year Type	Baseline	Proposed VA: Change from Baseline
C	187	-5
D	250	-2
BN	302	-10
AN	419	-16
W	684	-22
All	402	-12

9.5.3.6 American River

Figure 9.5-12 and Table 9.5-20 present EOA and EOS storage results for Folsom Reservoir. SacWAM results indicate that the proposed VAs would result in EOA storage which is slightly lower than baseline, and EOS storage which is often higher than baseline in the modeling due to balancing of storage between Shasta and Folsom and the way the VAs interact with the American Flow Management Standard (FMS).

The SacWAM modeling indicates increases in flows on the American River in the early winter through spring months, and a decrease during the summer months (Figure 9.5-13).

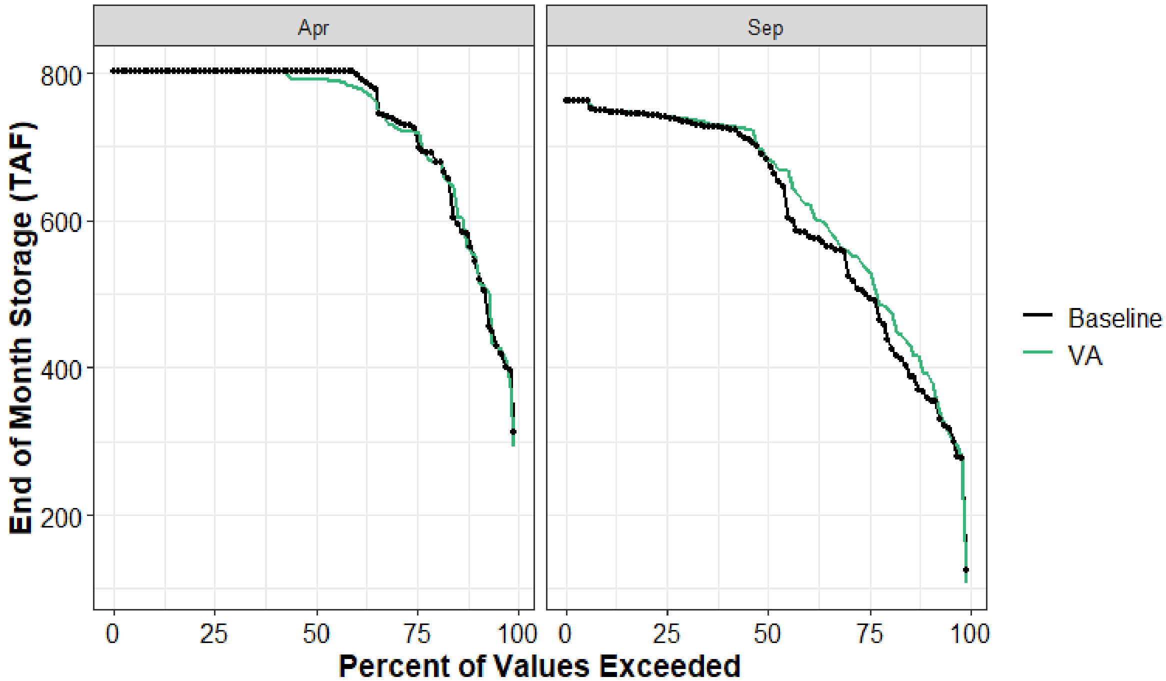


Figure 9.5-12. Folsom Reservoir End of April and End of September Carryover Storage under Baseline and Proposed VAs

Table 9.5-20. Change in Folsom Reservoir End of April and End of September Carryover Storage (TAF and Percent Difference) for All Years and Critical Years

Month	Water Year Type	Baseline (TAF)	Proposed VA: Change from baseline (TAF / % change)
April	All Years	734	-3 / (0)
April	Critical	504	-2 / (0)
September	All Years	606	14 / (2)
September	Critical	363	0 / (0)

Figure 9.5-13 presents modeled monthly flows for the American River above the confluence with the Sacramento River for baseline and the VA scenario. Table 9.5-21 and Table 9.5-22 present the monthly average baseline flows and changes from baseline for the VA scenario for the American River for January-June and July-December.

The stipulation in the VA proposal that additional flows from the American River will be released in 3 of every 8 non-wet year types results in additional VA flows occurring only in 35% of years. The SacWAM modeling indicates increases in springtime flows in the VA scenario in other years relative to baseline due to CVP reservoir storage rebalancing. In the VA scenario, the SacWAM modeling indicates higher flows on the Lower American River in the January-June period on average in all year types with the largest increase in dry years of 60 TAF more flow from the American River into the Sacramento River (Table 9.5-21). In the July-December period, flows are typically lower in the VA scenario with the largest decrease occurring in July of dry year types. As mentioned above, this decrease in flows in the Lower American is likely due to interactions between the proposed VAs and the FMS.

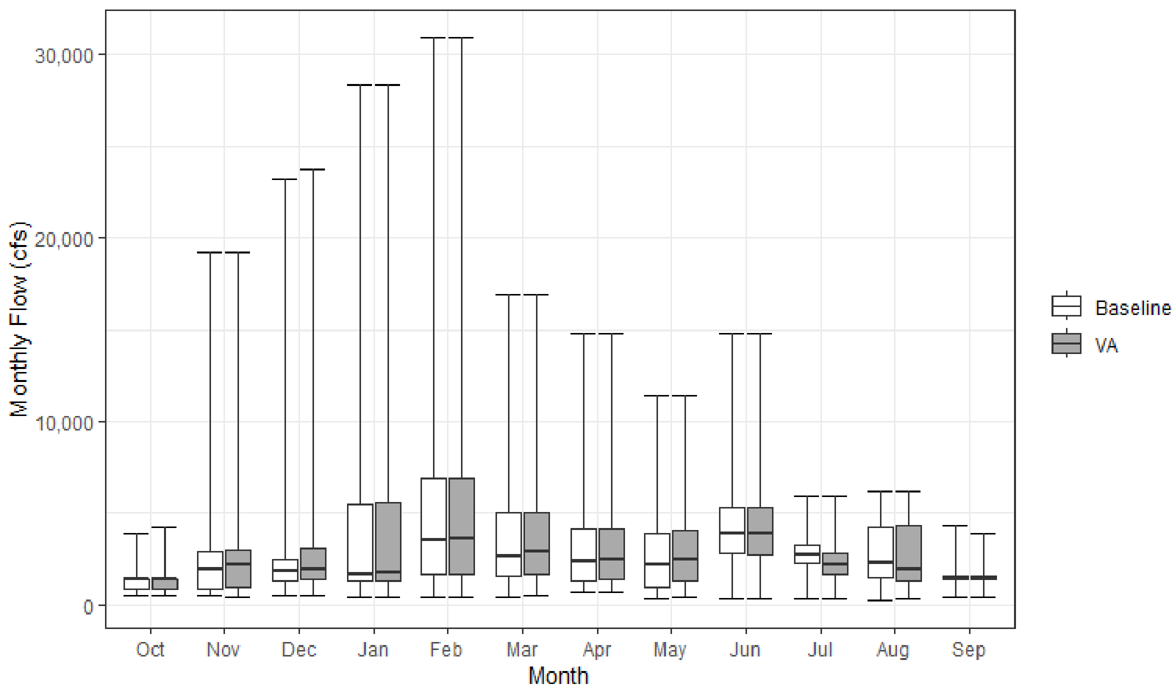


Figure 9.5-13. Monthly Streamflow for the American River above the Sacramento River under Baseline and Proposed VAs

Table 9.5-21. Change in January–June Monthly Average Flow for the American River above the Sacramento River by Water Year Type (TAF/yr)

Water Year Type	Baseline	Proposed VA: Change from Baseline
C	447	29
D	721	60
BN	1,069	28
AN	1,680	28
W	2,493	7
All	1,398	29

Table 9.5-22. Change in July–December Monthly Average Flow for the American River above the Sacramento River by Water Year Type (TAF/yr)

Water Year Type	Baseline	Proposed VA: Change from Baseline
C	393	-1
D	659	-52
BN	782	-39
AN	929	-15
W	1,259	-4
All	854	-22

9.5.3.7 Mokelumne River

Figure 9.5-14 and Table 9.5-23 present EOA and EOS storage results for Camanche Reservoir. Under the proposed VAs, EOA and EOS storage in Camanche is slightly lower than baseline (1%-2%).

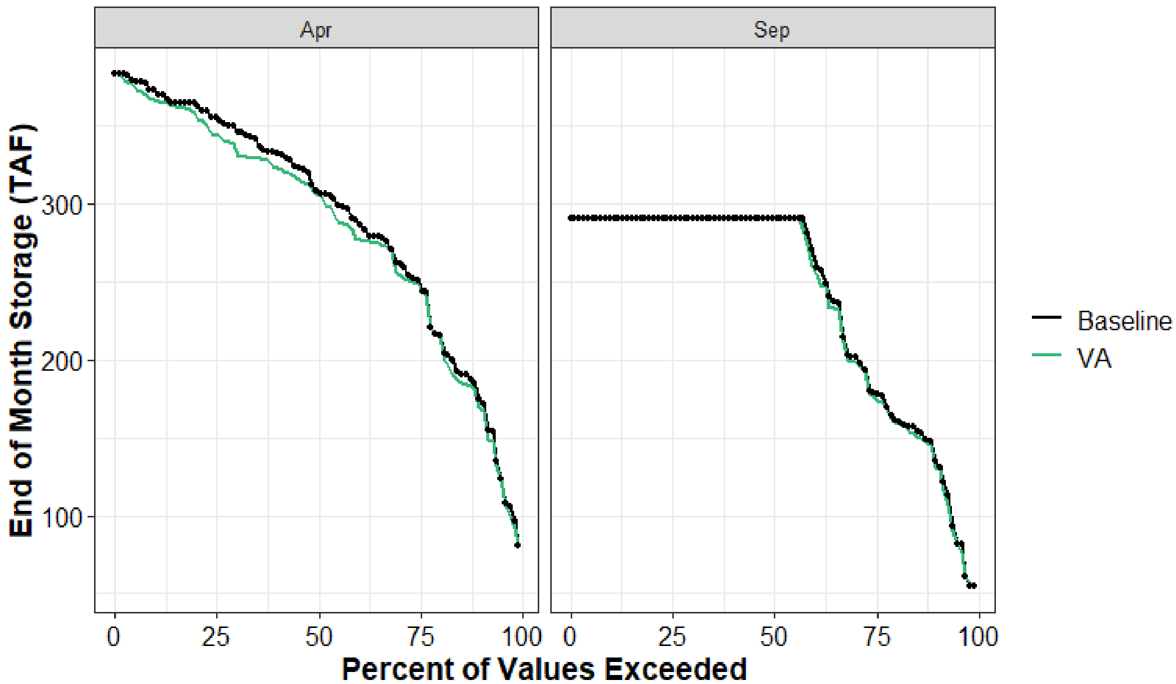


Figure 9.5-14. Camanche Reservoir End of April and End of September Carryover Storage under Baseline and Proposed VAs

Table 9.5-23. Change in Camanche Reservoir End of April and End of September Carryover Storage (TAF and Percent Difference) for All Years and Critical Years

Month	Water Year Type	Baseline (TAF)	Proposed VA: Change from baseline (TAF / % change)
April	All Years	291	-6 / (-2)
April	Critical	161	-3 / (-2)
September	All Years	240	-1 / (-1)
September	Critical	118	-2 / (-2)

Figure 9.5-15 presents modeled monthly flows for the Mokelumne River above the confluence with the Cosumnes River under baseline and the VA scenario. Table 9.5-24 and Table 9.5-25 present the monthly average baseline flows and changes from baseline for the VA scenario for the Mokelumne River for January-June and July-December.

The Mokelumne VA proposal indicates that when storage at the end of September is forecasted to drop below 350 TAF, no additional VA releases will occur. SacWAM estimates that this storage offramp to the release of additional VA flows occurs in 11 of the 93 years or 12% of the years. Under the VA scenario, SacWAM indicates an average increase in flows during January-June of 2 TAF averaged across all years (Table 9.5-24). SacWAM results also indicate an average decrease in flows of 2 TAF in July-December averaged across all years (Table 9.5-25).

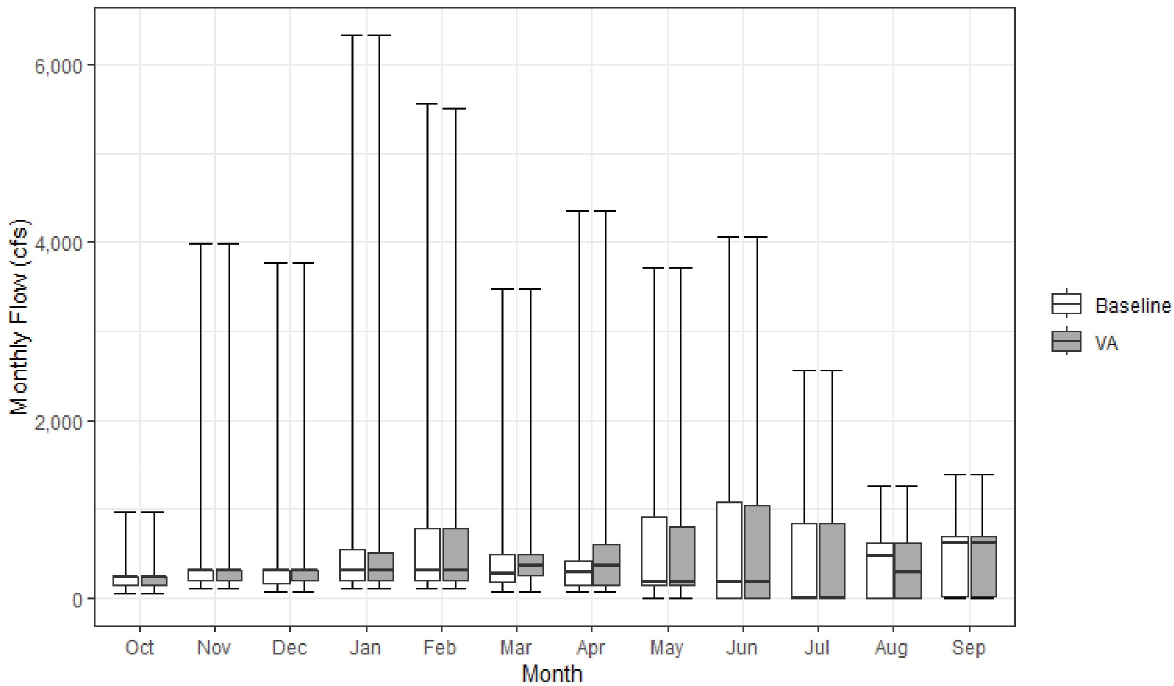


Figure 9.5-15. Monthly Streamflow for the Mokelumne River above the Confluence with the Cosumnes River under Baseline and Proposed VAs

Table 9.5-24. Change in January–June Monthly Average Flow for the Mokelumne River above the Confluence with the Cosumnes River by Water Year Type (TAF/yr)

Water Year Type	Baseline	Proposed VA: Change from Baseline
C	49	1
D	66	3
BN	123	3
AN	224	3
W	489	2
All	222	2

Table 9.5-25. Change in July–December Monthly Average Flow for the Mokelumne River above the Confluence with the Cosumnes River by Water Year Type (TAF/yr)

Water Year Type	Baseline	Proposed VA: Change from Baseline
C	38	0
D	52	-1
BN	113	-2
AN	180	-4
W	261	-2
All	140	-2

9.5.3.8 Putah Creek

Figure 9.5-16 and Table 9.5-26 present EOA and EOS SacWAM storage results for Lake Berryessa. Overall, SacWAM indicates that under the proposed VAs, EOA and EOS storage in Lake Berryessa would be about 1% lower compared to baseline on average. Because Lake Berryessa is large compared with the annual inflow volume, the reservoir does not spill very often. Therefore, very small increases in releases can compound year after year until the reservoir refills.

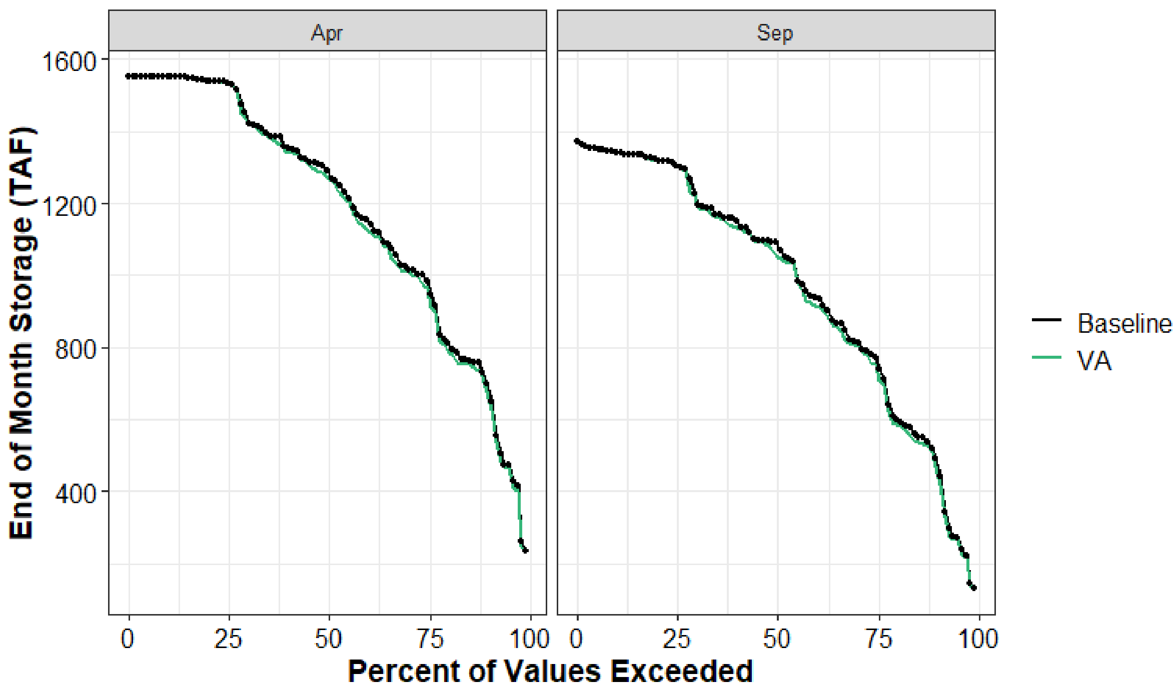


Figure 9.5-16. Lake Berryessa end of April and End of September Carryover Storage under Baseline and Proposed VAs

Table 9.5-26. Change in Lake Berryessa End of April and End of September Carryover Storage (TAF and Percent Difference) for All Years and Critical Years

Month	Water Year Type	Baseline (TAF)	Proposed VA: Change from baseline (TAF / % change)
April	All Years	1180	-11 / (-1)
April	Critical	808	-15 / (-2)
September	All Years	971	-11 / (-1)
September	Critical	611	-14 / (-2)

Figure 9.5-17 presents modeled monthly flows for Putah Creek above the Yolo Bypass under baseline and the VA scenario. Table 9.5-27 and Table 9.5-28 present the monthly average baseline flows and changes from baseline for the VA scenario for Putah Creek for January-June and July-December.

Under the VA scenario, SacWAM indicates a decrease (-1 TAF) in flow on average during January-June and an increase (2 TAF) in flow on average for July-December compared to baseline. The reason that flows decrease in the January – June period on average in the VA scenario is that there are instances when storage in Lake Berryessa is lower in the VA scenario resulting in smaller flood releases in wet years.

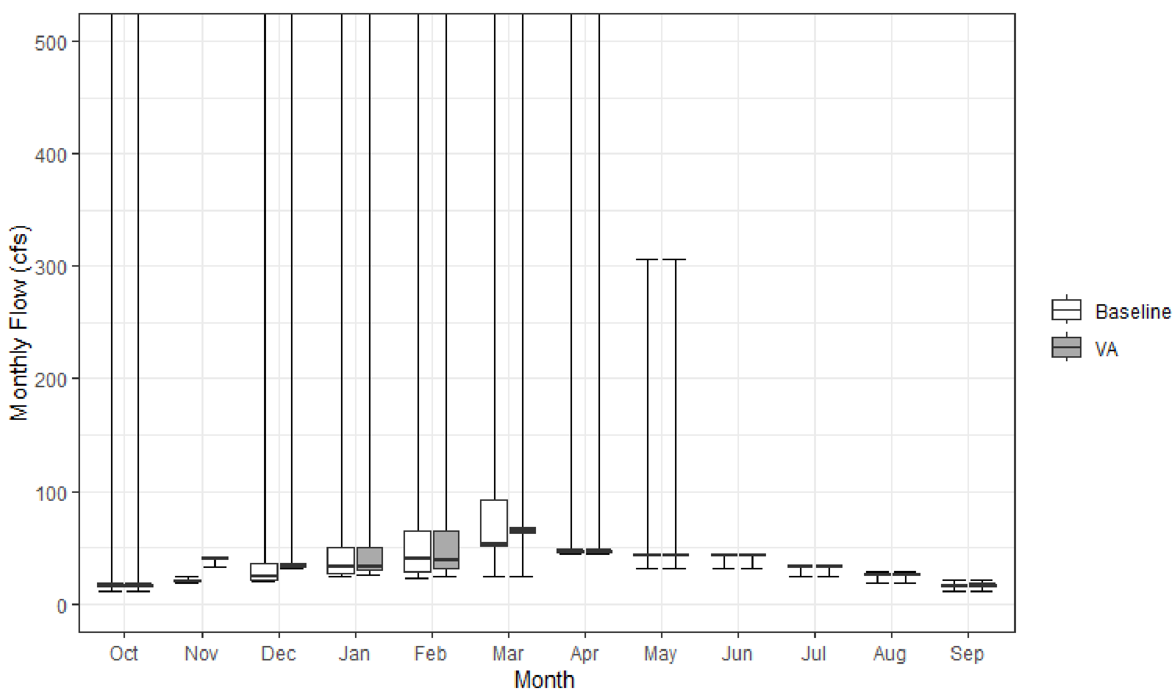


Figure 9.5-17. Monthly Streamflow for Putah Creek above the Yolo Bypass under Baseline and Proposed VAs

Table 9.5-27. Change in January–June Monthly Average Flow for Putah Creek above the Yolo Bypass by Water Year Type (TAF/yr)

Water Year Type	Baseline	Proposed VA: Change from Baseline
C	15	1
D	15	1
BN	24	0
AN	30	-1
W	194	-5
All	72	-1

Table 9.5-28. Change in July–December Monthly Average Flow for Putah Creek above the Yolo Bypass by Water Year Type (TAF/yr)

Water Year Type	Baseline	Proposed VA: Change from Baseline
C	8	2
D	8	2
BN	8	2
AN	9	2
W	15	1
All	10	2

9.5.3.9 Delta Inflows, Exports, Interior Delta Flows, and Delta Outflow Results

As discussed above, the proposed VAs include components that may affect Delta inflows, exports, interior Delta flows, and Delta outflows in different ways depending on how they are implemented and related factors. Specifically, the unspecified water purchases would either be provided through additional inflows to the Delta or export reductions that will affect inflows, exports, and interior Delta flows differently depending on where those flows originate. Further, the Tuolumne River VA and the Friant VA would result in additional Delta outflows (and inflows in the case of the Tuolumne River VA) and would affect interior Delta flows, but approval of the Tuolumne River VA is being considered separately and the Friant VA may not move forward. Accordingly, the results for Delta inflows, exports, interior Delta flows, and Delta outflows include different scenarios to represent the range of possible results under the VAs. Further, two scenarios are included to assess the benefits of the VAs on Delta outflows in combination with additional flows from the Merced and Tuolumne River that would be protected as Delta outflow under the VAs.

Delta Inflow

For Delta inflows there is a lower range VA inflow scenario (referred to as the “VA” scenario) that includes all Sacramento River and Delta tributary inflows, and includes the Tuolumne River VA flows, but does not include unspecified water purchases in inflows. There is also a higher range VA inflow scenario (referred to as “VA High Inflow”) that includes the unspecified water purchases in inflows as well as the additional Tuolumne River inflows. Because the possible Friant portions of the VAs would result from not diverting San Joaquin River Restoration Program flows and not specifically from additional inflows, the Friant VAs are not included in the VA High Inflow scenario. Figure 9.5-18 presents modeled and postprocessed mean monthly Delta inflow under the baseline, the 2008-2009 BiOps condition, the VA, and the VA High Inflow scenarios. Table 9.5-29 presents the mean change in Delta inflow for the VA and VA High Inflow scenarios from baseline, during January through June in each water year type. Table 9.5-30 presents the mean change in Delta inflow for the VA and the VA High Inflow scenarios from the 2008-2009 BiOps condition during January through June for each water year type. Modeling plus postprocessing results for changes to Delta inflow in July through December can be found in Table 9.5-31 and Table 9.5-32.

Results show an increase in mean Delta inflow in the VA scenario compared to baseline, particularly in March-May (Figure 9.5-18), with additional increases under the VA High Inflow scenario that includes the unspecified water purchases as Delta inflow. Compared to baseline, January-June mean Delta inflow is expected to increase in all water year types except for wet years under the VA scenario (Table 9.5-29). Increases for the VA scenario could be greatest in dry years at 428 TAF on average (Table 9.5-29). For the VA High Inflow scenario, there are expected increases in January-June inflows compared to baseline that are also greatest in dry years at 586 TAF on average (Table 9.5-29). Across all water year types, expected increases in January-June Delta inflow for the VA scenario compared to baseline is 208 TAF without considering the unspecified water purchases, and 322 TAF for the VA High Inflow scenario that includes the unspecified water purchases. Results suggest that July-December Delta inflows would decrease in all water year types compared to baseline, with the largest decrease of 167 TAF in below normal years for the VA and VA High Inflow scenarios (Table 9.5.3.9-3).

Expected changes in Delta inflow under the VA scenarios compared to the 2008-2009 BiOps condition resemble changes compared to baseline, with some differences in magnitude. Mean Delta inflow could increase for the VA and VA High Inflow scenarios, especially in March-May compared to the 2008-2009 BiOps condition, and these increases would be greater than increases from the baseline (Figure 9.5-18). January-June Delta inflows would be higher in the VA scenario in all water year types except for wet years and would be higher in the VA High Inflow scenario in all water year types, compared to the 2008-2009 BiOps condition (Table 9.5-30). Across water year types, Delta inflows could increase by 262 TAF under the VA scenario and by 376 TAF under the VA High Inflow scenario, during January through June (Table 9.5-30).

July-December Delta inflow is expected to be lower in the VA and VA High Inflow scenarios compared to the 2008-2009 BiOps condition across all water year types, and these decreases would be greater than decreases from baseline during critical and wet years (Table 9.5-31). Compared to the 2008-2009 BiOps condition, Delta inflow could decrease by 153 TAF in the VA and VA High Inflow scenarios compared to the 2008-2009 BiOps condition during July through December (Table 9.5-32).

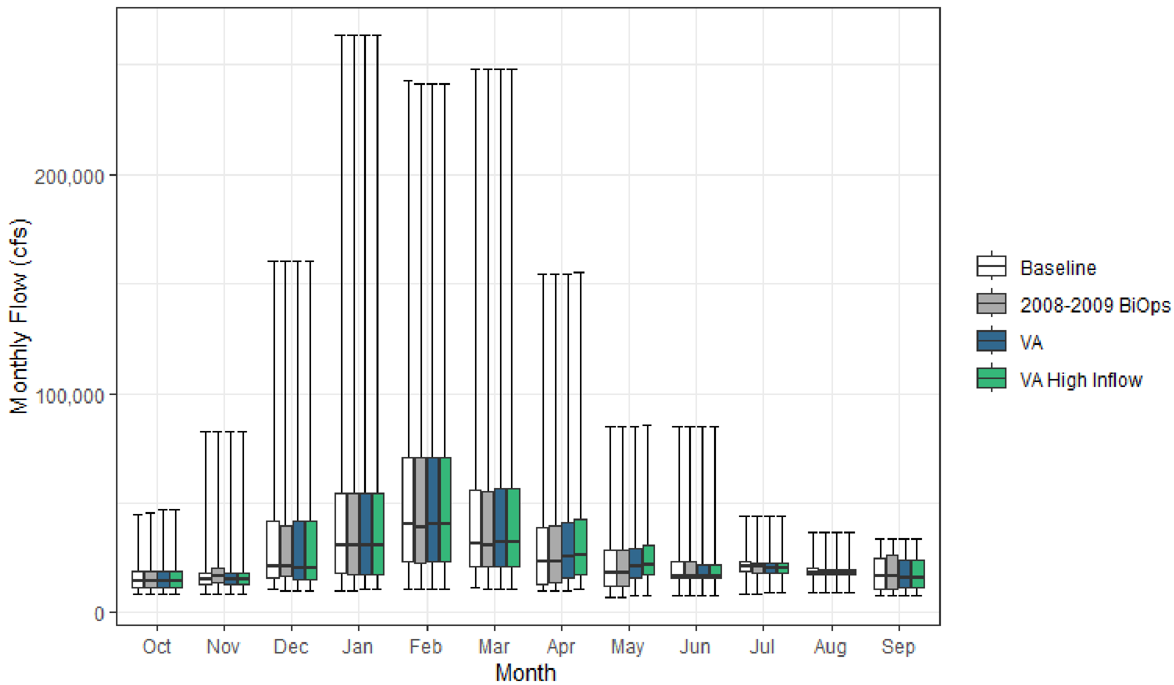


Figure 9.5-18. Monthly Total Delta Inflow under Baseline, 2008–2009 BiOps, VA, and VA High Inflow Scenarios

The VA High Inflows Scenario shown in Figure 9.5-18 includes unspecified water purchases postprocessed as additions to Delta inflow. The VA and VA High Inflow scenarios both include flows from the Tuolumne River VA.

Table 9.5-29. Change in January–June Average Delta Inflow by Water Year Type (TAF/yr) for VA Scenarios Compared with Baseline

Water Year Type	Baseline	Proposed VA: Change from Baseline	Proposed VA High Inflow: Change from Baseline
C	5,313	44	109
D	7,098	428	586
BN	10,033	367	436
AN	16,250	293	429
W	24,949	-1	122
All	13,902	208	322

Table 9.5-30. Change in January–June Average Delta Inflow by Water Year Type (TAF/yr) for VA Scenarios Compared with the 2008–2009 BiOps Condition

Water Year Type	2008-2009 BiOps	Proposed VA: Change from 2008-2009 BiOps	Proposed VA High Inflow: Change from 2008-2009 BiOps
C	5,307	50	115
D	7,090	436	594
BN	9,965	435	504
AN	16,054	489	625
W	24,904	44	167
All	13,848	262	376

Table 9.5-31. Change in July–December Average Delta Inflow by Water Year Type (TAF/yr) for VA Scenarios Compared with Baseline

Water Year Type	Baseline	Proposed VA: Change from Baseline	Proposed VA High Inflow: Change from Baseline
C	4,372	-20	-20
D	6,081	-44	-44
BN	6,837	-167	-167
AN	8,112	-147	-147
W	10,955	-88	-88
All	7,673	-89	-89

Table 9.5-32. Change in July–December Average Delta Inflow by Water Year Type (TAF/yr) for VA Scenarios Compared with the 2008-2009 BiOps Condition

Water Year Type	2008-2009 BiOps	Proposed VA: Change from 2008-2009 BiOps	Proposed VA High Inflow: Change from 2008-2009 BiOps
C	4,527	-175	-175
D	6,071	-34	-34
BN	6,798	-128	-128
AN	8,074	-109	-109
W	11,129	-263	-263
All	7,736	-153	-153

South of Delta Exports

As discussed in Chapter 6, *Changes in Hydrology and Water Supply*, under existing conditions, between approximately one third and half of the Sacramento/Delta water supplied is to South of Delta users via South Delta pumping facilities, with higher export rates in wetter years. These supplies are subsequently delivered to the San Francisco Bay Area, Central Coast, San Joaquin Valley, and Southern California, as discussed in greater detail in Section 2.8. Modeling results from SacWAM, plus postprocessing of unspecified water purchases, include two scenarios to quantify the possible ranges of changes in South of Delta exports that could be expected under the proposed VAs:

the VA scenario, and the VA High Export Cuts scenario. The VA scenario does not include export reductions from unspecified water purchases. The VA High Export Cuts scenario includes the assumption that export reductions would occur through the unspecified water purchases. This scenario also includes the Friant VA export reductions. These VA scenarios were compared to baseline and to the 2008-2009 BiOps condition. Although the comparison to the 2008-2009 BiOps condition is not used to analyze the benefits of the proposed VAs (Section 9.6, *Beneficial Environmental Effects of Proposed VAs*) as it is for Delta outflows, the comparison to this scenario is provided for consistency with other modeling and postprocessing results.

As discussed in Section 9.5.2, *VA Modeling Approach*, it is possible that the changes in exports and associated changes in interior Delta flows between the 2019 BiOps condition (as well as in the VA scenarios) and the baseline (and 2008-2009 BiOps condition) as modeled in SacWAM may overestimate actual increases in exports based on comparison to CalSim II analyses of the same regulatory change. Accordingly, the SacWAM analyses may provide conservative results for aquatic resources impact assessment purposes and, conversely, may underestimate to some degree water supply effects. As discussed above, for purposes of evaluating the possible benefits of the VAs on Delta outflows from January through June, a bookend that includes a correction factor for these differences is evaluated. A similar bookend analysis is not included for exports and interior Delta flows below because the proposed VAs are not being assessed for benefits for these parameters in the impact analysis.

Further, the possible increases in exports and associated increases in OMR and decreases in flows measured at Old and Middle River and the Lower San Joaquin River at Jersey Point (QWEST) shown in the SacWAM modeled VA scenarios are largely driven by the assumption in the VA scenarios that the I:E constraints are removed from the BiOps and ITP but not from the baseline, as well as the 2008-2009 BiOps condition. These changes, however, are not the result of the possible inclusion of the VAs in the Bay-Delta Plan because the VAs would not change any of the existing requirements in the Bay-Delta Plan. Instead, the VAs would add to the existing Bay-Delta Plan requirements. It is expected that there will be some changes to SWP and CVP operational requirements included in their associated BiOps and ITP as a result of the ongoing reconsultation process. However, it is not clear exactly what those changes will be. Accordingly, the potential impacts of the changes in exports and interior Delta flows are evaluated below in Section 9.7, *Environmental Analysis*, under cumulative impacts since any impacts would not be due to the addition of new inflow and outflow provisions to the Bay-Delta Plan, but the result of changes to BiOps and ITP requirements. Potential effects of reductions in exports associated with implementation of the VAs are considered in resource impact assessments.

Figure 9.5-19 and Table 9.5-33 through Table 9.5-38 below present SacWAM modeling plus postprocessing results for average South of Delta exports for baseline, the 2008-2009 BiOps condition, the VA, and VA High Export Cuts scenarios. Overall, results suggest that annual average South of Delta exports for the VA scenario would be higher than baseline and the 2008-2009 BiOps condition in April and May (Figure 9.5-19). The VA High Export Cuts scenario, which includes unspecified water purchases as reductions in exports, would result in smaller increases in exports compared to the VA scenario. Results suggest the VA and VA High Export Cuts scenarios would result in reductions in exports in March relative to baseline and the 2008-2009 BiOps condition (Figure 9.5-19).

During January through June, results show that South of Delta exports could increase in all water year types except critical years under the VA scenario compared to baseline and the 2008-2009

BiOps condition (Table 9.5-33 and Table 9.5-34). Under the VA High Export Cuts scenario, exports would generally decrease in critical and dry years compared to baseline and the 2008-2009 BiOps condition. Across all water year types and compared to baseline, SacWAM modeling indicates that South of Delta exports could increase by 166 TAF during January through June in the VA scenario without the unspecified water purchases. With the unspecified water purchases in the VA High Export Cuts scenario, exports could increase by 40 TAF (Table 9.5-33). The increases in exports during the spring could result in changes to interior Delta flows, including QWEST.

During July through December, South of Delta exports could decrease in all water year types compared to baseline under both VA scenarios (Table 9.5-35). The decrease in exports would likely be the same under the VA and VA High Export Cuts scenarios because additional export reductions would be implemented during the January-June period. Across all water year types, exports could decrease during July through December by 79 TAF compared with baseline. However, exports could increase under the proposed VAs compared to the 2008-2009 BiOps condition in all water year types except for critical years, with an average increase of 32 TAF.

Results suggest that annual average South of Delta exports could increase under the VA scenario in all water year types except critical years compared to baseline, with an annual average increase of 86 TAF without the unspecified water purchases (Table 9.5-37). Under the VA High Export Cuts scenario, the annual South of Delta exports could decrease by 40 TAF on average across water year types (Table 9.5-37), with decreases expected in critical and dry water year types and increases in other water year types. Compared to the 2008-2009 BiOps condition, exports could increase by 249 TAF and 123 TAF for the VA and VA High Export Cuts scenarios, respectively (Table 9.5-38).

Compared to the 2008-2009 BiOps condition, results suggest that increases in South of Delta exports would occur for all water year types except critical years. Under the VA High Export Cuts scenario, South of Delta exports would be expected to decrease in critical and dry years compared to the 2008-2009 BiOps condition. Generally, compared to the 2008-2009 BiOps condition, exports could increase between 123 and 249 TAF for the VA High Export Cuts and VA scenarios, respectively.

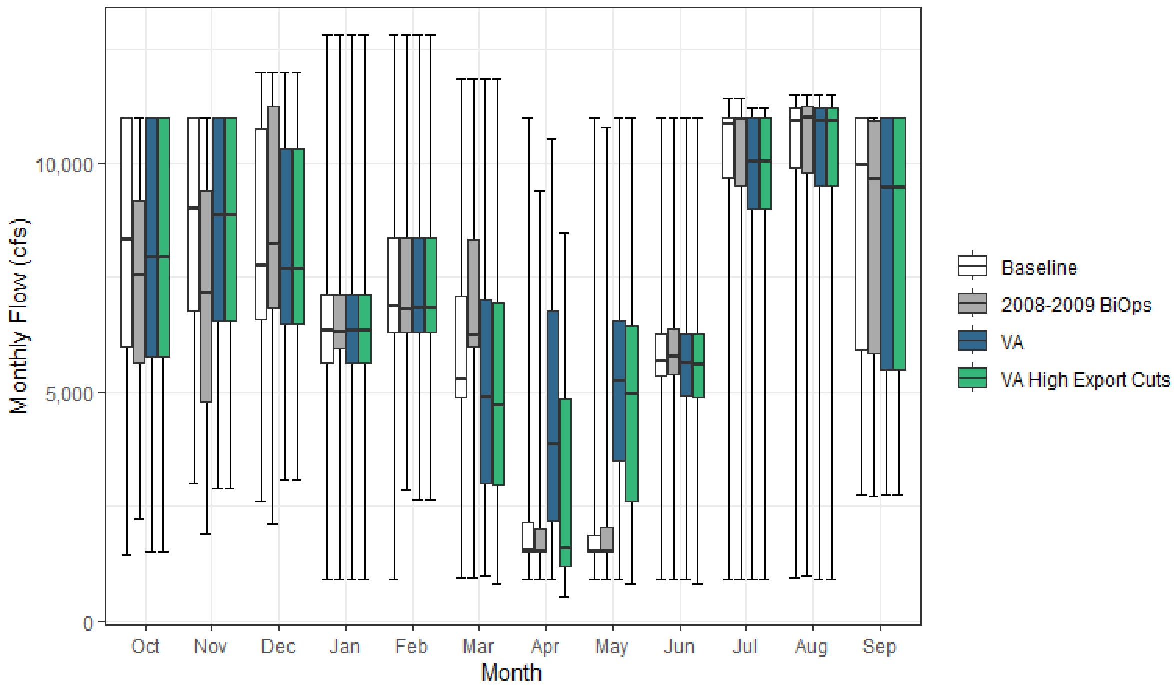


Figure 9.5-19. Monthly South of Delta Exports for Baseline, 2008–2009 BiOps Condition, VA, and VA High Export Cuts Scenarios

The VA High Export Cuts scenario shown in Figure 9.5-19 includes unspecified water purchases postprocessed as additional export reductions.

Table 9.5-33. Change in January–June Average South of Delta Exports by Water Year Type (TAF/yr) for the VA Scenarios Compared to Baseline.

Water Year Type	Baseline	Proposed VA: Change from Baseline	VA High Exports Cuts: Change from Baseline
C	1,179	-25	-96
D	1,545	121	-60
BN	1,669	249	161
AN	1,917	224	76
W	2,712	226	97
All	1,908	166	40

Table 9.5-34. Change in January–June Average South of Delta Exports by Water Year Type (TAF/yr) for the VA Scenarios Compared to the 2008–2009 BiOps Condition

Water Year Type	2008-2009 Biological Opinions	Proposed VA: Change from 2008-2009 Biological Opinions	VA High Export Cuts: Change from 2008-2009 Biological Opinions
C	1,197	-43	-114
D	1,606	60	-121
BN	1,735	183	95
AN	1,942	199	51
W	2,436	502	374
All	1,857	217	91

Table 9.5-35. Change in July–December Average South of Delta Exports by Water Year Type (TAF/yr) for the VA Scenarios Compared to Baseline

Water Year Type	Baseline	Proposed VA: Change from Baseline	VA High Export Cuts: Change from Baseline
C	1,712	-42	-42
D	3,025	-120	-120
BN	3,444	-105	-105
AN	3,519	-73	-73
W	3,711	-56	-56
All	3,160	-79	-79

Table 9.5-36. Change in July–December Average South of Delta Exports by Water Year Type (TAF/yr) for the VA Scenarios Compared to the 2008–2009 BiOps Condition

Water Year Type	2008-2009 BiOps	Proposed VA: Change from 2008-2009 Biological Opinions	VA High Export Cuts: Change from 2008-2009 Biological Opinions
C	1,768	-98	-98
D	2,874	31	31
BN	3,311	27	27
AN	3,445	1	1
W	3,536	118	118
All	3,049	32	32

Table 9.5-37. Annual South of Delta Exports (TAF/yr) for VA Scenarios by Water Year Type Compared with Baseline.

Water Year Type	Baseline	VA: Change from Baseline	VA High Export Cuts: Change from Baseline
C	2,890	-66	-137
D	4,570	1	-180
BN	5,113	144	56
AN	5,436	151	4
W	6,423	170	41
All	5,068	86	-40

Table 9.5-38. Annual South of Delta Exports (TAF/yr) for VA Scenarios by Water Year Type Compared with the 2008–2009 BiOps Condition

Water Year Type	Baseline	VA: Change from 2008-2009 Biological Opinions	VA High Export Cuts: Change from 2008-2009 Biological Opinions
C	2,964	-140	-212
D	4,480	91	-90
BN	5,046	210	122
AN	5,388	200	52
W	5,972	621	492
All	4,905	249	123

Interior Delta Flows

Export pumping at the SWP and CVP export facilities can cause changes in interior Delta flows, including Old and Middle River (OMR) reverse flows and net reverse flows in the San Joaquin River at Jersey Point. A negative value, or a reverse flow, indicates a net water movement across the Delta up the lower San Joaquin River and Old and Middle River channels to the export facilities in a north to south direction rather than the more natural east to west direction. The 2020 ITP generally requires that OMR reverse flows fall between -1,250 cfs and -5,000 cfs to protect fish species during the OMR management season (December-June), and the 2020 ITP identifies that OMR reverse flows of -2,500 cfs pose a medium level of entrainment risk for larval and juvenile smelts. The results below on changes to OMR flows reference these OMR thresholds from the 2020 ITP.

The proposed VAs would not result in changes to requirements for interior Delta flows. However, as described above, changes to inflows and Delta exports can change the flow patterns within the Delta. This section includes analyses of changes in interior Delta flows, including OMR flows and the net flow measured in the lower San Joaquin River at Jersey Point (QWEST). As described above for exports, the VA High Export Cuts scenario assumes that unspecified water purchases result from export reductions and also includes the Friant VA export reductions. The other scenario that does not include these export reductions is referred to as the VA scenario. For OMR, there are corresponding scenarios to the export and inflow scenarios, including a scenario that assumes the unspecified water purchases result from export reductions that also includes Tuolumne River VA inflows and Friant VA export reductions, referred to as “VA High Export Cuts” in the OMR and QWEST results presented below. There is also a scenario that does not include the unspecified water purchases as export reductions, the Friant VA export cuts, or Tuolumne River inflows, referred to as the "VA" scenarios for the OMR and QWEST results below. Changes in Delta exports are presented above, and changes in OMR are presented in Figure 9.5-20 and changes in QWEST are shown in Figure 9.5-21, below.

Results for net OMR flows in December through June are presented below as an exceedance frequency distribution plot. Overall, net negative OMR flows between 0 and -2,500 cfs could occur with greater frequency under the VA scenario compared with baseline and the 2008-2009 BiOps condition, primarily due to the possibility for greater exports in April and May relative to the baseline scenario (see South of Delta exports discussion above). However, the frequency of net flows more negative than -5,000 cfs would not increase under the VA scenario. In addition, the VA High Export Cuts scenario would likely result in a lower frequency of net negative OMR flows than the VA scenario and a similar frequency of net negative flows compared with baseline and the 2008-2009 BiOps condition (Figure 9.5-20).

Table 9.5-39 includes OMR net flow results for the following thresholds: 0, -1,250, -2,500, and -5,000 cfs during December through June under the VA scenarios, baseline, and the 2008-2009 BiOps condition. Under the VA scenario, modeling results indicate that OMR reverse flows during 14% of these months would be expected to be more positive than -1,250 cfs, compared to 18% of months under the 2008-2009 BiOps condition, and 28% of months under baseline. Under the VA High Export Cuts scenario, modeling indicates that 25% of months would be expected to have OMR flows more positive than the -1,250 cfs threshold. The VA scenario would be expected to have OMR flows more positive than the -2,500 cfs threshold in 29% of months compared with 37% months under the VA High Export Cuts scenario, whereas the baseline and 2008-2009 BiOps condition would be expected to have OMR flows more positive than the -2,500 cfs threshold in 32% of months and 34% of months, respectively. The VA scenario would be expected to have OMR flows more positive than the -5,000 cfs threshold during 84% of months, and the VA High Export Cuts scenario would be expected to have more positive OMR flows than the -5,000 cfs threshold during 80% of months. Modeling results suggest that the baseline and 2008-2009 BiOps condition would have OMR flows more positive than the -5,000 cfs threshold during 83% and 87% of months, respectively.

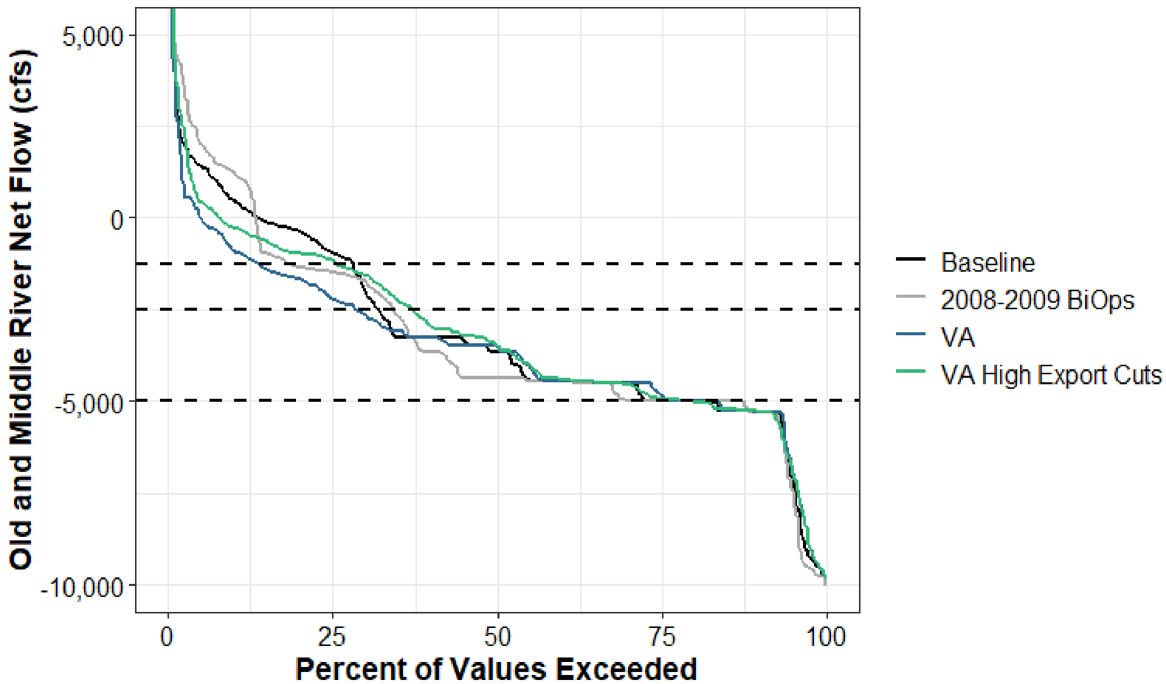


Figure 9.5-20. Monthly Exceedance Frequency Distribution of Old and Middle River Net Flow (cfs) for December–June under Baseline, 2008–2009 BiOps Condition, VA, and VA High Export Cuts Scenarios

The VA High Export Cuts scenario shown in Figure 9.5-20 includes postprocessed unspecified water purchases as export reductions and Tuolumne River inflows and Friant export reductions.

Table 9.5-39. Exceedance Frequency of Old and Middle River Net Flow (cfs) for December–June under Baseline, 2008–2009 BiOps Condition, VA, and VA High Export Cuts Scenarios

Threshold	Baseline	2008-2009 BiOps	VA	VA High Export Cuts
0	14	13	5	8
-1,250	28	18	14	25
-2,500	32	34	29	37
-5,000	83	87	84	80

Generally, positive QWEST flows can prevent fish entrainment by providing net downstream transport of migratory aquatic species away from export facilities (^SWRCB 2017). Figure 9.5-21 presents modeled monthly QWEST flows under the baseline, 2008-2009 BiOps condition, the VA, and the VA High Export Cuts scenarios. Modeling results suggest that under the VA scenario, QWEST would generally decrease during April and May relative to baseline and the 2008-2009 BiOps condition, but flow would not decrease by as much under the VA High Export Cuts scenario.

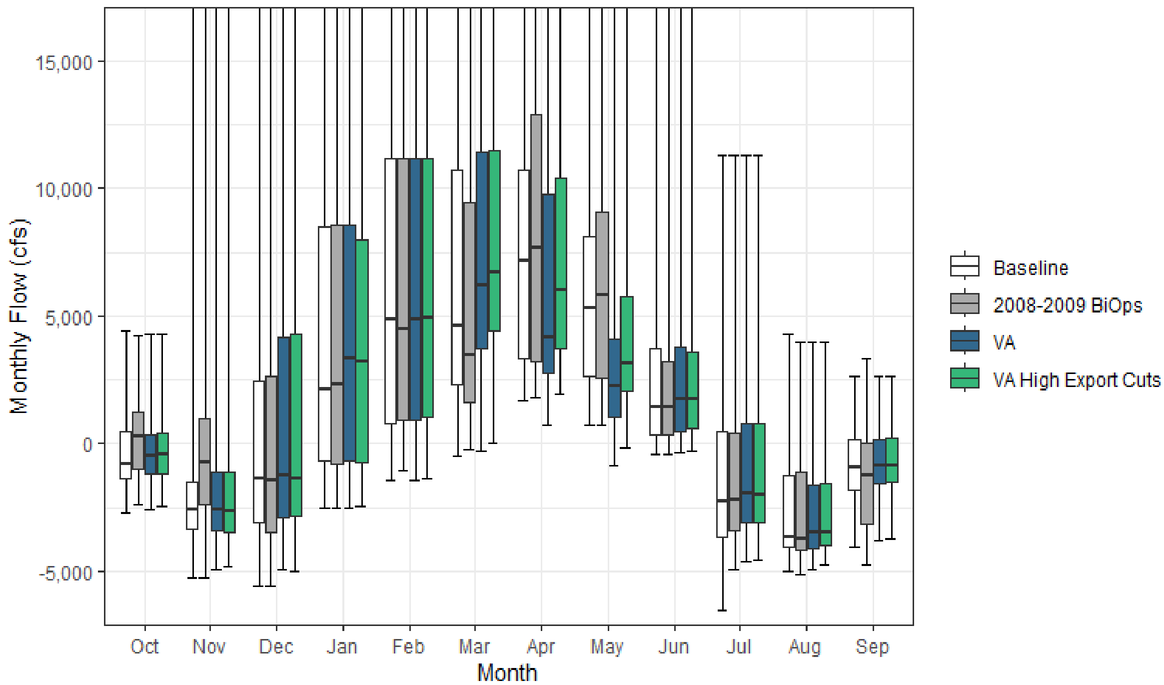


Figure 9.5-21. QWEST under Baseline, 2008–2009 BiOps Condition, VA, and VA High Export Cuts Scenarios

The VA High Export Cuts scenario shown in Figure 9.5-21 includes postprocessed unspecified water purchases as export reductions and Tuolumne River inflows and Friant export reductions.

Delta Outflow

For Delta outflows there is a lower range Delta outflow scenario that includes unspecified water purchases, but does not include the Tuolumne River and Friant VA components (referred to as the "VA w/o SJ contributions" scenario) and a higher range Delta outflow scenario that includes the Tuolumne River and Friant VA components, and unspecified water purchases (referred to as the "VA" scenario). Friant flow contributions are included in the VA scenario in recognition that Friant may rejoin the VAs in the future (Friant Water Authority 2023). The Tuolumne VA flows are excluded from the "VA w/o SJ contributions" scenario because the Tuolumne VA is being evaluated under a separate process to consider changes to the 2018 amendments to the Bay-Delta Plan that established updated LSJR flows and southern Delta salinity objectives. To illustrate the combined effects of the Tuolumne River VA with the other VA components, the Tuolumne River VA contributions are reflected in the VA scenario. These two scenarios are intended to encompass the potential range of VA flows given uncertainties with the San Joaquin contributions. The unspecified water purchases are part of both Delta outflow scenarios given that the uncertainty related to the source of this water (from exports or inflows) does not affect the Delta outflow results.

In addition, two scenarios are included to assess the benefits of the proposed VAs on Delta outflows during the January through June time period in combination with additional flows from the Merced and Stanislaus Rivers that would be protected as Delta outflow under the VAs either as part of a future VA or as part of the implementation of the 2018 LSJR flow updates to the Bay-Delta Plan. As discussed above, these scenarios also include a correction factor to account for model differences between SacWAM and CalSim II. The first scenario assumes the remaining San Joaquin River placeholder volumes identified in the VA Term Sheet above the Tuolumne River contributions are provided by the Merced and Stanislaus Rivers to Delta outflows (referred to as "VA w/Bias Correction and LSJR Placeholder"). The second scenario assumes additional Delta outflows from implementation of the 2018 LSJR Flow updates to the Bay-Delta Plan on the Merced and Stanislaus Rivers (referred to as "VA w/Bias Correction and 40% UF Merced & Stanislaus"). Both scenarios include the Tuolumne River VA and Friant contributions, as well as other VA contributions, including unspecified water purchases.

Figure 9.5-22 presents mean monthly Delta outflows from modeling and postprocessing under baseline, the 2008-2009 BiOps condition, the VA, and the VA without San Joaquin contributions scenarios. Table 9.5-40 and Table 9.5-41 present January-June mean changes in Delta outflow from baseline and the 2008-2009 BiOps condition, respectively, for the VA scenarios with and without San Joaquin contributions. Results for July-December changes in Delta outflow compared to baseline and the 2008-2009 BiOps condition are presented in Table 9.5-42 and Table 9.5-43, respectively.

Results presented below suggest that the largest increases in Delta outflow in the VA scenarios with and without San Joaquin contributions would occur in February through March. Delta outflow would increase in January-June compared to both the baseline and 2008-2009 BiOps condition, except in wet years. Increases in January-June Delta outflow would be greater for the VA scenario than the VA scenario without San Joaquin contributions, and increases in Delta outflow under both VA scenarios would be greater when compared to the 2008-2009 BiOps condition than baseline. The largest January-June increase would occur in dry years when Delta outflow under the VA scenario would be 488 TAF higher than baseline and 556 TAF higher than the 2008-2009 BiOps condition.

In the July through December period, results presented below suggest that Delta outflows could decrease on average in below normal through wet years compared to baseline for the VA scenarios with and without San Joaquin contributions. Delta outflow in July-December could decrease across all water year types for both VA scenarios compared to the 2008-2009 BiOps condition, and these decreases could be greater than decreases compared to baseline. In addition, decreases in July-December Delta outflow would be greater for the VA scenario without San Joaquin contributions.

Table 9.5-44 presents results for expected changes in July-December Monthly Total Delta Outflow by Water Year Type (TAF/yr) for the VA w/Bias Correction and LSJR Placeholder and VA w/Bias Correction and 40% UF Merced & Stanislaus scenarios compared to the 2008-2009 BiOps condition. Under the VA w/Bias Correction and LSJR Placeholder scenario, July-December Delta outflow would be expected to increase compared to the 2008-2009 BiOps condition on average in all years except wet years, when Delta outflow could decrease by up to 96 TAF. Delta outflow could increase further under the VA w/Bias Correction and 40% UF Merced & Stanislaus scenario compared with the 2008-2009 BiOps condition, including in wet years. The largest increase under either scenario would be expected in above normal years, with increases of 631 and 829 TAF under the VA w/Bias Correction and LSJR Placeholder and VA w/Bias Correction and 40% UF Merced & Stanislaus scenarios, respectively.

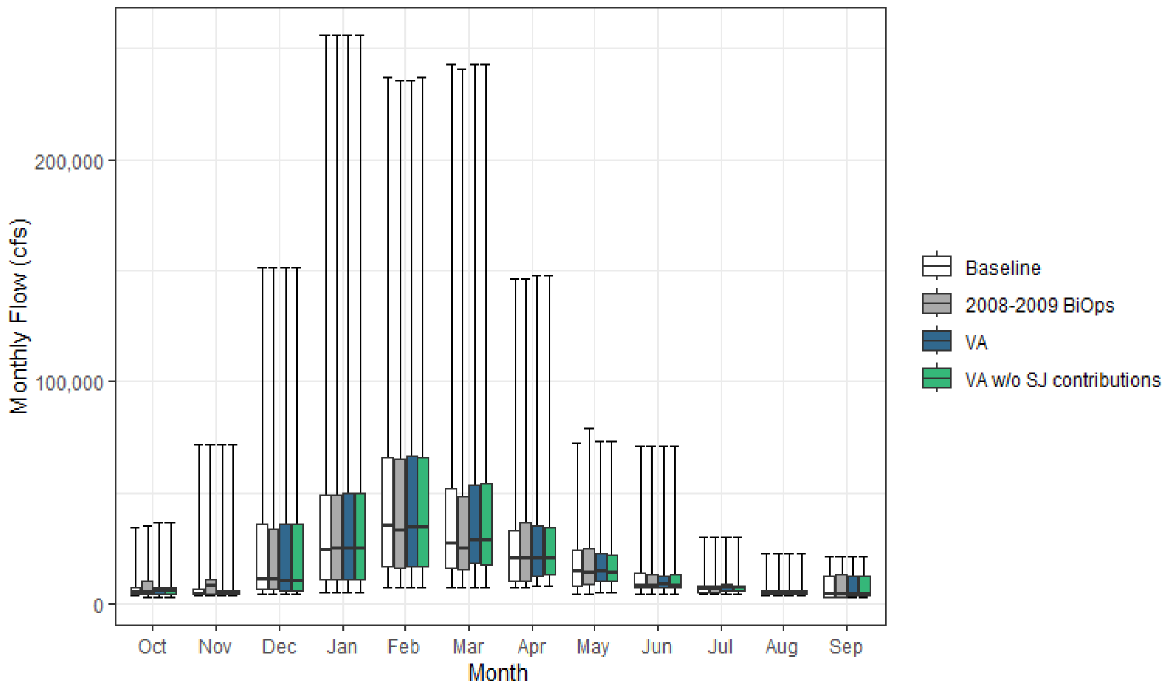


Figure 9.5-22. Monthly Total Delta Outflow for Baseline, 2008–2009 BiOps Condition, VA, and VA without San Joaquin Contributions Scenarios

VA and VA without San Joaquin Contributions scenarios shown in Figure 9.5-22 include postprocessed contributions to Delta outflow from unspecified water purchases.

Table 9.5-40. Change in January–June Monthly Total Delta Outflow by Water Year Type (TAF/yr) for VA Scenarios Compared to Baseline

Water Year Type	Baseline	Proposed VA: Change from Baseline	Proposed VA without San Joaquin contributions: Change from Baseline
C	3,659	142	92
D	5,127	488	400
BN	8,014	206	122
AN	14,128	218	180
W	22,106	-98	-91
All	11,691	169	123

Table 9.5-41. Change in January–June Monthly Total Delta Outflow by Water Year Type (TAF/yr) for the VA Scenarios Compared to the 2008–2009 BiOps Condition

Water Year Type	2008-2009 Biological Opinions	Proposed VA: Change from 2008-2009 BiOps	Proposed VA without San Joaquin contributions: Change from 2008-2009 BiOps
C	3,636	165	116
D	5,058	556	469
BN	7,881	340	256
AN	13,907	439	402
W	22,337	-330	-323
All	11,689	172	126

Table 9.5-42. Change in July–December Monthly Total Delta Outflow by Water Year Type (TAF/yr) for the VA Scenarios Compared to Baseline

Water Year Type	Baseline	Proposed VA: Change from Baseline	Proposed VA without San Joaquin contributions: Change from Baseline
C	1,875	22	13
D	2,313	77	66
BN	2,642	-61	-69
AN	3,877	-75	-64
W	6,608	-32	-34
All	3,797	-9	-14

Table 9.5-43. Change in July–December Monthly Total Delta Outflow by Water Year Type (TAF/yr) for VA Scenarios Compared to the 2008–2009 BiOps Condition

Water Year Type	2008-2009 Biological Opinions	Proposed VA: Change from 2008-2009 BiOps	Proposed VA without San Joaquin contributions: Change from 2008-2009 BiOps
C	1,975	-78	-87
D	2,454	-65	-76
BN	2,736	-155	-163
AN	3,912	-110	-100
W	6,958	-381	-383
All	3,972	-185	-189

Table 9.5-44. Change in January–June Monthly Total Delta Outflow by Water Year Type (TAF/yr) for VA w/Bias Correction and LSJR Placeholder and VA w/Bias Correction and 40% UF Merced and Stanislaus Scenarios Compared to the 2008–2009 BiOps Condition

Water Year Type	2008–2009 Biological Opinions	VA w/Bias Correction and LSJR Placeholder	VA w/Bias Correction and 40% UF Merced & Stanislaus
C	3,636	76	195
D	5,058	535	680
BN	7,881	599	735
AN	13,907	631	829
W	22,337	-96	70

9.5.3.10 Streamflows and Reservoir Levels in Other Regions

The proposed VAs could also affect streamflows and reservoir levels in other regions. Specifically, changes in Sacramento/Delta supplies could potentially affect reservoir levels in export reservoirs located outside of the Sacramento/Delta watershed that receive Sacramento/Delta supplies, and streamflows below export reservoirs. These changes are not modeled in SacWAM except for San Luis Reservoir. Results for San Luis Reservoir are provided in Appendix G3a)a and show that storage in San Luis Reservoir could change compared to baseline. Changes to storage in other export reservoirs would be expected to be small. As discussed below under Section 9.5.4, *Changes in Sacramento/Delta Surface Water Supply*, the SacWAM results indicate that the proposed VAs could potentially result in a slight increase in Sacramento/Delta supplies to other regions, so export reservoir levels would likely be similar to or could be slightly higher compared to baseline. However, the proposed VAs could also result in reduced Delta exports as a result of additional flow assets that would be provided through unspecified water purchases. If these flow assets are provided through additional water purchases from South of Delta sellers, Delta exports could be reduced, which could result in slight reductions in San Luis Reservoir and other export reservoir levels. Similarly, streamflows below export reservoirs are not modeled, but would likely be similar to baseline under the proposed VAs.

9.5.3.11 Summary of SacWAM Changes in Hydrology

Overall, the SacWAM results show that implementation of the proposed VAs could result in changes in hydrology, including changes in streamflow and reservoir levels in the VA tributaries compared to baseline. Increases in streamflows would generally occur during the spring months, although increases in streamflows could also occur at other times for some VA tributaries. The proposed VAs could also result in reductions in streamflows at times, generally during the fall or early winter months.

The SacWAM results also show that implementation of the proposed VAs could result in changes in reservoir levels for certain reservoirs in the Sacramento/Delta watershed, including Shasta Reservoir (Sacramento River), Oroville Reservoir (Feather River), Folsom Reservoir (American River) Camanche Reservoir (Mokelumne River), and Lake Berryessa (Putah Creek). Overall, storage levels in these reservoirs would be expected to be similar to baseline but could increase slightly at times and decrease slightly at times.

The proposed VAs would not be expected to result in changes in the flows into the Yolo Bypass. However, the proposed VAs include modifications to Tisdale Weir that SacWAM indicates would increase the flows into the Sutter Bypass at the Tisdale Weir in December through March by more than 100 TAF/yr on average.

If the VAs were adopted, actual operation could vary to some degree from modeled outcomes and there could be additional changes in streamflows and reservoir levels beyond the modeled changes. In particular, the proposed VAs include flexibility in the timing of flow assets, so streamflows and reservoir levels could deviate to some degree from modeled results. In addition, the SacWAM model results for VA tributaries do not include additional flow assets that could be provided through the Market Price and Permanent State Water Purchase components of the VA water purchase program (referred to as unspecified water purchases). As discussed above in Section 9.3, *Description of the Proposed Voluntary Agreements*, the proposed VAs include flow assets that would be provided through water purchases from unspecified willing sellers, which could include inflow sources within the Sacramento/Delta watershed or reductions in exports, both of which would result in additional Delta outflows. The VA tributary inflow analyses do not assume any additional inflows from unspecified water purchases given the unknown origin of these water purchases. Because some or all of the flows may be provided by additional Delta inflows from tributaries, it is possible that there would be some additional changes in streamflows and reservoir levels beyond the modeled changes on tributaries (including VA tributaries and other tributaries in the Sacramento/Delta watershed). In addition, it is possible that some upstream reservoirs could be reoperated on some tributaries, but these effects were not modeled.

The proposed VAs could affect reservoir levels in export reservoirs and streamflows below export reservoirs. These changes are not modeled in SacWAM, but would be expected to be small consistent with the analysis of effect on exports discussed below under Section 9.5.4, *Changes in Sacramento/Delta Surface Water Supply*. Overall, any reductions in export reservoir levels would be minimal. Similarly, streamflows below export reservoirs are not modeled, but would likely be similar to baseline under the proposed VAs.

The proposed VAs include components that may affect Delta inflows, exports, interior Delta flows, and Delta outflows in different ways depending on how they are implemented and related factors. Specifically, the unspecified water purchases could include inflow sources within the Sacramento/Delta watershed or reductions in exports and will affect inflows, exports, and interior Delta flows differently depending on where those flows originate. Further, the Tuolumne River VA and the Friant VA would result in additional Delta outflows (and inflows in the case of the Tuolumne River VA) and would affect interior Delta flows, but approval of the Tuolumne River VA is being considered separately and the Friant VA may not move forward. Accordingly, the results for Delta inflows, exports, interior Delta flows, and Delta outflows include different scenarios to represent the range of possible results under the VAs.

Changes in Delta inflows, outflows and exports would change the net flow in some channels in the Delta, including possible changes in flows in Old and Middle River.

Results for Delta inflows and Delta outflows presented in this section show that both Delta inflows and Delta outflows would increase on average on an annual basis under the proposed VAs compared to baseline. However, on a monthly average, Delta inflows would increase for some months and would decrease for other months compared to baseline. The largest monthly increases in average Delta inflows would occur during March through May. Delta outflows would increase on average on an annual basis under the proposed VAs both with San Joaquin basin contributions and without these contributions, but the increase would be larger with San Joaquin basin contributions. Results suggest that, on a monthly average, Delta outflows would increase in January-June compared to baseline, and could decrease in July-December.

9.5.4 Changes in Sacramento/Delta Surface Water Supply

9.5.4.1 Introduction

This section describes the changes in Sacramento/Delta surface water supplies that would occur as a result of the proposed VAs. *Sacramento/Delta water* is defined here as the portion of the surface water supply to regions that originates in or is diverted from water bodies in the Sacramento River watershed, Delta eastside tributaries, and Delta regions, and may be affected by the proposed VAs. As discussed in Chapter 6, *Changes in Hydrology and Water Supply*, Sacramento/Delta surface water supplies are used both within and outside of the Sacramento/Delta watershed under existing conditions. Therefore, VA flow assets could affect Sacramento/Delta surface water supplies that are used both within and outside of the Sacramento/Delta watershed. The total change in Sacramento/Delta surface water supplies is presented in this section, as well as the change by sector (agricultural, municipal, and wildlife refuge uses). Results are also presented separately for the Sacramento/Delta watershed, San Joaquin Valley, and other regions that receive Sacramento/Delta supplies (including the San Francisco Bay Area, Central Coast, and Southern California).

As discussed above, the proposed VAs include flow commitments from the Sacramento River, American River, Feather River, Mokelumne River, Yuba River, and Putah Creek (VA tributaries) identified in Section 9.3.3, *Tributary Assets*. The proposed VAs also include flow assets that would be provided through CVP/SWP export reductions identified in the VA Term Sheet, and flow assets that would be provided through water purchase programs. The sources for the PWA Water Purchase Fixed Price Program are identified and as such are modeled. However, the unspecified water purchases (PWA Water Purchase Market Price Program and permanent state water purchases) would be from unspecified willing sellers, which could include inflow sources within the Sacramento/Delta watershed or reductions in exports, both of which could result in additional Delta outflows. Because the unspecified water purchases under the proposed VAs could be provided from reductions in exports or increases in inflows, the water supply effects of both of these scenarios are evaluated in this section. Under both scenarios, the unspecified water purchases would be expected to be provided primarily or entirely from agricultural water users. Where applicable, results presented below for “VA Low Sac/Delta Supply” assume that the unspecified water purchases would be provided entirely from willing sellers in the Sacramento/Delta watershed, and results presented for “VA High Export Cuts” assume that the unspecified water purchases would be provided entirely from export reductions. Unspecified water purchases could be provided through a combination of willing sellers in the Sacramento/Delta watershed and from export reductions, which would be between these two scenarios.

The VA proposal identifies that some flow assets could be provided through groundwater substitution, including in basins subject to the Sustainable Groundwater Management Act (SGMA) where that is consistent with local management under SGMA. The SacWAM modeling considers that some flow assets could be provided through groundwater substitution in the American River watershed consistent with the VA documents. Flow assets in other watersheds could also be provided through groundwater substitution, but sufficient information is not available at this time to include additional groundwater substitution in the modeling. If additional flow assets are made available through groundwater substitution, water supply reductions for the Sacramento/Delta watershed would be less than indicated by the results, and associated effects such as land fallowing would be reduced.

The Chino Basin, Kern Fan, and Willow Springs Conjunctive Use projects are not included in the SacWAM modeling because water contributions from these projects would begin toward the end of the 8-year period. Therefore, effects of these projects on Sacramento/Delta water supplies are not evaluated in this section.

9.5.4.2 Total Sacramento/Delta Water Supply

Water supply originating in the Sacramento/Delta is used for agricultural, urban (municipal and industrial), and wildlife refuge uses both within and outside of the Sacramento/Delta watershed. Implementation of the proposed VAs could result in changes in Sacramento/Delta water supply. Figure 9.5-23 presents SacWAM results for total Sacramento/Delta surface water supply in the study area under baseline and the proposed VAs, by water year type. Overall, implementation of the proposed VAs are estimated to result in an average annual reduction of Sacramento/Delta surface water supply of approximately 123 TAF per year for the entire study area. As discussed below, most of the reductions in Sacramento/Delta surface water supply occur in the Sacramento/Delta watershed, but reductions in water supplies to other regions could also occur.

The results for the proposed VAs presented in Figure 9.5-23 and Table 9.5-45 below consider changes in water supply as a result of flow assets that would be provided through flow commitments on the VA tributaries, CVP/SWP export reductions identified in the VA Term Sheet, and water purchase programs, including unspecified water purchases. As discussed above, the unspecified water purchases could be provided from willing sellers in the Sacramento/Delta watershed, or from export reductions. Unspecified water purchases could also be provided through a combination of willing sellers in the Sacramento/Delta watershed and from export reductions. The VA results presented in Figure 9.5-23 and Table 9.5-45 do not distinguish between the "VA Low Sac/Delta Supply" and "VA High Export Cuts" scenarios because the effect on the total water supply would be the same. As such, water supply results for the proposed VAs shown below in Figure 9.5-23 and Table 9.5-45 are labeled as "VA."

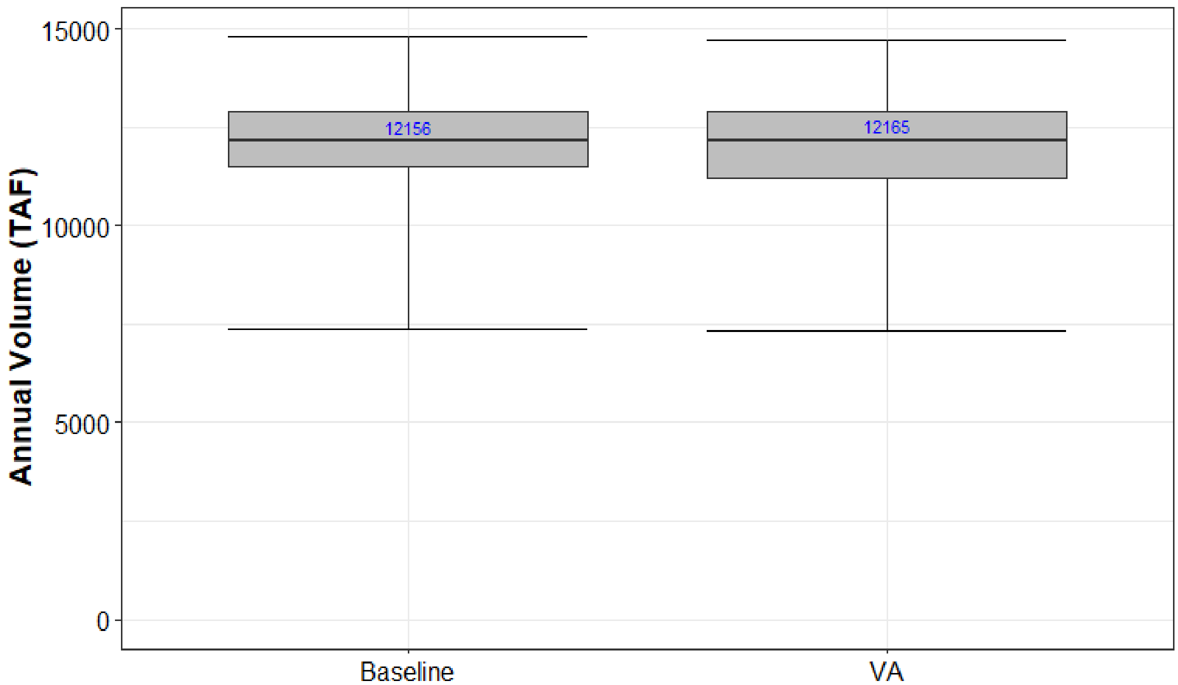


Figure 9.5-23. Annual Total Sacramento/Delta Surface Water Supply Under Baseline and Proposed VAs

Table 9.5-45. Annual Total Sacramento/Delta Supply under Baseline and Proposed VAs (TAF/yr)

Water Year Type	Baseline	Proposed VA: Change from Baseline
C	9,305	-81
D	11,563	-306
BN	12,149	-132
AN	12,334	-184
W	13,394	22
All	11,957	-123

9.5.4.3 Sacramento/Delta Supply to Sacramento River Watershed, Delta, and Delta Eastside Tributaries Regions (Sacramento/Delta watershed)

This section presents changes in Sacramento/Delta water supply for the proposed VAs for the Sacramento/Delta watershed, which includes the Sacramento River watershed, Delta, and Delta eastside tributaries regions.

Overall, the proposed VAs would result in a reduction in Sacramento/Delta surface water supplies within the Sacramento/Delta watershed. Figure 9.5-24 and Table 9.5-46 present SacWAM results for the total Sacramento/Delta surface water supply in the Sacramento/Delta watershed under baseline and the proposed VAs. Figure 9.5-24 and Table 9.5-46 present results that capture the range of changes in Sacramento/Delta surface water supplies that could occur within the Sacramento/Delta watershed under the proposed VAs. In the below figure, the “VA” scenario assumes that unspecified water purchases are provided entirely through reductions in Delta exports, and the "VA Low Sac/Delta Supply" scenario assumes that the unspecified water purchases are provided entirely from willing sellers in the Sacramento/Delta watershed and would affect agricultural uses. Because it is possible that unspecified water purchases would be provided through a combination of inflow sources within the Sacramento/Delta watershed and reductions in exports, the actual future condition could be between these two scenarios. Overall, the proposed VAs would be expected to result in a decrease in Sacramento/Delta surface water supply within the Sacramento/Delta watershed of approximately 92-205 TAF per year on average or approximately 1-3% of the total Sacramento/Delta surface water supply used within the Sacramento/Delta watershed. The largest reduction would be expected to occur in dry years where the supply is estimated to be reduced by 174-332 TAF, or approximately 2-5% of the total Sacramento/Delta surface water supply used within the Sacramento/Delta watershed.

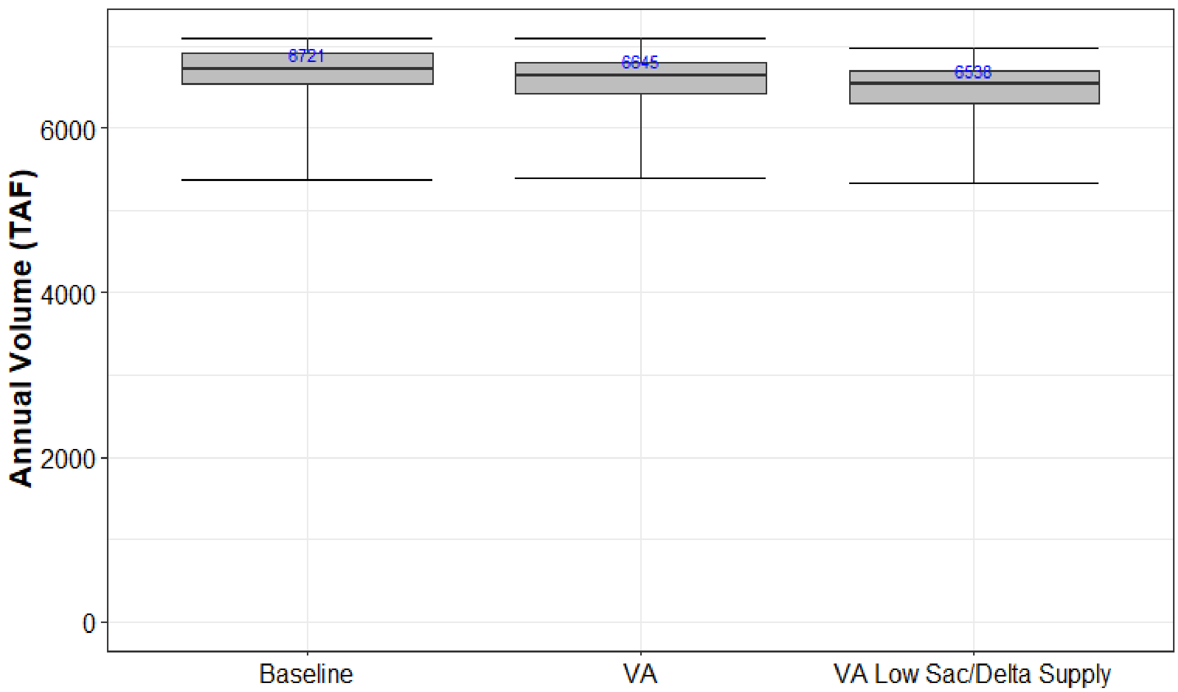


Figure 9.5-24. Annual Total Sacramento/Delta Supply to the Sacramento/Delta Watershed under Baseline and Proposed VAs

Table 9.5-46. Annual Total Sacramento/Delta Supply to the Sacramento/Delta Watershed under Baseline and Proposed VAs (TAF/yr)

Water Year Type	Baseline	Proposed VA: Change from Baseline	VA Low Sac/Delta Supply: Change from Baseline
C	6,234	-19	-84
D	6,710	-174	-332
BN	6,822	-156	-225
AN	6,771	-154	-290
W	6,769	-4	-127
All	6,680	-92	-205

Figure 9.5-25, Figure 9.5-26, Figure 9.5-27, Table 9.5-47, Table 9.5-48, and Table 9.5-49 present results for annual Sacramento/Delta supply to agricultural, municipal, and wildlife refuges uses within the Sacramento/Delta watershed. Consistent with the results presented above for total Sacramento/Delta surface water supply to the Sacramento/Delta watershed, the "VA" scenario assumes that unspecified water purchases are provided entirely through reductions in Delta exports, and the "VA Low Sac/Delta Supply" scenario assumes that the unspecified water purchases are provided entirely from willing sellers in the Sacramento/Delta watershed and would affect agricultural uses. Because it is possible that unspecified water purchases would be provided through a combination of inflow sources within the Sacramento/Delta watershed and reductions in exports, the actual future condition could be between these two scenarios.

Overall, these results show that reductions in Sacramento/Delta supply within the Sacramento/Delta watershed would be expected to primarily affect agricultural uses with an average reduction of 84-198 TAF/yr. The SacWAM results show that Sacramento/Delta supply for municipal uses within the Sacramento/Delta watershed would be expected to decrease by 8 TAF/yr on average. There would be no expected change in refuge water supplies within the Sacramento/Delta watershed as a result of the proposed VAs.

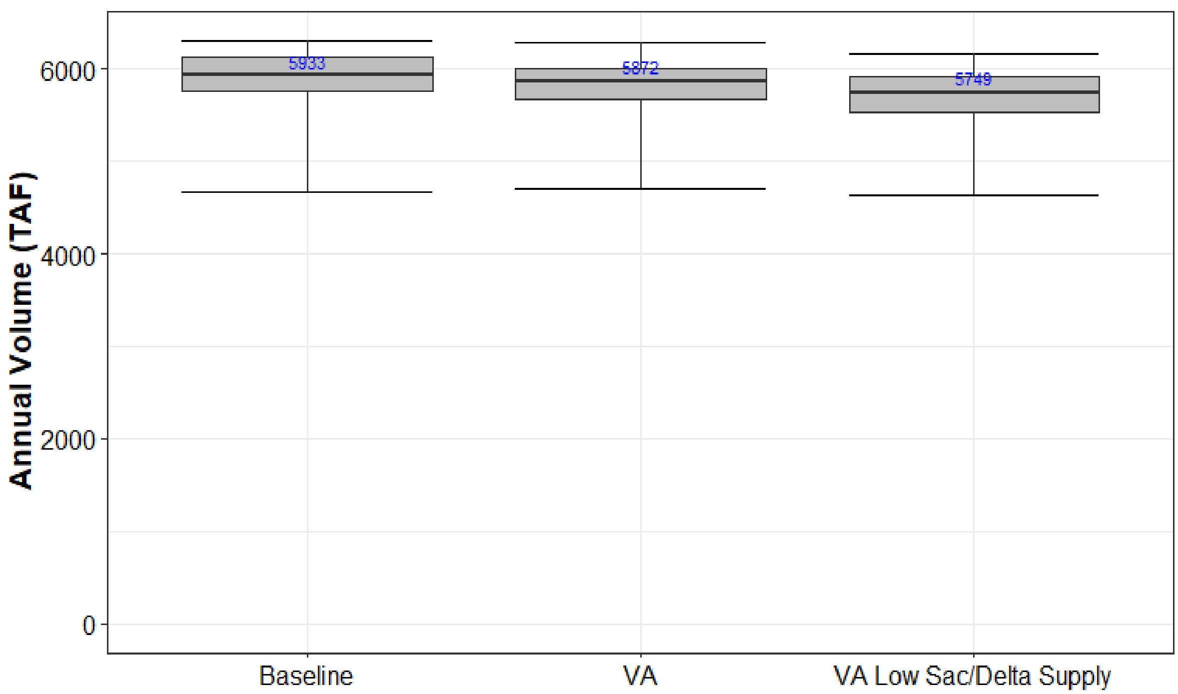


Figure 9.5-25. Annual Sacramento/Delta Supply to Agriculture in the Sacramento/Delta Watershed under Baseline and Proposed VAs

Table 9.5-47. Annual Sacramento/Delta Supply to Agriculture in the Sacramento/Delta Watershed under Baseline and Proposed VAs (TAF/yr)

Water Year Type	Baseline	Proposed VAs: Change from Baseline	VA Low Sac/Delta Supply: Change from Baseline
C	5,493	-8	-73
D	5,939	-151	-309
BN	6,039	-155	-224
AN	5,984	-152	-288
W	5,973	-3	-126
All	5,901	-84	-198

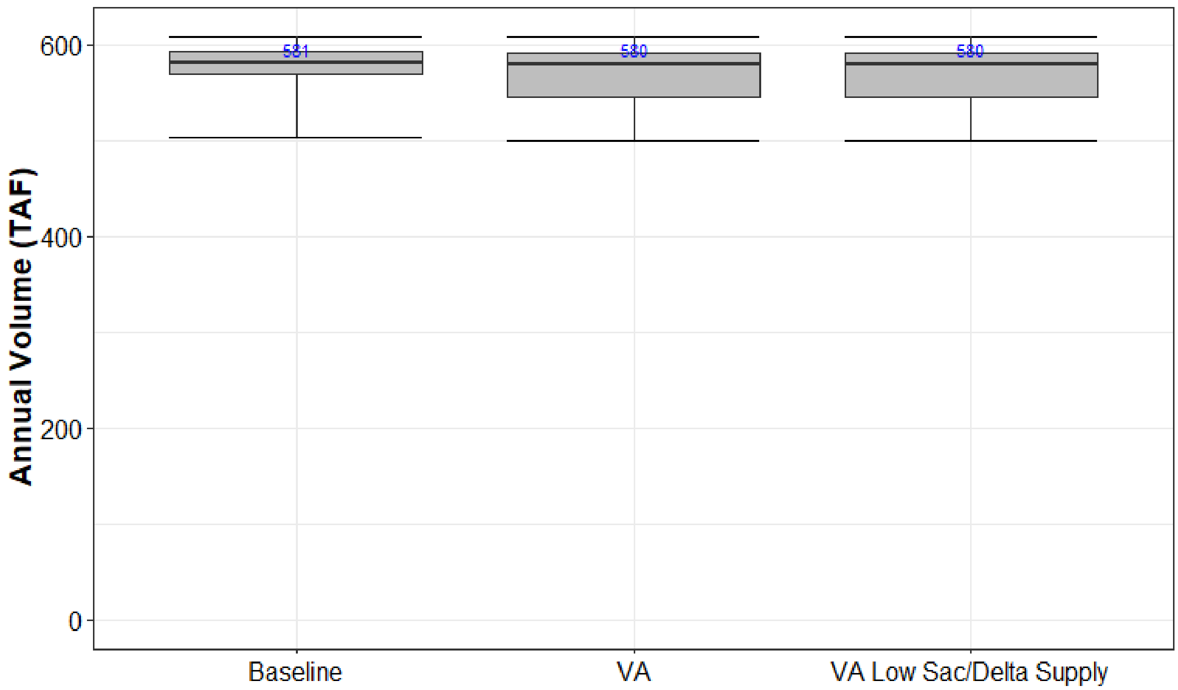


Figure 9.5-26. Annual Sacramento/Delta Supply to Municipal and Industrial Uses in the Sacramento/Delta Watershed under Baseline and Proposed VAs

Table 9.5-48. Annual Average Sacramento/Delta Supply to Municipal and Industrial Uses in the Sacramento/Delta Watershed under Baseline and Proposed VAs (TAF/yr)

Water Year Type	Baseline	Proposed VAs: Change from Baseline	VA Low Sac/Delta Supply: Change from Baseline
C	546	-12	-12
D	570	-23	-23
BN	582	0	0
AN	588	-2	-2
W	597	-1	-1
All	579	-8	-8

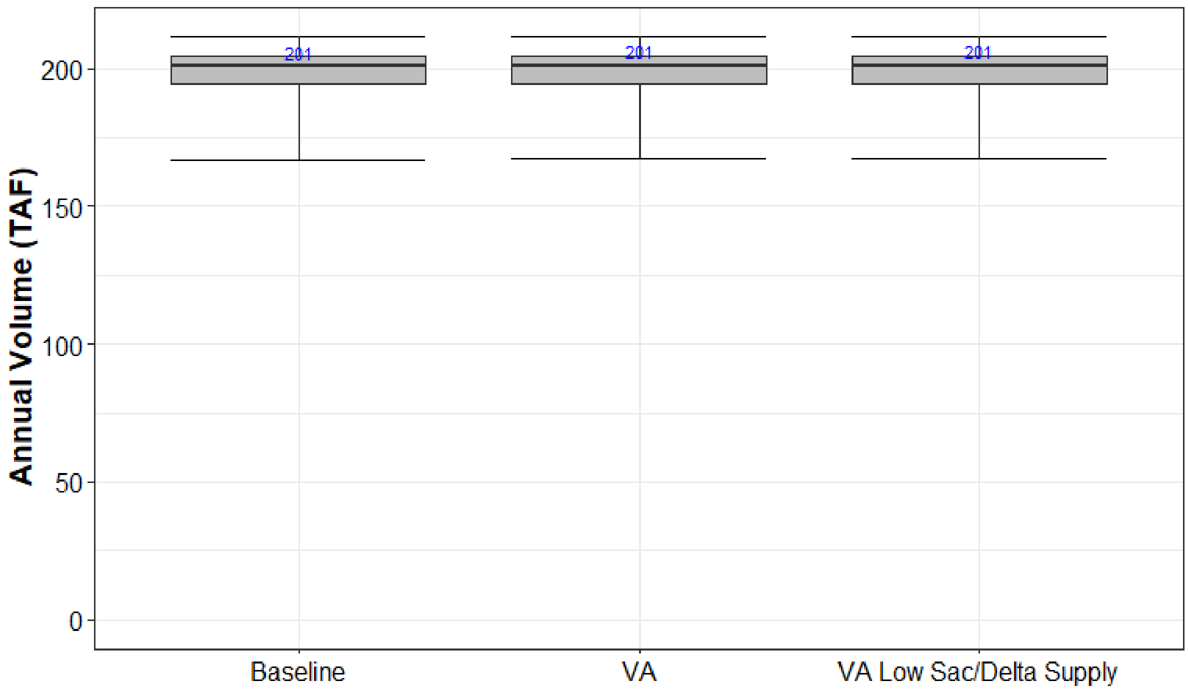


Figure 9.5-27. Annual Sacramento/Delta Supply to Wildlife Refuges in the Sacramento/Delta Watershed under Baseline and Proposed VAs

Table 9.5-49. Annual Sacramento/Delta Supply to Wildlife Refuges in the Sacramento/Delta Watershed under Baseline and Proposed VAs (TAF/yr)

Water Year Type	Baseline	Proposed VAs: Change from Baseline	VA Low Sac/Delta Supply: Change from Baseline
C	194	0	0
D	201	0	0
BN	201	0	0
AN	199	0	0
W	199	0	0
All	199	0	0

9.5.4.4 Sacramento/Delta Supply to San Joaquin Valley

This section presents SacWAM results for changes in Sacramento/Delta water supply to the San Joaquin Valley under the proposed VAs. As discussed in Chapter 6, *Changes in Hydrology and Water Supply*, the San Joaquin Valley region includes the watershed of the San Joaquin River upstream of the Delta and the Tulare Lake Basin. With respect to the SacWAM model domain, this includes WBA 61N and the primarily agricultural demands served by Central Valley Project and State Water Project deliveries to the San Joaquin Valley and Tulare Lake. WBA 61N is defined by the Stanislaus River to the South, and the boundaries of Oakdale Irrigation District and South San Joaquin Irrigation District to the North. Supplies to WBA 61N demands are from the Lower San Joaquin River and its tributaries and are unchanged in the modeled scenarios. As with other regions that receive some of their supply as exports from the Delta, the only portion of the supply that is analyzed here is the portion that was exported from the Delta (and to WBA 61N discussed above).

Figure 9.5-28 and Table 9.5-50 present SacWAM results for total Sacramento/Delta supplies to the San Joaquin Valley region under baseline and the proposed VAs. The results identified as "VA" below assume that unspecified water purchases would be provided entirely from willing sellers in the Sacramento/Delta watershed, and the results identified as "VA High Export Cuts" assume that all unspecified water purchases would be provided through reductions in Delta exports to agricultural users in the San Joaquin Valley. Because it is possible that unspecified water purchases would be provided through a combination of inflow sources within the Sacramento/Delta watershed and reductions in exports, the actual future condition could be between these two conditions.

Overall, these results show that the proposed VAs could result in a change in total Sacramento/Delta supplies to the San Joaquin Valley region, and the overall effect would be dependent on the sources of the unspecified water purchases, which are not fully known at this time. Under the proposed VAs, changes in Sacramento/Delta supplies to the San Joaquin Valley region could range from an average annual increase of up to 46 in TAF/yr or an average annual decrease of up to 68 TAF/yr. As described above in Section 9.5.3.9, *Delta Inflows, Exports, Interior Delta Flows, and Delta Outflow Results*, any increases in exports and associated supplies would not be the direct result of adding the VAs to the Bay-Delta Plan. The VAs would not change any of the existing requirements in the Bay-Delta Plan, including limits on exports. However, the VAs are assumed to be additive to the 2019 BiOps without the constraints of the 2020 ITP or recent court orders that limit exports as a function of San Joaquin River flows. The BiOps and ITP are currently under reconsultation and it is not clear what the outcome of that process will be. Accordingly, it is not clear whether the modeled increases in exports would actually occur. Further, accounting for the VA flows is being developed for approval by the State Water Board that may affect these results.

Figure 9.5-29, Figure 9.5-30, Table 9.5-51, and Table 9.5-52 present results for Sacramento/Delta supplies for agricultural and municipal uses in the San Joaquin Valley region under the proposed VAs. Consistent with the results presented for the total Sacramento/Delta supply to the San Joaquin Valley, the results identified as "VA" below assume that unspecified water purchases would be provided entirely from willing sellers in the Sacramento/Delta watershed, and the results identified as "VA High Export Cuts" assume that all unspecified water purchases would be provided through reductions in Delta exports to agricultural users in the San Joaquin Valley. Unspecified water purchases could be provided through a combination of inflow sources within the Sacramento/Delta watershed and reductions in exports, and the actual future condition could be between these two conditions.

These results show that Sacramento/Delta supply for agricultural uses could change under the proposed VAs, and the overall effect would be dependent on the sources of the unspecified water purchases consistent with the results for total Sacramento/Delta supply to the San Joaquin region. Under the proposed VAs, changes in Sacramento/Delta supplies for agricultural uses in the San Joaquin Valley region could range from an average annual increase of up to 46 TAF/yr and an average annual decrease of up to 69 TAF/yr. Again, as described above and in Section 9.5.3.9, Delta Inflows, Exports, Interior Delta Flows, and Delta Outflow Results, any increases in exports and associated supplies would not be the direct result of adding the VAs to the Bay-Delta Plan but the possible result of changes in BiOp and ITP related constraints that are not clear at this time. Further, accounting for the VA flows is being developed for approval by the State Water Board that may affect these results.

Because the Sacramento/Delta water supply reductions under the proposed VAs would be based on voluntary measures that would be largely or entirely from agricultural supplies, reservoir reoperations, or based on groundwater substitution, the proposed VAs would not be expected to result in substantial changes in Sacramento/Delta supplies to municipal uses in the San Joaquin Valley region. Figure 9.5-31 and Table 9.5-53 show that under the proposed VAs, changes in Sacramento/Delta supplies to municipal uses would be expected to be negligible.

There are no anticipated changes in Sacramento/Delta supply to wildlife refuges in the San Joaquin Valley region.

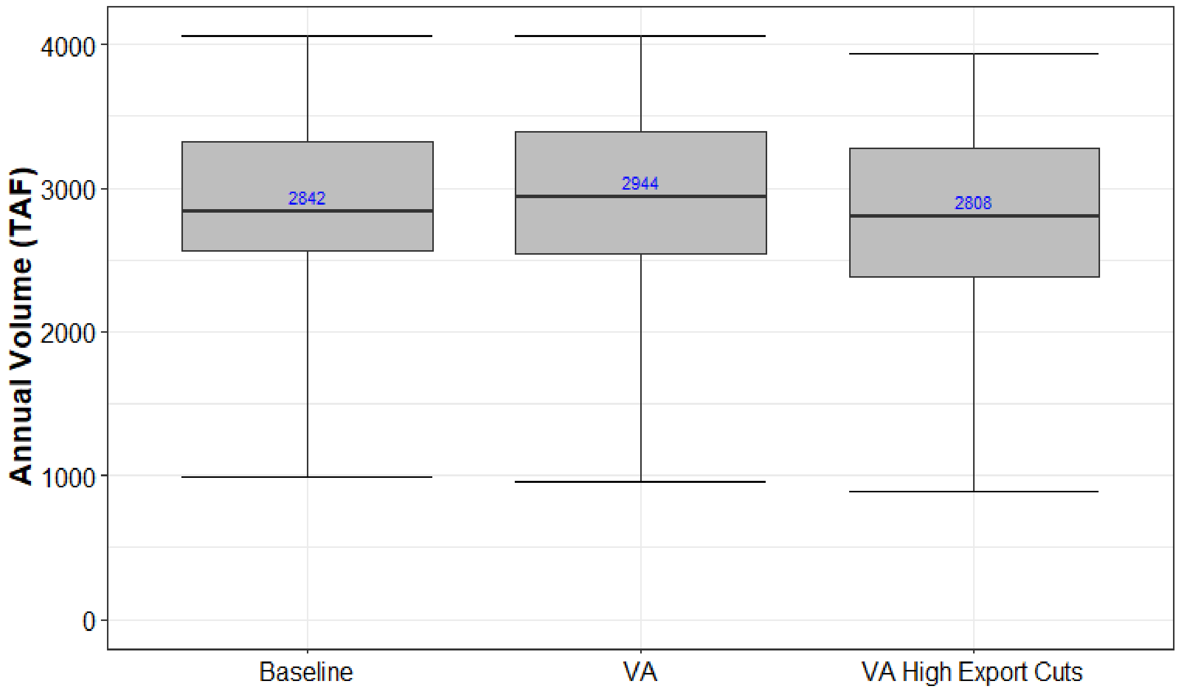


Figure 9.5-28. Annual Sacramento/Delta Supply to the San Joaquin Valley Region under Baseline and Proposed VAs

Table 9.5-50. Annual Sacramento/Delta Supply to the San Joaquin Valley Region (TAF/yr)

Water Year Type	Baseline	Proposed VAs: Change from Baseline	VA High Export Cuts: Change from Baseline
C	1,713	-29	-94
D	2,630	2	-156
BN	2,810	68	-1
AN	2,940	44	-92
W	3,507	105	-18
All	2,819	46	-68

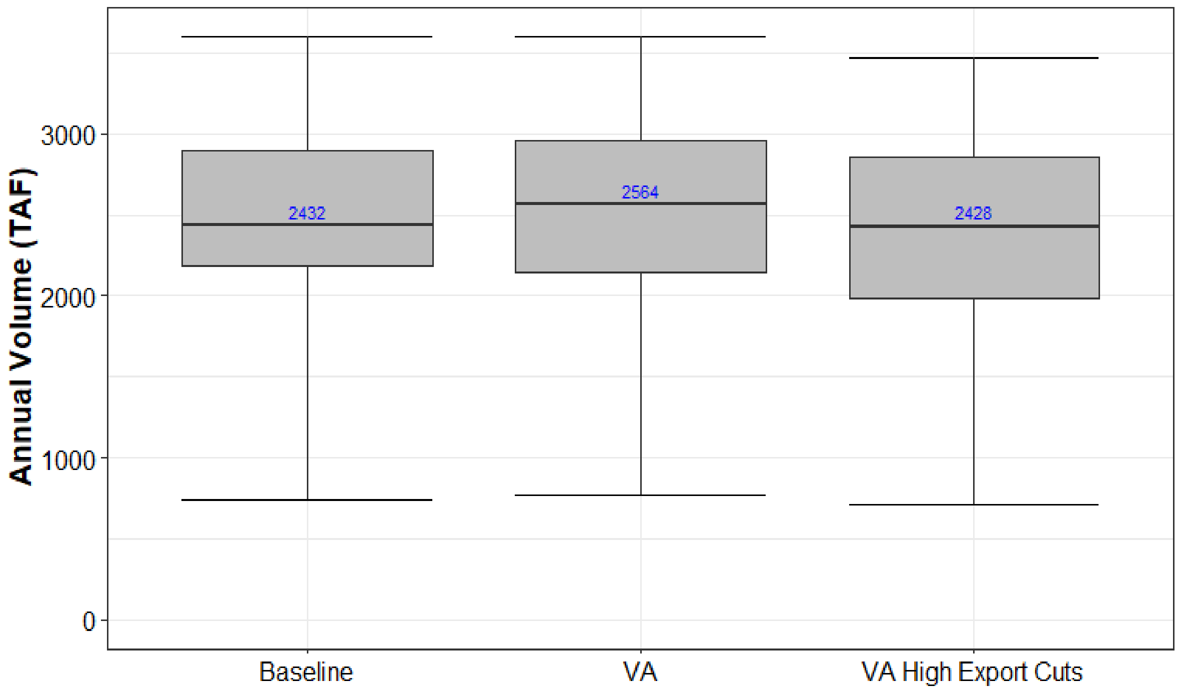


Figure 9.5-29. Annual Sacramento/Delta Supply to Agriculture in the San Joaquin Valley Region under Baseline and Proposed VAs

Table 9.5-51. Annual Sacramento/Delta Supply to Agriculture in the San Joaquin Valley Region (TAF/yr)

Water Year Type	Baseline	Proposed VAs: Change from Baseline	VA High Export Cuts: Change from Baseline
C	1,404	-25	-90
D	2,237	2	-156
BN	2,406	62	-7
AN	2,530	46	-90
W	3,069	101	-22
All	2,422	44	-69

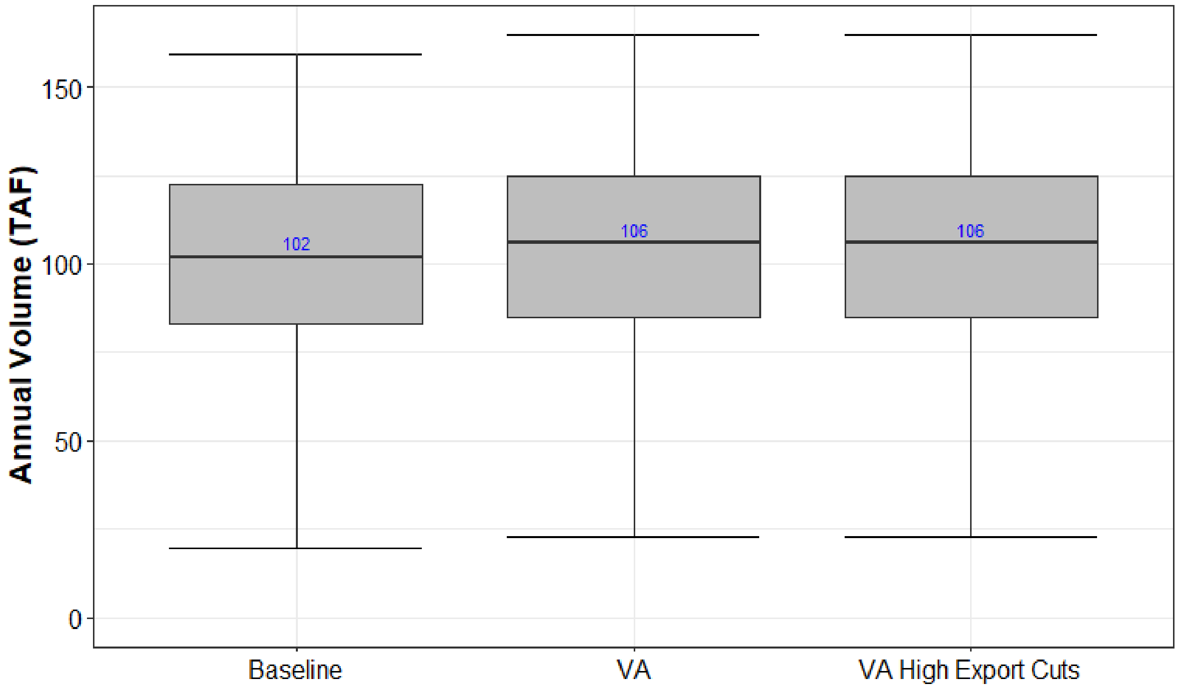


Figure 9.5-30. Annual Sacramento/Delta Supply to Municipal and Industrial Uses in the San Joaquin Valley Region under Baseline and Proposed VAs

Table 9.5-52. Annual Sacramento/Delta Supply to Municipal and Industrial Uses in the San Joaquin Valley Region (TAF/yr)

Water Year Type	Baseline	Proposed VAs: Change from Baseline	VA High Export Cuts: Change from Baseline
C	46	2	2
D	89	1	1
BN	101	3	3
AN	107	2	2
W	130	4	4
All	99	2	2

9.5.4.5 Sacramento/Delta Supply to San Francisco Bay Area, Central Coast, and Southern California

This section summarizes SacWAM model results for changes in Sacramento/Delta surface water supply to the San Francisco Bay Area, Central Coast, and Southern California under the proposed VAs. Model results are presented for changes in total Sacramento/Delta supply, and by sector.

Figure 9.5-31 presents SacWAM results for total Sacramento/Delta supplies to the San Francisco Bay Area, Central Coast, and Southern California regions. Table 9.5-53 also presents results for Sacramento/Delta supply to the San Francisco Bay Area, Central Coast, and Southern California regions under the proposed VAs, and presents results as the average change from baseline by water year type. The results identified as “VA” assume that unspecified water purchases would be provided entirely from willing sellers in the Sacramento/Deleta watershed, and the results identified as “VA High Export Cuts” assume that all unspecified water purchases would be provided through reductions in Delta exports to agricultural users in the San Joaquin Valley. Because it is assumed that unspecified water purchases would not be provided from users in these regions, results presented for changes in water supply to the San Francisco Bay Area, Central Coast, and Southern California are the same under the “VA” and “VA High Export Cuts” scenarios.

These results show that total Sacramento/Delta supplies to these regions is similar under baseline and under the proposed VAs, at approximately 2.6 MAF on average. The SacWAM results suggest that the Sacramento/Delta supplies to these regions could increase slightly under the proposed VAs. Again, as described above and in Section 9.5.3.9, *Delta Inflows, Exports, Interior Delta Flows, and Delta Outflow Results*, any increases in exports and associated supplies would not be the direct result of adding the VAs to the Bay-Delta Plan but the possible result of changes in BiOp and ITP related constraints that are not clear at this time. Further, accounting for the VA flows is being developed for approval by the State Water Board that may affect these results.

Figure 9.5-32, Figure 9.5-33, Table 9.5-54, and Table 9.5-54 present results for Sacramento/Delta supplies for agricultural and municipal uses and show that Sacramento/Delta water supply to both agricultural and municipal uses could increase slightly under the proposed VAs. Again, as described above and in Section 9.5.3.9, *Delta Inflows, Exports, Interior Delta Flows, and Delta Outflow Results*, any increases in exports and associated supplies would not be the direct result of adding the VAs to the Bay-Delta Plan but the possible result of changes in BiOp and ITP related constraints that are not clear at this time. Further, accounting for the VA flows is being developed for approval by the State Water Board that may affect these results.

Results for changes in Sacramento/Delta supply to wildlife refuges in the San Francisco Bay Area, Central Coast, and Southern California are not provided because Sacramento/Delta water supply is not provided to wildlife refuges in these regions.

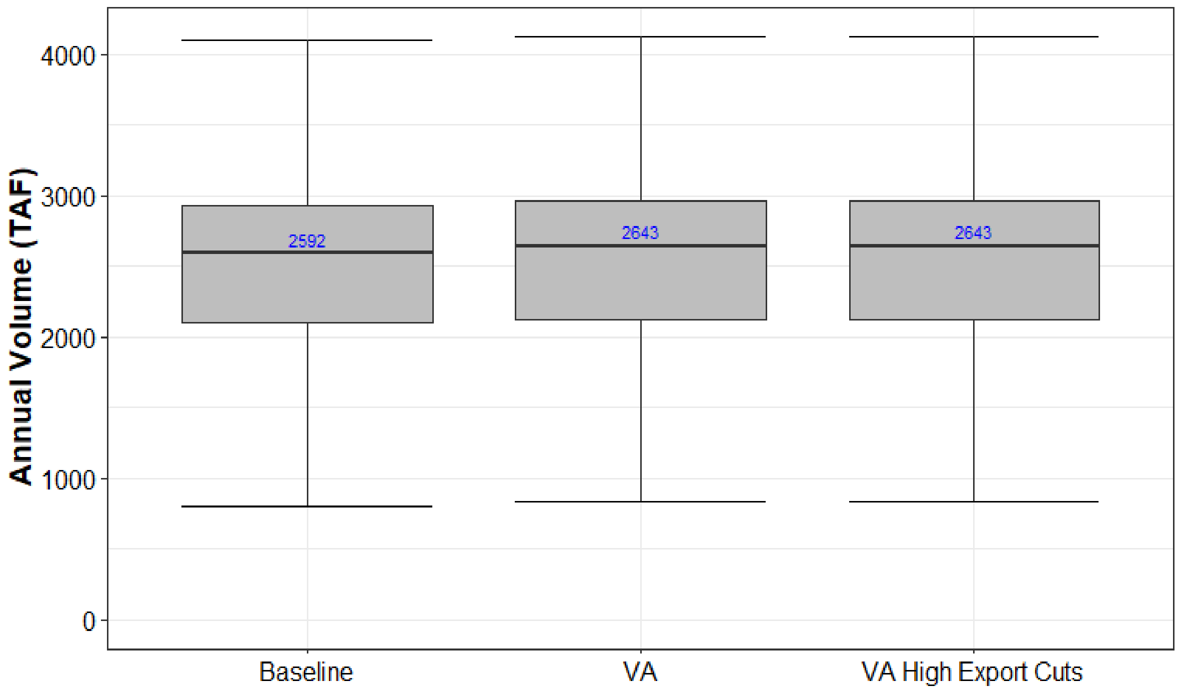


Figure 9.5-31. Annual Sacramento/Delta Supply to San Francisco Bay Area, Central Coast and Southern California Regions under Baseline and Proposed VAs

Table 9.5-53. Change in Annual Sacramento/Delta Supply to San Francisco Bay Area, Central Coast and Southern California Regions (TAF/y)

Water Year Type	Baseline	Proposed VAs: Change from Baseline	VA High Export Cuts: Change from Baseline
C	1,358	32	32
D	2,223	24	24
BN	2,517	26	26
AN	2,622	62	62
W	3,118	44	44
All	2,458	37	37

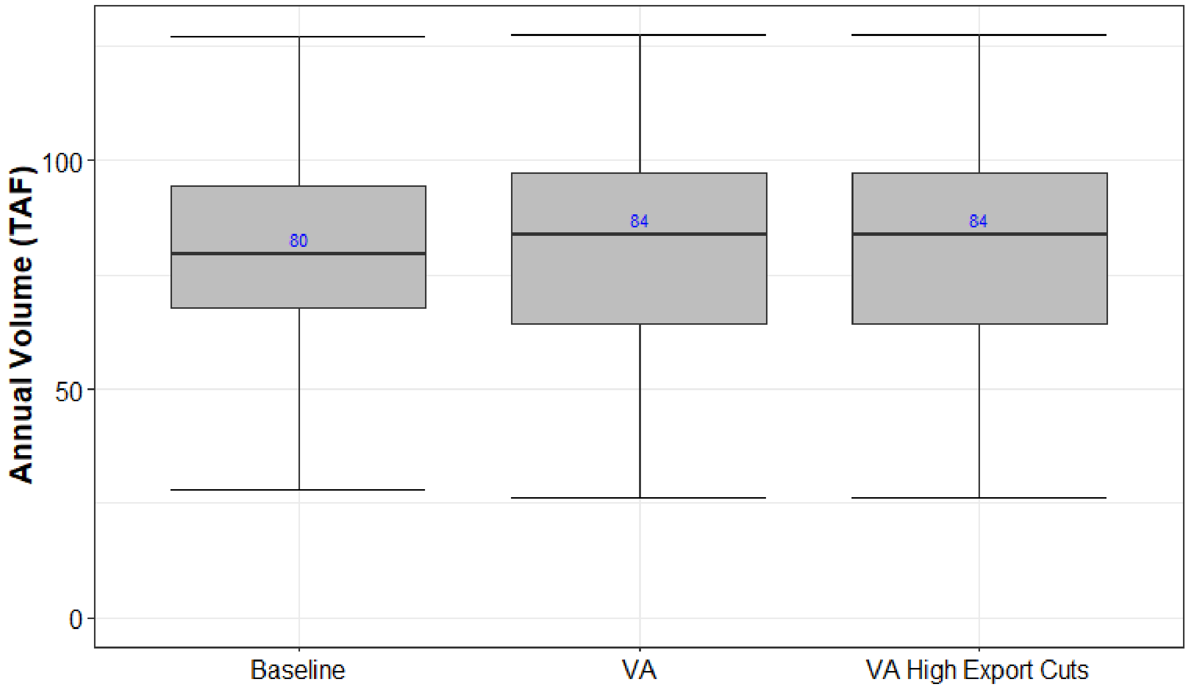


Figure 9.5-32. Annual Sacramento/Delta Supply to Agriculture in the San Francisco Bay Area, Central Coast, and Southern California Regions under Baseline and Proposed VAs

Table 9.5-54. Annual Sacramento/Delta Supply to Agriculture in the San Francisco Bay Area, Central Coast, and Southern California Regions (TAF/yr)

Water Year Type	Baseline	Proposed VAs: Change from Baseline	VA High Export Cuts: Change from Baseline
C	47	-1	-1
D	71	0	0
BN	78	2	2
AN	80	2	2
W	100	3	3
All	78	1	1

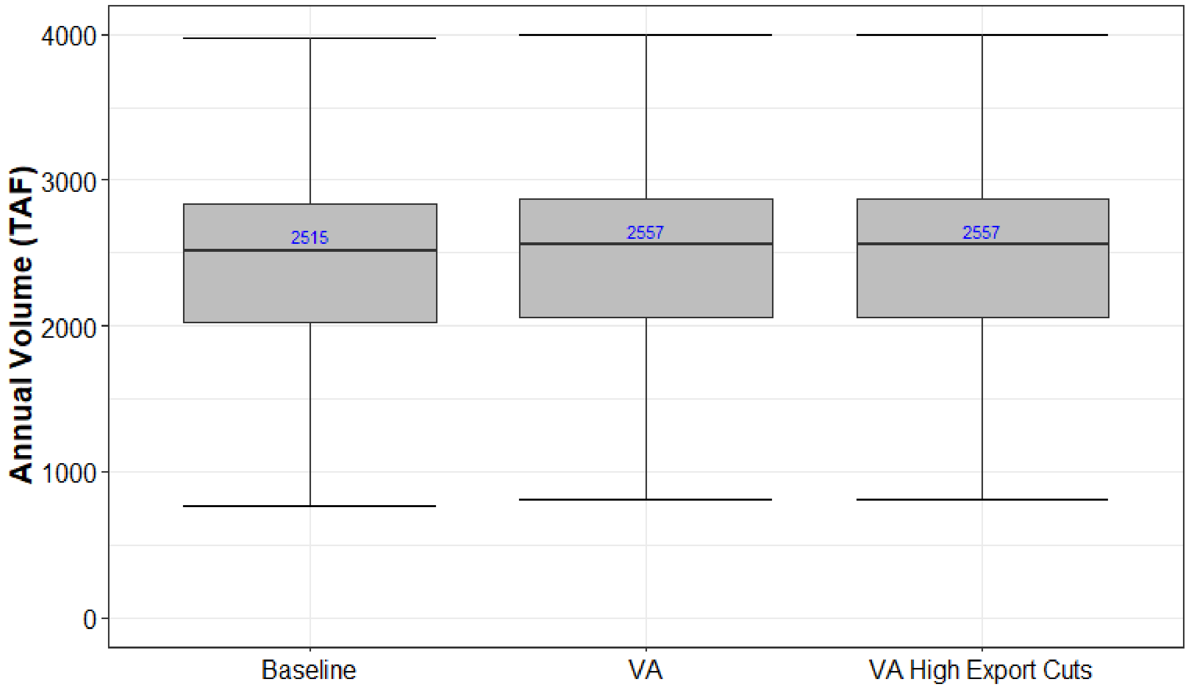


Figure 9.5-33. Annual Sacramento/Delta Supply to Municipal and Industrial Uses in the San Francisco Bay Area, Central Coast, and Southern California Regions under Baseline and Proposed VAs

Table 9.5-55. Annual Sacramento/Delta Supply to Municipal and Industrial uses in the San Francisco Bay Area, Central Coast, and Southern California Regions (TAF/yr)

Water Year Type	Baseline	Proposed VAs: Change from Baseline	VA High Export Cuts: Change from Baseline
C	1,311	33	33
D	2,152	24	24
BN	2,439	24	24
AN	2,542	60	60
W	3,018	41	41
All	2,380	35	35

9.5.4.6 Summary of SacWAM Changes in Water Supply

Overall, the SacWAM results displayed above show that implementation of the proposed VAs could result in changes in Sacramento/Delta surface water supplies to regions within and outside of the Sacramento/Delta watershed. Overall, implementation of the proposed VAs would result in an average annual reduction in Sacramento/Delta surface water supply for the entire study area. Most of the reductions in Sacramento/Delta surface water supplies would occur for users within the Sacramento/Delta watershed. As discussed above, the proposed VAs include new flow commitments from the Sacramento River, American River, Feather River, Mokelumne River, Yuba River, and Putah Creek (VA tributaries). The proposed VAs also include flows that would be provided through

CVP/SWP export reductions and through water purchase programs. The sources for the PWA Water Purchase Fixed Price Program are identified and as such are modeled. However, the unspecified water purchases (PWA Water Purchase Market Price Program and permanent state water purchases) would be from unspecified willing sellers, which could include inflow sources within the Sacramento/Delta watershed or reductions in exports, both of which could result in additional Delta outflows. Because the unspecified water purchases under the VAs could be provided from reductions in exports or increases in inflows, the water supply effects of both of these scenarios are evaluated. Because it is possible that unspecified water purchases could be provided through a combination of inflow sources within the Sacramento/Delta watershed and reductions in exports, the actual future condition could be between these two scenarios. Regardless of the source of the unspecified flow assets, the overall effect would be an average annual reduction in Sacramento/Delta surface water supply for the entire study area.

Sacramento/Delta water supply reductions under the proposed VAs would be based on voluntary measures that would be largely or entirely from agricultural supplies, reservoir reoperations, or groundwater substitution. The SacWAM results for the Sacramento/Delta watershed also show that Sacramento/Delta water supply reductions would primarily affect agricultural uses. The SacWAM results for the Sacramento/Delta watershed show that there could be a very small reduction in water supply for municipal use, and there would be no change in water supply to wildlife refuge uses.

The VA proposal identifies that some flow assets could be provided through groundwater substitution, including in basins subject to the Sustainable Groundwater Management Act (SGMA) where that is consistent with local management under SGMA. The SacWAM modeling considers that some flows could be provided through groundwater substitution in the American River watershed consistent with the VA documents. Flows in other watersheds could also be provided through groundwater substitution, but sufficient information is not available at this time to include additional groundwater substitution in the modeling. If additional flows are made available through groundwater substitution, water supply reductions for the Sacramento/Delta watershed would be less, and associated effects such as land fallowing would be reduced.

9.6 Beneficial Environmental Effects of Proposed VAs

A Final Draft Scientific Basis Report Supplement) has been prepared to document the science supporting the proposed VAs (Appendix G2). The Final Draft Scientific Basis Report Supplement builds on the 2017 Scientific Basis Report, particularly with additional scientific information supporting specific flow and non-flow physical habitat restoration actions in the tributaries, flood bypasses, and Delta outlined in the proposed VAs.

The Final Draft Scientific Basis Report Supplement was developed by State Water Board staff in collaboration with staff from CDFW (lead for aquatic ecosystem stressors analysis and description of VA assets on the Sacramento River and tributaries) and DWR (lead for aquatic ecosystem stressors in the Bay-Delta Estuary, hydrology and modeling, analytical approach, and anticipated VA outcomes). Previously, the Draft Scientific Basis Report Supplement was made available for public comment from January 5 to February 8, 2023, including a Board Workshop on January 19, 2023. Following receipt of public comments, the draft was revised as appropriate (see Chapter 1 of the Final Draft Scientific Basis Report Supplement for an overview of how comments were addressed) and the Final Draft Scientific Basis Report Supplement will be submitted for peer review pursuant to the requirements of California Public Health and Safety Code (section 57004), which requires that the scientific basis of any statewide plan, basin plan, plan amendment, guideline, policy, or regulation undergo external scientific peer review before adoption. In addition to documenting possible benefits of the proposed VAs for native fish species, the Final Draft Scientific Basis Report Supplement documents Traditional Ecological Knowledge (TEK) from California Native American Tribes within the Bay-Delta Watershed to inform reasonable protection of beneficial uses, including Tribal Beneficial Uses (TBUs) of Tribal Traditional Culture, Tribal Subsistence Fishing, and Subsistence Fishing (State Water Board 2020), in the event that these beneficial uses are incorporated into the Bay-Delta Plan. TEK could also inform adaptive management of the proposed VAs if they are adopted, through engagement by VA Parties with California Native American Tribes. As described further in the Final Draft Scientific Basis Report Supplement and the 2017 Scientific Basis Report, native aquatic species have been declining in tributaries and the Bay-Delta due to anthropogenic stressors, including degradation of habitat and changes in flows. These aquatic ecosystem stressors have also impacted the physical well-being and spiritual, and cultural uses of water by California Native American Tribes (see Chapter 2 of the Final Draft Scientific Basis Report Supplement for details on stressors impacting native species that are culturally significant to tribes).

The Final Draft Scientific Basis Report Supplement evaluates potential benefits of the VAs relative to the 2008-2009 BiOps condition, which is referred to as the “reference condition” in the Final Draft Scientific Basis Report Supplement. It includes quantitative evaluations of the projected changes in habitat provided for native species from VA proposed flows and physical habitat restoration actions. Suitable habitat for spawning and rearing habitat was defined by velocity, depth, temperature, and cover criteria, while suitable habitat for estuarine species was defined by salinity, temperature, and turbidity criteria. Habitat acreage that does not meet all applicable criteria is not quantified in these results but may provide some partial benefits. The Final Draft Scientific Basis Report Supplement also includes quantitative evaluations of projected changes in native species abundance indices and the frequency of ecological flow thresholds with VA proposed flows. These same analytical methods are used in Chapter 3, *Scientific Knowledge to Inform Fish and Wildlife Flow Recommendations*, to evaluate the benefits of the proposed Plan amendments described in Chapter 5, *Proposed Changes to the Bay-Delta Plan for the Sacramento/Delta*. In addition, a qualitative literature review was conducted to evaluate possible benefits of the proposed VAs where no quantitative models exist (see Chapter 4 of the Final Draft Scientific Basis Report Supplement for details on hydrological modeling and Chapter 5 of the Final Draft Scientific Basis Report Supplement for details on the analytical approach to evaluating the benefits of the VAs). The quantitative analyses indicate expected increases in suitable spawning and rearing habitat for salmonids and increases in suitable habitat and population abundance indices for estuarine species. Fall-Run and Spring Run Chinook Salmon (only analyzed for the Sacramento River) spawning (Figure 9.6-1 and Table 9.6-1), instream rearing (Figure 9.6-2 and Table 9.6-2), and floodplain (Table 9.6-2) habitats are expected to contribute toward the VA narrative objectives. However, the magnitude of increase varies with water year type and tributary such that not all habitat categories will have increases in all water year types.

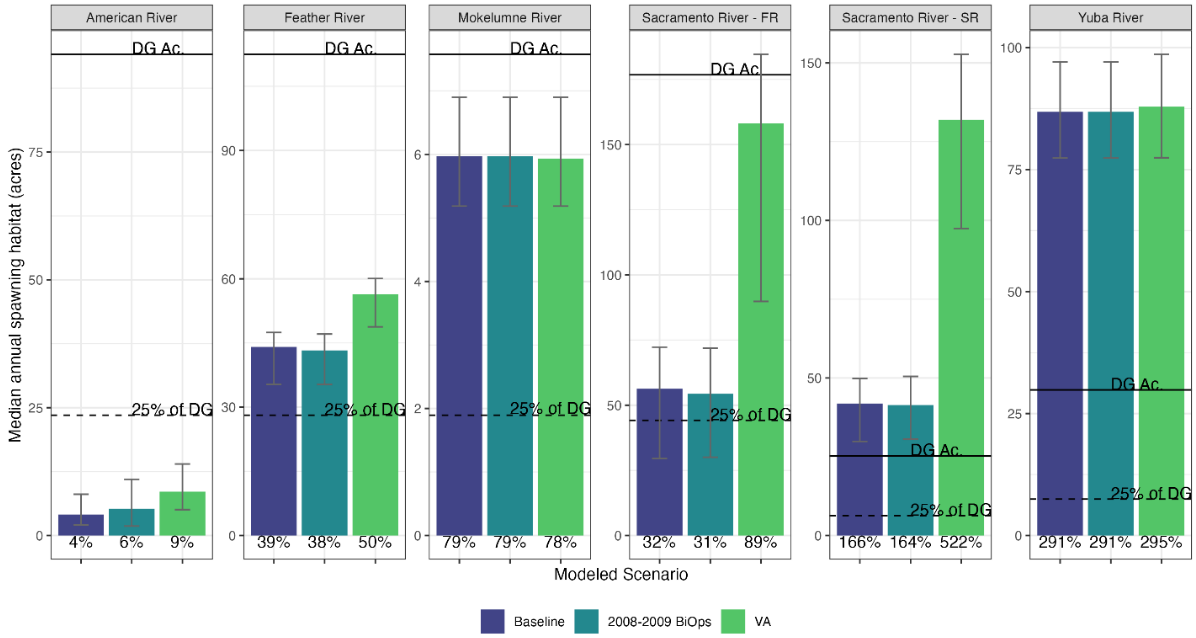


Figure 9.6-1. Median (across All Years) Spawning Habitat (Acres) under the 2008–2009 BiOps Condition and VA Scenarios for Each Watershed

Results shown in Figure 9.6-1 are presented for fall-run in all tributaries and for spring-run in the Sacramento River. Solid lines represent area of habitat required to support the doubling goal (DG) population, and dashed lines represent 25% of the doubling goal area. The amount of habitat as a percentage of the habitat needed to support the doubling goal is printed below each bar. Medians and quantiles were calculated across all years; therefore, the quantiles represent year-to-year variability, not the full uncertainty in expected outcomes.

Table 9.6-1. Spawning Habitat Results Compared to the VA Term Sheet Commitments and the Habitat Required to Support 25 Percent of the Doubling Goal

		Modeled Results (habitat suitable by depth, velocity, and temperature criteria)				
Watershed	Acres Proposed in VA Term Sheet	Acres to support 25% of doubling goal	Median Acres baseline	Median Acres 2008-2009 BiOps condition	Acres added by VA	Median Total Acres with VA
American River	25	23.5	4.09	5.22	4.48	8.57
Feather	15	28	44.08	43.25	12.31	56.39
Mokelumne	0	2	5.97	5.97	-0.04	5.93
Sac River - FR	113.5	44.25	56.3	54.4	101.8	158.1
Sac River - SR		6.25	41.92	41.4	90.01	131.93
Yuba	0	7.5	86.85	86.85	1.06	87.91

Note: Additional VA habitat is relative to baseline.

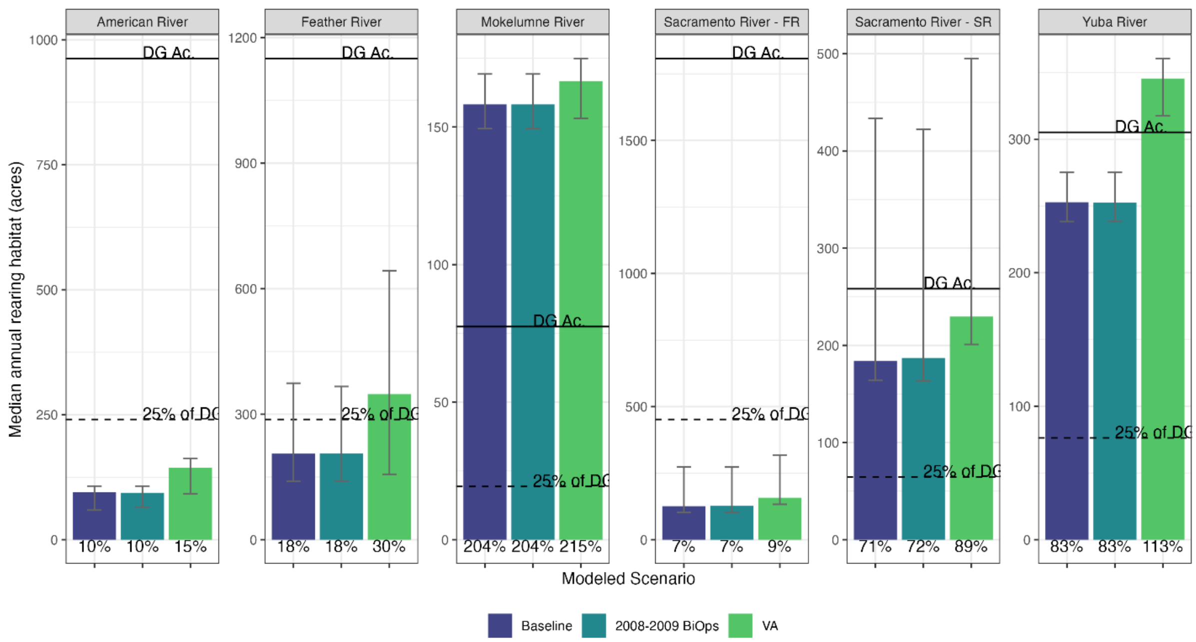


Figure 9.6-2. Median (across All Years) Rearing Habitat (Acres) under 2008–2009 BiOps Condition and VA Scenarios for Each Watershed, Including Both Floodplain and In-Channel Rearing Habitat

Results shown in Figure 9.6-2 are presented for fall-run in all tributaries and for spring-run in the Sacramento River. The amount of habitat as a percentage of the habitat needed to support the doubling goal (DG) is printed below each bar. Solid lines represent area of habitat required to support the doubling goal population, and dashed lines represent 25% of the doubling goal area. The amount of habitat as a percentage of the habitat needed to support the doubling goal is noted below each bar. Medians and quantiles were calculated across all years; therefore, the quantiles represent year-to-year variability, not the full uncertainty in expected outcomes. Note that the Sacramento and Feather River results do not include the 20,000 acres of floodplain restoration on the Sutter Bypass which may be available as rearing habitat for fish from the Feather and Sacramento Rivers.

Table 9.6-2. Rearing Habitat (Combined In-Channel and Floodplain) Results Compared to the VA Term Sheet Commitments and the Habitat Required to Support 25 Percent of the Doubling Goal

		Modeled Results (habitat suitable by depth, velocity, cover, and temperature criteria)							
Watershed	Acres Proposed in VA Term Sheet	Acres to Support 25% of Doubling Goal	Median Acres Baseline	Median Acres 2008-2009 BiOps Condition	Acres Added by VA	Median Total Acres with VA	MFE Baseline	MFE 2008-2009 BiOps Condition	MFE VA
American	75	240.5	95.24	93.91	48.83	144.07			
Feather	1660.25	287.5	205.85	206	142.37	348.22	47%	46%	66%
Mokelumne	26	19.25	158.23	158.23	8.43	166.66	51	51	51
Sac River - FR*	137.5	452	126.08	127.19	31.55	157.63			
Sac River - SR*		64.5	183.77	186.97	45.9	229.67			
Yuba	150	76.25	252.78	252.51	92.64	345.42	11%	11%	72%

Note: Additional VA habitat is relative to the baseline. Meaningful floodplain event (MFE) results represent the expected percent of years with floodplain events that would support salmonid rearing. * Numbers for the Sacramento River do not include the 20,000 acres of proposed floodplain habitat enhancements on the Sutter Bypass that may be available as rearing habitat for fish from the Feather and Sacramento Rivers during times when this floodplain is inundated and fish have access.

The proposed VAs are projected to surpass the spawning habitat needed to support 25% of the doubling goal (the target for the VAs) in all tributaries except the American River (Figure 9.6-1). The combination of instream rearing and floodplain habitat needed to support 25% of the doubling goal population is projected to be met in the Mokelumne, Sacramento (for Spring-Run), and Yuba Rivers in both the 2008-2009 BiOps condition and VA scenarios, and in the Feather River in the VA scenario, but not in any scenario in the American and Sacramento (for Fall-Run) Rivers (Figure 9.6-2). Sacramento River rearing habitat would surpass the habitat needed to support 25% of the doubling goal population with the addition of 20,000 acres of floodplain enhancement on the Sutter Bypass, provided that juvenile fish passage issues can be addressed. Floodplain habitat is expected to be provided to support 25% of the doubling goal population in 66–72% of years in each of the Feather (66%), Mokelumne (69%), and Yuba (72%) Rivers (Table 9.6-2).

Habitat areas for estuarine species are also expected to increase in the Bay-Delta (Table 9.6-3 and Figure 9.6-3), contributing toward the narrative objective for viable native fish populations proposed in the VAs. However, increases would be small relative to total region size. The frequency of achieving ecological flow thresholds would generally increase under the proposed VAs, although in some cases there are slight decreases (Table 9.6-4). Abundance indices based on flows under the proposed VAs of four species (California Bay shrimp [*Crangon franciscorum*], Sacramento splittail [*Pogonichthys macrolepidotus*], longfin smelt [*Spirinchus Thaleichthys*], and starry flounder [*Platichthys stellatus*]) are expected to increase in all water year types except wet years (in which they are expected to decrease) (Figure 9.6-4). Compared to the benefits of the VA scenario relative to the 2008-2009 BiOps condition, greater benefits to abundance indices would generally be realized under the "VA w/Bias Correction and LSJR Placeholder" and "VA w/Bias Correction and 40% UF Merced & Stanislaus" scenarios (as described in *Delta Outflow* in Section 9.5.3.9, *Delta Inflows, Exports, Interior Delta Flows, and Delta Outflow Results*). These scenarios would have smaller decreases (VA w/Bias Correction and LSJR Placeholder) or increases (VA w/Bias Correction and 40% UF Merced & Stanislaus) in abundance indices in Wet years, and greater increases in abundance indices in Above Normal and Below Normal years than the VA scenario when compared to the 2008-2009 BiOps condition. In Dry and Critical years, the VA w/Bias Correction and LSJR Placeholder scenario would have smaller increases in abundance indices than the VA scenario, while the VA w/Bias Correction and 40% UF Merced & Stanislaus scenario would have greater increases than the VA scenario.

Qualitatively, the synergy of flow and physical habitat restoration proposed in the VAs is expected to improve conditions for salmonids and estuarine species toward achieving the proposed new narrative viable native fish population objective and existing salmon protection objective (see Chapter 6 of the Final Draft Scientific Basis Report Supplement for details on the anticipated biological and environmental outcomes).

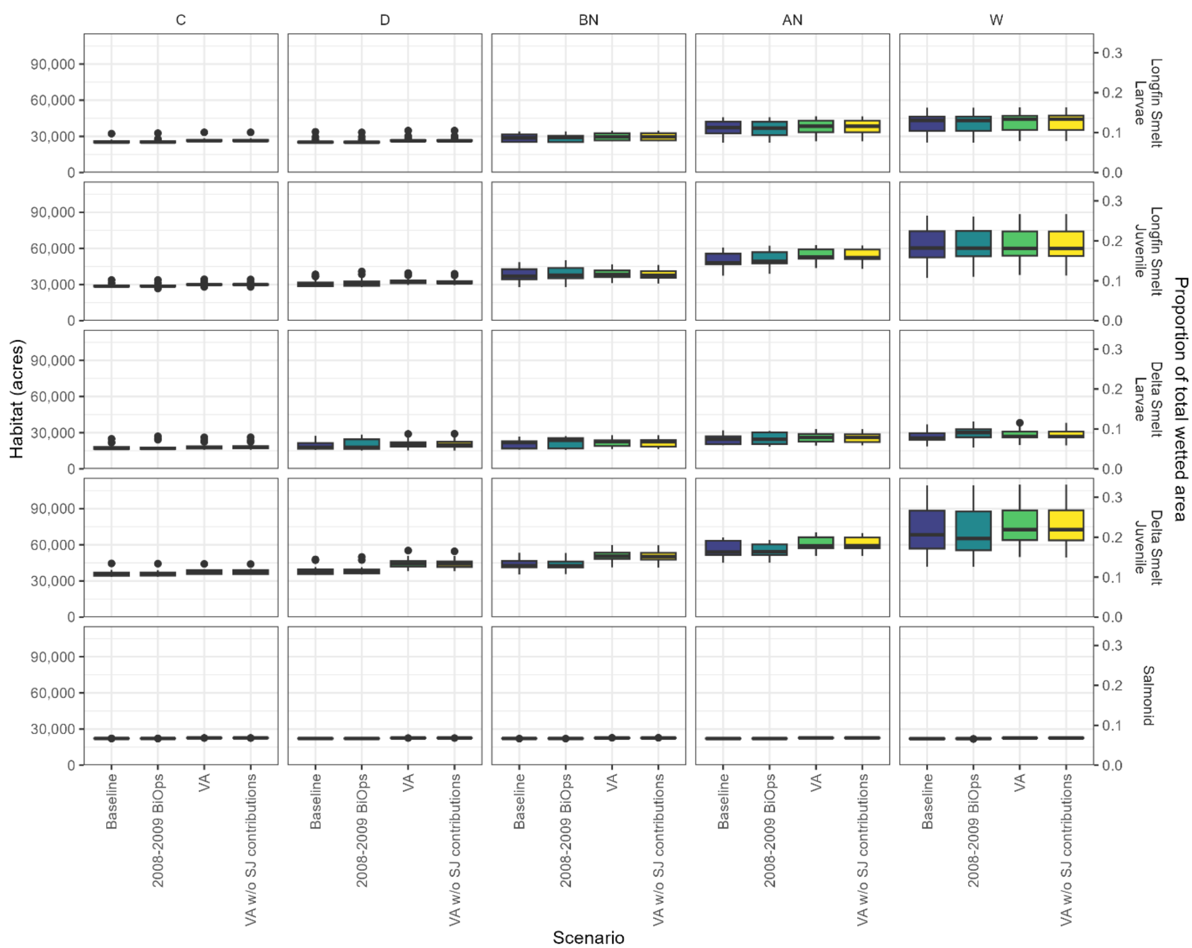


Figure 9.6-3. Total Suitable Estuarine Habitat Area Expected for Each Species, Scenario, and Water Year Type

Habitat area was first averaged within each water year across the designated months for each species and life stage (Section 5.3.5.3 of the Draft Scientific Basis Report Supplement) and is represented as the total acreage (left axis) and as the proportion of the total wetted area (right axis).

Table 9.6-3. Projected Increases in Habitat Area for Delta Smelt, Longfin Smelt, and Salmonids within Relevant Seasons for Each Species

Species and life stage	Season	Scenario	VA change from baseline (acres)	VA change from baseline (%)	VA change from 2008–2009 BiOps (acres)	VA change from 2008–2009 BiOps (%)
Longfin Smelt Larvae	Jan – Apr	VA	945–1202	2–5%	6351,600	2–5%
		VA w/o SJ	945–1210	2–5	635–1580	2–5%
Longfin Smelt Juveniles	Mar - Aug	VA	-261–4639	0–10%	-166–3,547	0–7%
		VA w/o SJ	-336–4330	-1–9	-241–3238	0–7%
Delta Smelt Larvae	Mar – Jun	VA	810–2278	4–13%	-3,184–2,260	-11–13%
		VA w/o SJ	762–2011	3–11	-3204–1993	-11–11%
Delta Smelt Juveniles	Jul – Nov	VA	1810–7893	5–19%	1,694-7,917	5-19%
		VA w/o SJ	1670–7610	5–18	1555–7634	4–18%
Salmonid Rearing	Oct - Jun	VA	472–585	2–3%	475–578	2–3%
		VA w/o SJ	473–591	2–3%	476–581	2–3%

Note: The VA w/o SJ contributions scenario excludes Friant and Tuolumne VA flows since the Friant VA is uncertain and the Tuolumne VA would be subject to State Water Board decision-making under a separate process within the Lower San Joaquin River Flows and Southern Delta Salinity updates to the Bay-Delta Plan. Results are provided as ranges across water year types. The VA Term Sheet proposes 5,227.5 acres of tidal wetland and floodplain habitat restoration, but only 4,074 acres were included in the modeling.

Table 9.6-4. Frequency of Exceeding Ecological Flow Thresholds within the Seasons Specified in Section 5.4 of the Final Draft Scientific Basis Report Supplement

Threshold (cfs)	Baseline	2008–2009 BiOps condition	VA	VA w/o SJ contributions
Georgiana Slough flow reversal low (17,000)	51%	53%	52%	52%
Georgiana Slough flow reversal high (20,000)	44%	43%	44%	44%
Fall Run outmigration (20,000)	26%	26%	26%	26%
Winter Run outmigration (20,000)	57%	57%	60%	60%
Bay Shrimp low (20,000)	51%	51%	55%	52%
Bay Shrimp high (25,000)	43%	41%	45%	44%
Longfin Smelt (43,000)	30%	29%	29%	29%
Sacramento Splittail low (30,000)	40%	39%	43%	41%
Sacramento Splittail high (47,000)	25%	26%	25%	25%
Starry Flounder (21,000)	44%	42%	46%	46%
Green and White Sturgeon (37,000)	15%	15%	15%	15%
Collinsville (7,100)	99%	99%	99%	99%
Chipps Island (11,400)	81%	81%	87%	87%
Port Chicago (29,200)	41%	41%	43%	43%

Note: The Georgiana Slough flow reversal threshold represents monthly flows while the other thresholds represent seasonally averaged flows. The VA interior Delta flows used for the Georgiana Slough flow reversal and the Fall and Winter Run outmigration thresholds do not include any unspecified water purchases (market price and permanent state water purchases) since the origin of that water is unknown. Thresholds for Collinsville, Chipps Island, and Port Chicago represent the flows that correspond to an average X2 location downstream of the specified location.

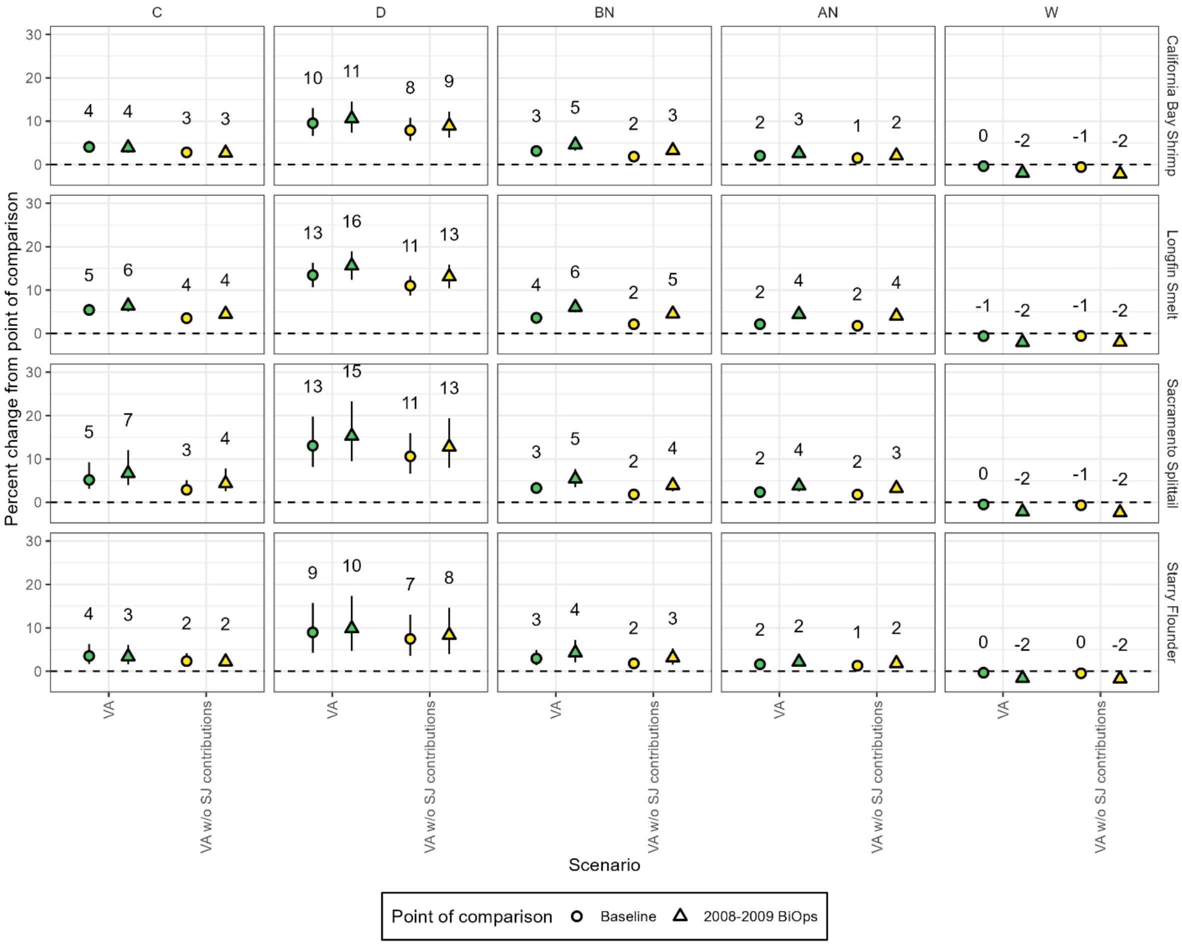


Figure 9.6-4. Potential Percent Increase (Median Prediction ± 95% Confidence Intervals) in Abundance Indices Relative to Baseline and 2008–2009 BiOps Condition

The median predictions (rounded to a whole number) in Figure 9.6-4 are also printed above each point. The VA w/o SJ contributions scenario excludes Friant and Tuolumne VA flows since the Friant VA is uncertain and the Tuolumne VA would be subject to State Water Board decision-making under a separate process within the Lower San Joaquin River Flows and Southern Delta Salinity updates to the Bay-Delta Plan.

While the quantitative and qualitative analyses described in the Final Draft Scientific Basis Report Supplement indicate expected benefits from the proposed VAs, the actual outcomes of the VAs are not certain at this time. As with all modeling analyses, the quantitative results have uncertainty arising from assumptions and simplifications, from unexpected events, unanticipated consequences, and unknowns in the system. Additional uncertainties in VA outcomes arise from the timing of physical habitat restoration completion; assumptions of the suitability of VA habitat assets; limitations in the habitat modeling approaches; the lack of a quantitative connection between certain aspects of habitat and species abundance; the focus on a few at-risk species; and others (see Chapter 7 of the Final Draft Scientific Basis Report Supplement for details on the uncertainty and a summary of the findings). As stated above, the VA Parties are developing accounting procedures for flow and non-flow assets that, when finalized, would provide additional certainty in how the assets would be provided and thus in the benefits they would be expected to provide. The proposed VAs, if adopted, would include a set of implementation criteria and habitat suitability and utilization criteria, along with a monitoring program, to ascertain the actual benefits realized and overall program success.

9.7 Environmental Analysis

9.7.1 Approach

As discussed in Section 9.3, *Description of the Proposed Voluntary Agreements*, the proposed VAs include a combination of proposed flow and non-flow habitat restoration measures on a portion of the Sacramento/Delta tributaries that are proposed over 8 years (with the possibility of extension), including varying amounts of increased flows, depending on water year type, and non-flow actions targeted at improving spawning and rearing capacity for juvenile salmonids, estuarine species, and other native fish and wildlife. The VA flows are intended to be additive to the Delta outflows required by D-1641 and resulting from the 2019 BiOps (though the VAs acknowledge that the BiOps may change).

This section provides an analysis of the potential environmental impacts of changes in hydrology and water supply that could occur as a result of implementing the proposed VA flow actions. The potentially significant and less-than-significant environmental impacts on various environmental resource areas are identified in this section. This section also identifies mitigation measures that could avoid or reduce potentially significant impacts. The CEQA environmental checklist is provided in Appendix G-5. An impact and mitigation measures summary table is provided in Section 9.7.22, *Impact Summary*. An economic analysis is provided in Section 9.8, *Economic Analysis and Other Considerations*.

The proposed VAs include physical habitat restoration on a portion of the Sacramento/Delta tributaries that are not analyzed for impacts in this chapter. Section 7.21, *Habitat Restoration and Other Ecosystem Projects*, evaluates the potential environmental impacts of physical habitat restoration and other complementary ecosystem projects that entities may undertake toward achieving the overall goal of improving conditions for fish and wildlife in the Sacramento/Delta.

The environmental analysis of the proposed VAs provided in this section does not include an analysis of the potential environmental impacts of the Chino Basin, Kern Fan, and Willow Springs Conjunctive Use projects that are identified in the VA Term Sheet as New Water Projects (before Year 8). Analysis of the potential environmental impacts of new facilities and infrastructure to supplement or conserve surface water supplies is provided in Section 7.22, *New or Modified Facilities*. Site-specific environmental impact analyses are in development stages for the Chino Basin, Kern Fan, and Willow Springs Conjunctive Use projects.

The proposed VAs also include a regulatory implementation pathway that as part of the VAs Alternative would apply to non-VA tributaries and would apply in the event the VAs are discontinued. The proposed regulatory implementation pathway is largely consistent with the proposed Plan amendments discussed in Chapter 5, *Proposed Changes to the Bay-Delta Plan for the Sacramento/Delta*, except that instead of updating the water quality objectives included in the Bay-Delta Plan with the objectives included in the proposed Plan amendments, the inflow, inflow based Delta outflow, and cold water habitat provisions of the proposed Plan amendments would be included in the program of implementation and could become applicable in the future if the VAs are not continued, and would be applicable for regions not covered by the VAs. The environmental impacts of the proposed Plan amendments (or regulatory implementation pathway) are described and analyzed in Sections 7.3 through 7.20 and are not evaluated in this section.

California water resource management is complex, and the analysis in Chapter 7, *Environmental Analysis*, covers a broad range of compliance methods across a large area of the state. As a result, the impact analyses are necessarily broad and already cover a wide range of foreseeable compliance measures and responses that could also be considered alternative means of compliance. The evaluation of reasonably foreseeable methods of compliance and response actions that may be taken in response to changed flow requirements are organized into four main categories: (1) changes in hydrology; (2) changes in water supply; (3) physical habitat restoration and other complementary ecosystem projects; and (4) new or modified facilities. Many of the impact mechanisms are already described in detail in Sections 7.3 through 7.20, and in 7.21, *Habitat Restoration and Other Ecosystem Projects*, and 7.22, *New or Modified Facilities*, for projects involving construction. The analysis in this chapter relies on the existing environmental setting and analysis in Chapter 7, *Environmental Analysis,* for efficiency.

This section also identifies various mitigation measures that could reduce potentially significant impacts of the proposed VAs. The mitigation measures identified in this section are also detailed in the corresponding environmental resource area section in Chapter 7, *Environmental Analysis*. In many cases, potentially significant impacts could be reduced to less-than-significant levels with mitigation incorporated. However, unless and until the mitigation is fully implemented, the impacts remain potentially significant.

9.7.2 Topics that Do Not Require Additional Impact Analyses

The evaluation of reasonably foreseeable methods of compliance and response actions that may be taken in response to the project are organized into four main categories: (1) changes in hydrology; (2) changes in water supply; (3) physical habitat restoration and other complementary ecosystem projects; and (4) new or modified facilities. The analyses in the resource sections of this chapter (Sections 9.7.3 through 9.7.20) are largely focused on environmental impacts that may result from changes in hydrology and changes in water supply, excluding other water management actions that entities may take to offset reductions in Sacramento/Delta surface water supply. These other water management actions include groundwater storage and recovery, water transfers, water recycling, and agricultural and municipal water conservation. The impacts of other water management actions are evaluated in Sections 7.3 through 7.20 for the proposed Plan amendments and are not repeated here.

Changes in Sacramento/Delta water supply from baseline would be smaller in magnitude under the proposed VAs than the changes that would occur under the proposed Plan amendments. Therefore, the magnitude of changes from other water management actions that would occur as a result of changes in water supply would be less under the proposed VAs than the proposed Plan amendments, although the impact mechanisms and significance determinations would be similar.

Other water management actions could result in potentially significant impacts to the following resource areas: Agriculture and Forest Resources, Biological Resources- Terrestrial, Biological Resources- Aquatic, Energy, Greenhouse Gas Emissions, Hydrology & Water Quality- Surface Water, Hydrology & Water Quality- Groundwater, and Utilities and Service Systems. Specific impacts and mitigation measures are discussed and detailed comprehensively in Sections 7.3 through 7.20. While impacts from other water management actions under the proposed VAs would be less compared with the proposed Plan amendments (e.g., less frequent, lower magnitude, shorter duration, etc.), these actions are still expected to occur in response to changes in hydrology and water supply and could result in potentially significant impacts. Impacts can be avoided or reduced by implementation of the Mitigation Measures indicated in Sections 7.3 through 7.20.

The other two main categories of reasonably foreseeable methods of compliance and response actions are physical habitat restoration and other complementary ecosystem projects, and new and modified facilities that involve construction. The environmental effects for these compliance methods and response actions that involve construction are evaluated in Sections 7.21, *Habitat Restoration and Other Ecosystem Projects*, and 7.22, *New or Modified Facilities*. Section 7.21 evaluates the environmental impacts of non-flow projects, including physical habitat restoration, fish passage projects, predation, and aquatic invasive species control. Section 7.22 evaluates the environmental impacts of new or modified water facilities, including new or modified reservoirs, new or changed points of diversion, new or upgraded drinking water treatment and wastewater treatment plant facilities, desalination plants, new groundwater wells, and groundwater storage and recovery. Section 7.22 also describes and evaluates new or modified boat ramps, stream gages and other monitoring devices, and water conservation projects. These impacts would likely be less under the proposed VAs than the proposed Plan amendments, although the impact mechanisms and significance determinations would be similar.

The proposed VAs could also result in beneficial environmental effects that could benefit native aquatic species in the Bay-Delta watershed. Section 9.6, *Beneficial Environmental Effects of Proposed VAs*, provides assessments of beneficial environmental effects of the proposed VAs.

9.7.3 Aesthetics

Section 7.3.2, *Environmental Setting*, describes the aesthetics setting to inform the impact discussion in this section; Section 7.3, *Aesthetics*; Section 7.21, *Habitat Restoration and Other Ecosystem Projects*; and Section 7.22, *New or Modified Facilities*. Section 7.3 describes the potential impacts that may result from changes in hydrology or changes in water supply under the proposed Plan amendments.

This section describes the potential impacts to aesthetics that may result from changes in hydrology or changes in water supply under the proposed VAs. There is the potential for effects on visual resources from changes in water levels at some reservoirs on VA tributaries and other tributaries, which could cause altered views (e.g., from highways, trails, or other viewpoints) from increased severity or duration of bathtub ring[1] effects. Reduced Sacramento/Delta water supply to agriculture could result in potential conversion of agricultural land, which could have visual impacts if property is developed or neglected.

[1] A line on the stone or other substrate in a reservoir roughly at the high-water point that is visible when water levels recede and expose bare area.

9.7.3.1 Impact Analysis

Impact AES-a: Have a substantial adverse effect on a scenic vista

Impact AES-b: Substantially damage scenic resources, including, but not limited to, trees, rock outcroppings, and historic buildings within a state scenic highway

Impact AES-c: Substantially degrade the existing visual character or quality of the site and its surroundings

Because the impact mechanisms that inform the analyses of scenic vistas, scenic resources viewed from within a state scenic highway, and visual character and quality are similar, Impacts AES-a, AES b, and AES-c are combined and addressed together.

Changes in Hydrology

Implementation of the proposed VAs could result in changes in hydrology, including changes in streamflow and reservoir levels on the VA tributaries compared to baseline. Increases in streamflows on VA tributaries would generally occur during the spring months, although increases in streamflows could also occur at other times for some VA tributaries. The proposed VAs could also result in reductions in streamflows at times, generally during the fall or early winter months. Overall, reservoir levels in Shasta Reservoir, Oroville Reservoir, Folsom Reservoir, Camanche Reservoir, and Lake Berryessa would be similar to baseline but could increase at times and decrease slightly at times. These changes in streamflows and reservoir levels would be smaller than the changes that would occur under the proposed Plan amendments.

If the VAs were adopted, actual operation could vary to some degree from modeled outcomes and there could be additional changes in streamflows and reservoir levels beyond the modeled changes on VA tributaries. Specifically, the proposed VAs include flexibility in the timing of flow assets, so streamflows and reservoir levels could deviate to some degree from modeled results. In addition, the VA Term Sheet describes flow assets that would be provided through unspecified water purchases, but the sources of water purchases are not fully known at this time. Unspecified water purchases could result in additional flow assets on other Sacramento/Delta tributaries which could affect streamflows and reservoir levels on those tributaries. These changes would be smaller than the changes that would occur under the proposed Plan amendments (discussed in Chapter 6, *Changes in Hydrology and Water Supply*, and 7, *Environmental Analysis*).

Given the existing variability of the volume and duration of river flows, viewers would not be sensitive to these changes. Viewers of the river corridors and Delta, including from state scenic highways or national scenic byways, could experience views that are similar to existing views. The impact would be less than significant.

Changes in reservoir levels on the VA tributaries and other tributaries could at times leave more exposed, barren land along the edges of some reservoirs. Under baseline, surface water elevations for reservoirs fluctuate throughout the year. The primary potential effect on views of reservoirs would be associated with potential reservoir drawdown that increases the severity or duration of the bathtub ring effect. Most of the changes in reservoir elevations would be within the historical ranges; however, elevations could be lower more frequently for some reservoirs. Changes in reservoir levels would be less than under the proposed Plan amendments; however, water-level changes at some reservoirs could be large enough to be noticed by viewers at times and could affect scenic vistas, views of reservoirs visible from state scenic highways or national scenic byways, or visual character. This impact could be potentially significant.

Implementation of Mitigation Measure MM-AES-a–c: 1 would reduce or avoid aesthetics impacts at reservoirs. Reservoirs on VA tributaries and other tributaries would not be subject to a new narrative cold water habitat objective and would not be required to develop and implement long-term strategies and annual plans for reservoir operations that would consider aesthetics. However, streams and reservoirs on VA tributaries may be subject to future changes that could result from issuance of new water rights orders or decisions, Federal Energy Regulatory Commission (FERC) licenses, and other future regulatory requirements. In exercising its regulatory authorities, the State Water Board would consider aesthetics and ensure that any aesthetics impacts are avoided or minimized. However, unless and until the mitigation is implemented, any impacts from changes in reservoir storage levels on aesthetics in reservoirs remain potentially significant.

Changes in Water Supply

Reduced Sac/Delta Water Supply

Implementation of the proposed VAs could result in changes in Sacramento/Delta surface water supplies, to regions both within and outside of the Sacramento/Delta watershed. Overall, implementation of the proposed VAs would result in an average annual reduction in Sacramento/Delta surface water supply for the entire study area. Most of the reductions in Sacramento/Delta surface water supplies would occur within the Sacramento/Delta watershed. In addition, Sacramento/Delta water supply reductions would primarily affect agricultural uses.

A reduction in irrigation water available for existing agricultural lands could result in changes to agricultural production, the types of agricultural uses, or land fallowing. A reduction in irrigation water could result in some land being permanently taken out of production and converted to other uses. If fallowed land was left undeveloped, it could function visually as open space, and the change would not adversely affect scenic vistas or visual character. In some areas, land taken out of agricultural production could be developed for nonagricultural uses which could adversely affect existing scenic vistas and could substantially affect the existing visual character. If a property owner abandons use and maintenance of existing structures on land removed from agricultural production and the property is left to deteriorate, then those features could contribute to rural blight. This impact could be potentially significant.

Mitigation Measure MM-AES-a–c: 2, which incorporates Mitigation Measure MM-AG-a,e to reduce the conversion of agricultural land to other uses, would reduce or avoid aesthetic impacts. However, unless and until the mitigation is implemented, any visual impacts from agricultural land conversion that results in neglected and blighted property remains potentially significant.

The visual quality of the urban environment may be affected by reduced municipal water supply, which could result in dry lawns or reduced park irrigation. However, Sacramento/Delta water supply reductions would be based on voluntary measures that would be largely or entirely from agricultural supplies, reservoir reoperation, or based on groundwater substitution. This impact would be less than significant.

Impact AES-d: Substantially degrade the existing visual character or quality of the site and its surroundings

Activities associated with changes in hydrology and changes in water supply would not create a new source of substantial light or glare that would adversely affect day or nighttime views because no construction or other activities that would cause light or glare are contemplated. There would be no impact.

9.7.4 Agriculture and Forest Resources

Section 7.4.2, *Environmental Setting*, describes the agriculture and forest resources setting to inform the impact discussion in this section; Section 7.4, *Agriculture and Forest Resources*; Section 7.21, *Habitat Restoration and Other Ecosystem Projects*; and Section 7.22, *New or Modified Facilities*. Section 7.4 describes the potential impacts that may result from changes in hydrology or changes in water supply under the proposed Plan amendments.

This section describes the potential impacts for agriculture and forest resources that may result from changes in hydrology or changes in water supply under the proposed VAs. This evaluation focuses on the potential conversion of irrigated farmland to nonagricultural use.

Changes in hydrology and supply under the proposed VAs would not affect forestland and timberland so there would be no impact to these resource areas. Accordingly, forestland and timberland resources (Impact AG-c and Impact AG-d) are not discussed further in this section.

9.7.4.1 Impact Analysis

Impact AG-a: Convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance (Important Farmland), as shown on the maps prepared pursuant to the Farmland Mapping and Monitoring Program of the California Resources Agency, to nonagricultural use

Impact AG-e: Involve other changes in the existing environment that, due to their location or nature, could result in conversion of important farmland to nonagricultural use

The analyses of conversion of important farmland under Impact AG-a and Impact AG-e are closely related and are, therefore, combined and addressed together.

A conservative threshold of significance for conversion is used that captures the importance of agriculture as a resource in California. All irrigated agriculture is used as a proxy for important farmland. The analysis assumes that any reduction in irrigated crop acreage is important farmland converted to nonagricultural use.

Most of the irrigated agriculture in the study area is located on the valley floor portion of the Sacramento/Delta, and the San Joaquin Valley. For these areas, growers' responses to changes in water supply are estimated using the Surface Water Agricultural Production (SWAP) model.

Changes in Water Supply

Implementation of the proposed VAs could result in changes in Sacramento/Delta surface water supplies, both within and outside of the Sacramento/Delta watershed. Overall, implementation of the proposed VAs would result in an average annual reduction in Sacramento/Delta surface water supply for the entire study area. Most of the reductions in Sacramento/Delta surface water supplies would occur for users within the Sacramento/Delta watershed. The SacWAM results show that Sacramento/Delta water supplies to the San Francisco Bay Area, Central Coast, and Southern California could increase slightly on average when compared to baseline. The proposed VAs could result in a change in total Sacramento/Delta supplies to the San Joaquin Valley region. The overall effect would be dependent on the sources of the unspecified water purchases, which are not fully known at this time.

As discussed above under Section 9.5, *Changes in Hydrology and Water Supply*, the unspecified water purchases would be provided from willing sellers in either the Sacramento/Delta watershed or CVP/SWP export areas. If unspecified water purchases are provided from willing sellers in the Sacramento/Delta watershed, this would result in a greater reduction in Sacramento/Delta supply within the Sacramento/Delta watershed. If unspecified water purchases are provided from reductions in Delta exports, it is assumed that these purchases would be provided from unspecified willing sellers in the San Joaquin Valley and would affect primarily agricultural uses. It is not expected that water users in the San Francisco Bay Area, Central Coast, and Southern California regions would participate in the Market Price and Permanent Sate Water Purchase components of the VA water purchase program. In these regions, the majority of Sacramento/Delta supplies are used for municipal purposes (Chapter 2, Section 2.8*, Existing Water Supplies*) and it is unlikely that municipal water users would choose to participate in this voluntary program. Moreover, the Sacramento/Delta water that does provide for agricultural uses in the San Francisco Bay Area, Central Coast, and Southern California generally supports higher net revenue crops such as wine grapes, vegetables, and orchard crops. It is unlikely that unspecified water purchases would affect these agricultural lands.

In this analysis, growers' responses to changes in water supply in the Sacramento/Delta and San Joaquin Valley are estimated using the SWAP model. SWAP model results are provided below for the proposed VAs, both with and without considering the effects of the unspecified water purchases. Because sources of the flow assets that would be provided through the unspecified water purchases are not fully known at this time, SWAP estimates the possible sources and effects of the unspecified water purchases based on economic criteria. Actual grower responses may vary from the SWAP model results. In particular, the unspecified water purchases would be provided from willing sellers that choose to participate in the water purchase program; therefore, the effects on agricultural production may differ from the SWAP model results.

The SWAP model considers agricultural cropping decisions under reduced water supply based on relative profit of crop production. Responses to reduced surface water supply would be expected to include switching to less water-demanding crops or fallowing land that is least profitable. SacWAM model results are incorporated into the SWAP model by defining the surface water supply available to SWAP regions, in a process similar to that used for evaluation of the flow scenarios in Chapter 7, *Environmental Analysis*. The unspecified water purchases are reflected in SWAP by reducing the aggregate total of all surface water supplies across all regions that receive surface water from the Sacramento/Delta watershed, including limits on the amount of rice land that can be fallowed consistent with the VAs proposal. This methodology is described in more detail in Appendix G3c. SWAP model results are presented in this section for both an average year and a dry year model run.

Although there could be localized impacts in the San Francisco Bay Area, Central Coast, and Southern California, there would likely be very little to no change in crop acreage in these regions resulting from implementation of the proposed VAs. Therefore, changes in crop acreage in the San Francisco Bay Area, Central Coast, and Southern California are not further evaluated in this section.

The analysis in Section 7.4, *Agricultural and Forest Resources*, indicates reductions in crop acres would be relatively small when groundwater is used to offset reduced surface water supply, but greater (i.e., larger reduction in crop acres) when groundwater is not used to replace lost surface water supply. To capture the most conservative outcome for evaluating potential impacts, the analysis for the proposed VAs quantifies estimated changes in crop acreage assuming groundwater is not used to replace lost surface water supply. However, the VA proposal identifies that some flow assets could be provided through groundwater substitution, including in the American River watershed. Flow assets in other watersheds could possibly also be provided through groundwater substitution. Therefore, the reduction in crop acreage under the proposed VAs could be less than indicated by the SWAP model results.

Sacramento/Delta

SWAP results for changes in crop acreages in the Sacramento/Delta are provided below for the proposed VAs, both with and without considering the effects of the unspecified water purchases. Results for average years are shown in Table 9.7-1, although as discussed above, actual operation could vary to some degree from modeled outcomes. The model results indicate that there could be a decline in crop acres for the proposed VAs with and without considering the effects of unspecified water purchases. The decrease in crop acreage could be about 0.5% when including unspecified water purchases, and about 0.2% without. A large share of the decrease is associated with reduced rice and pasture acreage. Additionally, decreases in grain corn, deciduous orchards, almonds and pistachios, and processing tomatoes may occur. Some crop shifting from higher to lower water-using crops may also take place, and this helps to explain why SWAP results indicate that wheat and field crops, and to a lesser extent, vegetables – generally lower water-intensive crops – may see an increase in acreage under the proposed VAs. If groundwater substitution is used to supplement reductions in surface water supplies, the change in crop acreage could be smaller than indicated by the SWAP modeling results.

Dry year results are provided in Table 9.7-2. The decrease in acreage could be about 0.7% when including unspecified water purchases, and about 0.3% without. A large share of the decrease is associated with reduced pasture and rice acreage. Additionally, decreases in producing acreage of corn, deciduous orchards, processing tomatoes, and almonds and pistachios may occur.

Table 9.7-1. SWAP Model Results for Irrigated Crop Acreage in the Sacramento/Delta Watershed, Average Year (acres)[a]

		Proposed VAs With Unspecified Water Purchases		Proposed VAs Without Unspecified Water Purchases	
Crop Group	Existing	Total	Change	Total	Change
Rice	567,700	561,000	-6,700	561,300	-6,400
Alfalfa & Pasture	382,600	374,700	-7,900	380,600	-2,000
Deciduous Orchards	369,300	368,600	-700	368,900	-400
Corn and All Silage	258,500	257,600	-900	258,700	200
Almonds & Pistachios	168,300	167,400	-900	167,800	-500
Wheat & Field Crops	194,100	199,700	5,600	197,900	3,800
Vine	134,700	134,800	100	134,700	0
Processing Tomatoes	101,600	101,300	-300	101,500	-100
Vegetables	78,800	78,800	0	78,900	100
Cotton	3,300	3,300	0	3,300	0
TOTAL	2,258,800	2,247,300	-11,500	2,253,600	-5,200

[a]SWAP model crop acreage estimates for an average year by crop group for baseline and proposed VAs with no replacement groundwater pumping.

Table 9.7-2. SWAP Model Results for Irrigated Crop Acreage, Proposed VAs in the Sacramento/Delta Watershed, Dry Year (acres)[a]

		Proposed VAs With Unspecified Water Purchases		Proposed VAs Without Unspecified Water Purchases	
Crop Group	Existing	Total	Change	Total	Change
Rice	557,100	551,500	-5,600	551,900	-5,200
Alfalfa & Pasture	355,700	346,500	-9,200	352,000	-3,700
Deciduous Orchards	367,900	367,500	-400	367,600	-300
Corn and All Silage	256,700	255,200	-1,500	256,600	-100
Almonds & Pistachios	165,700	165,400	-300	165,500	-200
Wheat & Field Crops	199,700	201,200	1,500	201,700	2,000
Vine	134,400	134,300	-100	134,400	0
Processing Tomatoes	100,800	100,500	-300	100,700	-100
Vegetables	78,700	78,600	-100	78,800	100
Cotton	3,300	3,300	0	3,300	0
TOTAL	2,220,000	2,204,000	-16,000	2,212,400	-7,600

[a]SWAP model crop acreage estimates for a dry year by crop group for baseline and proposed VAs with no replacement groundwater pumping.

The VA Term Sheet included a limit on the reduction in total rice acreage to 35,000 acres. However, the results for the Sacramento Valley for both with and without the unspecified water purchases show that total rice acreage is anticipated to decrease by far less than 35,000 acres.

San Joaquin Valley

The proposed VAs could also result in a change in water supply to the San Joaquin Valley region that could affect crop acreage in this region. SWAP results for average years are shown in

Table 9.7-3 for the proposed VAs both with and without consideration of the possible effects of the unspecified water purchases. The model results indicate that there could be a small decrease in total acreage of about 0.4% when including unspecified water purchases. The model run without including unspecified water purchases shows a smaller change in total crop acreage. A large share of the decrease in acreage between the with and without unspecified water purchases model runs is associated with reduced pasture acreage. Additionally, small decreases in production of alfalfa, grain corn, deciduous orchards, almonds and pistachios, and cotton may occur. Some crop shifting from higher to lower water-using crops could also take place. These impacts may be less if groundwater is used to substitute for reduced imports of Sacramento/Delta water supply.

Dry year results are provided in Table 9.7-4. The decrease in acreage could be about 0.5% when including unspecified water purchases, and about 0.1% without. Without the unspecified water purchases, the largest category with decreased crop acreage is processing tomatoes, wheat and field crops, and cotton; however, the decrease in acreage is less than 0.1%. All other categories have lesser reductions in crop acreage. When unspecified water purchases are included in the analysis, irrigated pasture is the most impacted crop in terms of acreage, representing more than three-fourths of the change. The SWAP model results suggest other crop categories, including grain corn, almonds and pistachios, and cotton, may otherwise experience a much smaller decline in acreage. Stated another way, the model finds that irrigated pasture in the San Joaquin Valley is the most likely crop to be included among unspecified water purchases when profitability is the leading criterion.

Table 9.7-3. SWAP Model Results for Irrigated Crop Acreage in the San Joaquin Valley Region, Average Year (acres)[a]

		Proposed VAs With Unspecified Water Purchases		Proposed VAs Without Unspecified Water Purchases	
Crop Group	Existing	Total	Change	Total	Change
Corn and All Silage	1,075,500	1,073,300	-2,200	1,076,000	500
Almonds & Pistachios	907,700	906,800	-900	907,500	-200
Alfalfa & Pasture	601,600	585,300	-16,300	599,400	-2,200
Deciduous Orchards	539,800	539,500	-300	539,800	0
Vine	449,100	449,200	100	449,100	0
Vegetables	308,400	308,700	300	308,800	400
Cotton	282,700	282,100	-600	282,700	0
Wheat & Field Crops	312,400	312,300	-100	313,100	700
Processing Tomatoes	198,600	198,600	0	198,700	100
Rice	10,100	10,000	-100	10,000	-100
TOTAL	4,685,800	4,665,800	-20,000	4,685,100	-700

[a]SWAP model estimated values for an average year by crop group for baseline and the proposed VAs with no replacement groundwater pumping.

Table 9.7-4. SWAP Model Results for Irrigated Crop Acreage in the San Joaquin Valley Region, Dry Year (acres)[a]

		Proposed VAs With Unspecified Water Purchases		Proposed VAs Without Unspecified Water Purchases	
Crop Group	Existing	Total	Change	Total	Change
Corn and All Silage	997,900	997,600	-300	998,300	400
Almonds & Pistachios	891,000	890,600	-400	890,700	-300
Alfalfa & Pasture	544,500	529,900	-14,600	544,800	300
Deciduous Orchards	535,700	535,700	0	535,700	0
Vine	441,900	442,200	300	441,800	-100
Vegetables	298,300	298,100	-200	298,000	-300
Cotton	268,500	266,900	-1,600	267,100	-1,400
Wheat & Field Crops	267,400	265,700	-1,700	265,600	-1,800
Processing Tomatoes	187,500	185,600	-1,900	185,700	-1,800
Rice	9,900	9,900	0	9,900	0
TOTAL	4,442,600	4,422,200	-20,400	4,437,600	-5,000

[a]SWAP model estimated values for a dry year by crop group for baseline and the proposed VAs with no replacement groundwater pumping.

Estimate of Water Purchase Sources Based on SWAP Results

As discussed above, the proposed VAs include three categories of water purchases: Fixed Price, Market Price, and Permanent State Water Purchases and the sources for the PWA Water Purchase Fixed Price Program are identified and as such are modeled. Additional details about assumed sources for water purchases based on SWAP results are presented in Appendix G3c.

In conclusion, although there is some uncertainty regarding the effects of the proposed VAs on crop acreage, the SWAP model results suggest that reductions in Sacramento/Delta water supply under the proposed VAs could lead to the removal of important farmland from irrigation in the Sacramento/Delta and the San Joaquin Valley, and as a result, to its conversion to nonagricultural uses. The SWAP results may overstate conversion for several reasons. First, equating reductions in irrigated acreage to cropland conversions likely overestimates potential acreage reductions because not all land acreage estimated to be removed from irrigation would be permanently converted to nonagricultural use. In addition, because the source of the unspecified water purchases is not fully known at this time, the actual effects of the unspecified water purchases on crop acreage could differ from those indicated by the SWAP model results. Finally, if groundwater substitution is used to supplement reductions in surface water supplies, the change in crop acreage under the proposed VAs could be less than indicated by the SWAP modeling results. Nonetheless, impacts would be potentially significant.

Mitigation Measure MM-AG-a,e: 2–6 could avoid or reduce the amount of agricultural conversion as a result of the proposed VAs. Water users can and should diversify their water supply portfolios to the extent possible, in an environmentally responsible manner and in accordance with the law. Diversification includes sustainable conjunctive use of groundwater and surface water, water transfers, water conservation and efficiency upgrades, and increased use of recycled water. Farmers are likely to implement efficiency and conservation measures on their own initiative in response to reduced supply. The State Water Board will continue to work with farmers and districts to develop and implement programs to increase water use efficiency and conservation in order to maximize the beneficial use of Sacramento/Delta supplies, including through conditions on discretionary approvals for funding and other approvals as appropriate. In addition, local agencies can and should impose conditions on such approvals to provide the permanent protection of an area of farmland equal to the converted area.

While the State Water Board has some authority to ensure mitigation is implemented for some actions, other mitigation measures are largely within the jurisdiction and control of other agencies or depend on how water users respond to the proposed VAs. Accordingly, the State Water Board cannot guarantee that measures will always be adopted or applied to fully mitigate potential impacts. Therefore, unless and until the mitigation is fully implemented, the impacts remain potentially significant.

The VA proposal identifies that some flow assets could be provided through groundwater substitution, including in the American River watershed. Flow assets in other watersheds could also possibly be provided through groundwater substitution, but sufficient information is not available at this time to include additional groundwater substitution modeling. If additional flow assets are made available through groundwater substitution, water supply reductions for the Sacramento/Delta watershed would be less, and associated effects such as land fallowing would be reduced. However, increased groundwater pumping and reduced groundwater recharge could result in reduced groundwater levels. Reduced groundwater levels also have the potential to result in additional pressure on agriculture. The magnitude of the effect on source area agricultural land conversions is unknown, but some conversion would be possible. This impact would be potentially significant. Impacts on agriculture related to groundwater substitution and groundwater levels could be reduced through implementation of Mitigation Measures MM-AG-a,e: 4 and 6. Unless and until the mitigation is fully implemented, the impacts remain potentially significant.

Changes in Hydrology

Stream and Reservoir Elevation at Diversions

Changes in flows could affect water surface elevation and the ability of existing diversion facilities to access water. As discussed above, the proposed VAs could result in changes in streamflows in the Sacramento/Delta watershed. The changes in streamflow under the proposed VAs would be smaller than those under the proposed Plan amendments. During the irrigation season, increases in flow are generally expected during the spring months and occasional decreases are expected at some locations during some summer or early fall months. If the proposed VAs were adopted, actual operation could vary to some degree from modeled outcomes and there could be additional changes in streamflows beyond the modeled changes. For example, the proposed VAs include flexibility in the timing of flow assets, so streamflows and reservoir levels could deviate to some degree from modeled results. In addition, the VA Term Sheet describes flow assets that would be provided through unspecified water purchases, but the sources of water purchases are not fully known at this time. However, the changes in flow would still likely be well within the typical range of flows seen on the VA tributaries under baseline and effects on water levels would be limited. Similarly, the proposed VAs could result in changes in reservoir levels, but the changes would be expected to remain within the range of conditions experienced under baseline. As a result, it is unlikely that the VAs would significantly affect use of existing diversion structures within the Sacramento/Delta watershed.

The proposed VAs could also result in changes in water surface elevations in other areas that receive Sacramento/Delta supplies. However, as described in Section 9.5, *Changes in Hydrology and Water Supply,* changes in reservoir storage and flows in export areas are expected to be small. As a result, effects on diversion facilities in other regions would be less than significant.

Sutter and Yolo Bypasses

It is unlikely the changes in flows under the proposed VAs would significantly increase flows into the Sutter and Yolo Bypasses during April through June, based on monthly results presented in Appendix G3a for the Yolo Bypass below Putah Creek inflow and Sacramento Slough at the downstream end of the Sutter Bypass. As described in Section 9.3.3, *Tributary Assets*, the proposed VAs include a notch in the Tisdale Weir. The VA proposes to operate the Tisdale Weir notch to increase flows into the Sutter Bypass during December through mid-March, which would not significantly affect crop production within the Sutter Bypass. This impact would be less than significant.

Impact AG-b: Conflict with existing zoning for agricultural use or conflict with a Williamson Act contract

Lands under Williamson Act and Farmland Security Zone contracts are restricted to compatible open space or agricultural uses, generally for rolling 10-year or 20-year terms.

The proposed VAs would not alter Williamson Act and Farmland Security Zone contract restrictions. Therefore, any change in hydrology or water supply under the proposed VAs would not conflict with Williamson Act provisions because the existing agricultural lands can and must be maintained in compatible open space and agricultural uses, which can include non-irrigated agricultural uses.

The Williamson Act holds that a reduction in the economic character of existing agricultural land is not a sufficient reason for cancellation of a contract. There is enough annual crop acreage for rotation if plantings of annual crops are rotated in years with reduced irrigation supply such that all lands would be irrigated on a staggered schedule or dryland farmed or fallowed in other years. Therefore, the proposed VAs would not conflict with the existing Williamson Act, and there would be no impact.

The proposed VAs would not conflict with existing zoning for agricultural use. Only cities and counties enact zone change. The proposed VAs would not change zoning and would not require a discretionary action that conflicts with a land zoned for agriculture. It could result in reduced irrigation available to designated important farmland as described under Impact AG-a and Impact AG-e; however, if the lands do not receive irrigation, they could be dryland farmed, rotated, deficit irrigated, or fallowed, all of which would be consistent with agricultural zoning. Therefore, a conflict would not occur as a result of the proposed VAs, and agricultural land would continue to maintain existing zoning. There would be no impact.

9.7.5 Air Quality

Section 7.5.2, *Environmental Setting*, describes the air quality resource setting to inform the impact discussion in this section; Section 7.5, *Air Quality*; Section 7.21, *Habitat Restoration and Other Ecosystem Projects*; and Section 7.22, *New or Modified Facilities*. Section 7.5 describes the potential impacts that may result from changes in hydrology or changes in water supply under the proposed Plan amendments.

This section describes the potential impacts for air quality that may result from changes in hydrology or changes in water supply under the proposed VAs with a focus on activities that could result in increased emissions.

Changes in hydrology could result in decreased emissions associated with an increase of hydropower generation. However, reoperation of reservoirs on VA tributaries and other tributaries could result in drawdown that leaves unvegetated soil exposed to wind, resulting in minor windblown dust emissions. Further, changes in reservoir levels and flows could increase harmful algal bloom (HAB) formation, which may generate odor.

Changes in water supply include reduced Sacramento/Delta supply to agriculture that could result in agricultural land fallowing and post-harvest rice burning, which could cause dust and increased emissions, respectively.

Changes in hydrology and changes in water supply would not induce substantial population growth or employment (see Sections 9.7.16, *Population and Housing,* and 7.23.4*, Growth-Inducing Effects*). Accordingly, these topics are not evaluated further in this section.

9.7.5.1 Impact Analysis

Impact AQ-a: Conflict with or obstruct implementation of the applicable air quality plan

Impact AQ-b: Violate any air quality standard or contribute substantially to an existing or projected air quality violation

Impact AQ-c: Result in a cumulatively considerable net increase of any criteria pollutant for which the project region is nonattainment under an applicable federal or state ambient air quality standard (including releasing emissions which exceed quantitative thresholds for ozone precursors)

The analyses of activities that generate emissions that could conflict with applicable air quality plans, contribute to National Ambient Air Quality Standards (NAAQS) and California Ambient Air Quality Standards (CAAQS) violations, and result in project-level and cumulative air quality impacts are closely related and are therefore combined and addressed together under Impacts AQ-a through AQ-c.

Changes in Hydrology

Implementation of the proposed VAs could result in changes in hydrology, including changes in streamflow and reservoir levels in the VA tributaries compared to baseline. Overall, reservoir levels in VA tributaries would be similar to baseline but could increase slightly at times and decrease slightly at times. The proposed VAs also include flow assets that would be provided through unspecified water purchases, but the sources of water purchases are not fully known at this time. The VA tributary inflow analyses do not assume any additional inflows from unspecified water purchases given the unknown origin of these water purchases, but some effects on reservoir levels in the Sacramento/Delta watershed could occur as a result of the unspecified water purchases. The proposed VAs could also affect reservoir levels in export reservoirs and streamflows below export reservoirs, but changes would be expected to be small. These changes would be smaller than the changes that would occur under the proposed Plan amendments (discussed in Chapter 6, *Changes in Hydrology and Water Supply*, and Chapter 7, *Environmental Analysis*).

As described in Section 9.7.8, *Energy*, changes in hydrology under the proposed VAs could result in a small increase of hydropower generation in the Sacramento/Delta due to changes in hydrology that could reduce emissions associated with electricity generation to a small degree. Therefore, it is not anticipated that changes in hydropower generation due to implementation of the proposed VAs would increase long-term emissions when compared with baseline. There would be no impact.

Reduced flows and reservoir levels on VA tributaries and other tributaries could result in drawdown in reservoirs that expose unvegetated soil to the drying action of sun and wind. While storage levels in some reservoirs may fall below baseline during certain times of the year, exposed soils would be at surface level, or potentially depressed within the reservoir, making wind dispersion less likely because wind speeds increase as a function of height above surface level. In addition, soil conditions in reservoirs are also typically cohesive sediments such as silt and clay. In the spring and early summer, these sediments would also have a higher moisture content following spring snowmelt and rains. In total, these conditions limit the potential for dispersion during drawdown and wind events.

Accordingly, changes in hydrology would not substantially increase airborne fugitive dust from wind erosion. This impact would be less than significant.

Changes in Water Supply

Overall, the SacWAM results show that implementation of the proposed VAs could result in changes in Sacramento/Delta surface water supplies, both within and outside of the Sacramento/Delta watershed. Most of the reductions in Sacramento/Delta surface water supplies would occur within the Sacramento/Delta watershed and would primarily affect agricultural uses. Reduced Sacramento/Delta supply to agriculture could result in agricultural land fallowing, which could result in increased fugitive dust if crop or vegetation stubble cover does not remain, or vegetative regrowth does not occur. However, reduced Sacramento/Delta supply to agriculture could result in other responses besides land fallowing, such as implementation of water conservation measures, dryland farming, or deficit irrigation. In addition, even some fallowed lands would be expected to retain crop stubble cover, ultimately experience vegetative regrowth, or both. This root material and regrowth would stabilize soils and serve to reduce the potential for fugitive dust, making any potential fugitive dust emissions due to fallowing temporary and limited in occurrence. These impacts would be less than significant.

Reduced water supply to agriculture could affect acreage of post-harvest flooding of rice fields, which could possibly result in an increased occurrence of post-harvest rice straw burning. Increased rice straw burning could affect air quality in rural and agricultural areas where rice is currently grown. Existing regulations limit rice straw burning and existing post-harvest rice straw management activities reduce and divert rice straw. Therefore, a reduction in Sacramento/Delta surface water supply for post-harvest flooding and subsequent fall rice straw decomposition would not result in a significant increase in rice straw burning compared with baseline. This impact would be less than significant.

The proposed VAs identify that some flow could be provided through groundwater substitution, including in the American River watershed. Flow in other watersheds could possibly also be provided through groundwater substitution. This could require additional pumping that would likely be powered by electric pumps because these pumps are cheaper and more efficient than diesel pumps for long-term use. Additional energy would come from either a renewable or nonrenewable source that is already permitted, and thus, no new operational air quality emissions would be expected. Use of renewable energy (e.g., solar) to power groundwater pumps has been steadily increasing in the agricultural sector, and this trend is expected to continue because associated costs have dramatically declined. As such, the ability to use solar pumps has increased. However, a small portion of groundwater pumping may still utilize other fuels (e.g., diesel, gasoline). Depending on the type of fuel used, emissions could vary, though diesel pumps are typically more polluting than pumps powered by other fuels.

Diesel pumps would generate exhaust-related emissions and toxic air contaminants during operations. The installation of additional diesel pumps would need to comply with the air pollutant rules and requirements of respective air districts to reduce associated emissions. For example, the Sacramento Metropolitan Air Quality Management District administers an Agricultural Engine Registration program that requires the registration of all diesel-fueled stationary and portable engines that are rated greater than 50 horsepower and used exclusively for agricultural purposes. Similarly, the San Joaquin Valley Air Pollution Control District requires operators of diesel-fueled engines rated at 50 horsepower and greater to secure permits.

Based on calendar year 2020 emission factors from the California Emissions Estimator Model, using an 84-horsepower (model default) diesel pump for 1 hour would generate 0.386 gram of reactive organic gas, 3.432 grams of CO, 3.219 grams of nitrogen oxide, 0.006 gram of sulfur dioxide, 0.189 gram of PM10, and 0.0189 gram of PM2.5. These emissions would occur locally at the pump source and are well below published air district thresholds. However, depending on the extent of groundwater pumping, multiple diesel-powered pumps could be operating simultaneously within an air district where the combined emissions level of all other groundwater pumping could exceed the applicable air district thresholds.

This impact would be potentially significant. To reduce potential air quality impacts from diesel pumps, entities undertaking or agencies approving these actions would need to implement Mitigation Measure MM-AQ-a–c, which includes provisions such as the use of energy-efficient pumps and equipment alternatives to diesel-fueled pumps, or replacement with electric pumps, that would mitigate criteria air pollutant emissions from groundwater pumping and groundwater storage and recovery activities. However, unless and until the mitigation is fully implemented, the impact remains potentially significant.

Impact AQ-d: Expose sensitive receptors to substantial pollutant concentrations

Changes in Hydrology

As discussed under Impacts AQ-a through AQ-c, changes in hydrology (flows and reservoir levels) may expose soils to wind events at certain times of the year when reservoir drawdown lowers water levels, resulting in windblown dust emissions. These effects are expected to be less than significant, and there is low probability that sensitive receptors (e.g., residences, hospitals, schools) would be in proximity to increased pollutant concentrations due to windblown dust from reservoir drawdown. This impact would be less than significant.

Changes in Water Supply

As discussed under Impacts AQ-a through AQ-c, changes in water supply may result in agricultural land fallowing, post-harvest rice burning, and groundwater pumping, resulting in localized fugitive dust and emissions (e.g., DPM).

Fallowed land could result in exposed soils and windblown fugitive dust, which could increase the likelihood of exposure to naturally occurring asbestos and Valley fever. The potential for sensitive receptors (e.g., residences, hospitals, schools) to be in proximity to fallowed land would be minimal. This impact would be less than significant.

The amount of pollutant emissions associated with post-harvest rice burning and groundwater pumping may vary depending on location and extent. While the precise location and magnitude of required emissions-generating activities is not known, and the resulting pollutant emissions cannot be determined with certainty at this time, any increase in emissions is likely to be minor given the limited and infrequent extent of the action. DPM emissions from diesel pumps would be generated only when pumps are in use. These emissions-generating activities would occur in or adjacent to agricultural lands, rural areas, or in areas with suitable land use designations and zoning for infrastructure (e.g., public facilities). Therefore, there is low probability that sensitive receptors (e.g., residences, hospitals, schools) would be in proximity to increased pollutant concentrations. This impact would be less than significant.

Impact AQ-e: Create objectionable odors affecting a substantial number of people

Reduced storage levels in some reservoirs on VA tributaries and other tributaries may increase the formation of harmful algal blooms (HABs), which could produce odor compounds. Any associated odors would dissipate as a function of distance and are not anticipated to affect a substantial number of people (i.e., result in more than five odor complaints per year averaged over 5 years). This impact would be less than significant.

The VA proposal identifies that some flow could be provided through groundwater substitution. Odors could be emitted during the operation of groundwater wells, from the extraction of materials from wells during well sampling and from emissions from diesel equipment. The objectionable odors that could be produced would be temporary and localized to the well site. This impact would be less than significant.

9.7.6 Biological Resources

9.7.6.1 Terrestrial Biological Resources

Sections 7.6.1.2, *Environmental Setting*, and 7.6.1.3, *Regulatory Setting*, describe background information on terrestrial biological resources and the regulatory setting related to special-status species, their habitat, and sensitive natural communities to inform the impact discussion in this section; Section 7.6.1, *Terrestrial Biological Resources*; Section 7.21, *Habitat Restoration and Other Ecosystem Projects*; and Section 7.22, *New or Modified Facilities*. Section 7.6.1 describes the potential impacts that may result from changes in hydrology or changes in water supply under the proposed Plan amendments.

This section describes potential impacts for terrestrial biological resources that may result from changes in hydrology or changes in water supply under the proposed VAs. Changes in hydrology could reduce the water level in reservoirs and streamflows on VA tributaries and other rivers and streams, which could affect some sensitive species and riparian habitat. Changes in water supply could negatively affect certain special-status wildlife species and habitat that relies on Sacramento/Delta water supplied to certain agricultural lands. SWAP results were reviewed to determine whether projected changes in cropping patterns due to changes in water supply have a potential to affect special-status wildlife species that use certain agricultural lands as habitat.

Impact Analysis

Impact TER-a: Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations, or by the California Department of Fish and Game or U.S. Fish and Wildlife Service

Changes in Hydrology

Implementation of the proposed VAs could result in changes in hydrology, including changes in streamflow and reservoir levels on the VA tributaries compared to baseline. Increases in streamflows on VA tributaries would generally occur during the spring months, although some increases in streamflows could also occur at other times for some VA tributaries. In addition, both Delta inflows and Delta outflows would increase on average on an annual basis under the proposed

VAs compared to baseline. These changes would be smaller compared to the proposed Plan amendments.

Increased flows could help restore and maintain natural processes, such as sediment deposition, marsh accretion, nutrient transport, seed dispersal, and flow-related disturbance, which would maintain and improve habitat conditions for native freshwater wetland and riparian species. This benefit would include any special-status plants and wildlife found in these habitats, including freshwater emergent wetlands; seasonal wetlands; seeps, springs, and meadows; and managed wetlands. Increases in Delta inflows and Delta outflows could benefit freshwater marshes and tidal marshes in the Delta and Suisun Bay. Special-status wildlife species that occur in these habitats also may benefit, including, but not limited to, western pond turtle, giant gartersnake, tricolored blackbird, northern harrier, white-tailed kite, least bittern, Suisun song sparrow, California black rail, and yellow-headed blackbird.

The proposed VAs could also result in reductions in streamflows at times, generally during the fall or early winter months. Overall, reservoir levels on VA tributaries would be similar to baseline but could increase at times and decrease at times. If implemented, actual operation of the VAs could vary to some degree from modeled outcomes and there could be additional changes in streamflows and reservoir levels beyond the modeled changes. For example, the proposed VAs include flexibility in the timing of flow assets, so streamflows and reservoir levels could deviate to some degree from modeled results. In addition, the VA tributary inflow analyses do not assume any additional inflows from unspecified water purchases given the unknown origin of these water purchases. However, these additional flow assets could be provided on VA tributaries and other Sacramento/Delta tributaries, which could affect streamflows and reservoir levels on those tributaries. Similarly, unspecified water purchases could result in reductions in export reservoir levels and streamflows below export reservoirs. These changes would be smaller than the changes that would occur under the proposed Plan amendments (discussed in Chapter 6, *Changes in Hydrology and Water Supply*, and 7, *Environmental Analysis*).

Changes in streamflows under the proposed VA are not expected to significantly affect bank swallow nesting habitat on the Sacramento or Feather Rivers. As discussed in Section 7.6.1, *Terrestrial Biological Resources*, flows in the range of 14,000 to 30,000 cubic feet per second (cfs) during the bank swallow breeding season of April through July have been associated with localized bank collapse events that resulted in partial or complete colony failure. The proposed VAs could result in changes in flow on the Sacramento and Feather Rivers during the bank swallow breeding season, but SacWAM results show that the proposed VAs would not increase the frequency at which flows ranging from 14,000 to 30,000 cfs occur on the Sacramento and Feather Rivers during the bank swallow breeding season. The impact would be less than significant.

The proposed VAs would not result in changes in flows into the Yolo Bypass. The proposed VAs include modifications to Tisdale Weir that would increase the flows into the Sutter Bypass at the Tisdale Weir in December through March by more than 100 TAF/yr on average. Increases in the frequency and duration of floodplain inundation during the winter months in the Sutter Bypass and other floodplains in the Sacramento/Delta would generally improve habitat for wintering waterfowl and may benefit some other wildlife species that occur in floodplains.

Changes in reservoir levels under the proposed VAs would generally be expected to be small and would not significantly affect special-status wildlife species that use reservoirs and their shorelines such as bald eagle, American white pelican, and western pond turtle. Similarly, special-status amphibians that may rely on riparian and wetland habitat in upper watershed reservoirs will likely not be significantly affected. It is possible that some upstream reservoirs could be reoperated on some tributaries, such as on the upper American River, but these changes would be unlikely to significantly affect special-status amphibians.

Changes in Supply

Implementation of the proposed VAs could result in changes in Sacramento/Delta surface water supplies, both within and outside of the Sacramento/Delta watershed. Overall, implementation of the proposed VAs would result in an average annual reduction in Sacramento/Delta surface water supply across the study area. Most of the reductions in Sacramento/Delta surface water supplies would occur within the Sacramento/Delta watershed. The SacWAM results for the Sacramento/Delta watershed also show that Sacramento/Delta water supply reductions would primarily affect agricultural uses. There would be no expected change in water supply for wildlife refuge uses.

Changes in water supply could negatively affect special-status wildlife species that rely on Sacramento/Delta water supplied to certain agricultural lands. The species with the greatest potential to be adversely affected by changes in water supply, based on their rarity and dependence on specific crops, are giant gartersnake, Swainson's hawk, greater sandhill crane, tricolored blackbird, and California black rail. As discussed in Section 7.6.1, *Terrestrial Biological Resources,* the SWAP model was used to estimate the changes in crop acreage that could occur as a result of changes in water supply in the valley floor portions of the Sacramento/Delta watershed and San Joaquin Valley regions. The SWAP results for percentage change in acreage of crops most important to giant gartersnake, Swainson's hawk, greater sandhill crane, and tricolored blackbird under the proposed VAs compared with baseline are presented in Table 9.6-1 through Table 9.6-4.

The VA proposal identifies that some flow assets could be provided through groundwater substitution, including in basins subject to the Sustainable Groundwater Management Act (SGMA) where that is consistent with local management under SGMA. If flow assets are made available through groundwater substitution, Sacramento/Delta water supply reductions and changes in crop acreage would be less than suggested by the modeling results, and associated impacts to terrestrial biological species would be less.

Giant Gartersnake

Giant gartersnakes could be affected by changes in rice acreage resulting from reduced Sacramento/Delta water supplies to agriculture. The giant gartersnake uses agricultural areas dominated by rice production, which provide alternative habitat in the absence of wetlands. Table 9.7-5 shows the potential change in acreage of crops that are used as giant gartersnake habitat in the Sacramento/Delta watershed and San Joaquin Valley regions under the proposed VAs for average and dry year conditions, compared with baseline.

The SWAP results include modeled changes in crop acreage that could occur as a result of the VA tributary assets as well as Delta and estuary assets (including unspecified water purchases). However, as discussed in Section 9.7.4, *Agriculture and Forest Resources*, the effects of the proposed VAs on crop acreage could vary from modeled outcomes. For example, SWAP estimates the source of unspecified water purchases based on economic related assumptions. However, the unspecified water purchases would be provided from unspecified willing sellers that choose to participate in the water purchase program, and outcomes would likely differ to some extent from modeled outcomes.

Nonetheless, the effects on giant gartersnake resulting from changes in Sacramento/Delta water supplies could be potentially significant, particularly if no replacement groundwater pumping is used to supply rice lands affected by changes in surface water supply. These effects would be less if replacement groundwater pumping is used as a substitute for reduced Sacramento/Delta water supply.

Table 9.7-5. Giant Gartersnake Habitat Acreage under the Proposed VAs in the Sacramento/Delta and San Joaquin Valley Regions

	Estimated Total Acreage under Proposed VAs	Change from Baseline (acres)	Percent Change from Baseline
Average Year	561,000	-6,700	-1.2%
Dry Year	551,500	-5,600	-1.0%

Source: SWAP results for proposed VAs.

Swainson's Hawk

Changes in Sacramento/Delta water supplies could result in a decrease in the amount of agricultural foraging habitat available to Swainson's hawks. These crop types include alfalfa, irrigated pasture, and other field-grass hay. Table 9.7-6 shows the potential change in acreage of Swainson's hawk habitat in the Sacramento/Delta watershed and San Joaquin Valley regions under the proposed VAs for average and dry year conditions, compared with baseline.

The SWAP results include modeled changes in crop acreage that could occur as a result of the VA tributary assets as well as Delta and estuary assets (including unspecified water purchases). However, as discussed in Section 9.7.4, *Agriculture and Forest Resources*, the effects of the proposed VAs on crop acreage could vary from modeled outcomes. For example, SWAP estimates the source of unspecified water purchases based on economic related assumptions. However, the unspecified water purchases would be provided from unspecified willing sellers that choose to participate in the water purchase program, and outcomes would likely differ to some extent from modeled outcomes. Nonetheless, the effects on Swainson's hawk resulting from changes in Sacramento/Delta water supplies could be potentially significant, particularly if no replacement groundwater pumping is used to supply agricultural lands affected by changes in water supply. These effects would be less if replacement groundwater pumping is used as a substitute for reduced Sacramento/Delta water supply.

Table 9.7-6. Swainson's Hawk Habitat Acreage under the Proposed VAs in the Sacramento/Delta and San Joaquin Valley Regions

	Estimated Total Acreage under Proposed VAs	Change from Baseline (acres)	Percent Change from Baseline
Average Year	1,534,100	-24,900	-1.6%
Dry Year	1,407,900	-24,400	-1.7%

Source: SWAP results for proposed VAs.

Greater Sandhill Crane

Changes in Sacramento/Delta water supplies could result in a decrease in the amount of agricultural foraging habitat available to greater sandhill cranes. These crop types include: alfalfa, corn, corn silage, grain, irrigated pasture, rice, and other field-grass hay. Table 9.7-7 shows the potential change in acreage of greater sandhill crane habitat in the Sacramento/Delta watershed and San Joaquin Valley regions under the proposed VAs for average and dry year conditions, compared with baseline.

The SWAP results include modeled changes in crop acreage that could occur as a result of the VA tributary assets as well as Delta and estuary assets (including unspecified water purchases). However, as discussed in Section 9.7.4, *Agriculture and Forest Resources*, the effects of the proposed VAs on crop acreage could vary from modeled outcomes. For example, SWAP estimates the source of unspecified water purchases based on economic related assumptions. However, the unspecified water purchases would be provided from unspecified willing sellers that choose to participate in the water purchase program, and outcomes would likely differ to some extent from modeled outcomes. Nonetheless, the effects on greater sandhill crane could be potentially significant, particularly if no replacement groundwater pumping is used for agricultural lands affected by reductions in Sacramento/Delta supply. These effects would be less if replacement groundwater pumping is used as a substitute for reduced Sacramento/Delta water supply.

Table 9.7-7. Greater Sandhill Crane Habitat Acreage under the Proposed VA in the Sacramento/Delta and San Joaquin Valley Regions

	Estimated Total Acreage under proposed VAs	Change from Baseline (acres)	Percent Change from Baseline
Average Year	3,256,600	-28,300	-0.9%
Dry Year	3,049,800	-31,100	-1.0%

Source: SWAP results for proposed VAs.

Tricolored Blackbird

Changes in Sacramento/Delta water supplies could result in a decrease in the amount of nesting and foraging habitat available to tricolored blackbirds on agricultural lands. These crop types include alfalfa, corn, corn silage, grain, irrigated pasture, and rice. Table 9.7-8 shows the potential change in acreage of tricolored blackbird habitat in the Sacramento/Delta watershed and San Joaquin Valley regions under the proposed VAs for average and dry year conditions, compared with baseline.

The SWAP results include modeled changes in crop acreage that could occur as a result of the VA tributary assets as well as Delta and estuary assets (including unspecified water purchases). However, as discussed in Section 9.7.4, *Agriculture and Forest Resources*, the effects of the proposed VAs on crop acreage could vary from modeled outcomes. For example, SWAP estimates the source of unspecified water purchases based on economic related assumptions. However, the unspecified water purchases would be provided from unspecified willing sellers that choose to participate in the water purchase program, and outcomes would likely differ to some extent from modeled outcomes. Nonetheless, the effects on tricolored blackbird resulting from changes in Sacramento/Delta water supply could be potentially significant, particularly if no replacement groundwater pumping is used for agricultural lands affected by reduced deliveries. These effects would be less if replacement groundwater pumping is used as a substitute for reduced Sacramento/Delta supply.

Table 9.7-8. Tricolored Blackbird Habitat Acreage Under the Proposed VAs in the Sacramento/Delta and San Joaquin Valley Regions

	Estimated Total Acreage under proposed VAs	Change from Baseline (acres)	Percent Change from Baseline
Average Year	3,027,300	-28,700	-0.9%
Dry Year	2,518,200	-30,600	-1.2%

Source: SWAP results for proposed VAs.

California Black Rail

It is possible that some flow provided under the proposed VAs could reduce Sacramento/Delta agricultural water supplies in the portions of the Sierra Nevada foothills that currently support California black rail habitat. Even though the potential reduction of surface water supplies is low, because of the rarity of this species, the impact on the Sierra Nevada population of California black rail would be considered potentially significant.

Conclusion

Changes in crop acreages could result in a reduction of habitat for giant gartersnake, Swainson's hawk, greater sandhill crane, and tricolored blackbird. In addition, possible reductions in irrigation water in the Sierra Nevada foothills could reduce habitat for the California black rail. These impacts could be potentially significant.

Potentially significant impacts on terrestrial species resulting from habitat loss from reduced Sacramento/Delta water supply to agriculture could be avoided or reduced through implementation of Mitigation Measures MM-TER-a: 2, 4 and 5. The proposed VAs are intended to be implemented with physical habitat restoration that would provide benefits for both aquatic and terrestrial species. In addition, management measures exist that agricultural water users can implement to avoid or minimize impacts on special-status species. Unless and until the mitigation is fully implemented, the impacts remain potentially significant.

The proposed VAs would result in an average annual reduction in Sacramento/Delta surface water supply that would primarily affect agricultural uses. Any potential reductions in water supply to municipalities under the proposed VAs would not be large enough to alter the flow and chemical constituent concentrations of wastewater treatment plant (WWTP) influent and subsequently affect WWTP effluent discharges to receiving waters in a manner that affects water quality and special-status terrestrial species occurring in association with streams or riparian and emergent marsh habitat. There would be no impact.

The VA proposal identifies that some flow assets could be provided through groundwater substitution, including in the American River watershed consistent with the VA documents. Flow assets in other watersheds could also be provided through groundwater substitution. Increased groundwater pumping could result in potentially significant impacts on groundwater dependent habitats in some areas and therefore on the special-status species which have some or all of their life cycle associated with groundwater dependent ecosystems. Draw-downs of shallow groundwater systems may make groundwater unavailable to groundwater dependent ecosystems. Impacts on these natural communities in turn affects habitat availability and the long-term survival of plants and wildlife that rely on the groundwater dependent natural communities to survive. Although valley oak woodlands, as discussed in Impact TER-b, could be affected, this community does not represent a major source of nesting habitat for special-status species that use this habitat; therefore, the impact on these special-status species would be less than significant.

Impact TER-b: Have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, or regulations, or by the California Department of Fish and Game or U.S. Fish and Wildlife Service

Impact TER-c: Have a substantial adverse effect on federally protected wetlands as defined by Section 404 of the Clean Water Act (including, but not limited to, marshes, vernal pool, coastal, etc.) through direct removal, filling, hydrological interruption, or other means

The analyses of effects on sensitive natural communities including riparian habitat and federally protected wetlands are closely related and are therefore combined and addressed together under Impact TER-b and Impact TER-c. As these natural communities may serve as habitat for sensitive terrestrial species, the discussions below may also reiterate analyses made in Impact TER-a.

Changes in hydrology under the proposed VAs would generally result in riverine flows in the Sacramento/Delta that are similar to or greater than baseline flows during spring. These changes could help support natural processes such as sediment deposition, marsh accretion, nutrient transport, seed dispersal, and flow-related disturbance. These changes would also potentially improve functions and services of existing wetlands, such as sediment retention, nutrient uptake, and supporting biological productivity. Increases in Delta inflows and Delta outflows could benefit freshwater marshes and tidal marshes in the Delta and Suisun Bay.

Increased inundated floodplain habitat in the Sacramento/Delta during the wet season months would likely benefit riparian and wetland habitat served by flow-related ecosystem processes such as seasonal increases in groundwater recharge beneath inundated floodplain areas. Areas of increased inundation would include, but not be limited to, the Sutter Bypass.

Changes in reservoir levels and streamflows below reservoirs under the proposed VAs would not significantly affect riparian and wetland habitat. The impact would be less than significant.

Reductions in Sacramento/Delta supplies could affect water quality in managed wetlands if those lands receive some or all of their water supply from the Sacramento/Delta either directly or indirectly. The VA documents indicate no flow assets would come from refuge supplies, although wetlands theoretically could experience some indirect effects. It is possible that reductions in agricultural supply could cause reductions in agricultural drainage. With less Sacramento/Delta supply, the remaining inflow from agricultural drainage and groundwater could become more degraded, and dilution of this low-quality water with fresh surface water supplies could be reduced. The effect is likely to be more substantial in the San Joaquin Valley region, where water quality is already poor in some locations. For example, the extensive and ecologically important areas within the Grasslands Ecological Area are fed by a combination of surface water imports, groundwater, and agricultural drainage. However, as discussed in Section 9.7.4, *Agriculture and Forest Resources*, reductions in agricultural water supply under the proposed VAs would likely to be small compared to each region's total agricultural water supply. These changes in Sacramento/Delta water supplies would be smaller under the proposed VAs compared to the proposed Plan amendments. As a result, managed wetlands are unlikely to experience substantial reductions in water supply or water quality due to reductions in agricultural drainage or groundwater levels associated with the proposed VAs. The impacts on wetland habitat from reduced supply to managed wetlands would be less than significant.

The SacWAM results show that Sacramento/Delta water supply reductions would primarily affect agricultural uses. Sacramento/Delta water supply reductions would be based on voluntary measures that would be largely or entirely from agricultural supplies, reservoir reoperations, or based on groundwater substitution. Any changes to municipal water supplies would be small and would not be expected to affect sensitive riparian and wetland habitat and other natural communities where municipal discharges incidentally supplement flow. There would be no impact.

The VA proposal identifies that some flow could be provided through groundwater substitution, including in the American River watershed consistent with the VA documents. Flow in other watersheds could also be provided through groundwater substitution. Increased groundwater pumping could result in decreased groundwater levels, particularly in localized areas. Riparian-associated natural communities would generally not be adversely affected by decreased groundwater levels that could occur as a result of the proposed VAs. In non-riparian areas, sensitive natural communities such as valley oak woodlands and wetlands could potentially be affected by reduced groundwater levels. As discussed in Section 7.6.1, *Terrestrial Biological Resources,* valley oaks take up water through deep taproots and extensive horizontal roots. Valley oaks are also resistant to short-term drought and mature trees primarily suffer drought damage when a series of dry seasons lowers water tables to extreme depths. Most valley oak woodlands in the Central Valley have been removed because of agricultural conversion; however, the adverse effect on small stands and individual valley oaks in these regions would not be expected to rise to a level of significance because of their ability to tolerate periods of drought (e.g., deep rooting depths, extensive horizontal roots).

Seasonal wetlands and vernal pools depend on seasonal surface water, seasonally saturated soils, and water perched above hardpans, not deeper groundwater aquifers. However, in some instances, sensitive perennial wetland communities, such as fens, bogs, seeps, and marshes cold be affected by increased groundwater pumping, particularly in localized areas if additional groundwater pumping occurs in close proximity to wetlands. There could be instances where lowered groundwater levels from increased groundwater pumping could affect groundwater-dependent ecosystems, including riparian and wetland habitat and sensitive natural communities. This could be a potentially significant impact. Implementation of Mitigation Measure MM-TER-b,c: 2 (which incorporates MM-GW-b, as applicable) would reduce impacts of lowered groundwater levels on groundwater dependent ecosystem habitat. Groundwater impacts and associated impacts on wetlands and sensitive groundwater-dependent natural communities could be reduced by sustainable groundwater management, groundwater storage and recovery, increased use of water recycling from existing facilities, and agricultural conservation measures. However, unless and until the mitigation is fully implemented, impacts caused by reduced groundwater levels on riparian and wetland habitat and sensitive natural communities remain potentially significant.

Impact TER-d: Interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites

Changes in hydrology from increased flows under the proposed VAs could generally benefit riverine and associated wetland and riparian habitat and natural communities in the Sacramento/Delta. Native resident and migratory wildlife that use these habitats as migratory corridors or nursery sites could also benefit. Relatively small decreases in reservoir levels would not significantly affect resident waterfowl breeding habitat. The impact would be less than significant.

The proposed VAs identify that some flow could be provided through groundwater substitution, including in the American River watershed. Flow in other watersheds could also potentially be provided through groundwater substitution. Increased groundwater pumping could result in decreased groundwater levels, which have the potential to affect groundwater-dependent ecosystems in localized areas that may provide habitat for migratory and resident waterfowl and shorebirds. However, many waterfowl and shorebirds use wetland habitat at wildlife refuges and other managed wetlands, which would not be significantly affected by changes in groundwater levels. The impact of reduced groundwater levels would not significantly affect waterfowl and shorebirds. Increased groundwater pumping would not be expected to directly affect migratory waterfowl and shorebirds and thus there would be no impact.

Impact TER-e: Conflict with any local policies or ordinances protecting biological resources such as a tree preservation policy or ordinance

Actions associated with changes in hydrology and water supply under the proposed VAs would not conflict with any local policies or ordinances protecting terrestrial biological resources. Many general plans within the study area contain policies that call for the conservation of biological resources within the respective general plan areas. The proposed VAs would not conflict with these policies because they would not result in a change in land use or zoning or result in the direct removal of biological resources. There would be no impact.

Impact TER-f: Conflict with the provisions of an adopted habitat conservation plan, natural community conservation plan, or other approved local, regional, or state habitat conservation plan

The proposed VAs would not create adjacent incompatible land uses, develop land, or otherwise result in actions incompatible with conservation plans or activities as the proposed VAs do not require or result in those types of activities. The proposed VAs would not likely impair a permittee’s ability to undertake required conservation actions as changes in flows would be based on voluntary measures and unlikely to be provided if needed to meet a conservation action. Increased flows under the proposed VAs could complement the actions identified in the conservation/habitat management plans that preserve and restore riverine and estuarine habitat and associated special-status species. There would be no impact.

9.7.6.2 Aquatic Biological Resources

Sections 7.6.2.2, *Environmental Setting*, and 7.6.2.3, *Regulatory Setting*, describe background information on aquatic biological resources and the regulatory setting to inform the impact discussion in this section; Section 7.6.2, *Aquatic Biological Resources;* Section 7.21, *Habitat Restoration and Other Ecosystem Projects*; and Section 7.22, *New or Modified Facilities*. Section 7.6.2 describes the potential impacts that may result from changes in hydrology or changes in water supply under the proposed Plan amendments.

This section describes potential impacts for aquatic biological resources from changes in hydrology and changes in water supply under the proposed VAs. The analysis in this section focuses on native fish addressed in the context of their native riverine and estuarine habitat. Most effects on aquatic biological resources including fish would be expected to be beneficial and any impacts less than significant. Potential impacts on aquatic species could occur below certain reservoirs that have limited capacity to maintain storage conditions needed to provide suitable downstream temperatures for native fish.

Impact Analysis

Impact AQUA-a: Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations, or by the California Department of Fish and Game or U.S. Fish and Wildlife Service

Impact AQUA-d: Interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites

The discussion of Impact AQUA-a and Impact AQUA-d is combined because fish migration is integral to the discussion of effects on special-status species generally.

Changes in Hydrology

Sacramento/Delta Tributaries

Implementation of the proposed VAs could result in changes in hydrology, including changes in streamflow and reservoir levels in the VA tributaries compared to baseline. Increases in streamflows would generally occur during the spring months, although increases in streamflows could also occur at other times for some VA tributaries. The proposed VAs could also result in slight reductions in streamflows at times, generally during the fall or early winter months. These changes would be much smaller than the changes that would occur under the proposed Plan amendments. Overall, reservoir levels in Shasta Reservoir, Oroville Reservoir, Folsom Reservoir, Camanche Reservoir, and Lake Berryessa would be similar to baseline but could increase at times and decrease at times.

As discussed above in Section 9.5, *Changes in Hydrology and Water Supply*, if the VAs were adopted, actual operation could vary to some degree from modeled outcomes and there could be additional changes in streamflows and reservoir levels beyond the modeled changes. For example, the proposed VAs include flexibility in the timing of flow assets, so streamflows and reservoir levels could deviate to some degree from modeled results. In addition, the proposed VAs include flow assets that would be provided through unspecified water purchases, which could include inflow sources within the Sacramento/Delta watershed (including on other Sacramento/Delta tributaries). The VA tributary inflow analyses do not assume any additional inflows from unspecified water purchases given the unknown origin of these water purchases. In addition, it is possible that some upstream reservoirs could be reoperated on some tributaries, but these effects were not modeled. The proposed VAs could also affect reservoir levels in export reservoirs and streamflows below export reservoirs, but these changes would be expected to be small.

To the extent that proposed VA flow assets are intended to provide increased flow on VA tributaries concentrated during winter and spring months, this would be expected to benefit native aquatic species, including Chinook salmon and steelhead.

Geomorphic Flows

As discussed in Section 7.6.2, *Aquatic Biological Resources*, floods, and their associated sediment transport, are important drivers of the river-riparian system. Smaller magnitude, frequent floods maintain channel size, shape, and bed texture, while larger, infrequent floods provide beneficial disturbance to both the channel and its adjacent floodplain and riparian corridor. However, flood disturbance can pose a risk to salmonid eggs and embryos in redds by causing scour and fill of spawning areas. The erosion and flood risk analysis presented in Section 9.7.12.1, *Surface Water*, discusses that peak flows on VA tributaries would generally be similar to baseline. Therefore, the effect of changes in wet season flows and flood disturbance on special-status aquatic species or their habitat and on the movement of any native resident or migratory fish would be less than significant.

Peak flows on other tributaries would not be expected to change under the proposed VAs. There would be no impact on other tributaries.

Water Temperature

Sacramento/Delta Tributaries

As discussed in Section 7.6.2, *Aquatic Biological Resources*, water temperature is a key factor in defining habitat suitability for aquatic organisms. Exposure of Chinook salmon and steelhead populations to elevated water temperature is a major factor contributing to their decline (see Chapter 4, *Other Aquatic Ecosystem Stressors*). Reductions in cold water storage impede reservoirs from meeting suitable downstream water temperature, especially during critically dry years. Dams and reservoirs now block Chinook salmon and steelhead access to much of these species' historical higher elevation habitat, which consistently provide colder water temperatures suitable for successful spawning and juvenile rearing. Physical and operational measures, including temperature control devices (TCD) and seasonal storage management, are employed at Central Valley reservoirs to improve the reliability of cold water discharges during critical summer and fall spawning and rearing periods. However, as discussed in Section 7.6.2, many reservoirs have existing problems with temperature for which existing temperature controls may not be sufficient.

Changes in flow and reservoir storage under the proposed VAs could affect stream temperatures and the availability of cold water to protect anadromous salmonids and other native fishes. While both VA narrative objectives refer to temperature (either directly or indirectly via 'water quality conditions'), and the VAs are in part intended to avoid temperature impacts, the VAs do not include an explicit commitment to cold water temperature provisions. A It is possible that there would be some instances on some streams where temperatures could increase.

This section describes potential water temperature-related biological effects of the proposed VAs in several VA tributaries, including the Sacramento, American, and Feather Rivers. Methods used for the water temperature effects analysis are summarized in Section 7.6.2, *Aquatic Biological Resources*, but generally relies on SacWAM modeling results for the proposed VAs as inputs for HEC-5Q temperature modeling. If the VAs were adopted, actual operation could vary to some degree from modeled outcomes and there could be additional changes in streamflows, reservoir levels, and water temperatures beyond the modeled changes. For example, the proposed VAs include flexibility in the timing of flow assets, so streamflows and reservoir levels could deviate to some degree from modeled results, including for temperature benefits. In addition, the VA tributary inflow analyses do not assume any additional inflows from unspecified water purchases given the unknown origin of these water purchases. More details on the methodology are provided in Appendix G3e, *Water Temperature Modeling and Fish Assessment for the Sacramento, Feather, and American Rivers*. For other VA tributaries outside the HEC-5Q model domain, a qualitative assessment of temperature impacts is provided based on SacWAM results and assumptions of effects on temperature.

Sacramento River

The potential water temperature-related effects of the VAs in the Sacramento River were evaluated for the following fish species: winter-, spring- and fall-/late fall-run Chinook salmon, Central Valley steelhead, and green sturgeon. Suitable water temperature criteria for these species are presented in Appendix A6, Table A6-48. As described in Section 7.6.2, *Aquatic Biological Resources*, these criteria were taken from peer-reviewed literature and relevant agency technical reports.

Model results presented in Appendix G3e indicate that only limited effects of the VAs on temperatures would be expected (including both favorable or unfavorable effects) for any life stage of winter-, spring- and fall-/late fall-run Chinook salmon, Central Valley steelhead, or green sturgeon in the Sacramento River (Appendix G3e, Table Sac_VA_WR-1, Table Sac_VA_SR-1, Table Sac_VA_FR-1, Table Sac_VA_LFR-1, Table Sac_VA_ST-1, and Table Sac_VA_GS-1). Unfavorable results could occur in ≤1.1% of month-water year type combinations for all life stages of all species present in the river. Favorable results could occur in ≤0.5% of month-water year type combinations for all life stages of all evaluated species present in Sacramento River. Overall, water temperature conditions under the proposed VA scenario would be expected to be similar to baseline.

American River

The potential water temperature-related effects of the VAs in the American River were evaluated for the following fish species: winter- and fall-run Chinook salmon and Central Valley steelhead. Suitable water temperature criteria for these species are presented in Appendix A6, Table A6-49. As described in Section 7.6.2, *Aquatic Biological Resources*, these criteria were taken primarily from peer-reviewed scientific literature and relevant agency technical reports.

Model results presented in Appendix G3e indicate that there would be no expected effects of the VAs on temperatures for winter-run Chinook salmon non-natal rearing, and very few favorable and unfavorable effects on any life stage of fall-run Chinook salmon and Central Valley steelhead in the American River (Appendix G3e, Table Amer_VA_WR-1, Table Amer_VA_FR-1, and Table Amer_VA_ST-1). Unfavorable results could occur in ≤1.7% of month-water year type combinations for all life stages of fall-run Chinook salmon and steelhead present in the river. Favorable results could occur in ≤2% of month-water year type combinations for all life stages of fall-run Chinook salmon and steelhead present in the river. Overall, water temperature conditions under the proposed VA scenario would be expected to be similar to baseline.

Feather River

The potential water temperature-related effects of the VAs in the Feather River were evaluated for the following fish species: winter-, spring- and fall-run Chinook salmon, Central Valley steelhead, and green sturgeon. Suitable water temperature criteria for these species are presented in Appendix A6, Table A6-50. As described in Section 7.6.2, *Aquatic Biological Resources*, these criteria were taken from peer-reviewed literature and relevant agency technical reports.

Model results presented in Appendix G3e indicate that there would be expected to be very few temperature related effects on any life stage of winter-run non-natal rearing and on any life stage of spring- and fall-run Chinook salmon, Central Valley steelhead, or green sturgeon in the Feather River (Appendix G3e, Table Feath_VA_WR-1, Table Feath_VA_SR-1, Table Feath_VA_FR-1, Table Feath_VA_FR-1, and Table Sac_VA_GS-1). Unfavorable results could occur in ≤1.7% of month-water year type combinations for all life stages of all species present in the river. Favorable results could occur in ≤2% of month-water year type combinations for all life stages of all species present in the river. Overall, water temperature conditions under the proposed VA scenario would be expected to be similar to baseline.

Other Tributaries

The analysis of temperature-related effects in VA tributaries other than the Sacramento, American, and Feather Rivers relies on a qualitative interpretation of SacWAM reservoir storage and flow outputs. The qualitative analysis assumes that increases in flow and/or reservoir storage will cause a reduction in water temperatures that can benefit native fish species. The proposed VAs could also result in reductions in streamflows at times, generally during the all or early winter months. Overall, reservoir levels in VA tributaries would be similar to baseline but could increase or decrease to some degree at times. These changes would be smaller than the changes that would occur under the proposed Plan amendments (discussed in Chapter 6, *Changes in Hydrology and Water Supply*, and 7, *Environmental Analysis*). Reduced carryover storage could lead to lower flows during fall months. Reductions in flows and carryover storage could reduce cold water habitat and affect special-status fish species in the reaches below these reservoirs.

Some changes in water temperature are also possible on other (non-VA) tributaries in the Sacramento/Delta watershed, as well as streams below export reservoirs. As discussed in Section 9.5, *Changes in Hydrology and Water Supply*, additional flow assets could be provided through unspecified water purchases, which could include inflow sources within the Sacramento/Delta watershed including inflows from other (non-VA) tributaries. The VA tributary inflow analyses do not assume any additional inflows on non-VA tributaries given the unknown origin of these water purchases, but some changes in streamflow, reservoir levels, and water temperature are possible on non-VA tributaries. In addition, the proposed VAs could affect reservoir levels in export reservoirs and streamflows below export reservoirs.

Conclusion

Overall, changes in streamflows and reservoir levels would be less under the proposed VAs than the proposed Plan amendments, and model results for the American, Feather, and Sacramento Rivers indicate that water temperature conditions under the proposed VA would be similar to baseline; however, it is possible that there could be some instances on some streams where temperatures could increase. Because the sources of the unspecified water purchases are not fully known at this time but could include inflow sources within the Sacramento/Delta watershed, it is possible that there could be additional changes in water temperature on the American, Feather, and Sacramento Rivers or other Sacramento/Delta tributaries beyond the changes that were modeled and analyzed. The proposed VAs include flexibility in the timing of flow assets, which could reduce or avoid possible temperature-related effects. However, due to the uncertainty in the timing and location of VA flow assets and possible changes in water temperatures, this impact is conservatively considered potentially significant.

Implementation of Mitigation Measure MM-AQUA-a–d: 1.ii and 3 would reduce or avoid temperature impacts on aquatic species. Streams and reservoirs on VA tributaries may be subject to future changes that could result from issuance of new water rights orders or decisions, Federal Energy Regulatory Commission licenses, and other future regulatory requirements. In exercising its regulatory authorities, the State Water Board would consider aquatic biological resources and ensure that any impacts are avoided or minimized. In addition, the proposed VAs include physical habitat restoration and State and federal resource agencies should continue to develop, refine, and implement species recovery plans to protect aquatic biological resources, including special-status fish species. However, unless and until the mitigation is implemented, any impacts from changes in reservoir storage levels on water temperatures remain potentially significant.

Delta Inflow, Outflow, and Interior Delta Flows

As discussed in Section 9.3, *Description of the Proposed Voluntary Agreements*, and 9.5.2, *VA Modeling Approach*, the VAs would include flow assets that would be provided through unspecified water purchases (PWA Water Purchase Market Price Program and permanent state water purchases). These flow assets could include inflow sources within the Sacramento/Delta watershed or reductions in exports, both of which could result in additional Delta outflow. In addition, the Tuolumne River VA and the Friant VA could result in additional inflow and outflow and could affect interior Delta flows, but approval of the Tuolumne River VA is being considered separately and the Friant VA may not move forward. Therefore, potential impacts of changes in Delta inflow, outflow, exports, and interior Delta flows on aquatic species are evaluated for different scenarios to evaluate a range of possible outcomes that could occur under the proposed VAs (see Section 9.5.3.9, *Delta Inflows, Exports, Interior Delta Flows, and Delta Outflow Results*).

For impacts of changes in Delta inflow and outflow, scenarios are evaluated for two time periods: January-June and July-December. Generally, changes to flows are expected to have greater effects on anadromous and estuarine fish species in January-June (see Chapter 3, *Scientific Knowledge to Inform Fish and Wildlife Flow Recommendations*). During the winter-spring period, flows support juvenile Chinook salmon and Central Valley steelhead migrating through the Delta from the Sacramento River Basin and rearing in the Delta. In addition, January-June flows support adult spring-run, winter-run, and late fall-run Chinook salmon, as well as Central Valley steelhead migrating through the Delta upstream to the Sacramento and San Joaquin River spawning tributaries. Delta outflow during January-June supports native estuarine fish species (See Chapter 3, Table 3.14-1). For interior Delta flows, impacts analyses are presented for changes in flows during December-June, which is considered the OMR management season in the 2020 ITP and the 2019 BiOps (See Chapter 3, Table 3.14-3), and encompasses the months when interior Delta flow conditions most strongly impact the abundance and survival of Chinook salmon and native estuarine fish species (See Chapter 3, Tables 3.4-7, 3.5-1, and 3.8-1).

Delta inflows in January-June support migratory conditions for emigrating juvenile salmonids and other anadromous and estuarine fishes that migrate through the Delta and lower reaches of the Sacramento and San Joaquin Rivers and provide attraction and homing cues for adult salmon, steelhead, sturgeon, and other species migrating upstream. The impacts of changes in Delta inflow under the proposed VAs are evaluated for a lower range VA inflow scenario ("VA" scenario) that includes all Sacramento River and Delta tributary inflows and includes Tuolumne River VA flows but does not include unspecified water purchases in inflows. There is also a higher range VA inflow scenario ("VA High Inflow") that includes the unspecified water purchases in inflows and the additional Tuolumne River inflows (see Section 9.5.3.9, *Delta Inflows, Exports, Interior Delta Flows, and Delta Outflow Results*).

Implementation of the proposed VAs could result in increases in Delta inflow in January-June compared to baseline when considering both the VA scenario and VA High Inflow scenario that includes contributions from unspecified water purchases as Delta inflow (See *Delta Inflow* in Section 9.5.3.9, *Delta Inflows, Exports, Interior Delta Flows, and Delta Outflow Results*). Under the VA and VA High Inflow scenarios, inflow could decrease in July-December in all water year types and increase in January-June in most water year types compared to the baseline, with larger increases in inflow under the VA High Inflow scenario in January-June. However, the VA scenario could result in a slight decrease in Delta inflow compared to baseline in January-June during wet years (Table 9.5-29). The effects of the VA and VA High Inflow scenarios are the same in July-December but differ for January-June because additional inflows from unspecified water purchases under the proposed VAs would occur under the VA High Inflow scenario (which assumes the unspecified purchases occur during March-May).

Overall, because the magnitude of these changes is relatively small and decreases in inflow are expected to be limited to wet years in January-June and to July to December for other water year types, these changes in Delta inflow under the proposed VAs would have less than significant impacts on candidate, sensitive, or special-status fish species and would not interfere substantially with the movement of any native resident or migratory fish in the Delta. Small changes in inflow are less likely to impact native fish species during wet years when conditions are generally better, and changes during July-December are less likely to impact spawning, rearing, and migration conditions of candidate and listed species (see above discussion and Chapter 3, *Scientific Knowledge to Inform Fish and Wildlife Flow Recommendations*).

Delta Outflow

Delta outflows support native estuarine and anadromous aquatic species that inhabit the Bay-Delta and its tributaries throughout the year as juveniles or adults. Delta outflows affect habitat conditions for migration and rearing of estuarine and anadromous fish species. Flows are important for protecting native species populations by supporting key functions including maintaining appropriate low salinity zone (LSZ) habitat, migratory cues, reduced stranding and straying, and other functions (see Chapter 3, *Scientific Knowledge to Inform Fish and Wildlife Flow Recommendations*).

Impacts from changes in Delta outflow resulting from the proposed VAs are evaluated under two scenarios: 1) VA flows from the Sacramento, Feather, American, Mokelumne, and Tuolumne Rivers; Putah Creek; and Delta outflow contributions, including from Friant water users identified in the VA Term Sheet (referred to as the “VA” scenario), and 2) the VA flows without Tuolumne River flows and Friant contributions (referred to as the “VA without San Joaquin contributions”). These two scenarios both include postprocessing of unspecified water purchases and are meant to encompass the potential range of VA flows given uncertainties with the San Joaquin contributions (see Section 9.5.3.9, *Delta Inflows, Exports, Interior Delta Flows, and Delta Outflow Results*).

Implementation of the proposed VAs with or without San Joaquin contributions could result in increases in January-June Delta outflow compared to baseline and 2008-2009 BiOps condition in all water year types except wet years (See *Delta Outflow* in Section 9.5.3.9, *Delta Inflows, Exports, Interior Delta Flows, and Delta Outflow Results*). Greater increases in January-June Delta outflow are expected under the VA scenario including San Joaquin contributions. However, January-June Delta outflow could decrease in wet years under the VA scenarios relative to baseline. There could also be decreases in July-December Delta outflow during below normal, above normal, and wet water year types for the VA with and without San Joaquin contributions compared to baseline.

The changes in wet year January-June Delta outflows under the proposed VAs represent less than 1% of total Delta outflow and would have less than significant impacts on estuarine fish species based on flow-abundance relationships, in which species abundances are expected to change by less than 3% in wet years under the proposed VAs due to changes in Delta outflow (See Section 9.6, *Beneficial Environmental Effects of Proposed VAs*). In addition, Delta outflow conditions are generally good for fish during wet years, so small changes in Delta outflow during wet years are less impactful than under dry conditions (See Chapter 3, *Scientific Knowledge to Inform Fish and Wildlife Flow Recommendations* and Section 9.6). Changes in July-December Delta outflow would be expected to have less than significant impacts to aquatic species because outflow during this period is less influential on candidate, sensitive, or special-status anadromous and estuarine fish species (see Chapter 3, Table 3.14-1).

Under the proposed VAs, expected increases in Delta outflow during winter and spring months of most water year types could benefit estuarine fishes (e.g., longfin smelt, and Delta smelt) that use the Bay-Delta estuary for migration, spawning, and rearing (See Section 9.6, *Beneficial Environmental Effects of Proposed VAs*). Generally, the further X2 is located downstream of the confluence of the confined deep channels of the Sacramento and San Joaquin Rivers and the effects of the SWP and CVP export facilities into the broad, shallow, cool channels of Suisun Marsh and Suisun Bay, the better fish and other species respond (see Chapter 3, *Scientific Knowledge to Inform Fish and Wildlife Flow Recommendations*).

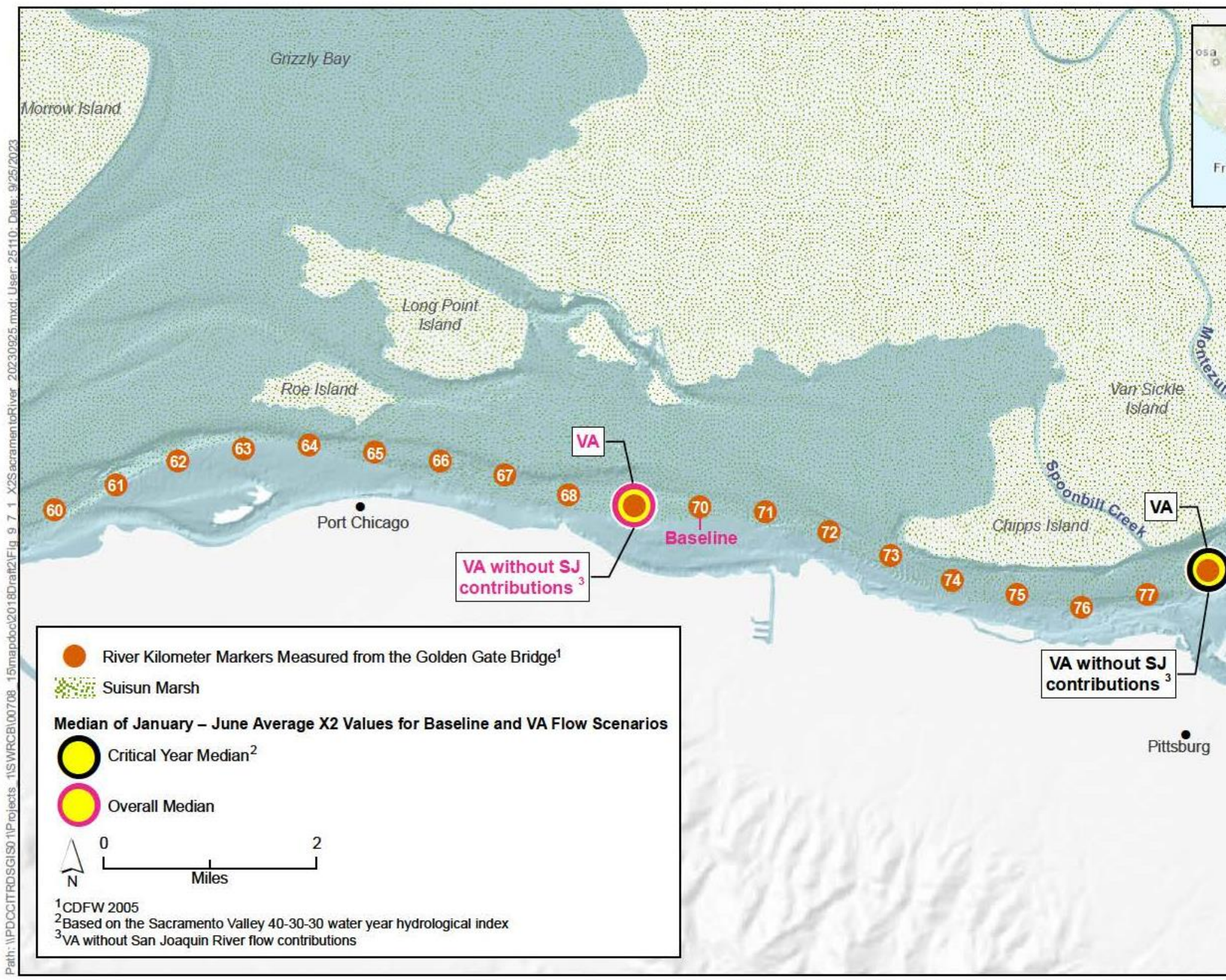


Figure 9.7-1 identifies the frequency of meeting an X2 position at Collinsville (81km), Chipps Island (75 km), and Port Chicago (64 km) under baseline and the proposed VAs from January through June. Overall, the SacWAM modeling and Delta outflow post-processing results with and without San Joaquin River flow contributions (see Section 9.5.2, *VA Modeling Approach*) show that the frequency of meeting an X2 position at or downstream of Chipps Island and Port Chicago would be unchanged under the proposed VAs compared to baseline. Therefore, the proposed VAs would have less than significant impacts on native fish species through changes to the position of X2.

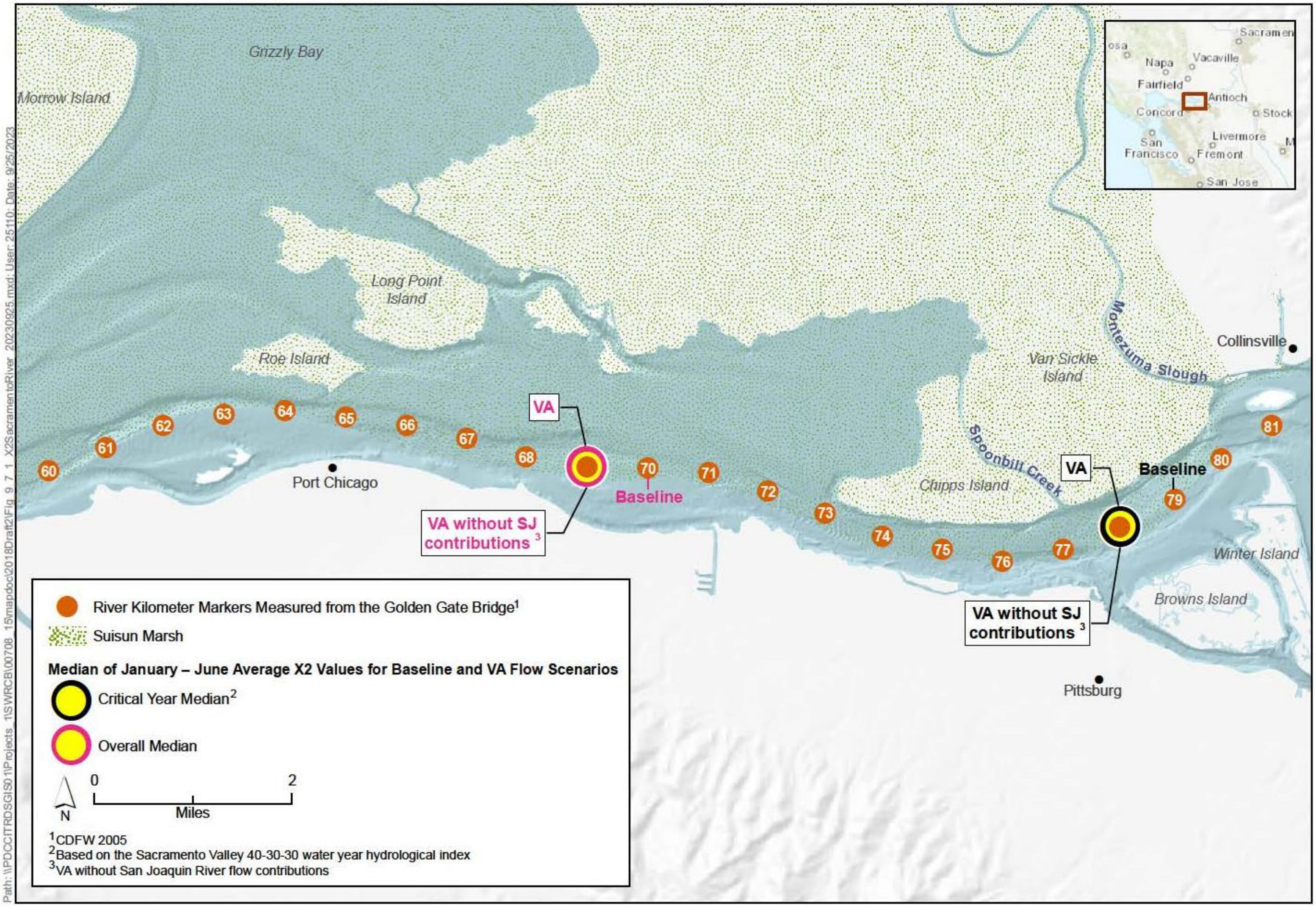


Figure 9.7-1. X2 Position for Baseline and VA Flow Scenarios Presented as Median of the January through June Average Values

Interior Delta Flows

Water diversions at the SWP and CVP export facilities (in combination with other conditions) can cause changes in interior Delta flows, including Old and Middle River (OMR) flows and net flows in the San Joaquin River at Jersey Point (QWEST). The major freshwater source in the Delta, the Sacramento River, enters on the northern side of the Delta while the two major pumping facilities, the SWP and CVP, are in the south. This results in a net water movement across the Delta in a north-south direction along a web of channels including Old and Middle Rivers instead of the more natural pattern from east to west or from land to sea. A negative value, or a reverse flow, indicates a net water movement across the Delta up the lower San Joaquin River and Old and Middle River channels to the export facilities. High net reverse flows have several negative ecological consequences. First, net reverse flows draw fish within the influence of the changes in flow patterns, especially the weaker swimming larval and juvenile forms, into the SWP and CVP export facilities. Second, net reverse flows reduce spawning and rearing habitat for native species, like Delta smelt. Third, net reverse flows result in a confusing environment for migrating juvenile salmonids leaving the San Joaquin River Basin that can result in predation and other impacts that result in or contribute to mortality. Finally, net reverse flows also alter the natural water quality gradients that native fish species rely upon for homing and other functions in the Delta by drawing Sacramento River water across and into the interior Delta (see Chapter 3, *Scientific Knowledge to Inform Fish and Wildlife Flow Recommendations*).

The 2020 ITP for long-term operations of the SWP specifies OMR reverse flows for December-June to protect state listed, threatened, and candidate species, including Winter-Run Chinook Salmon, Spring-Run Chinook Salmon, longfin smelt, and Delta smelt, from entrainment at the SWP pumping facilities. The 2020 ITP generally requires that OMR reverse flows fall between -1,250 cfs and -5,000 cfs to protect these species during the OMR management season of December-June (see Chapter 3, Table 3.14-3), depending on assessment of species' entrainment risk, population indices, and certain environmental conditions. The 2020 ITP identifies that OMR reverse flows of -2,500 cfs pose a medium level of entrainment risk for larval and juvenile smelts. These OMR thresholds are discussed below.

As discussed in Chapter 5, *Proposed Changes to the Bay-Delta Plan for the Sacramento/Delta*, the current Bay-Delta Plan and D-1641 do not include any required limitation on OMR flows or QWEST, but do include limitations on exports based on total Delta inflows referred to as the export to inflow ratio (E:I) and based on San Joaquin River inflows referred to as the San Joaquin River inflow to export ratio (I:E). The current Bay-Delta Plan and D-1641 generally require that exports be no greater than 100% of the flow of the San Joaquin River at Vernalis (1:1 San Joaquin River inflows to exports) from April 15 to May 15, or 1,500 cfs, whichever is greater. The Bay-Delta Plan and D-1641 I:E requirements are less stringent than the 2020 ITP, which largely incorporates I:E requirements from the prior 2009 NMFS BiOp generally limiting I:E to between 1:1 in drier conditions up to 4:1 in wetter conditions for all of April and May, or 1,500 cfs, whichever is greater. As discussed in Chapter 6, *Changes in Hydrology and Water Supply*, the baseline includes the 2020 ITP limits on both the SWP and CVP given that the 2020 ITP is still operative and has been applied to the CVP based on recent court orders, prior to which the 2009 NMFS BiOp was applicable. The proposed VAs would not result in changes to the existing Bay-Delta Plan or D-1641 E:I or I:E requirements. However, the VAs are proposed to be additive to the 2019 BiOps that do not include the I:E requirements from the 2020 ITP (or 2009 BiOp) for either the CVP or the SWP.

The assumed elimination of I:E constraints in the modeling for the proposed VA scenarios, results in changes to interior Delta flows, including OMR and QWEST, compared to baseline. The impacts of changes in interior Delta flows are assessed with two scenarios (See *Interior Delta Flows* in Section 9.5.3.9, *Delta Inflows, Exports, Interior Delta Flows, and Delta Outflow Results*) that are meant to provide a range of possible changes in interior Delta flows: 1) the “VA” scenario that does not include export reductions associated with unspecified water purchases or additional VA Tuolumne River inflows or Friant VA export reductions; and 2) the “VA High Export Cuts” scenario which assumes the unspecified water purchases result from export reductions and includes Tuolumne River VA inflows and Friant VA export reductions. Under the proposed VAs, the frequency of net OMR reverse flows could increase in December-June compared to baseline. Under the VA scenario modeling results suggest that the frequency of months with mean monthly OMR reverse flows more negative than -5,000 cfs would remain largely unchanged, but the frequency of reverse flows more negative than -2,500 cfs and -1,250 cfs could increase. Similarly, QWEST could generally decrease during April and May relative to baseline under the VA scenario. Under the VA High Export Cuts scenario, the expected frequency of net OMR reverse flows of -1,250 to -5,000 cfs during December-June would be less and QWEST would not decrease by as much. The potential impacts of these changes are discussed further in the cumulative impacts section of this chapter because those changes would not be the result of adding the VAs to the Bay-Delta Plan itself, but could be the result of possible cumulative changes to the operative BiOps and ITP.

Changes in Supply

Overall, implementation of the proposed VAs would result in an average annual reduction in Sacramento/Delta surface water supply for the entire study area. Most of the reductions in Sacramento/Delta surface water supplies would occur within the Sacramento/Delta watershed. The SacWAM results for the Sacramento/Delta watershed also show that Sacramento/Delta water supply reductions would primarily affect agricultural uses. Sacramento/Delta water supply reductions would be based on voluntary measures that would be largely or entirely from agricultural supplies or based on groundwater substitution.

Changes in water supply would result in reduced Sacramento/Delta supply for irrigation use under the proposed VAs that could adversely affect special-status fish species that depend in part on Sacramento/Delta water supply for habitat. However, Sacramento/Delta water supply reductions would be based on voluntary measures, and it is unlikely that that flow assets would be provided from sources already committed for the specific purpose of providing water for a special-status species or their habitat. This impact would be less than significant.

The SacWAM results for the Sacramento/Delta watershed show that there would be only a very small reduction in water supply for municipal use. Sacramento/Delta water supply reductions would be based on voluntary measures that would be largely or entirely from agricultural supplies or based on groundwater substitution. Any changes to municipal water supplies would be small and would not be large enough to potentially affect flow and chemical constituent concentrations of WWTP influent and subsequently WWTP effluent discharges to receiving waters, and there would be no effect on aquatic biological resources. There would be no impact.

The VA proposal identifies that some flow could be provided through groundwater substitution, including in the American River watershed. Flow in other watersheds could also potentially be provided through groundwater substitution. An increase in groundwater pumping could lower groundwater levels in some locations. Potential changes in groundwater levels could affect stream-aquifer interactions (i.e., streambed seepage) in some locations, and negatively affect some special-status fish species. Native fish species such as anadromous salmonids can be affected by even short-term, localized disruptions in flow to provide suitable conditions for completion of their freshwater life cycle. The potential for changes in groundwater levels to affect stream-aquifer interactions in any given stream can vary by stream reach and depends on several factors such as the underlying geology, proximity and connectivity of groundwater wells to the stream, the rate and duration of groundwater pumping, and groundwater recharge rates. These impacts are conservatively considered to be potentially significant. Implementation of Mitigation Measures MM-AQUA-a,d: 7 through 9 could reduce or avoid potential impacts on aquatic biological resources resulting from changes in stream-aquifer interactions from lower groundwater levels. These measures include incorporation of applicable groundwater mitigation measures to reduce lowering of groundwater levels.

Impact AQUA-f: Conflict with the provisions of an adopted habitat conservation plan, natural community conservation plan, or other approved local, regional, or state habitat conservation plan

The proposed VAs would not create adjacent incompatible land uses, develop land, or otherwise result in actions incompatible with conservation plans or activities as the proposed VAs do not require or result in those types of activities. The proposed VAs would not likely impair a permittee's ability to undertake required conservation actions as changes in flows would be voluntary and unlikely to be provided if needed to meet a conservation action. Increased flows under the proposed VAs could complement the actions identified in the conservation/habitat management plans that preserve and restore riverine and estuarine habitat and associated special-status species. There would be no impact.

9.7.7 Cultural Resources

Sections 7.7.2, *Environmental Setting*, and 7.7.3, *Regulatory Setting*, describe cultural and paleontological resources and the regulatory setting to inform the impact discussion in this section; Section 7.7, *Cultural Resources*; Section 7.21, *Habitat Restoration and Other Ecosystem Projects*; and Section 7.22, *New or Modified Facilities*. Section 7.7 describes the potential impacts that may result from changes in hydrology or changes in water supply under the proposed Plan amendments.

This section describes the potential impacts on cultural and paleontological resources that may result from changes in hydrology or changes in water supply under the proposed VAs. Most actions associated with changes in hydrology and water supply would not affect cultural resources because these activities do not involve increased ground disturbance from construction activity. Changes in hydrology could expose or otherwise damage sensitive cultural resources, primarily from changes in reservoir water elevations.

Changes in hydrology and changes in water supply would not result in actions that require any ground disturbance and, accordingly, would not result in conditions that would destroy unique paleontological resource sites or unique geologic features. There would be no impact, and Impact CUL-c is not further evaluated in this section.

9.7.7.1 Impact analysis

Impact CUL-a: Cause a substantial adverse change in the significance of a historical resource as defined in Section 15064.5

Impact CUL-b: Cause a substantial adverse change in the significance of an archaeological resource as defined in Section 15064.5

The analyses of historical and archaeological resources are closely related and are therefore combined and addressed together under Impact CUL-a and Impact CUL-b.

Implementation of the proposed VAs could result in changes in hydrology, including changes in streamflow and reservoir levels in the VA tributaries compared to baseline. Some changes in streamflow and reservoir levels could also occur on other tributaries in the Sacramento/Delta watershed as a result of possible unspecified water purchases that could be provided through inflows. The proposed VAs could affect reservoir levels in export reservoirs and streamflows below export reservoirs, but changes would be expected to be small.

River flows under the proposed VAs would generally be expected to remain within the range of historical levels with annual and interannual variation. Inundation and exposure of historic or archaeological resources would continue at rates similar to baseline, with generally higher flows during the spring months on VA tributaries. Many sites along the VA tributaries have been destroyed by past mining practices and developments in agriculture and irrigation, or previously have been affected by the construction of dams and reservoirs or other development. Although remnants of sites have been discovered within the region, many have been highly disturbed. The change in flows in the rivers is not expected to substantially alter or adversely change historic or archaeological resources. Flow increases could benefit historic and archaeological resources to the extent that increased instream flows contribute to the integrity of buried resources through inundation and, therefore, reduced exposure, contribute to the waterways that define the sense of place in the Delta, and contribute to the Delta's status as a National Heritage Area. This impact would be less than significant.

Changes in reservoir levels could expose previously inundated cultural resources to increased wave action, erosion, and human activity (e.g., looting). Baseline surface water elevations for reservoirs fluctuate throughout the year. Many reservoirs historically experience substantial changes in water elevation based on operational needs and hydrology. While changes would be small, water levels at some reservoirs on VA tributaries and other tributaries could be reduced at times. Significant historic or archeological resources that were previously submerged could be exposed and damaged by erosion or vandalism, causing a substantial adverse change in the significance of the resource. This impact would be potentially significant.

Implementation of Mitigation Measures MM-CUL-a,b: 1(which incorporates MM-AQUA-a-d: 1.ii) and 2 would reduce or avoid impacts on historical and archeological impacts associated with changes in reservoir levels. All reservoirs are subject to existing regulatory requirements, independent of the Bay-Delta Plan, such as FERC license requirements and NMFS BiOp requirements. In exercising its regulatory authorities, the State Water Board would consider cultural resources effects and ensure that impacts are avoided or minimized. In addition, reservoirs may already be subject to resource management plans that contain cultural resource protection measures, including procedures in the event of an unanticipated discovery, or could reduce the impact to a less-than-significant level at previously recorded sites. Cultural mitigation measures are commonly employed on a variety of projects and in many cases, reduce potential significant impacts to less-than-significant levels. However, until and unless the mitigation is implemented, any impact of changes in reservoir storage levels on cultural resources under the proposed VAs remains potentially significant.

Impact CUL-d: Disturb any human remains, including those interred outside of dedicated cemeteries

Changes in river flows would not significantly alter or adversely change the baseline of human burials interred within or outside of dedicated cemeteries. Flow increases could benefit buried remains to the extent that increased instream flows contribute positively to the integrity of buried resources through inundation. This impact would be less than significant.

Changes in reservoir levels could result in more exposed barren land at reservoir edges when the water level is lowered. Exposure of previously inundated land may yield human burials, which could result in the disturbance of the burial and impacts from human activity, such as looting. As discussed under Impact CUL-a and Impact CUL-b, some reservoirs levels could be reduced below baseline, possibly affecting human remains or burials. Implementation of Mitigation Measure MM-CUL-d would involve implementation of or compliance with practices to protect cultural resources found on lands surrounding reservoirs in the event of an unanticipated discovery and could reduce these impacts to less-than–significant levels. However, unless and until the mitigation measures are fully implemented, the identified impacts related to cultural resources would remain potentially significant.

9.7.8 Energy

Section 7.8.2, *Environmental Setting*, describes the agriculture and forest resources setting to inform the impact discussion in this section; Section 7.8, *Energy*; Section 7.21, *Habitat Restoration and Other Ecosystem Projects*; and Section 7.22, *New or Modified Facilities*. Section 7.8 describes the potential impacts that may result from changes in hydrology or changes in water supply under the proposed Plan amendments.

This section describes the potential energy impacts that may result from changes in hydrology or changes in water supply under the proposed VAs, with a focus on how changes in hydrology and changes in water supply interact with hydropower, power flow grid reliability, and overall statewide energy supplies and goals.

9.7.8.1 Impact Analysis

Implementation of the proposed VAs could result in changes in hydrology, including changes in streamflow and reservoir levels in the VA tributaries compared to baseline. Increases in streamflows on VA tributaries would generally occur during the spring months, although increases in streamflows could also occur at other times for some VA tributaries. The proposed VAs could also result in reductions in streamflows at times, generally during the fall or early winter months. These changes would be smaller compared to changes that would occur under the proposed Plan amendments. Overall, reservoir levels in VA tributaries would be similar to baseline but could increase at times and decrease at times.

The proposed VAs include new flow commitments for the VA tributaries, as well as flows that would be provided through CVP/SWP export reductions and through water purchase programs. The sources for the PWA Water Purchase Fixed Price Program are identified and as such are modeled in SacWAM. However, the unspecified water purchases (PWA Water Purchase Market Price Program and permanent state water purchases) would be from unspecified willing sellers, which could include inflow sources within the Sacramento/Delta watershed or reductions in exports, both of which could result in additional Delta outflows. As discussed in Section 9.5, *Changes in Hydrology and Water Supply*, the SacWAM VA tributary inflow analyses do not assume any additional Delta inflows from unspecified water purchases given the unknown origin of these water purchases. Similarly, the hydropower evaluations presented in this section, which rely on SacWAM model results, do not consider the effects of unspecified water purchases. The effects of the proposed VAs on hydropower generation could vary to some degree from modeled outcomes, and there could be additional changes beyond the modeled outcomes. The hydropower analysis includes an estimate of what those additional effects could be. It is also possible that some upstream reservoirs could be reoperated on some tributaries. Upstream effects were not modeled, but significant changes in upstream tributary or reservoir operations would be unlikely.

Modeling was conducted to evaluate how the proposed VAs would affect energy demand and generation in California, including:

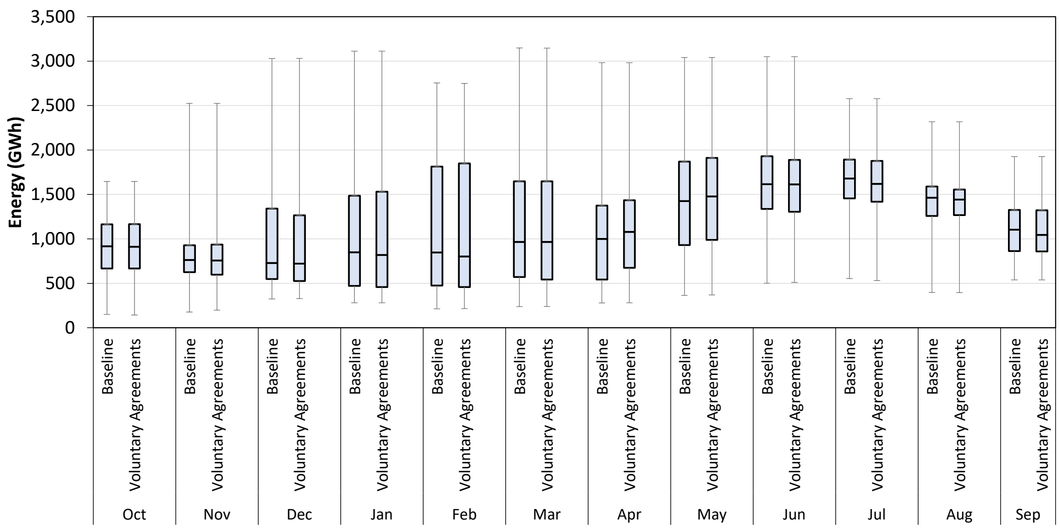
- Changes in hydropower generation within the Sacramento River watershed and the Delta eastside tributaries regions.
- Effect of summer reduction in hydropower generation on reliability of the electric grid (power flow modeling).
- Change in the energy needed for CVP and SWP exports from the Delta.

A description of the methods for these analyses is provided in more detail in Appendix A5, *Hydropower, Energy Grid, and Export Energy Analyses*. Results for the analysis of the VAs are presented in Appendix G3-d.

Impact EN-a: The effects of the project on energy resources

Evaluation of Hydropower Generation in the Sacramento/Delta

The effects of the proposed VAs on hydropower generation in the Sacramento/Delta were evaluated using the same method used for the proposed Plan amendments as described in Section 7.8.3, *Impact Analysis*. The main effect of the proposed VAs on hydropower would be a small increase in generation during the spring and a small reduction during the summer, resulting primarily from changes in flow (Figure 9.7-2). The largest increases in hydropower generation are estimated to occur during April (see Table G3d-1 in Appendix G3d).



Energy results were estimated with flow and storage simulated by SacWAM.
GWh = gigawatt hour

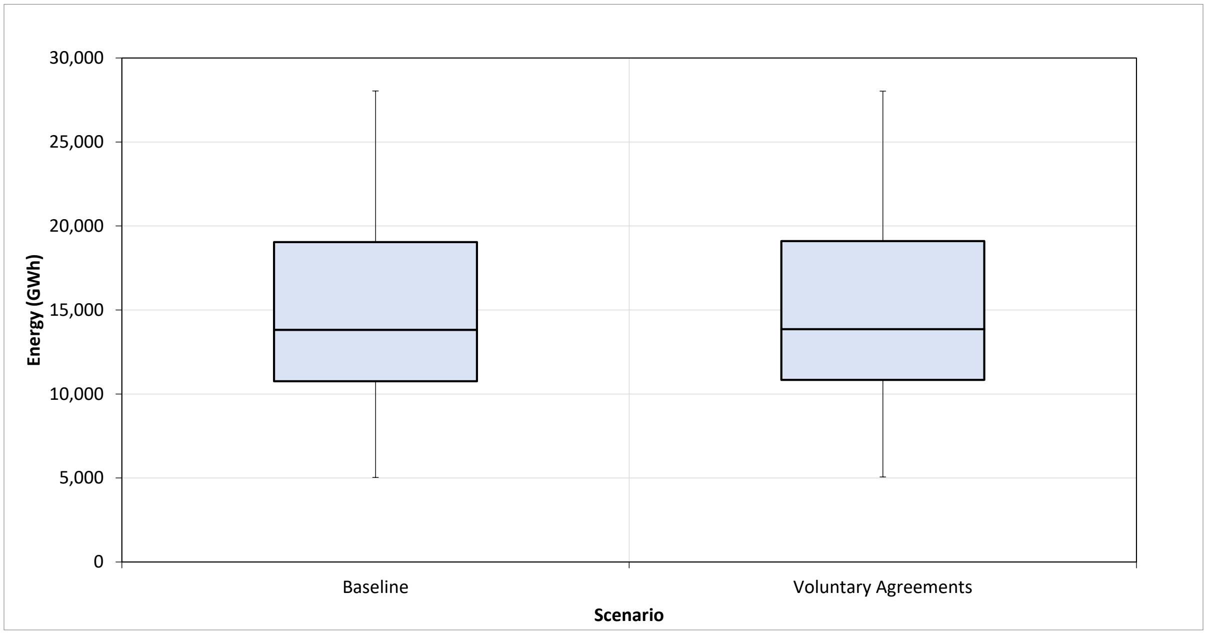
Figure 9.7-2. Monthly Hydropower Generation for Sacramento River Watershed and Delta Eastside Tributaries Regions

These hydropower effects are based on VA flows as modeled in SacWAM, excluding effects that could occur as a result of unspecified water purchases because the sources of these assets are not fully known at this time. As described in Appendix G3-d, the hydropower effects calculated based on SacWAM results were increased to extrapolate monthly hydropower effects associated with all Sacramento/Delta VA flows combined (Table 9.7-9). This extrapolation causes spring generation to increase to up to 26 percent (April of dry water year types). Changes in summer generation is of more concern than changes during other times of the year because peak demand for electricity occurs in the summer. The extrapolated percent reduction values shown in Table 9.7-9 for summer months are largest for below normal years in September (6.7 Percent). This variation is relatively small compared to the variation in hydropower generation under baseline within a year (e.g., average monthly generation of 838 GWh to 1,669 GWh, Table G3d-1) or from year to year (e.g., annual generation of 5,028 GWh to 28,036 GWh, Table G3d-3). The reduction in summer hydropower generation would be expected to be replaced by other sources of electricity, particularly increased generation at natural gas facilities.

Table 9.7-9. Average Monthly Hydropower Generation by Water Year Type—Baseline and Change from Baseline Expanded to Account for Flow Assets not Simulated by SacWAM

Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Baseline (GWh)												
C	928	641	547	385	357	429	422	671	995	987	865	746
D	892	778	695	544	603	723	676	1,021	1,421	1,481	1,280	890
BN	944	803	767	824	936	873	967	1,373	1,666	1,775	1,525	1,050
AN	820	815	913	1,348	1,523	1,663	1,223	1,744	1,699	1,782	1,500	1,280
W	936	1,018	1,817	2,001	1,936	2,067	1,832	2,250	2,206	1,986	1,676	1,386
Change from Baseline (GWh)												
C	-11	-2	-15	-13	-8	-9	36	39	-10	-1	-4	-9
D	-8	-6	-31	-18	-17	14	176	134	-12	-41	18	-24
BN	-7	-18	-11	-12	-28	-2	163	107	-30	-56	-30	-70
AN	6	-18	-41	-3	-4	-12	192	99	-47	-60	-22	-56
W	-1	-15	-28	1	0	-2	63	33	-16	-38	-9	-21
Percent Change from Baseline												
C	-1.2	-0.3	-2.8	-3.3	-2.2	-2.1	8.6	5.9	-1.0	-0.1	-0.5	-1.2
D	-0.9	-0.7	-4.5	-3.3	-2.9	1.9	26.0	13.1	-0.8	-2.8	1.4	-2.7
BN	-0.8	-2.2	-1.4	-1.5	-3.0	-0.2	16.9	7.8	-1.8	-3.1	-2.0	-6.7
AN	0.7	-2.3	-4.4	-0.2	-0.2	-0.7	15.7	5.7	-2.8	-3.3	-1.5	-4.4
W	-0.1	-1.5	-1.5	0.1	0.0	-0.1	3.4	1.4	-0.7	-1.9	-0.6	-1.5

Annually, hydropower effects would be expected to be minimal because the total annual flow would not change and reservoir storage effects would be expected to be small (Figure 9.7-3). Because the modeled effects on annual hydropower generation would be small (increase of 11 GWh, Table G3d-3), expansion to include effects of unspecified water purchases would not significantly affect this conclusion. Because the annual effect on hydropower generation in the Sacramento/Delta would be minimal and because other sources of energy could replace the relatively small reductions in hydropower generation that may occur in some months, energy impacts associated with hydropower generation in the Sacramento/Delta region would be less than significant.



Energy results were estimated with flow and storage simulated by SacWAM.
GWh = gigawatt hour

Figure 9.7-3. Annual Hydropower Generation for Sacramento River Watershed and Delta Eastside Tributaries Regions

Evaluation of Change in Energy to Export Sacramento/Delta Water Supply

As discussed above, the SacWAM model run of the proposed VAs indicates that there could be some increases in exports compared to baseline due to the elimination of the 2020 ITP I:E requirements in the 2019 BiOps accounting base upon which VA assets are intended to be added. These possible increases in exports would not be the result of adding the VAs to the Bay-Delta Plan, but due to the cumulative effects of possible changes to the BiOps and ITP. Although these cumulative increases in exports modeled in SacWAM could increase energy needed for conveyance, the increases would be relatively small compared to total Delta exports and could replace other water sources that have their own energy requirements. In addition, if much of the unspecified water purchases were to come from Delta exports, as was evaluated in the High Export Cuts scenario, increases in exports would largely be offset. Overall, this impact would be less than significant.

Impact EN-b: The effect of the project on peak and base period demands for electricity and other forms of energy

As described for Impact EN-a, changes in hydrology would have only a small effect on average hydropower generation. The proposed VA flow assets could cause variable responses to reduced water supply, which could have variable effects on energy use. For example, the VA proposal identifies that some flow assets could be provided through groundwater substitution, which could result in increased energy use associated with increased groundwater pumping. However, most of the VA assets are not expected to be provided through groundwater substitution, but instead through fallowing of agricultural land, which would not impact energy use. Because of the relatively small volume of VA flows as a percent of total water supply, the proposed VAs are not expected to result in substantial increases in energy to replace reductions in water supply. The combined effects are unlikely to affect energy availability and demand during base periods.

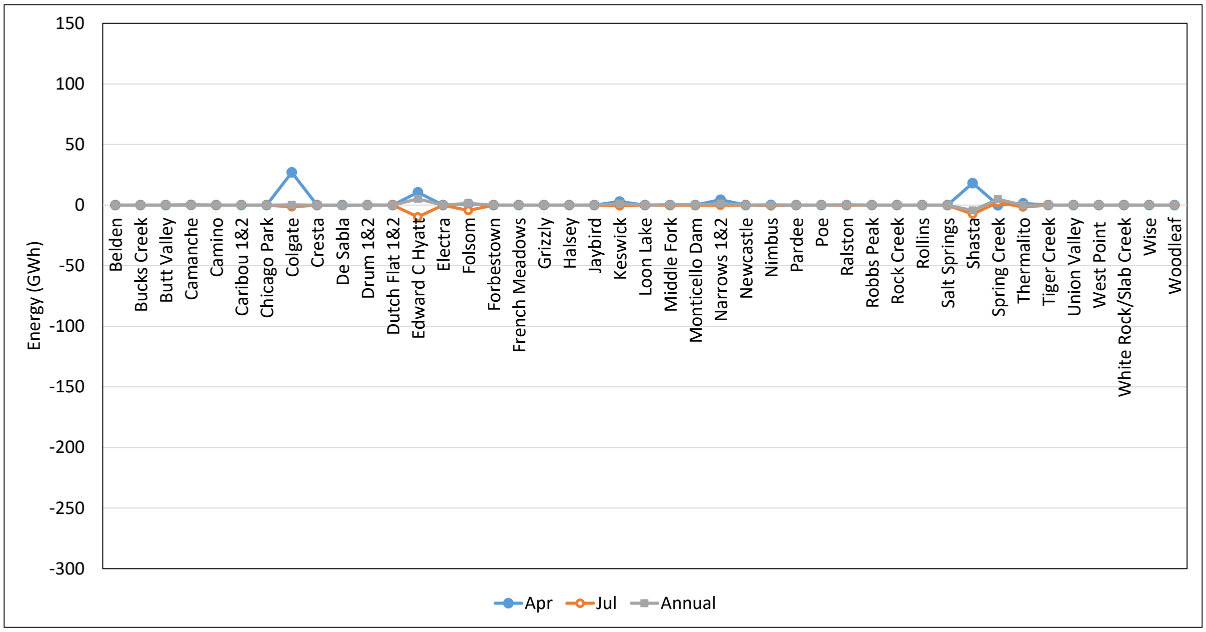
Changes in hydrology would result in a small effect on peak energy generation because there could be a small reduction in hydropower generation during the summer as described for Impact EN-a. However, because the estimated reduction in monthly average Sacramento/Delta hydropower generation during the summer for each water year type is 6.7 percent or less (Table 9.7-9) and could readily be replaced by other sources of energy, Impact EN-b would be less than significant.

Impact EN-c: The effects of the project on local and regional energy supplies and requirements for additional capacity

Effects at Individual Facilities

The largest changes in flow and hydropower would be expected to occur on VA tributaries at the rim reservoirs and downstream. As discussed above, the VA tributary inflow analysis as modeled in SacWAM does not assume any additional inflows from unspecified water purchases given the unknown origin of these water purchases. Because unspecified water purchases could be provided by additional Delta inflows from Sacramento/Delta tributaries, there could be some additional changes in streamflows and reservoir levels beyond the modeled changes. Effects of unspecified water purchases on hydropower cannot be assessed for individual facilities, although the total seasonal effect is approximated as described for Impact EN-a to estimate combined effect of all VA assets on timing of hydropower generation. In addition, it is possible that some upstream reservoirs could be reoperated on some tributaries. Upstream effects were not modeled, but significant changes in upstream tributary or reservoir operations would be unlikely. The effect of unspecified water purchases on hydropower generation at individual facilities is unlikely to have a substantially different pattern than what was modeled (i.e., the net effect on annual average hydropower generation would be minimal), although there could be minor effects at additional facilities and some seasonal differences.

To show which facilities could be most affected, a summary of average changes at each of the facilities evaluated is provided for the proposed VAs (Figure 9.7-4). The figure shows results for April (the month with the largest increases in hydropower generation) and July (the summer month with the largest decreases in average hydropower generation), as well as the annual total. As expected, based on facility size and location, the most noticeable changes occur at Shasta, Oroville (Hyatt Powerhouse), New Bullards Bar (Colgate Powerhouse), and Folsom.



GWh = gigawatt hour

Figure 9.7-4. Estimated Average Change in Hydropower Generation for the VAs at Individual Hydroelectric Facilities

The ability of the electric grid to handle local reductions in hydropower generation at facilities depends on generation capacity at other facilities and on the ability of the grid infrastructure to convey electricity from those facilities. These estimated changes in local hydropower generation are relatively small. For example, the largest reduction in average July generation, 10 GWh at Hyatt Powerplant, represents only 3.4 percent of the average July baseline generation of 295 GWh for this facility.

California Power Flow Grid Reliability

As described in Section 7.8.3, *Impact Analysis*, under Impact EN-c, Power Gem's Transmission Adequacy and Reliability Assessment software (TARA) was used to evaluate grid reliability assuming reductions in Sacramento/Delta hydropower calculated for the 75 percent of unimpaired flow scenario (75 scenario), which as described in Appendix G3d would have a much larger effect on hydropower than the VAs even after accounting for the VA assets that would be provided through unspecified water purchases. The power flow analysis relied on the estimated changes in hydropower at individual hydropower facilities. Even under the 75 scenario, the grid is expected to remain reliable. Because the effects of the proposed VAs on grid reliability would be less compared to the 75 scenario, the proposed VAs would also not be expected to cause any violations of reliability criteria.

Although the power flow modeling results show that the California electric grid would generally be reliable under the Proposed VAs, there are some extreme circumstances that can cause California's electric grid to become unreliable due to inadequate electric supply, leading to the need for rotating power outages. If these rotating outages occur again, changes in hydrology could cause a relatively small incremental exacerbation of the outages. During the August 14, 2020, period of rolling power outages, demand for CAISO power peaked at 46,777 MW. To prevent grid failure, rolling blackouts were instituted to reduce power use by approximately 1,000 MW.

As described for the power flow analysis described in Appendix G3d, *Hydropower, Energy Grid, and Export Energy Analyses for Proposed Voluntary Agreements*, the largest estimated reduction of the proposed VAs on monthly hydropower generation, including the effect of unspecified water purchases (Table 9.7-9), is approximately 70 GWh; this is equivalent to 97 MW for the month. A 97 MW reduction in peak power generation associated with the VAs represents only approximately 0.2 percent of the CAISO peak energy demand during the August 14, 2020, rolling blackouts. Impact EN-c would be less than significant because under the proposed VAs, effects due to changes in hydrology on power outages would be rare and would represent a relatively small percent of power used by California during periods of peak demand.

Impact EN-d: The degree to which the project complies with existing energy standards

Overall Per Capita Consumption and Reliance on Natural Gas or Oil

As described for Impacts EN-a and EN-b, energy use in the state is not likely to change substantially overall as a result of the proposed VAs. As a result, there would not be an increase in overall per capita energy consumption or an increase in reliance on natural gas or oil.

Reliance on Renewable Energy Resources

As discussed in Section 7.8.2.2, *Electricity in California*, SB 100 and SB 1020 identify increasingly stringent renewable energy goals for the RPS, with providers of electricity eventually obligated to supply 100 percent carbon-free electricity by 2045. Because the proposed VAs are expected to have minimal effect on hydropower generation at the small hydropower facilities in the Sacramento/Delta that contribute to the California RPS was (Appendix G3-d, *Hydropower, Energy Grid, and Export Energy Analyses,* Table G3d-6) and because recent annual trends in in-state energy generation show that renewable energy generation is growing (Section 7.8, Impact EN-d), the proposed VAs are unlikely to prevent the attainment of the goals of SB 100 and SB 1020.

Because the VAs would be unlikely to hinder the attainment of the objectives of SB 100 and SB 1020, increase overall per capita energy consumption, or increase reliance on natural gas, this impact would be less than significant.

Impact EN-e: Energy requirements and energy use efficiencies by amount and fuel type for each stage of the project

As described for Impacts EN-a and EN-b, the proposed VAs are not expected to cause substantial changes in hydropower generation or in energy required for providing water supply. As such, the proposed VAs are not expected to have a significant net energy cost and this impact would be less than significant.

Impact EN-f: The project's projected transportation energy use requirements and its overall use of efficient transportation alternatives

The proposed VAs would result in Sacramento/Delta water supply reductions based on voluntary measures that would be largely or entirely from agricultural supplies or based on groundwater substitution. A reduction in agricultural water supply could affect agricultural production in California's Central Valley. The effect of reduced agricultural production on overall transportation energy use is complex. Determining the effect of the changes in water supply is speculative and would depend on farmers' responses to reduction in water supply and consumer responses to reduction in California agricultural product supply. However, as described in more detail in Section 7.8.3, *Impact Analysis*, it is unlikely that a reduction in California agricultural production would cause a substantial increase in energy use for transportation. This impact would be less than significant.

9.7.9 Geology and Soils

Section 7.9.2, *Environmental Setting*, describes the geology and soils setting to inform the impact discussion in this section; Section 7.9, *Geology and Soils*; Section 7.21*, Habitat Restoration and Other Ecosystem Projects*; and Section 7.22, *New or Modified Facilities*. Section 7.9 describes the potential impacts that may result from changes in hydrology or changes in water supply under the proposed Plan amendments.

This section describes the potential impacts to geology and soils that may result from changes in hydrology and changes in water supply under the proposed VAs. Activities that affect geology and soils include those that would subject people or structures to potential adverse effects due to earthquake, seismic shaking, or landslides; result in soil erosion and loss; or be located on unstable or expansive soils. Changes in hydrology and water supply would not result in new human-occupied structures or other construction that would have the potential to interact with or be affected by the geologic and soil environments.

Changes in hydrology (flow conditions and reoperation of reservoirs) would not expose people or structures to substantial adverse effects from earthquake fault rupture; strong seismic ground shaking; seismic-related ground failure, including liquefaction; or landslides. Earthquake damage that may occur to existing Delta levees, reservoirs, or other water infrastructure would not be any different than those that would occur under baseline. Reservoir drawdown below baseline levels could reveal previously unexposed erodible bedrock or sediments, but no natural vegetation community or agricultural soils would be affected. There would be no impacts under Impact GEO-a and Impact GEO-b. Impact GEO-a is not further evaluated in this section.

Changes in hydrology and changes in water supply would not result in new human-occupied structures or other construction that would be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial risks to life or property. There would be no impact, and Impact GEO-d is not further evaluated in this section.

Conditions or actions associated with changes in hydrology and changes in water supply would not involve constructing or operating septic tanks; therefore, septic tanks would not be affected by soils incapable of supporting their use or other alternative wastewater disposal systems. There would be no impact, and Impact GEO-e is not further evaluated in this section.

9.7.9.1 Impact Analysis

Impact GEO-b: Result in substantial soil erosion or the loss of topsoil

As discussed above, changes in hydrology would not result in substantial soil erosion or the loss of topsoil, and there would be no impact.

The SacWAM results displayed above show that implementation of the proposed VAs could result in changes in Sacramento/Delta surface water supplies, both within and outside of the

Sacramento/Delta watershed. Overall, implementation of the proposed VAs would result in an average annual reduction in Sacramento/Delta surface water supply for the entire study area. Most of the reductions in Sacramento/Delta surface water supplies would occur within the Sacramento/Delta watershed.

Sacramento/Delta water supply reductions would be based on voluntary measures that would be largely or entirely from agricultural supplies or based on groundwater substitution. Reduced Sacramento/Delta supply to agriculture could lead to changes in agricultural land use or the fallowing of agricultural land resulting in agricultural fields with unvegetated (bare) soils. Lack of vegetation allows surface water or wind to increase soil erosion. However, some fallowed fields would retain crop stubble cover, ultimately experience vegetation regrowth, or both. The root material and regrowth would stabilize soils to some extent and reduce their potential for increased erosion. These soils would also be undisturbed for periods of time, which would allow the surfaces to consolidate, in turn reducing their erosion potential. As discussed in Section 7.9, *Geology and Soils*, active agricultural production includes substantial soil disturbance from tillage, crop harvesting, and other activities. Additionally, even unfallowed agricultural soil may be bare during the rainy season and subject to greater surface water erosion than vegetated soil. In contrast, lands subject to less intensive use due to a reduction in surface water irrigation (e.g., dryland farming, deficit irrigation, grazing) would experience no change or potentially less erosion and sedimentation. While there may be an initial period of increased erosion and sedimentation if active agriculture is reduced, the reduced tillage and other activities would result in less erosion and sedimentation in the long run. Therefore, reducing existing levels of soil disturbance resulting from active agricultural practices and irrigation may thereby reduce erosion and loss of topsoil compared with baseline. Consequently, there would not be substantial soil erosion or loss of topsoil due to agricultural land fallowing. The impacts would be less than significant.

Impact GEO-c: Be located on a geologic unit or soil that is unstable or that would become unstable as a result of the project and potentially result in an onsite or offsite landslide, lateral spreading, subsidence, liquefaction, or collapse

Changes in hydrology, including flows and reservoir levels, would not result in an on-site or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse. The geologic and soil materials underlying streams and reservoirs are saturated with water. Lowering reservoir levels has the potential to cause localized landslides as the water drains from these materials, increasing pore water pressure and decreasing internal friction. However, as discussed in Section 7.9, *Geology and Soils*, this effect is more common during the initial years after reservoir construction and operation as existing unstable materials move downslope. These movements diminish with time as the available unstable materials are removed by landslides. Existing reservoirs have been in operation for decades, and there is limited additional movement associated with reservoir drawdown. The geologic and soil materials at depth would have moved if they had been potentially unstable and subject to landslides. During drawdown, unconsolidated reservoir margin sediments also have the potential to be destabilized by lateral spreading, subsidence, liquefaction, or collapse. Similar to landslides, susceptible unstable materials have been progressively removed by these processes over time. There would be no impact.

The VA proposal identifies that some flow could be provided through groundwater substitution, including in the American River watershed consistent with the VA documents. Flow in other watersheds could also be provided through groundwater substitution. Lower groundwater levels from increased groundwater pumping and reduced incidental recharge from irrigation could exacerbate existing problems associated with ground subsidence. Several management strategies could be implemented at the local or regional level, including groundwater storage and recovery, water transfers, increased use of recycled water, and water conservation. These measures are likely to have positive effects on some groundwater basins and reduce or slow ground subsidence by replacing water that would otherwise be extracted. However, groundwater substitution that reduces runoff that would otherwise recharge groundwater could also lower groundwater levels, and reduced groundwater levels may lead to or exacerbate existing subsidence conditions. These impacts would be potentially significant.

Implementation of Mitigation Measure MM-GEO-c (which incorporates applicable measures MM-GW-b, 1-6) could reduce impacts. However, no immediate mitigation is available to minimize the impacts of increased groundwater pumping and reduced groundwater recharge over the long term. Implementing SGMA and other actions to increase groundwater levels or reduce groundwater extraction could reduce or halt subsidence. The State Water Board also has SGMA oversight and can intervene if proposed or implemented measures are considered insufficient. While the State Water Board has some authority to ensure that mitigation is implemented for some actions, other mitigation measures are largely within the jurisdiction and control of other agencies or depend on how water users respond to the proposed Plan amendments. The State Water Board cannot guarantee that measures will always be adopted or applied in a manner that fully mitigates the impact. Therefore, unless and until the mitigation is fully implemented, the impacts remain potentially significant.

9.7.10 Greenhouse Gas Emissions

Section 7.10.2, *Environmental Setting*, describes the greenhouse gas (GHG) emissions setting to inform the impact discussion in this section; Section 7.10, *Greenhouse Gas Emissions*; Section 7.21, *Habitat Restoration and Other Ecosystem Projects*; and Section 7.22, *New or Modified Facilities*. Section 7.10 describes the potential impacts that may result from changes in hydrology or changes in water supply under the proposed Plan amendments.

This section describes the potential greenhouse gas emissions impacts that may result from changes in hydrology and changes in water supply under the proposed VAs. Changes in hydrology, including changes in the amount and timing of flows and changes in reservoir operations and levels could alter the production of hydropower generation. Increased hydropower production could reduce GHG emissions from non-renewable power generation.

Changes in water supply include reductions in Sacramento/Delta supply for agriculture. Chapter 7, *Environmental Analysis*, evaluates increase energy consumption and increase GHG emissions due to increased groundwater pumping as a response action to reduced Sacramento/Delta supplies. The proposed VAs identify that some flow could be provided through groundwater substitution, which could result in additional GHG emissions.

9.7.10.1 Impact Analysis

Impact GHG-a: Generate greenhouse gas emissions, either directly or indirectly, that may have a significant impact on the environment

Changes in Hydrology

Increased Hydropower Generation in the Sacramento River Watershed and Delta Eastside Tributaries Regions

Multiple hydropower generation facilities in the Sacramento/Delta could be affected by the proposed VAs (see Section 9.7.8, *Energy*), but the number of hydropower generation facilities that could be affected by the proposed VAs is smaller than the proposed Plan amendments. Hydropower effects based on VA assets as modeled in SacWAM show that the main effect of the proposed VAs on hydropower could be a small increase in generation during the spring and a small reduction during the summer, resulting primarily from changes in flow. The annual effect on hydropower generation in the Sacramento/Delta would be minimal and could result in a net increase of hydropower generation on an annual basis. Increased hydropower generation would displace power generation from natural gas facilities and would be expected to result in a reduction of GHG emissions.

Emission factors from USEPA's Emissions and Generation Revenue Integrated Database for natural gas facilities were used to determine GHG emissions reductions associated with increased hydropower production. Table 9.7-10 lists the GHG emission factors for CO_2, CH_4, and N_2O for natural gas facilities used in the analysis, which are also discussed in Section 7.10, *Greenhouse Gas Emissions*.

Table 9.7-10. Greenhouse Gas Emission Factors for Natural Gas Facilities (pounds per megawatt hour)

Area	CO2	CH4	N2O
California	895.9	0.016	0.002

CH_4 = methane; CO_2 = carbon dioxide; N_2O = nitrous oxide

Table 9.7-11 presents the GHG emissions reduction estimates due to increases in hydropower generation. Emission factors are multiplied by the change in hydropower generation between baseline and the VA scenario to determine the change in GHG emissions. Annual average hydropower generation could increase by approximately 11 gigawatt hours (GWh), resulting in a decrease of 4,475 $MTCO_2e$ per year due to a reduced power supply demand from existing natural gas facilities.

Table 9.7-11. Reduction in Greenhouse Gas Emissions Associated with Increased Hydropower Generation

Changes in Annual Average Hydropower Generation from Baseline (flow scenario)	Greenhouse Gas Reduction (metric tons/year)			
	CO_2	N_2O	CH_4	CO_2e
Baseline	0	0	0	0
+11 GWh (Voluntary Agreements)	4,470	<1	<1	4,475

Sources: Appendix A5, *Hydropower, Energy Grid, and Export Energy Analyses* (Table A5-8); USEPA 2022, page ref. n/a. See also Section 7.8, *Energy*.
CH_4 = methane; CO_2 = carbon dioxide; CO_2e = carbon dioxide equivalent; GWh = gigawatt hour; N_2O = nitrous oxide

Changes in hydrology under the proposed VAs could result in net GHG reductions due to estimated net increases in hydropower, as identified in Table 9.7-11. While unlikely, there may be reductions in hydropower depending on how flow assets are deployed in upper watersheds and the sources of unspecified water purchases that are not known. Because effects on annual hydropower generation are close to zero (increase of 11 GWh, Table G3d-3), expansion to include VA assets that were not modeled in SacWAM would make little difference in this conclusion. Impacts would be less than significant.

Evaluation of Change in Energy to Export Sacramento/Delta Water Supply

A large amount of energy is required to pump CVP and SWP exports uphill toward their destinations, and only a portion of this energy can be recaptured when some of the water drops in elevation on its way to its final destination. Depending on sources for unspecified water purchases, changes in hydrology associated with the proposed VAs could result in increases or decreases in SWP and CVP Delta exports, which could cause an increase or decrease in the amount of energy needed to move water to consumers. The largest increase in export energy could occur if Delta exports were not affected by unspecified water purchases. Even in this case, the percent increase would be small; in this case, increases in SWP and CVP exports could result in an average increase in calculated annual export energy of approximately 149 GWh, which is 2.0 percent of the baseline value of 7,393 GWh (see Table G3d-7). In this case of increased exports, some of the additional water supply from the Delta would replace water that had other associated energy costs, which would reduce the net effect. Because exact effects on energy to export water from the Delta and energy needed for alternative supplies cannot be quantified, effects on emissions cannot be quantified precisely but are likely relatively small.

California's continued climate change efforts, which include expanding power procured from renewable resources, would reduce emissions as the GHG intensity of the state energy supply declines as a function of time. Accordingly, the net change in annual energy-related GHG emissions from implementation of the proposed VAs over time is unknown and cannot be quantified with certainty. However, pursuant to SB 100 and SB 1020, potential indirect emissions from increased energy demand on the state's electric grid would be expected to be negligible by 2045, when the grid may achieve carbon neutrality.

California's 2017 Climate Change Scoping Plan and the *2022 Scoping Plan for Achieving Carbon Neutrality* include measures that will provide emissions reductions from the electric power sector to achieve the state's 2030 and 2045 GHG reduction goals. By 2045, all retail sales of electricity to California end-users would be provided by zero-carbon resources under the state's renewable portfolio standard (RPS) (SB 100/1020). SB 1020 also requires state agencies to rely on 100 percent renewable energy and zero-carbon resources to serve their own facilities by 2030. Although implementation of the VAs could result in some increased energy demand in the near-term, resultant power generation emissions would be expected to decline consistent with the state's GHG reduction trajectory to reach carbon neutrality by 2045. Therefore although the potential increases of SWP and CVP exports could result in greenhouse gas emissions, either directly or indirectly, any impacts resulting from indirect increases in emissions under the proposed VAs are anticipated to be mitigated in the future by existing requirements for reductions in GHG emissions. In addition, the possible increases in emissions due to increases in exports under the proposed VAs would be small, and therefore this impact would be less than significant.

The proposed VAs identify that some flow could be provided through groundwater substitution, including in the American River watershed. Flow in other watersheds could also be provided through groundwater substitution. Increased groundwater pumping could result in additional emissions. As discussed in Section 7.10, *Greenhouse Gas Emissions*, several local air pollution control districts (e.g., Sacramento Metropolitan Air Quality Management District) have established a threshold of 10,000 $MTCO_2e$ per year to evaluate emissions from individual industrial and stationary source projects, such as diesel-powered pumps. It is currently unknown what types of pumps (electric, diesel, gas, other fuel) would be used to pump groundwater because it is not known at this time which wells (existing and/or new) would increase pumping. However, based on the U.S. Department of Agriculture (USDA) 2013 Farm and Irrigation Survey, it is anticipated that most deep wells are and would be powered by electric pumps, while a smaller portion would be powered by diesel, gasoline, and other fuels). Electric pumps produce fewer GHG emissions per unit of power than fossil-fuel–powered pumps. For example, an electric pump would generate about 30 percent less emissions per horsepower-hour than an equivalently sized diesel pump (based on emission factors from USEPA and Trinity Consultants). More than 85 percent of irrigation wells in California are powered by electric pumps.

Depending on the type of fuel used, emissions could vary, though diesel pumps are typically more polluting than pumps powered by other fuels. Therefore, this analysis conservatively assumes that diesel pumps would be used for groundwater pumping.

Emissions from diesel-powered pumps would occur locally at the pump source. Depending on the extent of groundwater pumping, the combined emissions level of all other groundwater pumping in the study area could exceed the 10,000 $MTCO_2e$ threshold. This would be a potentially significant impact. Implementation of Mitigation Measure MM-GHG-a will reduce potential GHG emissions through implementation of water use efficiency, water conservation, energy efficiency, and irrigation system management strategies. Implementation of Mitigation Measure MM-GHG-b requires compliance with applicable air quality plans, programs, rules, and regulations and promotes use of renewable energy sources to minimize GHG emissions. These measures were adapted from agency best practice and mitigation designed to avoid or minimize GHG emissions effects, including: California Air Pollution Control Officers Association's *Handbook for Analyzing Greenhouse Gas Emission Reductions, Assessing Climate Vulnerabilities, and Advancing Health and Equity: Designed for Local Governments, Communities, and Project Developers*, DWR's CAP, State Water Board's *Resolution No. 2017-0012: Comprehensive Response to Climate Change,* and USEPA's *Water Conservation Plan Guidelines* and *Energy Efficiency in Water and Wastewater Facilities*. Many of these measures are project-level measures appropriate for project-specific development. Individual projects by other public agencies would be subject to the appropriate level of environmental review at the time they are proposed, and site-specific, project-specific mitigation would be identified to avoid or reduce significant effects prior to any project-level action. However, some actions may not require approvals and may not be subject to project-level CEQA review. Unless and until the mitigation is fully implemented, this impact remains potentially significant.

Impact GHG-b: Conflict with an applicable plan, policy or regulation adopted for the purpose of reducing the emissions of greenhouse gases

The proposed VAs would not conflict with larger state efforts related to GHG emissions and climate change. The State Water Board intends to follow the direction provided in its Resolution 2017-0012 to ensure that criteria (e.g., whether a project is consistent with plans or state goals to reduce or mitigate GHGs, including consistency with CARB's *California's 2017 Climate Change Scoping Plan*, regulations, or requirements adopted by CARB; or whether a proposed project is part of a plan that includes overall reductions in GHG emissions) are met.

Analyses provided in Section 9.7.8, *Energy*, suggest that implementation of the proposed VAs could result in an annual increase in hydropower production, which would result in a reduction in GHG emissions. An increase in hydropower generation could result in a decrease in GHG emissions from fossil-fueled electric generating facilities. However, some VA flow assets could be provided through groundwater substitution, which could result in additional GHG emissions from diesel pumps used to pump groundwater.

Executive Order (EO) S-3-05 establishes GHG emissions reduction targets for the state of California, including reducing GHG emissions to 80 percent below 1990 levels by 2050. EO B-55-18 strengthens the state's reduction commitment to achieve carbon neutrality by 2045. This target was codified by AB 1279, which also mandates an 85-percent reduction in statewide anthropogenic GHG emissions (from 1990 levels) by 2045. EO B-30-15 requires all state agencies to implement measures pursuant to statutory authority to reduce GHG emissions in order to meet the state's reduction targets. The state's RPS also requires electric utilities to achieve sales of renewably generated electricity of 44 percent by 2024, 52 percent by 2027, 60 percent by 2030, 90 percent by 2035, 95 percent by 2040, and 100 percent by 2045. GHG emissions from electricity generation is, therefore, expected to decrease over time, eventually achieving carbon neutrality in 2045. The proposed VAs are unlikely to hinder attainment of the state's RPS. Further, RPS energy procurement is currently in excess of the obligation under the state's RPS.

Overall, changes in hydrology and water supply would not conflict with the Clean Air Act; however, as discussed above under Impact GHG-a, the proposed VAs include some flow that could be provided through groundwater substitution, which could result in increases in use of diesel pumps for groundwater pumping. This could potentially result in emissions in excess of the 10,000 $MTCO_2e$ per year threshold that could affect the state's ability to meet the SB 32 (2030) and AB 1279 (2045) GHG reduction goals. This impact would be potentially significant. Implementation of Mitigation Measures MM-GHG-a and MM-GHG-b can reduce potential GHG emissions and conflicts with the state's GHG reduction plans from increased groundwater pumping if adopted by local water districts and suppliers, regional groundwater agencies, irrigation districts, local utilities, and local agencies and governments. Unless and until the mitigation is fully implemented, this impact remains potentially significant.

9.7.11 Hazards and Hazardous Materials

Section 7.11.2, *Environmental Setting*, describes the hazards and hazardous materials setting to inform the impact discussion in this section; Section 7.11, *Hazards and Hazardous Materials*; Section 7.21, *Habitat Restoration and Other Ecosystem Projects*; and Section 7.22, *New or Modified Facilities*. Section 7.11 describes the potential impacts that may result from changes in hydrology or changes in water supply under the proposed Plan amendments.

This section describes the potential impacts related to hazards and hazardous materials that may result from changes in hydrology or changes in water supply under the proposed VAs. Activities that may accidentally release hazardous materials, expose people to hazardous materials, create safety hazards, impede an emergency response plan, or expose people or structures to wildfire risks could result in a significant impact. Implementation of the proposed VAs could result in changes in hydrology, including changes in streamflow and reservoir levels in the VA tributaries compared to baseline. These changes would be much smaller compared to the proposed Plan amendments. Altered timing of flows and changes in reservoir levels would not involve hazardous materials and, therefore, would not create a significant hazard to the public or the environment through routine transport, use, or disposal of hazardous materials; upset and accident conditions involving the release of hazardous materials; or emission of hazardous materials within 0.25 mile of a school. Rivers and reservoir levels would remain within their historical channel and banks and would not newly inundate or reveal hazardous sites. Changes in flow and reservoir levels would not have any effect on public airports or private airstrips as these actions would not increase the capacity or present a safety hazard at existing airports or change where people or airports are located. These actions also would not impair implementation of or physically interfere with an adopted emergency response plan or emergency evacuation plan. There would be no impacts.

Implementation of the proposed VAs would result in a reduction in Sacramento/Delta surface water supply. Most of the reductions in Sacramento/Delta surface water supplies would occur within the Sacramento/Delta watershed. Sacramento/Delta water supply reductions would be based on voluntary measures that would be largely or entirely from agricultural supplies or based on groundwater substitution. Changes in water supply involving changes in crops on agricultural land or fallowing of agricultural land and reduced Sacramento/Delta water supply to municipalities would not involve hazardous materials. Accordingly, these changes would not create a significant hazard to the public or environment through the routine transport, use, or disposal of hazardous materials, nor would these changes directly cause the release of hazardous materials into the environment by upset or accident or emit hazardous materials within 0.25 mile of a school. Any earthwork associated with agricultural operations would be in areas already affected by ground disturbance and other actions would not require ground disturbance; therefore, these changes would not affect existing hazardous materials sites. There would be no impact.

Changes in water supply would not change or increase the locations of people or infrastructure and, therefore, would not affect public airports and private airstrips, and would not impair implementation of or physically interfere with an adopted emergency response plan or emergency evacuation plan. There would be no impact.

Increased groundwater pumping would not result in use of any hazardous materials because these actions would not require the use of new machinery or other sources for hazardous materials and would not involve new ground disturbance. Because these changes would not involve the use of hazardous materials, impacts from routine transport, use, or disposal of hazardous materials; release of hazardous materials into the environment by upset or accident; or emission of hazardous materials within 0.25 mile of a school would not occur. There would be no impact. Accordingly, these topics (Impacts HAZ-a through HAZ-g) are not evaluated further in this section.

The potential for changes in reservoir operations and reduced water storage levels to affect wildfire suppression is evaluated in this section under Impact HAZ-h.

9.7.11.1 Impact Analysis

Impact HAZ-h: Expose people or structures to a significant risk of loss, injury or death involving wildland fires, including where wildlands are adjacent to urbanized areas or where residences are intermixed with wildlands

As discussed in Section 7.11, *Hazards and Hazardous Materials*, wildland fire suppression practices include the use of water from reservoirs to fill tanker trucks, planes, and dip tanks carried by helicopters, as well as fire retardants and fire suppressants.

Changes in hydrology may result in changes to reservoir operations such that water levels may be lower during fire season (roughly summer through early fall). However, it is unlikely that lower water levels would prevent access to water for such use, thus impeding fire suppression and exposing people or structures to increased risk of loss, injury, or death from wildland fire. Reservoirs would continue to be available for fire suppression water, and any increased use of fire retardants would be due to increased fire intensity from climate change, not as a result of changes in hydrology and reduced water supply under the proposed VAs. Impacts from changes in reservoir levels would be less than significant.

9.7.12 Hydrology and Water Quality

9.7.12.1 Surface Water

Section 7.12.1.2, *Environmental Setting*, describes the environmental setting to inform the impact discussion in this section; Section 7.12.1, *Surface Water*; Section 7.21, *Habitat Restoration and Other Ecosystem Projects*, and Section 7.22, *New or Modified Facilities.* See Section 9.7.12.2, *Groundwater*, for a discussion of checklist Impact b and groundwater quality. Section 7.12.1 describes the potential impacts that may result from changes in hydrology or changes in water supply under the proposed Plan amendments.

This section describes potential impacts for surface water that may result from changes in hydrology and changes in water supply under the proposed VAs. Changes in hydrology, including changes in streamflows and reservoir levels, are generally analyzed qualitatively for potential water quality impacts under Impacts SW-a and SW-f. Increasing flows at certain places and times while decreasing flows at others, and changes in Delta outflow and the volume of water exported from the Delta, are evaluated for water quality impacts, including concentration of contaminants, mobilization and methylation of mercury, water temperature, and HABs. Water temperature and Delta hydrology and water quality are assessed, in part, with HEC-5Q temperature model results for the Sacramento, Feather, and American Rivers and with Delta Simulation Model II (DSM2) hydrology and water quality results for the Delta.

Changes in hydrology, including potential changes in runoff patterns, sediment movement, and flooding are evaluated under Impacts SW-c, SW-d, and SW-i. Changes in water supply, including reductions in Sacramento/Delta water supplies would have no impact on flood control operations nor substantially increase drainage in a manner that would cause flooding or erosion. There would be no impacts, and these actions are not evaluated further under Impacts SW-c, SW-d, and SW-i.

Changes in hydrology could result in a change in the amount of surface water stored in the existing reservoirs or released to the rivers. These changes would not increase the amount of stormwater generated, collected, or discharged to surface waters relative to baseline. Changes in water supply, including reduced agricultural or landscape irrigation, could reduce runoff of polluted water, potentially improving the capacity of existing or planned stormwater drainage systems. There would be no impact associated with stormwater drainage and polluted runoff, and Impact SW-e is not evaluated further in this section.

Portions of the study area are within a 100-year flood hazard area. However, changes in hydrology and supply under the proposed VAs would not result in the development of housing, and therefore would not place housing within a 100-year flood hazard area. Similarly, the proposed VAs would not place structures within a 100-year flood hazard area. There would be no impacts, and Impacts SW-g and SW-h are not evaluated further in this section.

Although some locations in the study area are prone to inundation by seiche, tsunami, or mudflow, changes in hydrology would not result in an increased risk or impacts related to flooding from inundation by tsunami, seiche, or mudflow because the changes in hydrology resulting from the proposed VAs would not change the conditions that create these hazards: proximity to the source of the hazard (ocean, enclosed waterbody, or steep terrain) and seismic and topographic conditions. Changes in water supply, including changes in deliveries of Sacramento/Delta supplies would not increase the risk of inundation by tsunami, seiche, or mudflow in these areas. There would be no impact, and Impact SW-j is not evaluated further in this section.

Impact Analysis

Impact SW-a: Violate any water quality standards or waste discharge requirements

Impact SW-f: Otherwise substantially degrade water quality

The analyses of water quality standards and water quality degradation are closely related and are therefore combined and addressed together under Impact SW-a and Impact SW-f.

Changes in Hydrology

Implementation of the proposed VAs could result in changes in hydrology, including changes in streamflow and reservoir levels in the VA tributaries and other tributaries compared to baseline. These changes would be smaller compared to the changes that would occur under the proposed Plan amendments. Increases in streamflows on VA tributaries would generally occur during the spring months, although some increases in streamflows could also occur at other times for some VA tributaries. The proposed VAs could also result in reductions in streamflows at times. In general, reservoir levels in VA tributaries would be similar to baseline but could increase at times and decrease at times. The largest changes in storage are expected at New Bullards Bar Reservoir, where storage could be lower at times (Figure 9.5-10) because the Yuba River VA proposes to reduce storage levels in order to provide for increased flows, and Folsom Reservoir, where carryover storage could be higher (Figure 9.5-12). Both Delta inflows and Delta outflows would increase on average on an annual basis under the proposed VAs compared to baseline. Delta outflow would be expected to increase most months, with the largest increases expected during March and April, although there could be some months with small reductions in outflow relative to baseline (Appendix G3a).

If the VAs were adopted, actual operations could vary to some degree from modeled outcomes and there could be additional changes in streamflows and reservoir levels beyond the modeled changes.

The proposed VAs include flow that would be provided though water purchases, but the sources of water for the unspecified water purchases described in the VA Term Sheet are not fully known at this time; therefore, the SacWAM VA tributary inflow analyses do not assume any additional inflows from unspecified water purchases given the unknown origin of these water purchases. In addition, unspecified water purchases were not included in the DSM2 and water temperature modeling. Furthermore, it is possible that some upstream reservoirs could be reoperated on some tributaries. Upstream effects were not modeled, but significant changes in upstream tributary or reservoir operations would be unlikely.

As discussed above, there could be some increases in exports during April and May under the proposed VAs in combination with cumulative changes to BiOp and ITP export constraints compared to baseline. The combined effect of the VAs and regulatory changes on Delta exports would vary by month and water year type with a possible overall increase in Delta exports as described in Section 9.5.3.9, *Delta Inflows, Exports, Interior Delta Flows, and Delta Outflow Results.* These increases in Delta exports would not be the result of adding the proposed VAs to the Bay-Delta Plan, but instead the possible result of cumulative changes to the BiOps and ITP compared to baseline.

Sacramento River Watershed and Delta Eastside Tributaries Regions

Total Suspended Solids and Turbidity

As described in Section 7.12.1, *Surface Water*, changes in stream flow could cause an increase in total suspended solids (TSS) and turbidity, which could be either beneficial or detrimental depending on magnitude and location. The relationship between TSS or turbidity and flow is nonlinear. The highest flows result in the mobilization and transport of large amounts of sediment.

As part of the flood-risk evaluation for Impact SW-i, the occurrence of the highest flows were assessed by determining the 90^{th} percentile and maximum monthly SacWAM flows for the months of the year with the highest flows (see

Table 9.7-12). The results indicate the highest flows for the proposed VAs would generally be similar to or less than baseline flows; increases in the flow indicators are less than 0.5%. The one exception is maximum Feather River flows in February, but this increase is counteracted by reductions in high flow during January. As a result, the very highest turbidity and TSS levels are not expected to increase.

Increases and decreases in flow under the proposed VAs would fall within the range of flow, TSS, and turbidity concentrations that occur naturally under baseline. Light effects on phytoplankton primary production would likely be small, and drinking water treatment facilities are equipped to handle the levels of turbidity expected to occur with the proposed VAs. Impacts would be less than significant.

Potential erosion and siltation effects, which are related to but distinct from the water quality attributes of TSS and turbidity, are discussed under Impacts SW-c and SW-d.

Contaminants

Changes in hydrology under the proposed VAs could affect the concentration of contaminants, such as pathogens, trace metals and metalloids, current-use pesticides, legacy contaminants, and contaminants of emerging concern (CECs). When flows increase, the movement of sediment and any adhered contaminants may increase. The long-term water quality impacts on the movement and deposition of sediment and adhered contaminants would generally be minimal because contaminants are likely already present in areas where sediment deposition occurs, and higher flows can also help move sediment and adhered contaminants out of the system.

Increased input of dissolved contaminants to the Sacramento River system may occur by increasing inundation of locations in flood bypasses subject to pesticide application. More frequent inundation of these agricultural areas is unlikely to substantially increase pesticide concentrations because the proposed VAs would not cause increased pesticide application, repeated inundation would wash away pesticides, and inundation would occur during the rainy season, after many pesticides have had the chance to degrade after application. In addition, when flood bypasses are inundated, VA and other tributaries would still have relatively high flows that sufficiently dilute contaminants.

Increases in flow would help dilute local sources of dissolved contaminants, thus improving water quality. Conversely, reductions in flow could reduce dilution of local contaminants, either from WWTP discharges, other types of contaminated discharges, or uncontrolled and natural sources of contaminants. Reductions in flow are expected to be relatively small with the proposed VAs in comparison to the proposed Plan amendments; however, the reductions in flow could occasionally increase the concentration of contaminants and result in localized degradation in some areas. This impact would be potentially significant.

Implementation of Mitigation Measure MM-SW-a,f: 1 would reduce or avoid water quality impacts from increased concentration of contaminants that may occur if streamflow is reduced. Contaminants in waterbodies are a statewide water quality issue that exists independently of potential incremental effects from the proposed Plan amendments; various ongoing state efforts are addressing this problem. The regulation of water quality pollution is accomplished primarily through waste discharge permits, including NPDES permits for point-source discharges, and WDRs for nonpoint-source discharge. As explained in Section 7.12.1.2, *Environmental Setting*, the State and regional water boards administer a variety of permit programs that regulate discharges of waste. TMDLs are adopted and implemented to bring waterbodies into compliance over time when water quality impairments persist. The State and regional water boards, pursuant to their pre-existing duties and Mitigation Measure MM-SW-a,f: 1, will continue to regulate waste discharges and support TMDL development and implementation. Efforts to control some contaminants may take time. The State Water Board cannot be certain that these efforts will mitigate every incremental water quality impact associated with reduced flows to a less-than-significant level. Unless and until the mitigation is fully implemented and proven effective, the impacts remain potentially significant.

<u>Mercury</u>

Mercury is a statewide problem and the amount of mercury moved from one area to another is of concern under existing conditions, as is the conversion of mercury to more harmful methylmercury. Mercury impacts could occur due to increases in water level fluctuation in reservoirs (average of annual maximum minus average minimum water surface elevation).Based on SacWAM results, it is unlikely the proposed VAs would have substantial effects on average reservoir fluctuation. However, if the VAs were adopted, actual operation could vary to some degree from modeled outcomes and there could be additional changes in reservoir levels beyond the modeled changes.

Mercury impacts could also be associated with downstream mercury transport and inundation of floodplains. Given mercury's high affinity for particles, increased suspended sediments from greater streamflow from changes in hydrology could increase the transport of mercury, potentially affecting the achievement of water quality standards in tributaries with mercury TMDLs or known impairments. The potential negative consequences of this effect could be exacerbated if the receiving water forms intermittent wetlands that are conducive to converting mercury to methylmercury.

The Sutter and Yolo Bypasses exemplify locations where the combination of increased mercury input and transformation to methylmercury could occur due to the existing concentration of mercury in the tributaries and large wetland acreage. Due to high concentrations of mercury in Putah and Cache Creeks, mercury is more of a concern in the Yolo Bypass than the Sutter Bypass. The proposed VAs would cause minimal changes in the flows into the Yolo Bypass. The proposed VAs include modifications to Tisdale Weir that would increase the frequency and magnitude of flows into the Sutter Bypass; during January through March, frequency of spill over Tisdale Weir would be expected to increase about 25% and average January through June flow over the weir would be expected to increase approximately 100 TAF (Table 9.5-8). Although the Sutter Bypass contains a smaller amount of mercury than the Yolo Bypass, increased flow into the Sutter Bypass could still increase transformation of mercury into methylmercury due to floodplain inundation. The effect of increases in mercury and methylmercury may carry downstream to the Delta and San Francisco Bay, although these effects would be dissipated by mixing with other water sources, settling of mercury attached to sediment, dredging, accumulation in organisms, and photodegradation of methylmercury back to mercury. Potential mercury impacts associated with downstream mercury transport and inundation of floodplains would be potentially significant.

As discussed in Section 7.12.1, *Surface Water*, the State Water Board recognizes that wetlands and floodplain inundation provide valuable water quality, wildlife habitat, and flood control functions, and should not be disincentivized due to mercury concerns. Floodplain benefits are described in Section 3.14.2, *Floodplain Inundation*, and Appendix A8, *Floodplain Inundation Analysis*. Methylmercury production from physical habitat restoration projects, such as notching the Fremont Weir, is evaluated in Section 7.21, *Habitat Restoration and Other Ecosystem Projects*.

Mercury impacts can be reduced through implementation of Mitigation Measure MM-SW-a,f: 2, excluding the portion of measure 2i related to long-term strategy and annual operations plans (which are not currently proposed under the VAs) and excluding measure 2iii related to high flows on Cache Creek (which are not expected to change under the proposed VAs). Mercury is a statewide water quality issue that exists independently of the potential incremental effects from the proposed VAs and is being addressed through various state and federal water quality efforts. The State Water Board will continue its efforts to develop and implement mercury control measures for reservoirs, including efforts to understand and control sources of methylmercury and to address fish consumption concerns. In addition, the State Water Board will work with the appropriate regional water boards to implement the San Francisco Bay Mercury and the Sacramento-San Joaquin Delta Methylmercury TMDLs. Health-related effects associated with mercury can be limited by issuance of fish consumption advisories from the California Office of Environmental Health Hazard Assessment (OEHHA). Resolving mercury issues is expected to take time and will occur on multiple fronts; however, the State Water Board cannot be certain that these efforts will mitigate all potential mercury impacts associated with the proposed VAs to a less-than-significant level. Unless and until the mitigation is fully implemented and proven effective, the impacts remain potentially significant.

Temperature

Elevated water temperatures are an existing concern in California, particularly in rivers where rim reservoirs prevent access to upper watershed habitat for native cold-water anadromous fish. Section 9.7.6.2, *Aquatic Biological Resources,* focusses on temperature-related fish effects.

Simulated changes in temperature associated with the proposed VAs on the Sacramento, Feather, and American Rivers are small as shown in Appendix G3e (most monthly 10th, 50th, and 90th percentiles of daily average VA temperatures are within 1°F of baseline temperatures). However, actual operation could vary to some degree from modeled outcomes. The simulated temperatures represent temperature effects based on SacWAM results for VA tributary flows, which do not assume additional inflows from unspecified water purchases given the unknown origin of these water purchases. If unspecified water purchases are provided from sources in the Sacramento, Feather, and American River watersheds, water temperatures on these rivers could be further affected beyond the model results presented in Appendix G3e. In addition, the proposed VAs include flexibility in the timing of flow assets, so streamflows, reservoir levels, and water temperatures could deviate to some degree from modeled results. Changes in water temperature could also occur in other Sacramento/Delta tributaries that were not included in the water temperature modeling, and it is possible that there could be instances where an increase in water temperature could occur due to reduced reservoir storage levels and reduced streamflows. This impact would be potentially significant.

Implementation of Mitigation Measure MM-SW-a,f: 3 will avoid or reduce temperature impacts in the Sacramento/Delta. This alternative incorporates MM-AQUA-a,d: 1.ii for temperature control and reservoir management. Reservoirs on VA tributaries would not be subject to a new narrative cold water habitat objective and would not be required to develop and implement long-term strategies and annual plans for reservoir operations that would consider water temperature. However, streams and reservoirs on VA tributaries may be subject to future changes that could result from issuance of new water rights orders or decisions, FERC licenses, and other future regulatory requirements. In exercising its regulatory authorities, the State Water Board would consider water temperature and ensure that any temperature impacts are avoided or minimized. However, unless and until the mitigation is implemented, any impacts from changes in reservoir storage levels and releases on water temperature downstream of reservoirs, remain potentially significant.

Harmful Algal Blooms (HABs)

Changes in hydrology may result in reduced reservoir storage levels in some reservoirs at some times and in associated shallower, warmer, more stable water column conditions in those reservoirs. These conditions could lead to increased reservoir algal bloom formations, and with lower storage levels, blooms could be more likely to be exposed to reservoir outlets, affecting supplies from the reservoir for downstream releases and water supply purposes. As simulated by SacWAM, under the proposed VAs, reservoir levels would generally be similar to baseline, but could increase at times and decrease at times. Actual operations could vary to some degree from modeled outcomes. In addition, it is possible that some upstream reservoirs could be reoperated on some tributaries, but these effects were not modeled. Lower reservoir levels could increase the production of HABs. While changes would generally be expected to be smaller compared to the changes that would occur under the proposed Plan amendments, this impact would be potentially significant.

Potential HAB impacts in Sacramento/Delta reservoirs can be reduced through implementation of Mitigation Measures MM-SW-a,f: 1, 4, and 5. HABs are a statewide water quality issue that exists independently of potential incremental effects from changes in hydrology. Several ongoing activities to address HABs, such as those coordinated by the Freshwater and Estuarine Harmful Algal Bloom (FHAB) Program, could also be employed to mitigate impacts. The State and regional water boards regulate discharges of nitrogen and phosphorus, which contribute to HAB formation. The most immediate HAB response efforts include public education and notification efforts to minimize exposure of pets and people to waterbodies containing HABs. The California Water Quality Monitoring Council maintains a website for the California Cyanobacteria and Harmful Algal Bloom (CCHAB) Network that tracks HABs and provides information about how to respond to HABs, including information from the USEPA on measures that should be implemented to prevent and respond to HABs in surface waters and drinking water supplies. While the State Water Board and others are engaged in efforts to address HABs, those efforts will take time and may not fully resolve HAB issues, including the incremental impacts associated with changes in hydrology under the proposed VAs. Unless and until the mitigation is fully implemented and proven effective, the impacts remain potentially significant.

Delta Region

The DSM2 model of Delta hydrodynamics and water quality was used to simulate the effect of changes in hydrology on electrical conductivity (EC), a measure of salinity, in the Delta, as described in Appendix A2, *Delta Simulation Model II* (*DSM2) Methods and Results*. The DSM2 model uses SacWAM results as model input. The results used as DSM2 model input include VA tributary inflows, but do not assume additional inflows from unspecified water purchases given the unknown origin of these water purchases. In addition, the results used as DSM2 model input do not include San Joaquin basin VA contributions. The DSM2 results for EC and flow combined with consideration of possible additional contributions were used to infer water quality effects for other Delta water quality constituents, including chloride, bromide, and HABs. DSM2 results are presented as a series of graphs and tables in Appendix G3b to evaluate effects relative to water quality objectives for habitat, agriculture, and municipal supply.

Unspecified water purchases and VA contributions from the San Joaquin basin would likely result in a combination of increased Delta inflow, increased Delta outflow, and reduction in Delta exports. The main effect of these changes would be a reduction in seawater intrusion. Some additional smaller effects could also occur. Higher Delta inflow could slightly alter salinity in the Delta by altering the percent of water originating from the Sacramento River (lower EC) versus the San Joquin River (higher EC). Reductions in Delta exports could reduce movement of Sacramento River water toward the southern Delta and reduce flow in channels conveying water to Delta exports. In addition, there could be shifting in the timing of effects. Unspecified water purchases would likely increase Delta outflow during the spring, which could lead to reductions in flow during other times of the year. The SacWAM VA run and the associated DSM2 run include these types of effects, but the magnitude of these effects could be somewhat greater if unspecified water purchases were included.

<u>Electrical Conductivity, Chloride, and Bromide</u>

The DSM2 results show that salinity within the Delta channels is largely influenced by seawater intrusion, which is controlled by the balance between tidal exchange (constant at each location) and Delta outflow. The proposed VAs would result in an increase in Delta outflow on an annual basis and would result in an increase in Delta outflow relative to baseline in most months, thereby reducing seawater intrusion and salinity. Occasionally, Delta outflow may be reduced relative to baseline. However, the changes in Delta outflow represent only a small percent of total Delta outflow and would have minimal effect on salinity within the Delta (Appendix G3b). Inclusion of unspecified water purchases and VA contributions from the San Joaquin basin would be unlikely to cause substantial increases in Delta salinity and would not cause any water quality violations. The proposed VAs would not cause violations of water quality objectives for salinity in the Delta, and the effect on salinity would be less than significant.

Because concentrations of chloride and bromide are correlated with salinity, the effects of the proposed VAs on chloride and bromide are similar to the effects on salinity. The proposed VAs are expected to produce little to no change in chloride and bromide concentrations at municipal intakes and would not result in exceedances of water quality objectives. Impacts would be less than significant.

<u>Harmful Algal Blooms (HABs) Nutrients, Organic Material, Harmful Algal Blooms, Invasive Aquatic Plants, and Dissolved Oxygen</u>

As discussed in Section 7.12.1, *Surface Water*, increased flows could result in overbank flows, which may lead to more nutrients and organic material transported into the Delta. Increases in nutrients and organic material could result in increased algal growth, which may be beneficial for fish but at high levels could cause eutrophication or degradation of drinking water quality. Excessive growth of algae and HABs can harm beneficial uses of water. However, it is unlikely that the proposed VAs would cause such a large increase in inundation of existing floodplains that nutrient levels would exceed drinking water thresholds, especially because algal growth would deplete nutrients and would likely limit the extent of any elevated nutrient concentrations. Increases in particulate organic material, including algae, are also unlikely to cause impacts on drinking water quality because particulate matter may be removed from drinking water prior to water treatment through settling, flocculation, and/or filtration. Increased floodplain inundation is also unlikely to increase HABs or invasive aquatic plants because inundation would likely occur during the winter and spring, and, therefore, is unlikely to result in increased eutrophication and low dissolved oxygen. Overall, increased floodplain inundation that could occur as a result of changes in flow under the proposed VAs would have less-than-significant impacts on nutrients, organic material, invasive aquatic plants, and HABs.

Changes in Delta channel flows is an additional mechanism by which the proposed VAs might affect HABs and invasive aquatic plants in the Delta. HABs and invasive aquatic plants occur in backwaters, dead-end sloughs, and other waterways with poor water circulation in the central and southern Delta. It is unlikely that HAB formation and presence of aquatic invasive plants in dead-end sloughs and other channels with poor circulation would be affected because tidal and net flow in these channels would not be significantly affected by the proposed VAs.

The Stockton area provides one example of an area with problematic HABs where the proposed VAs are unlikely to affect conditions for HABs. As described in Appendix G3b, DSM2 results indicate the proposed VAs would have little effect on net flow in the San Joaquin River near Stockton and the dead-end slough where the Stockton Waterfront is located. As a result, hydrologic conditions that affect HAB formation (e.g., residence time, turbidity, and turbulence) are not expected to significantly change as a result of the proposed VAs. The DSM2 results do not incorporate unspecified water purchases and possible VA contributions from the San Joaquin River. If these VA assets were included, there would be not be expected to be an increase in conditions conducive to HAB formation in this area because these additional VA assets would reduce exports of San Joaquin

River restoration water in the spring and would increase Tuolumne River inflows to the Delta modestly, which would be expected to have negligible effects on flow and HABS near the Stockton Waterfront compared to baseline.

Flow effects on HAB formation are more likely in channels that convey water to the export pumps. Increases in water travel time through channels that convey water to the CVP and SWP export pumps could increase HAB formation or increase presence of invasive aquatic plants due to reductions in exports. DSM2 results were used to predict net flows in southern Delta channels and assess whether there would be increased probability of HABs and invasive aquatic plants. Similar to the approach used for the proposed Plan amendments discussed in Section 7.12.1, *Surface Water*, Victoria Canal was selected as a representative large channel that could be affected by changes in Delta exports and that has already experienced some limited formation of HABs. The DSM2 results indicate that average monthly baseline travel times through Victoria Canal are between 0.6 and 1.3 days during primary months for HAB activity, June through October. Model results for the proposed VAs show very little change in travel time during the bloom period as compared to baseline, with the average change being between 0.0 and 0.1 days (Appendix G3b).

As described in Section 9.7.6.2, *Aquatic Biological Resources*, there could be some increases in exports that could result from BiOp and ITP differences between the baseline for this draft Staff Report and the 2019 BiOps condition upon which the VA flows are intended to be added. However, these effects would primarily occur during April and May, and would likely have little effect on the primary months for HAB activity of June through October.

Additional reductions in Delta exports could occur due to unspecified water purchases and the proposed Friant VA that were not included in the DSM2 modeling. As discussed in Section 9.5, *Changes in Hydrology and Water Supply*, unspecified water purchases would be provided from unspecified willing sellers, which could include inflow sources within the Sacramento/Delta watershed or reductions in exports. Additional reduction in Delta exports as a result of unspecified water purchases could cause increases in travel times to the export pumps during June through October, the primary months for HABs. However, given the relatively small magnitude of these potential effects compared to total Delta exports, such increases would likely have little effect on the probability of HAB formation and bloom severity. This impact would be less than significant.

<u>Water Temperature</u>

As described in Section 7.12.1, *Surface Water*, changes in flow could cause limited temperature effects on Delta water temperature. By the time water reaches the Delta, it generally has warmed considerably, approaching equilibrium values. As water approaches equilibrium, effects of changes in hydrology would be diminished and large changes in flow would be needed to cause substantial changes in Delta temperatures. It is unlikely that the small percent changes in Delta inflow associated with the proposed VAs would have much effect on Delta water temperatures. This impact would be less than significant.

Changes in Supply

Overall, the proposed VAs would result in a reduction in Sacramento/Delta surface water supplies, both within and outside of the Sacramento/Delta watershed. Water supply reductions would primarily affect agricultural uses, and there would be only be expected to be a very small reduction in water supply for municipal use, and no change in water supply for wildlife refuge uses. In addition, as discussed in Section 9.5, *Changes in Hydrology and Water Supply*, flow assets that could be provided through the unspecified water purchases would likely primarily affect agricultural uses. Reductions in water supply to municipalities under the proposed VAs would be based on voluntary measures and would not be large enough to potentially alter the flow and chemical constituent concentrations of WWTP influent and subsequently affect WWTP effluent discharges to receiving waters in a manner that affects water quality. This impact would be less than significant.

Reductions in surface water supply for agriculture could lead to a reduction in irrigated acreage or result in the use of other sources of water, particularly groundwater. Irrigation water does not need to meet the same water quality standards as municipal water. However, elevated levels of some constituents, particularly salinity, can reduce crop yield. Ultimately, if groundwater salinity is too high for even the most salt-tolerant plants to be grown profitably, it will not be used. Increased use of groundwater for agriculture could result in agricultural drainage that is of lower quality, particularly on the western side of the San Joaquin Valley. Regardless of the water source, agricultural drainage is generally of low quality with constituents including pesticides, nitrates, selenium, and high salinity. A reduction in surface water supply could also reduce the total volume of runoff from fallowing and conservation measures. The net effect of reduced drainage quality and quantity would generally be a negligible change in the number and concentrations of contaminants entering waterways in flowing streams where drainage water constitutes a small percent of the total flow.

Reductions in Sacramento/Delta supplies could affect water quality in managed wetlands if those lands receive some or all of their water supply from the Sacramento/Delta either directly or indirectly. The VA documents indicate that no flow assets would come from refuge supplies, although wetlands theoretically could experience indirect effects. It is possible that reductions in agricultural supply could cause reductions in agricultural drainage. With less Sacramento/Delta supply, the remaining inflow from agricultural drainage and groundwater could become more degraded, and dilution of this low-quality water with fresh surface water supplies could be reduced. However, as described in Section 9.7.4, *Agriculture and Forest Resources*, reductions in agricultural water supply under the proposed VAs would likely be small compared to each region's total agricultural water supply. As a result, managed wetlands are unlikely to experience substantial reductions in water supply or water quality due to reductions in agricultural drainage or groundwater levels associated with the proposed VAs. The impacts on wetland habitat from reduced supply to managed wetlands would be less than significant.

The VA proposal identifies that some flow could be provided through groundwater substitution, including in the American River watershed. Flow in other watersheds could also be provided through groundwater substitution. Increased groundwater pumping and reduced incidental recharge from applied irrigation water could result in reduced groundwater levels. Reductions in groundwater levels could reduce streamflow either by increasing surface water percolation to groundwater or by reducing groundwater accretions to surface water. In addition, increased groundwater pumping adjacent to streams could accelerate stream depletions more directly. Groundwater accretions are generally beneficial to streams because they increase flow and may provide cold water inflow in the summer. Groundwater accretions are most important in streams where the accretions contribute a large portion of the summer base flow or create cold water refugia for fish and other aquatic species. Potential reductions in groundwater accretions could cause increases in water temperature. This could also cause decreases in water quality due to lower streamflows, or improvements in water quality due to less input from lower-quality groundwater. Due to the relatively small effect of the proposed VAs on water supply, effects associated with groundwater substitution would not be widespread, but local impacts could be potentially significant.

These surface water quality effects from lowered groundwater levels could be reduced through implementation of Mitigation Measure MM-SW-a,f: 6 and 8, which incorporates applicable groundwater mitigation measures to reduce lowering of groundwater levels. In addition, groundwater impacts and associated impacts on surface water quality could be reduced through the diversification of water portfolios that include sustainable groundwater management, groundwater storage and recovery, increased use of recycled water from existing facilities, and agricultural and municipal water conservation measures. However, unless and until the mitigation is fully implemented, impacts of reduced groundwater levels on water quality remain potentially significant.

Impact SW-c: Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, in a manner which would result in substantial erosion or siltation on- or off-site

Impact SW-d: Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, or substantially increase the rate or amount of surface runoff in a manner which would result in flooding on- or off-site

The analyses of Impact SW-c and Impact SW-d are closely related and are, therefore, combined and addressed together. Potential erosion impacts evaluated are those that could result in excessive erosion or deposition, as opposed to sediment movement that is ecologically beneficial. Similarly, potential flooding impacts evaluated here focus on flooding outside of the floodplain bounded by levees. These types of impacts could negatively affect infrastructure and would also indicate unstable stream conditions.

High flows are considered the primary means of sediment transport and channel change. Excessive sedimentation (i.e., deposition and siltation) can reduce channel conveyance capacities. Substantial erosion or siltation can also result in a major rearrangement of channel gravels that would disrupt salmonid spawning beds or cause substantial instream siltation that would adversely affect in-sediment fauna, including salmon eggs and alevins. Scouring that can undermine streambanks or levees is most likely to occur when flows are near or exceeding channel capacities.

The proposed VAs would generally result in increased flows in VA tributaries during spring, primarily April and May, and generally would not be intended to increase flows during the winter months. In addition, priority years for the proposed VAs include above normal, below normal, and dry years. The proposed VAs would provide for only small possible increases in flow during wet water years, which are the year types most likely to produce flows substantial enough to cause deleterious erosion or flooding.

Changes in high flows under the proposed VAs were evaluated in more detail as presented in the flood risk evaluation under Impact SW-i. The flood risk evaluation analyzes high flows during the wettest months on the six VA tributaries. The proposed VAs would not increase flows when they are at peak levels, when flood risk is highest. No significant increases in high flows would occur under the proposed VAs and impacts SW-c and SW-d would be less than significant.

Impact SW-i: Expose people or structures to a significant risk of loss, injury, or death involving flooding, including flooding as a result of the failure of a levee or dam

Reservoir operations are guided by flood control rule curves, which define the volume of flood space necessary during different months of the year. The same flood control curves and daily operations would be used for operations of reservoirs under the proposed VAs and the same end-of-month flood control storage space would be maintained. SacWAM modeling mimics flood control operations by not allowing encroachment into the flood control space that is determined for each reservoir by the US Army Corps of Engineers (USACE) or other operational requirements.

Although adherence to flood control rules would limit the likelihood of deleterious flooding, increased upstream reservoir storage during the flood control season could be interpreted as a reduction in the flexibility of real-time operations to capture flood flows and avoid downstream flood risk. SacWAM modeling of the proposed VAs indicates that storage on the VA tributary reservoirs would generally be similar to or slightly less than baseline. The one exception is Folsom Reservoir, which may have increases in carryover storage. However, SacWAM modeling indicates that these increases in Folsom Reservoir storage would not occur during wetter conditions, when storage is less than the 25 percent exceedance levels (Figure 9.5-12). As a result, it is unlikely the proposed VAs would cause an increase in the peak magnitude of flood control releases due to higher storage levels.

Flood risk can be further assessed by evaluation of flows. Although SacWAM monthly modeling does not simulate the peak flow events that last hours or days and does not include unspecified water purchases, the SacWAM results can be used to indicate whether the proposed VAs could cause increased flooding. Decreases in peak monthly flow would indicate that flows for shorter time scales would also likely decrease. In addition, because flow effects associated with the unspecified water purchases are likely to be similar to the flow effects modeled in SacWAM, a decrease in peak SacWAM flows would indicate that unspecified water purchases would likely cause additional decreases in peak flow.

Table 9.7-12 shows maximum and 90th percentile flows (10 percent exceedance) for baseline and the proposed VAs as modeled by SacWAM. These flows represent the highest flows, the flows most likely to cause flooding. The results indicate the peak flows for the proposed VAs would generally be similar to or less than baseline flows; any increases in the flow indicators are less than 0.5%. The one exception is maximum Feather River flows in February, which increase by 1,164 cfs. This increase does not represent a significant effect because the peak February flows are less than the peak January flows on the Feather River, the increase is only approximately 2 percent, other metrics of peak flow on the Feather River (e.g., 90th percentile flows in January) show a decrease, and real-time operations would be expected to be managed to prevent an increase in flood risk.

Because the proposed VAs are not expected to increase the occurrence of peak flows or high storage levels, impact SW-i would be less than significant.

Table 9.7-12. Changes in High Flows on Voluntary Agreement Tributaries during High Flow Months under the Proposed Voluntary Agreements

High Flow Months	High Flow Indicator	Baseline Condition	Proposed VAs	Difference (cfs)	Percent Change
American River Flow (cfs)					
January	Max flow	28,322	28,324	2	0.01
	90th Percentile	9,007	9,010	3	0.03
February	Max flow	30,920	30,923	3	0.01
	90th Percentile	11,538	11,540	2	0.02
Feather River Flow (cfs)					
January	Max flow	66,475	66,525	50	0.08
	90th Percentile	22,604	21,268	-1,336	-5.91
February	Max flow	54,456	55,620	1,164	2.14
	90th Percentile	27,057	27,055	-2	-0.01
March	Max flow	54,566	54,564	-2	0.00
	90th Percentile	26,986	26,982	-4	-0.01
Mokelumne River Flow (cfs)					
January	Max flow	6,335	6,336	1	0.02
	90th Percentile	1,611	1,611	0	0.00
February	Max flow	5,565	5,518	-47	-0.84
	90th Percentile	1,709	1,691	-18	-1.05
Putah Creek Flow (cfs)					
January	Max flow	4,813	4,788	-25	-0.52
	90th Percentile	271	252	-19	-7.01
February	Max flow	6,187	6,135	-52	-0.84
	90th Percentile	715	715	0	0.00
March	Max flow	5,725	5,725	0	0.00
	90th Percentile	863	834	-29	-3.36
Sacramento River Flow at Knights Landing (cfs)					
November	Max flow	21,263	21,315	52	0.24
	90th Percentile	12,601	12,314	-287	-2.28
December	Max flow	22,301	22,312	11	0.05
	90th Percentile	21,019	21,013	-6	-0.03
January	Max flow	23,406	23,368	-38	-0.16
	90th Percentile	21,599	21,611	12	0.06
February	Max flow	24,394	24,404	10	0.04
	90th Percentile	22,207	22,217	10	0.05
March	Max flow	23,579	23,584	5	0.02
	90th Percentile	21,411	21,417	6	0.03
April	Max flow	22,033	21,987	-46	-0.21
	90th Percentile	19,126	19,125	-1	-0.01

High Flow Months	High Flow Indicator	Baseline Condition	Proposed VAs	Difference (cfs)	Percent Change
Yuba River Flow (cfs)					
December	Max flow	15,368	14,481	-887	-5.77
	90th Percentile	4,591	4,540	-51	-1.11
January	Max flow	22,279	22,332	53	0.24
	90th Percentile	5,943	5,927	-16	-0.27
February	Max flow	19,091	19,176	85	0.45
	90th Percentile	6,693	6,693	0	0.00

Gray-shaded cells indicate months with a flow increase of > 100 cfs or > 5%.
Flows are at the furthest downstream location on all the rivers, except Sacramento River values are for the Sacramento River at Knights Landing.
cfs = cubic feet per second
TAF = thousand acre-feet

9.7.12.2 Groundwater

Section 7.12.2.2, *Environmental Setting*, describes the environmental setting to inform the impact discussion in this section; Section 7.12.2, *Groundwater*; Section 7.21, *Habitat Restoration and Other Ecosystem Projects*; and Section 7.22, *New or Modified Facilities.* Section 7.12.2 describes the potential impacts that may result from changes in hydrology or changes in water supply under the proposed Plan amendments.

This section describes the groundwater effects that may result from changes in hydrology and changes in water supply under the proposed VAs. This section first describes changes in groundwater levels (Impact GW-b) that could occur from responses to decreased Sacramento/Delta surface water supply. Water quality impacts, including drinking water quality impacts (Impact GW-a and Impact GW-f), are then evaluated together based on the identified possible changes in groundwater quantity.

Water users could choose to increase groundwater pumping in response to changes in Sacramento/Delta water supply, which could also result in potentially significant impacts from increased groundwater pumping as a substitute supply where available and not locally restricted. Overall, because the magnitude of reductions in Sacramento/Delta supply under the proposed VAs would be less than those under the proposed Plan amendments, the magnitude of these potential groundwater-related response actions and environmental impacts would also be expected to be less.

For a discussion of potential subsidence impacts related to reduced groundwater levels, see Section 9.7.9, *Geology and Soils*. For a discussion of potential impacts on surface water, see Section 9.7.12.1, *Surface Water*.

Impact Analysis

Impact GW-b: Substantially deplete groundwater supplies or interfere substantially with groundwater recharge, such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level (e.g., the production rate of pre-existing nearby wells would drop to a level that would not support existing land uses or planned uses for which permits have been granted)

Overall, implementation of the proposed VAs would result in an average annual reduction in Sacramento/Delta surface water supply for the entire study area. Most of the reductions in Sacramento/Delta surface water supplies would occur for users within the Sacramento/Delta watershed. Sacramento/Delta water supply reductions would primarily affect agricultural uses. There could be a very small reduction in water supply for municipal use, and there would be no change in water supply for wildlife refuge uses.

The VA proposal identifies that some flow could be provided through groundwater substitution, including in basins subject to the Sustainable Groundwater Management Act (SGMA) where that is consistent with local management under SGMA. The SacWAM modeling considers that some flow could be provided through groundwater substitution in the American River watershed. Flow in other watersheds could also be provided through groundwater substitution, but sufficient information is not available at this time to include additional groundwater substitution in the modeling.

Impacts could occur as a result of flow provided through groundwater substitution, which would increase groundwater pumping at times in certain locations in lieu of use of surface water provided as part of the VAs. In addition, impacts to groundwater could occur as a result of a reduction in incidental groundwater recharge from transmission losses and deep percolation from irrigation. The distribution of groundwater impacts would vary depending on several factors, such as local groundwater basin characteristics, local land use and irrigation practices, proximity to rivers and streams where stream-aquifer interactions would be affected, reservoirs and conveyance infrastructure, and locations of groundwater wells. Overall, because the magnitude of reductions in Sacramento/Delta supply under the proposed VAs would be less than those under the proposed Plan amendments, the magnitude of these potential groundwater-related response actions and environmental impacts would also be expected to be less, although these impacts remain potentially significant.

Potential impacts on groundwater resulting from flow assets provided through groundwater substitution or from reduced incidental recharge from application of applied irrigation water could be reduced through implementation of Mitigation Measure MM-GW-b, 1-6. Local groundwater management under SGMA could reduce or eliminate impacts, particularly in medium- and high-priority groundwater basins. In addition, water users can and should diversify their water supply portfolios in an environmentally responsible manner and in accordance with the law to mitigate groundwater impacts. Diversifying water portfolios may include sustainable use of groundwater and groundwater storage and recovery and conjunctive use, water transfers, water conservation and efficiency upgrades, and recycled water. The State Water Board will continue efforts to encourage and promote environmentally sound recharge projects that use surplus surface water, increased use of recycled water, sustainable water transfers, and conservation. While the State Water Board can ensure that mitigation is implemented for actions within its authority, other mitigation measures are largely within the jurisdiction and control of other agencies. The State Water Board cannot guarantee that measures always will be adopted or applied in a manner that fully mitigates the impact. Therefore, unless and until the mitigation is fully implemented, the impact remains potentially significant.

As discussed in Section 7.12.2, *Groundwater*, reduced groundwater storage and declining groundwater levels could result in reductions in overlying surface water flows, although the impacts often are delayed from the start of pumping or groundwater level decline. Many variables influence the magnitude and timing of groundwater pumping impacts on surface streams, including the distance between the well and stream, the properties of the aquifer, and the duration and volume of groundwater pumping. The effects of reduced groundwater levels on surface water flows are discussed further under Section 9.7.12.1, *Surface Water*.

Changes in reservoir levels would not significantly affect groundwater recharge rates or groundwater levels. Many reservoirs are built in narrow canyons with rock walls that generally direct groundwater toward the stream channel downstream. To the extent that reservoir operations contribute to groundwater recharge, much of that recharge would mimic recharge from stream-aquifer interactions where higher flows or reservoir levels would be associated with higher recharge rates, and lower flows or reservoir levels would be associated with lower recharge rates. If reservoir levels are reduced and downstream flows are increased, groundwater recharge from stream-aquifer interactions would increase. The SacWAM results suggest that changes in reservoir levels would be smaller compared to the proposed Plan amendments and the net impact on groundwater recharge would be minimal. Accordingly, impacts from changes in reservoir levels would be expected to be less than significant.

Impact GW-a: Violate any water quality standards or waste discharge requirements

Impact GW-f: Otherwise substantially degrade water quality

As discussed under Impact GW-b, an increase in substitute groundwater pumping as a result of flow provided through groundwater substitution and a reduction in incidental groundwater recharge from the application of applied irrigation water could result in lower groundwater levels in certain locations under the proposed VAs. These changes would not directly affect the concentration of groundwater contaminants. However, at the local scale, there is the potential that increased groundwater pumping could cause a change in the groundwater flow gradient, which could affect groundwater quality through exacerbating the migration of natural and anthropogenic groundwater contaminants.

As discussed in Section 7.12.2, *Groundwater*, groundwater quality degradation from groundwater pumping can arise via two mechanisms: the migration of degraded groundwater caused by local pumping, or the drawdown of salt-rich shallow groundwater into deeper, more pristine portions of the aquifer. Increased groundwater pumping in basins that are already in overdraft, or in basins that are salt sinks, may concentrate salts in groundwater over time through evaporation and subsequent enrichment. Additional contaminant loading could occur through application of fertilizers and pesticides via agricultural or municipal activities. Changing irrigation volumes and processes can have various results on groundwater quality.

Decreased irrigation water application can result in fewer soil flushing events, causing levels of salts and nutrients to build up in soil over time; when a flushing event does occur (either through precipitation or application of excess irrigation water), the water that percolates into the aquifer can be highly concentrated in those salts and nutrients that were previously concentrated in the soil. Excess irrigation water can sometimes dilute existing salt and nutrients in the soil but can also cause additional groundwater degradation where excess nutrients are applied as part of agricultural practices. Decreased groundwater recharge, along with increased nutrient loading and possible changes in flow direction and gradient of contaminant plumes could lead to increased groundwater degradation, which could affect drinking water wells.

While the magnitude of reductions in Sacramento/Delta supply under the proposed VAs would be less than those under the proposed Plan amendments, localized impacts on groundwater quality associated with changes in groundwater levels could occur and could be potentially significant.

Groundwater quality and associated drinking water impacts could be reduced through implementation of Mitigation Measures MM-GW-b, 1-6 and MM-GW-a,f. Some communities may develop replenishment projects to ensure additional higher-quality drinking water supplies. Regulations are in place to protect consumers from unsafe drinking water; however, communities with degraded groundwater quality could experience additional costs and financial burdens. Communities dependent on groundwater supplies could face additional costs for wellhead treatment efforts, replacement wells, deepening wells, consolidations, or connecting to surface water sources. SGMA implementation may address some of the supply issues, including for economically disadvantaged communities (DACs). The State Water Board will continue its commitment to the human right to water through financial assistance, technical assistance, consolidations, and other means, including for communities that may be affected by reduced groundwater supplies or groundwater quality concerns. The Safe and Affordable Drinking Water Fund will continue to provide support for operations and maintenance so community water systems can provide a sustainable source of safe drinking water. The LIRA program provides rate relief for low-income ratepayers of water utilities. While these efforts are expected to help reduce impacts to communities that rely on groundwater for drinking water supplies, it is not certain that these efforts will always fully mitigate impacts.

Private domestic well owners may be less able to absorb costs associated with declining groundwater elevations or degraded groundwater quality. The State Water Board has provided funding for replacement or deepening of private domestic wells affected by the 2012 to 2016 drought through its Cleanup and Abatement Account. SB 108 also provided limited funding for replacement of private domestic wells that could no longer be used due to declining groundwater elevations. However, presently, there are limited funding opportunities from the State Water Board or other funding entities for private well replacement or treatment of poor water quality. The State Water Board will promote and support future funding sources, as appropriate.

The State Water Board cannot guarantee that measures will always be adopted or applied in a manner that would fully mitigate impacts. Therefore, unless and until the mitigation is fully implemented, the impacts of reduced groundwater levels on groundwater quality and drinking water remain potentially significant.

9.7.13 Land Use and Planning

Section 7.13.1, *Environmental Setting*, describes the land use and planning setting to inform the impact discussion in this section; Section 7.13, *Land Use and Planning*; Section 7.21, *Habitat Restoration and Other Ecosystem Projects*; and Section 7.22, *New or Modified Facilities*. Section 7.21 and Section 7.22 describe and analyze potential land use and planning impacts from various actions that involve construction. Section 7.13 describes the potential impacts that may result from changes in hydrology or changes in water supply under the proposed Plan amendments.

This section describes the potential impacts related to land use and planning that may result from changes in hydrology or changes in water supply under the proposed VAs. Impacts related to land use and planning would occur if the actions would divide an established community or conflict with local or regional planning documents. Physical division of an existing community can result from the addition of new infrastructure, such as a new road or rail line, or a change in land use that physically divides an established community by creating barriers that would change existing travel patterns or prevent access to community facilities. Conflicts with local or regional planning documents may result if land is proposed for a land use designation that differs from that outlined in applicable land use plans, policies, or regulations that were adopted to avoid impacts on environmental resources. Changes in hydrology and changes in water supply do not involve these types of projects.

Under the proposed VAs, changes in hydrology and changes in water supply would not physically divide an established community. Changes in hydrology include changes in flow and reservoir levels and would not divide an established community because water would remain within existing channels and reservoirs and would not involve the construction of any physical infrastructure that could create a barrier. Changes in water supply include reduced Sacramento/Delta supply primarily for agricultural uses. Changes to agricultural crop type or production would be on land that is already designated as agricultural and would not divide an established community. There would be no impacts resulting from changes in hydrology and supply under Impact LU-a.

Changes in hydrology would not conflict with any land use plan, policy, or regulation adopted for the purpose of avoiding or mitigating an environmental effect. Flows are expected to remain within historical ranges and would not conflict with any land use plan, policy, or regulation. Changes in water supply include reduced Sacramento/Delta supply primarily for agricultural uses but would not be expected to result in conflicts with local land use plans, policies, or regulations intended to avoid or mitigate environmental effects. Agricultural users may expand their use of groundwater to replace irrigation supplies, which in turn, could lead to a reduction in available groundwater supplies. However, even with reduced irrigation water supplies, these lands could be dryland farmed, rotated, deficit irrigated, or fallowed—all of which would be compatible with agricultural zoning (see Section 9.7.4, *Agriculture and Forest Resources*). Therefore, changes in water supply would not conflict with existing agricultural zoning. There would be no impact from changes in hydrology and supply under Impact LU-b.

In Section 9.7.6.1 *Terrestrial Biological Resources*, Impact TER-f evaluates whether changes in hydrology and water supply would conflict with provisions of any applicable habitat conservation plans (HCPs) or natural community conservation plans (NCCPs). Impacts would be less than significant under Impact LU-c.

9.7.14 Mineral Resources

Changes in hydrology and changes in water supply under the proposed VAs would not result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the state. While changes in flows could possibly affect when existing mineral resources (aggregate) can be accessed, this would not result in a loss of availability of a valuable resource for the region. Changes would not affect extraction of, nor require use of, any aggregate resources and would not interfere with mining operations or affect land designated as MRZ-2. Reduced Sacramento/Delta water supply would not make land unavailable for mining, affect mining activities, or use large quantities of aggregate resources because the actions would not involve land use changes. Similarly, changes in hydrology and supply would not affect extraction of oil and natural gas resources. There would be no impacts.

9.7.15 Noise

Section 7.15.2, *Environmental Setting*, describes the noise and vibration setting to inform the impact discussion in this section; Section 7.15, Noise; Section 7.21, *Habitat Restoration and Other Ecosystem Projects*; and Section 7.22, *New or Modified Facilities*. Section 7.15 describes the potential impacts that may result from changes in hydrology or changes in water supply under the proposed Plan amendments.

This section describes the potential impacts and mitigation measures for noise and vibration that may result from changes in hydrology or changes in water supply under the proposed VAs. Activities that generate noise or vibration could have a potentially significant impact on noise-sensitive receptors through exceedances of established noise standards, exposure of persons to excessive levels of groundborne vibration or noise, or through substantial increases in ambient noise levels that annoy or disturb people and potentially cause an adverse psychological or physiological effect on human health.

Changes in hydrology would not result in an increased level of noise and vibration, because the associated tributary flows and reservoir levels would not generate a meaningful difference in noise or vibration levels. Changes in water supply could result in reduced Sacramento/Delta water supply primarily for agricultural uses. Reduced agricultural activity due to agricultural land fallowing could result in lowered noise levels in the immediate area relative to existing ambient noise because of the reduced use of farm equipment.

The VA proposal identifies that some flow could be provided through groundwater substitution, including in basins subject to the Sustainable Groundwater Management Act (SGMA) where that is consistent with local management under SGMA. The SacWAM modeling considers that some flow could be provided through groundwater substitution in the American River watershed consistent with the VA documents. Flow in other watersheds could also be provided through groundwater substitution, but sufficient information is not available at this time to include additional groundwater substitution in the modeling. These conditions are evaluated in this section.

Actions associated with changes in water supply would continue the use of existing infrastructure and would not result in new or increased exposure of people residing or working near public or private airports or airstrips to excessive aircraft noise. There would be no impact, and Impact NOI-e and Impact NOI-f are not further evaluated in this section.

9.7.15.1 Impact Analysis

Impact NOI-a: Exposure of persons to or generation of noise levels in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies

Impact NOI-c: A substantial permanent increase in ambient noise levels in the project vicinity above levels existing without the project

Impact NOI-d: A substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project

The analysis of activities that could expose persons to noise or generate substantial permanent, temporary, or periodic increases in ambient noise levels are closely related and therefore are combined and addressed together under Impacts NOI-a, NOI-c, and NOI-d.

Increased groundwater pumping that could occur as a result of groundwater substitution under the proposed VAs could expose noise-sensitive receptors to higher noise levels. Increased groundwater pumping may result in a permanent, temporary, or periodic increase in ambient noise that could be considered substantial, depending on the existing ambient noise, the noise generated by the pump, noise levels of future activities, and the proximity to noise-sensitive land uses. However, noise from these pumps is expected to be minor and intermittent. Furthermore, groundwater pumps often are not close to noise-sensitive (e.g., residential) land uses. Because it is not known where increased pumping will occur, noise impacts associated with noise levels in excess of established local general plan or noise ordinance standards, a substantial permanent increase in ambient noise levels in the project vicinity above existing levels, and a substantial temporary or periodic increase in ambient noise levels in the project vicinity above existing levels could occur, and the impacts would be potentially significant.

Entities or agencies that increase groundwater pumping should implement Mitigation Measure MM-NOI-a,c,d to reduce potential operations noise impacts on noise-sensitive land uses. Implementation of this mitigation measure could reduce noise impacts through compliance with applicable regulations and incorporation of noise-reduction measures such that operational noise does not exceed applicable local noise standards or limits. Unless and until Mitigation Measure MM-NOI-a,c,d is implemented, the identified noise impacts remain potentially significant.

Impact NOI-b: Exposure of persons to or generation of excessive groundborne vibration or groundborne noise levels

Increased groundwater pumping could generate additional intermittent and localized vibration effects when the well is pumping; however, this additional level of vibration would likely be imperceptible at distances beyond 25 feet. Further, groundwater pumps often are not located near noise-sensitive (e.g., residential) land uses. Municipal groundwater wells often are enclosed in some type of small low-profile structure or fence that reduces the operating noise of the well. Therefore, the likelihood for vibration from the increased operation of groundwater pumps being perceptible is low. The impact would be less than significant.

9.7.16 Population and Housing

Activities that would have an impact on population and housing would be development or infrastructure projects that could induce substantial population growth in an area or activities that could result in displacement of substantial numbers of people or existing housing, necessitating the construction of replacement housing elsewhere. Changes in hydrology and changes in water supply under the proposed VAs would not result in activities that would affect population and housing. There would be no impacts.

9.7.17 Public Services

Activities that lead to impacts on public services generally are associated with an increase in population and changes in land use. As a location's population increases, the need for additional or new public services and public service facilities generally increases (i.e., police or fire protection, search and rescue, emergency medical services, schools, libraries, or city and county parks). The actions associated with changes in hydrology or changes in water supply under the proposed VAs would not increase demand on the public services and therefore, would have no potential impacts related to these public services. There would be no impacts.

9.7.18 Recreation

Section 7.18.2, *Environmental Setting*, describes the environmental setting to inform the impact discussion in this section; Section 7.18, Recreation; Section 7.21, *Habitat Restoration and Other Ecosystem Projects*; and Section 7.22, *New or Modified Facilities*. Section 7.18 describes the potential impacts that may result from changes in hydrology or changes in water supply under the proposed Plan amendments.

This section describes the potential impacts to recreation that may result from changes in hydrology or changes in water supply under the proposed VAs. The focus is on potential impacts on water-dependent and water-enhanced recreational activities.

9.7.18.1 Impact Analysis

Impact REC-a: Increase the use of existing neighborhood and regional parks or other recreational facilities such that substantial physical deterioration of the facility would occur or be accelerated

Changes in Hydrology

Implementation of the proposed VAs could result in changes in hydrology, including changes in streamflow and reservoir levels in the VA tributaries compared to baseline. Increases in streamflows on VA tributaries would generally occur during the spring months, although increases in streamflows could also occur at other times for some VA tributaries. The proposed VAs could also result in reductions in streamflows at times, generally during the fall or early winter months. Overall, reservoir levels in VA tributaries would be similar to baseline but could increase at times and decrease at times. If the VAs were adopted, actual operation could vary to some degree from modeled outcomes and there could be additional changes in streamflows and reservoir levels beyond the modeled changes. For example, the VA tributary inflow analyses do not assume any additional inflows from unspecified water purchases given the unknown origin of these purchases, but could result in additional changes in streamflow and reservoir levels beyond the modeled changes on VA tributaries or on other tributaries in the Sacramento/Delta watershed. These changes would be much smaller than the changes that would occur under the proposed Plan amendments (discussed in Chapter 6, *Changes in Hydrology and Water Supply*, and Chapter 7, *Environmental Analysis*).

Changes in flows would vary by tributary, although flows would remain within the historical range of flows observed both within the rivers and interior to the Delta. The magnitude of changes in streamflow would be unlikely to significantly affect boating, swimming or wading activities. Similarly, while lower water levels at any of the reservoirs could affect the recreational facilities and activities by precluding or limiting lake access from existing facilities such as marinas, boat launch ramps, and beaches, users would be unlikely to shift to other locations in sufficient numbers to substantially degrade those facilities. Impacts would be less than significant.

As discussed in Section 7.12.1, *Surface Water*, and 9.7.12.1, *Surface Water*, increased harmful algal blooms could occur where there would be a substantial reduction in storage in reservoirs. HABs can pose a potential health risk to humans and animals through the release of cyanotoxins. Excessive growth of HABs, as can occur in surface waterbodies with ample nutrients, low flow, and elevated water temperatures, can limit recreational activities in those waterbodies due to concerns about public exposure to cyanotoxins. Under the proposed VAs, reservoir levels would generally be similar to baseline, but could increase slightly at times and decrease slightly at times. However, actual operation could vary to some degree from modeled outcomes. In addition, it is possible that some upstream reservoirs could be reoperated on some tributaries, but these effects were not modeled. Lower reservoir levels could increase the production of HABs. While changes would generally be expected to be smaller compared to the changes that would occur under the proposed Plan amendments, these changes could affect HAB production in reservoirs. An incremental increase in potential HABs from changes in reservoir levels could cause closures to recreation in some waterbodies, but the potential increased frequency of closures is not expected to result in a substantial number of recreationists moving to alternate recreational locations to the extent that it would physically deteriorate those alternate locations. Even if some recreational users moved to other reservoirs at certain times and during certain years, based on the number of other available recreational areas and the temporary nature of closures, this shift would not likely be in sufficient numbers of recreationists or an extended period of time to result in substantial deterioration of recreational facilities at alternate locations. Therefore, the impact would be less than significant.

HABs and the proliferation of invasive aquatic plants affect surface waterbodies in the Delta under existing conditions. As discussed under Section 9.7.12.1, the proposed VAs could result in changes in interior Delta flows, including possible increases in travel time through channels in the interior Delta at times. However, given the relatively small magnitude of these potential effects compared to total Delta exports, such increases would likely have little effect on the probability of HAB formation and bloom size and would not significantly affect recreational opportunities in the Delta. Impacts would be less than significant.

As discussed in Section 7.18, *Recreation*, reservoirs provide sportfishing for cold water species such as salmon and trout (frequently maintained by stocking) and warm water species such as bass, crappie, and sunfish. The proposed VAs could result in changes in reservoir levels, but these changes would not be expected to reduce fishing opportunities at these reservoirs: trout populations would be maintained due to stocking, bass would move into deeper water, and sunfish are tolerant of many habitats and conditions. Anglers likely would not need to seek opportunities elsewhere because of changes in reservoir levels. Although occasional drawdowns could affect sportfish populations, based on the temporary nature of the drawdowns, these drawdowns are not expected to change sportfish populations enough to result in a substantial number of anglers moving to other reservoirs. This impact would be less than significant.

Changes in Water Supply

The proposed VAs would result in an average annual reduction in Sacramento/Delta surface water supply for the entire study area. The Sacramento/Delta water supply reductions would primarily affect agricultural uses. The SacWAM results for the Sacramento/Delta watershed show that there would be only a very small reduction in water supply for municipal use, and there would be no expected change in water supply for wildlife refuge uses.

The proposed VAs would not be expected to affect water supplies and associated recreational opportunities at wildlife refuges. Fallowing and idling agricultural lands could reduce rice production that supports greater sandhill crane populations dependent on rice fields; however, based on the limited amount of potentially affected crop acreage, this change would not significantly affect opportunities for wildlife viewing. Overall, the impact of the proposed VAs on opportunities for wildlife viewing would be less than significant.

Sacramento/Delta water supply reductions would be based on voluntary measures that would be largely or entirely from agricultural supplies, reservoir reoperation, or based on groundwater substitution. Any reduction of Sacramento/Delta supply for municipal use would be small and would not be expected to affect municipal recreational facilities such as swimming pools, municipal parks, and playfields. There would be no impact.

Impact REC-b: Include recreational facilities or require the construction or expansion of recreational facilities that might have an adverse physical effect on the environment

As discussed above, changes in hydrology and supply under the proposed VAs would not significantly impact recreational facilities or require construction or expansion of recreational facilities. There would be no impact.

9.7.19 Transportation and Traffic

Section 7.19.2, *Environmental Setting*, describes the transportation/traffic setting to inform the impact discussion in this section; Section 7.19, *Transportation/Traffic*; Section 7.21, *Habitat Restoration and Other Ecosystem Projects*; and Section 7.22, *New or Modified Facilities*. Section 7.21 and Section 7.22 describe and analyze potential transportation impacts from various actions that involve construction. Section 7.19 describes the potential impacts that may result from changes in hydrology or changes in water supply under the proposed Plan amendments.

This section describes the potential impacts on transportation/traffic that may result from changes in hydrology or changes in water supply under the proposed VAs. Activities that could affect transportation/traffic are generally associated with new construction or operation of facilities that require use by people (e.g., commercial buildings, residential housing), which could increase use of transportation infrastructure or services. The actions associated with changes in hydrology and changes in water supply would not involve new construction or operation of facilities inhabited or used by people. These actions would not generate population growth or economic activity that would increase traffic or result in conditions that would conflict with an applicable congestion management plan, change air traffic patterns, or substantially increase a hazard due to design features. There would be no impact. Accordingly, these topics (Impacts TRA-b, TRA-c, and TRA-d) are not evaluated further in this section.

9.7.19.1 Impact Analysis

Impact TRA-a: Conflict with an applicable plan, ordinance, or policy establishing measures of effectiveness for the performance of the circulation system, taking into account all modes of transportation, including mass transit and non-motorized travel and relevant components of the circulation system, including, but not limited to intersections, streets, highways and freeways, pedestrian and bicycle paths, and mass transit

Impact TRA-f: Conflict with adopted policies, plans, or programs regarding public transit, bicycle, or pedestrian facilities, or otherwise decrease the performance or safety of such facilities

The analyses of activities that could conflict with an applicable transportation plan, ordinance, or policy or an adopted policy, plan, or program regarding public transit, bicycle, or pedestrian facilities are closely related; therefore, Impacts TRA-a and TRA-f are combined and addressed together.

The proposed VAs could result in changes in hydrology, including changes in streamflow and reservoir levels in tributaries compared to baseline. The proposed VAs would not result in changes in the flows into the Yolo Bypass. However, the proposed VAs include modifications to Tisdale Weir that would increase the flows into the Sutter Bypass at the Tisdale Weir in December through March by more than 100 TAF/yr on average.

The proposed VAs could result in changes in reservoir levels at times in some locations. These changes would generally be expected to be small. Small changes in reservoir levels would not affect water navigation because the presence of reservoirs generally impedes navigation and boating within reservoirs is used for recreational purposes and not typically for transportation.

Roads and pedestrian and bicycle paths access close to waterways on the landward side of levees and on top of levees would not be more susceptible to flooding under the proposed VAs. Increased inundation of floodplains bounded by levees, including bypasses would not likely affect transportation corridors, including roads and pedestrian and bicycles paths. The impact would be less than significant.

The proposed VAs could result in changes in Sacramento/Delta surface water supplies, both within and outside of the Sacramento/Delta watershed. Overall, implementation of the proposed VAs would result in an average annual reduction in Sacramento/Delta surface water supply for the entire study area, primarily from agricultural use. Most of the reductions in Sacramento/Delta surface water supplies would occur within the Sacramento/Delta watershed. Changes in water supply and the resultant changes in agricultural land use or fallowing that affect agricultural production could lead to changes in agricultural product-related transportation. However, determining the effect of these changes is speculative and would depend on farmers' responses to reduction in water supply and consumers' responses to reduction in California agricultural product supply. It is unlikely that a reduction in California agricultural production would cause a substantial change in transportation such that there would be any impact on the circulation system, transit operations, or use of pedestrian or bicycle paths. This impact would be less than significant.

Impact TRA-e: Result in inadequate emergency access

Changes in hydrology and changes in water supply under the proposed VAs would not require new construction or the operation of facilities that would require impediments to roadways or transportation systems and, therefore, would not result in impacts on transportation systems or traffic conditions that would result in inadequate emergency access. As noted under Impacts TRA-a and TRA-f, a few transportation corridors within floodplains bounded by levees could be subject to increased inundation. These corridors are known to be subject to inundation and are secondary to other transportation corridors. As a result, emergency services authorities have predetermined alternate routes for emergency access within these corridors. There would be no impact.

9.7.20 Utilities and Service Systems

Section 7.20.2, *Environmental Setting*, describes the environmental setting to inform the impact discussion in this section; Section 7.20, *Utilities and Service Systems*; Section 7.21, *Habitat Restoration and Other Ecosystem Projects*; and Section 7.22, *New or Modified Facilities*. Section 7.20 describes the potential impacts that may result from changes in hydrology or changes in water supply under the proposed Plan amendments.

This section describes the potential impacts to utilities and service systems that may result from changes in hydrology or changes in water supply under the proposed VAs.

Changes in hydrology and supply associated with the proposed VAs would not involve construction or cause changes in population or land use that would result in an increased demand for utilities or service systems.

Changes in hydrology and water supply would not increase storm water runoff from developed areas and, therefore, would not necessitate the construction of new or expanded storm water drainage facilities. There would be no storm water drainage impact due to these mechanisms and Impact UT-c is not further evaluated in this section.

For the same reason, changes in hydrology and supply would not generate wastewater or require a determination by a wastewater treatment provider that it has adequate capacity to serve the project (Impact UT-e). There would be no impact and this topic is not further evaluated further in this section.

9.7.20.1 Impact Analysis

Impact UT-a: Exceed wastewater treatment requirements of the applicable Regional Water Quality Control Board

Changes in streamflow under the proposed VAs would be smaller compared to the proposed Plan amendments and would be unlikely to affect instream chemical constituent concentrations due to changes in instream dilution, potentially affecting the ability of a waste discharger or drinking water provider to comply with waste discharge requirements and/or water quality standards. Generally, these utilities are highly regulated and are unlikely to violate waste discharge requirements and drinking water quality standards.

Sacramento/Delta water supply reductions under the proposed VAs would be based on voluntary measures that would be largely or entirely from agricultural supplies or based on groundwater substitution. The SacWAM results for the Sacramento/Delta watershed show that there would likely be only a very small reduction in water supply for municipal use. Reductions in water supply to municipalities under the proposed VAs would not be large enough to potentially alter the flow and chemical constituent concentrations of WWTP influent and subsequently affect WWTP effluent discharges to receiving waters in a manner that affects water quality. Changes in hydrology and supply would not result in exceedances of wastewater treatment requirements. There would be no impact.

Impact UT-b: Require or result in the construction of new water or wastewater treatment facilities or expansion of existing facilities, the construction of which could cause significant environmental effects

The proposed VAs would not result in exceedances of drinking water standards and wastewater discharge water quality objectives. Accordingly, the proposed VAs would not result in construction to modify or expand existing treatment facilities in order to avoid exceedances and come into or continue compliance with treatment requirements. There would be no impact.

Impact UT-d: Have sufficient water supplies available to serve the project from existing entitlements and resources, or are new or expanded entitlements needed

Implementation of the proposed VAs would result in an average annual reduction in Sacramento/Delta surface water supply to the entire study area. Most of the reductions in Sacramento/Delta surface water supplies would occur within the Sacramento/Delta watershed. The SacWAM results for the Sacramento/Delta watershed also show that Sacramento/Delta water supply reductions would primarily affect agricultural uses. The SacWAM results for the Sacramento/Delta watershed show that there could be a very small reduction in water supply for municipal use.

Overall, the reductions in Sacramento/Delta supply under the proposed VAs would be smaller compared to the proposed Plan amendments. Sacramento/Delta water supply reductions would be based on voluntary measures that would be largely or entirely from agricultural supplies, reservoir reoperation, or based on groundwater substitution. Any water supply reductions to municipal water users would be small and would not result in the need to obtain new water supplies. Impacts of reduced Sacramento/Delta supplies to municipal water users would be less than significant.

As discussed in Section 9.7.12, *Hydrology and Water Quality*, lower groundwater levels could occur in localized areas if flows are provided through groundwater substitution or from reduced incidental recharge from the application of applied irrigation water. While the magnitude of impacts would be less under the proposed VAs compared to the proposed Plan amendments, lower groundwater levels could potentially impact communities in the Sacramento River watershed, Delta eastside tributaries, and San Joaquin Valley regions that rely on groundwater as their primary water supply source. As discussed in Section 7.20, *Utilities and Service Systems*, communities that rely on groundwater for drinking water supplies in the San Joaquin Valley region have been facing challenges from declining groundwater levels under existing conditions, with critical shortages or dry wells occurring in some areas during prolonged drought periods. DACs that rely solely on groundwater often disproportionately experience impacts on their drinking water supplies. Their groundwater wells are often shallow and thus are more susceptible to water quality issues or the risk of going dry if the groundwater level is lowered. The frequency and severity of these challenges could increase in localized areas as a result of the proposed VAs. Impacts could be potentially significant.

SGMA implementation may address some of the supply issues faced by DACs, depending on how groundwater sustainability plans are developed and how groundwater sustainability agencies consider impacts on DAC water users from local groundwater management actions.

The State Water Board is committed to the human right to water and to exercising its authority to ensure supplies for all users. Mitigation Measures MM-UT-d: 2,3, 5 and 6 (incorporating MM-GW-b, 1-6) and MM-UT-a could avoid or reduce impacts on municipal supplies that could occur as a result of the proposed VAs. Water users can and should diversify their water supply portfolios to the extent possible, in an environmentally responsible manner and in accordance with the law. The State Water Board will continue to work with municipal suppliers to develop and implement programs to increase water use efficiency and conservation in order to maximize the beneficial use of Sacramento/Delta supplies, including through conditions on discretionary approvals for funding and other approvals as appropriate. Implementation of groundwater mitigation can reduce municipal impacts associated with lower groundwater levels. Additional mitigation measures below may provide assistance to communities with limited supplies or impaired quality. These programs may not reach every community and may not be sufficient to resolve all possible concerns. Unless and until the mitigation is fully implemented, the impacts remain potentially significant.

Impact UT-f: Be served by a landfill with sufficient permitted capacity to accommodate the project’s solid waste disposal needs

Impact UT-g: Comply with federal, state, and local statutes and regulations related to solid waste

The analysis of landfill capacity and compliance with solid waste regulations are closely related and are therefore combined and addressed together under Impact UT-f and UT-g.

Changes in hydrology under the proposed VAs would not generate solid waste and would not contribute to landfills. There are no federal, state, or local statutes or regulations related to solid waste that are applicable to these changes in flows and reservoir levels.

Changes to agricultural crop type or production resulting from changes in water supply could generate solid waste. If reduced irrigation water supply leads to the conversion of orchards to other crop types, the trees would be removed from the field and may be turned into wood chips, which may be used as mulch or compost or disposed of in a landfill. However, it is unlikely that agricultural land use changes would happen at such a scale that additional landfill capacity would be required. The proposed VAs would present no obstacle to agricultural producer’s continued operation in compliance with federal, state, and local regulations related to solid waste. There would be no impact.

9.7.21 Cumulative Impacts, Growth-Inducing Effects, and Significant Irreversible Environmental Changes

9.7.21.1 Cumulative Impacts

Section 7.23, *Cumulative Impact Analysis, Growth-Inducing Impacts, and Significant Irreversible Environmental Changes*, describes the cumulative impacts associated with the proposed Plan amendments and Low Flow and High Flow Alternatives together with other projects (and programs) that could cause related impacts. Due to the size and complexity of Sacramento/Delta water supply and use, the environmental analyses are necessarily broad to cover the wide range of foreseeable compliance measures and responses that may result from implementation of the project.

As discussed in Section 9.3, *Description of the Proposed Voluntary Agreements*, the proposed VAs include a combination of flow and physical habitat restoration measures on a portion of the Sacramento/Delta tributaries that would be implemented over 8 years (with the possibility of extension), including varying amounts of increased flows, depending on water year type, and non-flow habitat restoration actions targeted at improving spawning and rearing capacity for juvenile salmonids, estuarine species, and other native fish and wildlife. The VA flows are intended to be additive to the Delta outflows required by D-1641 and resulting from the 2019 Biological Opinions (though the VAs acknowledge that the BiOps may change).

Potential environmental impacts of the proposed VAs are discussed above in 9.7.3 – 9.7.20 and are detailed comprehensively in Table 9.7-13 identifies the potentially significant and less-than-significant environmental impacts of changes in hydrology and water supply under the proposed VAs on various environmental resource areas. Table 9.7-13 also identifies mitigation measures that could reduce potentially significant impacts of the proposed VAs. Unless and until the mitigation is fully implemented, the impacts remain potentially significant.

Due to the significant overlap of actions under the proposed VAs and the proposed Plan amendments, this cumulative impact analysis relies extensively on the analysis in Section 7.23, *Cumulative Impact Analysis, Growth-Inducing Impacts, and Significant Irreversible Environmental Changes,* and will focus on issues that require additional evaluation and any differences in impact conclusions.

The cumulative analyses of reasonably foreseeable methods of compliance and response actions are organized into the following categories:

- Change in Hydrology (changes in streamflows and reservoir levels).
- Changes in Water Supply (e.g., reduced Sacramento/Delta supply for agricultural, municipal, and wildlife refuge use, increased groundwater pumping, other water management actions that do not involve construction [groundwater storage and recovery, water transfers, water recycling, and water conservation]).
- Habitat restoration and other complementary ecosystem actions (described in Section 7.21, *Habitat Restoration and Other Ecosystem Projects*).
- New or modified facilities that involve construction (e.g., new or modified dams/reservoirs and points of diversion; groundwater wells and groundwater storage and recovery projects; new or modified drinking water treatment plants, including desalination plants and wastewater treatment plants) (described in Section 7.22, *New or Modified Facilities*).

The cumulative project list in Section 7.23.1.2 includes relevant projects, programs, and categories of projects (referred to as projects); individual projects are detailed in Table 7.23-1. Project categories (e.g., FERC projects) group together similar types of projects that may interact with the proposed Plan amendments in a way that could result in cumulatively significant impacts. In addition, individual projects are included and evaluated that do not fit into an obvious category or have particular relevance and interaction with the proposed Plan amendments (e.g., the Sustainable Groundwater Management Act [SGMA]). Development of the list focused on projects that involve water supplies, actions in the Delta including restoration, projects that could affect agriculture or municipal water supply, and water quality. The list also focused on projects or project classes with similar goals, or that propose or have taken similar actions to achieve their goals, although some projects may have different goals for the same resources evaluated for the proposed Plan amendments.

There are some redundancies between the projects included on the cumulative project list and those that are discussed in the existing environmental analyses, including in Sections 7.21, *Habitat Restoration and Other Ecosystem Projects*, and 7.22, *New or Modified Facilities*. Many of the projects or types of projects in the cumulative project list include reasonably foreseeable compliance methods and response actions to the proposed Plan amendments but also are considered as past, present, and probable future projects that need to be reviewed cumulatively.

The analysis in Section 7.23.1.3 describes and analyzes the potential cumulative impacts of changes in hydrology and water supply as appropriate for each resource area with the projects and project categories detailed in Table 7.23-1. In addition, impacts from construction and operation of habitat and other ecosystem projects and new or modified facilities evaluated in Sections 7.21, *Habitat Restoration and Other Ecosystem Projects,* and 7.22, *New or Modified Facilities*, are described and analyzed in combination with the projects and project categories detailed in Table 7.23-1.

Changes in Hydrology

Generally, the changes in hydrology under the proposed VAs are smaller than the changes in hydrology that would occur under the proposed Plan amendments evaluated in Chapter 7, *Environmental Analysis*. Overall, the SacWAM modeling and postprocessing results show changes in flows and minor changes in reservoir storage on VA tributaries. Priority years for the proposed VAs include above normal, below normal, and dry years, but there are changes in hydrology in wet and critical year types as well. Changes in hydrology under the proposed VAs could result in potentially significant impacts to the following resource areas: aesthetics, aquatic biological resources, cultural resources, and hydrology and water quality. Impacts from changes in hydrology under the proposed VA could interact with the projects listed in Table 7.23-1 resulting in cumulative impacts similar to those described in Section 7.23, *Cumulative Impact Analysis, Growth-Inducing Impacts, and Significant Irreversible Environmental Changes*, in each applicable resource section, although impacts would be more limited in magnitude and geographic scope than the cumulative impacts related to the proposed Plan Amendments.

As described in Section 9.7.6.2, *Aquatic Biological Resources*, there could be some increases in exports that could result from BiOp and ITP differences between the baseline for this draft Staff Report and the 2019 BiOps condition upon which the VA flows are intended to be added. Those increases in exports would be offset by the VA flow assets to some degree, but the SacWAM modeling indicates that there may still be some overall increases in exports. However, any increases in exports and associated changes in interior Delta flows under the proposed VAs relative to baseline would be the result of differences in the assumed BiOp and ITP constraints under the VAs and baseline and not as a result of the addition of proposed VAs to the Bay-Delta Plan since adding the VAs to the Bay-Delta Plan will not change the existing export or other interior Delta flow constraints in the plan. Flows from the proposed VAs are added to the 2019 BiOps condition, which differs from baseline in that it does not include San Joaquin inflow to export constraints for either the SWP or CVP that are included in the 2020 ITP, and were included in the 2009 NMFS BiOp to limit exports as a function of San Joaquin River flows. By contrast, the baseline incorporates the San Joaquin inflow to export constraints as formulated in the 2020 ITP but applied to both SWP and CVP exports. Due to these differences in the inflow to export constraints, the 2019 BiOps condition upon which the VA scenario is built results in higher south of Delta exports during April and May compared to baseline (Figure 9.3-2) that can result in increases in net negative flows in Old and Middle Rivers and decreases in QWEST. Although the proposed VAs would increase Delta inflows and reduce exports through flow commitments that are additive to existing D-1641 requirements, changes to the BiOps assumed under the VA accounting may result in overall increases in exports to some degree.

The inflow to export constraints in the ITP and BiOps may change with the ongoing federal and state Endangered Species Act reconsultation processes for long-term operations of the SWP and CVP. The reconsultation process is expected to result in updated BiOps and an updated ITP that will avoid jeopardy to listed species. However, it is possible that there would be other impacts to non-listed and listed species depending on the outcomes. As discussed in Section 9.7.6.2, *Aquatic Biological Resources*, while impacts to native fish species are not likely, there is still a possibility of potentially significant cumulative impacts to some fish species during the spring of some years from increased south of Delta exports that increase the frequency of reverse flows in Old and Middle Rivers and reduce QWEST flows. Therefore, consistent with the conservative approach used in the rest of the draft Staff Report, it is assumed that the proposed VAs added to the 2019 BiOps condition may cause potentially significant cumulative impacts to native fish species.

Chapter 3, *Scientific Knowledge to Inform Fish and Wildlife Flow Recommendation*s documents the effects of interior Delta flow patterns on native fish species, which are briefly summarized here. Entrainment of fish into the CVP and SWP pumping facilities would be expected to increase with net OMR reverse flows between -2,500 and -5,000 cfs and to be substantial at flows more negative than -5,000 cfs. Outmigrating juvenile salmonids are at risk of straying into the interior Delta where they experience higher predation pressure and are also more likely to be entrained into the SWP and CVP pumping facilities with higher OMR reverse flows. Net reverse flows in the San Joaquin River at Jersey Point (QWEST) could also potentially decrease the survival of fall-run Chinook salmon smolts migrating through the lower San Joaquin River. In addition, Delta smelt may be entrained by OMR reverse flows when adults migrate into the Delta in winter and early spring to spawn and again when the larvae migrate back downstream to the low salinity zone in late spring. Longfin smelt juveniles are also at risk of entrainment in spring and their entrainment risk is expected to increase with flows more negative than -1,500 cfs. Green and white sturgeon have both been salvaged at SWP and CVP facilities and are vulnerable to entrainment by exports year-round. There is also risk of entrainment of Sacramento splittail into the export facilities in the spring during upstream spawning migration.

As mentioned above, the ongoing reconsultation process for the SWP and CVP may reduce cumulative impacts of increased exports on interior Delta flows. In addition, the proposed VAs include other measures that may mitigate these impacts, including flexible deployment of tributary flows that could increase Delta inflows and unspecified water purchases that could come from export reductions during the spring (see Section 9.5.3.9, *Delta Inflows, Exports, Interior Delta Flows, and Delta Outflow Results*). These possible export reductions are reflected in the VA High Export Cuts scenario and could have similar effects on exports and interior Delta flows as the I:E constraint included in the 2009 NMFS BiOp. If the VAs' unspecified water purchases come from reduced exports, as shown in the VA High Export Cuts scenario, differences in exports and interior Delta flows between the proposed VAs and the baseline are expected to be relatively small. In addition, the VAs include non-flow habitat restoration assets that could potentially help mitigate these cumulative impacts. Habitat restoration in the Delta may reduce the potential impacts associated with net negative flows in the interior Delta by improving other environmental conditions that could support populations of native estuarine and anadromous fish species, including through potentially increasing physical habitat, improving water quality, and increasing food supply (SBR Supplement p. 6-27). In addition, as described in Section 9.5, *Changes in Hydrology and Water Supply*, it is possible that actual increases in exports under the VAs would be lower than assumed in the SacWAM modeling for this draft Staff Report. The VA parties are developing flow accounting that should help to clarify whether there may be overall increases in exports and associated negative Old and Middle River flows that could result in a change to this cumulative impact determination in the final Staff Report.

Changes in Supply

Generally, the changes in Sacramento/Delta water supply under the proposed VAs would be less than the changes that would occur under the proposed Plan amendments. Under the proposed VAs, there would be a reduction in average annual Sacramento/Delta surface water supply for the entire study area, with most of the reductions occurring for users in the Sacramento/Delta watershed. These reductions would be based on voluntary measures that would primarily affect agricultural uses or be based on groundwater substitution, with only minor reductions in water supply anticipated for municipal uses and no anticipated change in water supply for wildlife refuges. The VA proposal identifies that some flow could be provided through groundwater substitution, including in the American River watershed consistent with the VA documents. Flow in other watersheds could also be provided through groundwater substitution. Increased groundwater pumping and reduced incidental recharge from applied irrigation water could result in reduced groundwater levels. Changes in supply (including groundwater substitution) under the proposed VAs could result in potentially significant impacts to the follow resource areas: aesthetics, agriculture and forest resources, air quality, biological resources, geology and soils, greenhouse gas emissions, hydrology and water quality, noise, and utilities and service systems. Impacts from changes in supply under the proposed VA could interact with the projects listed in Table 7.23-1 resulting in cumulative impacts similar to those analyzed in Section 7.23, *Cumulative Impact Analysis, Growth-Inducing Impacts, and Significant Irreversible Environmental Changes*, in each resource section as applicable, although impacts under the proposed VAs would be more limited in magnitude and geographic scope. Mitigation measures to avoid or reduce impacts similar to the mitigation measures found in Table 9.7-13 should be considered for the referenced cumulative projects as well as the proposed VAs.

Changes in supply also include other water management actions that entities may take to offset reductions in Sacramento/Delta surface water supply. These other water management actions include groundwater storage and recovery, water transfers, water recycling, and agricultural and municipal water conservation, that are evaluated in Sections 7.3 through 7.20 for the proposed Plan amendments. Impacts from other water management actions in response to the proposed VAs could interact with the projects listed in Table 7.23-1 resulting in cumulative impacts similar to those analyzed in Section 7.23, *Cumulative Impact Analysis, Growth-Inducing Impacts, and Significant Irreversible Environmental Changes*, in each resource section as applicable, although impacts under the proposed VAs would be more limited in magnitude and geographic scope. Mitigation measures to avoid or reduce impacts similar to the mitigation measures found in the Table 7.1-2 should be considered for the referenced cumulative projects as well as the proposed VAs.

Non-Flow Measures

The other two main categories of reasonably foreseeable methods of compliance and response actions are physical habitat restoration and other complementary ecosystem projects, and new and modified facilities that involve construction. The impacts of physical habitat restoration, including physical habitat restoration measures similar to those included in the proposed VAs, and new facilities and modified facilities, including conjunctive use projects similar to those identified in the VA Term Sheet as New Water Projects, are evaluated in Section 7.21, *Habitat Restoration and Other Ecosystem Projects*, and Section 7.22, *New or Modified Facilities*, respectively. These impacts would be similar for habitat restoration and other ecosystem projects, and likely less for new or modified facilities under the proposed VAs than the proposed Plan amendments, although the impact mechanisms and significance determinations would be similar. Impacts from physical habitat restoration and new and modified facilities under the proposed VAs could interact with the projects listed in Table 7.23-1 resulting in cumulative impacts similar to those analyzed in Section 7.23, *Cumulative Impact Analysis, Growth-Inducing Impacts, and Significant Irreversible Environmental Changes*, in each resource section as applicable, although impacts under the proposed VAs could be more limited in magnitude and geographic scope. Mitigation measures to avoid or reduce impacts similar to the mitigation measures found in the Tables 7.21-1 and 7.22-1 should be considered for the referenced cumulative projects as well as the proposed VAs.

9.7.21.2 Growth-Inducing Effects

Similar to the proposed Plan amendments, the proposed VAs would not directly induce economic population or housing growth. Changes in hydrology, including changes in streamflows and reservoir levels, under the proposed VAs would not result in the provision of any new housing, businesses, or infrastructure to support or induce economic, population, or housing growth. Therefore, changes in hydrology would not result in indirect growth inducement or remove any obstacles to growth.

Implementation of the proposed VAs would result in changes in Sacramento/Delta water supply that would primarily affect agricultural uses. These changes would be less compared to the proposed Plan amendments. Reductions in Sacramento/Delta water supply to municipal uses would be small and would not directly or indirectly encourage growth. Reductions in Sacramento/Delta water supply to agricultural uses could result in some agricultural lands being taken out of production, and it is possible that such lands could then be converted to housing or other economic uses. However, conversion of agricultural lands to nonagricultural uses are governed by many factors, including the proximity of land to a developed area and other factors that affect its potential profitability as housing development. Local general plan and zoning patterns make it probable that a new housing use would require discretionary decisions by local agencies, such as general plan amendments, rezoning, subdivisions, or conditional use permits. Given the uncertainty and individual and governmental decisions involved and given that the proposed VAs would be based on voluntary measures, it is unlikely that the proposed VAs would lead agricultural lands to be converted to housing or other economic uses that would indirectly induce growth.

Groundwater substitution would not directly or indirectly affect growth as the increased pumping would replace the Sacramento/Delta supply. Therefore, a reduction in Sacramento/Delta surface water supply and the subsequent changes in groundwater pumping would not result in growth-inducing effects.

Use of other water management actions in response to reduced Sacramento/Delta supply would likely result in an increase in the reliability of users' existing water supply portfolios rather than an overall increase in water supply. These actions therefore would not result in growth-inducing effects. The proposed VAs include non-flow habitat measures. Habitat restoration and other ecosystem projects would not result in growth-inducing effects. Habitat restoration and other ecosystem projects could result in short-term employment opportunities for construction and operation of these projects; however, the work would be largely temporary and seasonal. Project features would not lead to population growth or remove potential obstacles to future development. Moreover, habitat restoration or other ecosystem projects would not result in additional infrastructure that would create new sources of water that would foster population or housing growth or remove obstacles to such growth.

The proposed VAs include conjunctive use projects identified in the VA Term Sheet as New Water Projects, and could also reduce Sacramento/Delta water supplies. New or modified facilities could be developed in response to reduced Sacramento/Delta water supplies. New or modified facilities do not involve construction of new homes or businesses, extension of roads, other infrastructure, or other actions that may directly or indirectly induce substantial population growth in an area. Further, these projects would not develop amenities (e.g., malls, amusement parks, hotels) that would attract a substantial number of people to an area.

Some new or modified facilities could result in increased water supply to specific areas that could encourage some growth in some locations. However, this response would not significantly induce population growth statewide. As explained in more detail in Section 7.23.2, water availability is not the limiting factor preventing or slowing population growth in California, with the exception of a few, mostly coastal, areas that have imposed development or water connection moratoria because of limited municipal water supply. Any additional water supply resulting from new or modified facilities is more likely to result in an increase in the reliability of existing water supply portfolios than an increase in water supply that would foster growth. Construction of new or modified facilities would result in employment opportunities for construction and operation of the facilities, but these employment opportunities would be unlikely to significantly induce population growth. Overall, although new or modified facilities could encourage some growth in some locations, they would not cause substantial population growth.

9.7.21.3 Significant Irreversible Environmental Changes

Section 7.23.3 identifies the significant irreversible changes that could result directly from implementing the proposed Plan amendments and indirectly through potential related habitat restoration projects and/or new or modified facilities. Similar to the significant and irreversible environmental changes identified in Section 7.23.3.1, the proposed VAs could lead to conditions or other actions that (1) could result in the permanent loss or damage of resources for future or alternative purposes; or (2) could use natural resources associated with agriculture, cultural resources, energy, geology and soils, and groundwater resources such that they may not be recovered or recycled or may be used or affected such that they cannot be restored or returned to their original condition.

The level of loss or consumption of the resource would be incrementally less under the proposed VAs compared to the proposed Plan amendments as identified in more detail above. Changes in hydrology and water supply under the proposed VAs would generally be smaller and closer to baseline compared to the changes that would occur under the proposed Plan amendments. Similarly, impacts of construction from habitat restoration and other ecosystem projects under the VAs would be similar to the proposed Plan amendments and new or modified facilities would be less under the proposed VAs than the proposed Plan amendments

9.7.22 Impact Summary

This section provides a summary of the potentially significant impacts, less than significant impacts, and beneficial environmental effects of the proposed VAs. Table 9.7-13 identifies impacts from changes in hydrology and supply under the proposed VAs. Many other identified potentially significant environmental impacts could be reduced to less-than-significant levels with mitigation incorporated; however, due to the large scope of the project and wide range of possible response actions, sufficient information is not available to conclude with certainty that the mitigation measures would reduce all impacts to less-than-significant levels in all circumstances. Some mitigation activities are within the State Water Board's jurisdiction. However, other mitigation measures are largely within the jurisdiction and control of other agencies or depend on how water users respond to the project. Accordingly, the State Water Board cannot guarantee that measures will always be adopted or applied fully to mitigate potentially significant impacts. Therefore, unless and until the mitigation is fully implemented, the impacts remain potentially significant.

In addition, the environmental analysis often considers a range of potential outcomes, including the most conservative for evaluating potentially significant effects on the physical environment. In many cases, there may be no impact. For each resource area, the analysis assumes a worst-case scenario. Some impacts are inversely proportional, and it is not possible for a worst-case scenario to occur for every environmental resource area.

It is important that the CEQA impact conclusions be understood in the context of the nature of the proposed project, which is intended to be a restoration action. The Porter-Cologne Act (Wat. Code, § 13000 et seq.) is California's comprehensive water quality control statue, which implements portions of the federal Clean Water Act. The primary purpose of the federal Clean Water Act is to restore and maintain the chemical, physical, and biological integrity of the Nation's waters (Clean Water Act § 101(a).) Water quality objectives are established to ensure the reasonable protection of beneficial uses and the prevention of nuisance, in consideration of various factors including past, present, and probable future beneficial uses of water (Wat. Code, § 13241.) The Bay-Delta Plan identifies various beneficial uses of water in the Bay-Delta watershed and establishes water quality objectives designed to reasonably protect those uses. The impacts that could potentially result from implementation occur in a system that has been highly altered, and the project would be expected to improve conditions for native fish and wildlife in the Sacramento/Delta watershed over time. However, changes in hydrology and changes in water supply could result in some environmental impacts at certain times and locations that must be analyzed under CEQA. These potential environmental impacts should be viewed in light of the overall purpose and goals of the Sacramento/Delta update to the Bay-Delta Plan.

Table 9.7-13. Impact and Mitigation Measure Summary—Proposed Voluntary Agreements [1]

Impact	Impact Conclusions	Proposed Mitigation
AESTHETICS		
Impact AES-a: Have a substantial adverse effect on a scenic vista **Impact AES-b:** Substantially damage scenic resources, including, but not limited to trees, rock outcroppings, and historic buildings within a state scenic highway **Impact AES-c:** Substantially degrade the existing visual character or quality of the site and its surroundings	**Potentially Significant** Reservoir level changes may result in exposure of more unvegetated ground or "bathtub rings" Agriculture land conversion could affect aesthetic resources if properties are developed or neglected	**MM-AES-a–c: Mitigate impacts of the project that could have a substantial adverse effect on a scenic vista or could substantially damage a scenic resource or degrade the existing visual character or quality of a site and its surroundings** 1. Reservoir Management (MM-AQUA-a,d: 1.ii) 2. Measures to Mitigate Conversion of Agricultural Land (MM-AG-a,e)
	Less than Significant Altered streamflows could affect water levels and appearance Reduced Sacramento/Delta supply to municipalities could affect the visual quality of the urban environment	—
Impact AES-d: Create a new source of substantial light or glare which would adversely affect day or nighttime views in the area	**No Impact**	—
AGRICULTURE AND FOREST RESOURCES		
Impact AG-a: Convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance (Farmland), as shown on the maps prepared pursuant to the Farmland Mapping and Monitoring Program of the California Resources Agency, to nonagricultural use **Impact AG-e:** Involve other changes in the	**Potentially Significant** Reduced Sacramento/Delta supply to agriculture could lead to changes in distribution of crop types and acreage and conversion of farmland to nonagricultural use Lower groundwater levels could reduce groundwater available for agricultural use	**MM-AG-a,e: Mitigate impacts related to the conversion of Prime and Unique Farmland and Farmland of Statewide Importance (important farmland) to nonagricultural use** 1. Diversify Water Portfolios 2. Increase Efficiency of Agricultural Water Use 3. Impose Conditions on Land Use Changes or

Impact	Impact Conclusions	Proposed Mitigation
existing environment that, due to their location or nature, could result in conversion of Important Farmland to nonagricultural use		Other Discretionary Approvals 4. Reduce Impacts on Groundwater (MM-GW-b, 1-6) 5. Oversight and Approval of Water Transfers
	Less than Significant Reduced streamflow and water levels at some locations could affect the ability of existing diversion intakes to divert water for agricultural use Increased inundation in the Sutter and Yolo Bypasses during the planting season could affect crop acreage	—
Impact AG-b: Conflict with existing zoning for agricultural use or conflict with a Williamson Act contract	**No Impact**	—
Impact AG-c: Conflict with existing zoning for, or cause rezoning of forest land (as defined in Public Resources Code Section 12220(g)), timberland (as defined by Public Resources Code Section 4526), or timberland zoned Timberland Production (as defined by Government Code Section 51104(g))	**No Impact**	—
Impact AG-d: Result in the loss of forest land or conversion of forest land to non-forest use	**No Impact**	—
AIR QUALITY		
Impact AQ-a: Conflict with or obstruct implementation of the applicable air quality plan	**Potentially Significant** Increased groundwater pumping using diesel pumps and generators could result in emissions	**MM-AQ-a–c: Mitigate impacts from criteria air pollutant emissions from groundwater pumping**

Impact	Impact Conclusions	Proposed Mitigation
Impact AQ-b: Violate any air quality standard or contribute substantially to an existing or projected air quality violation **Impact AQ-c:** Result in a cumulatively considerable net increase of any criteria pollutant for which the project region is non-attainment under an applicable federal or state ambient air quality standard (including releasing emissions which exceed quantitative thresholds for ozone precursors)	**Less than Significant** Lower streamflows and reservoir levels could result in exposure to increased windblown dust emissions Agricultural land fallowing could result in exposure to increased fugitive dust Post-harvest rice burning could result in exposure to air pollutant emissions	—
Impact AQ-d: Expose sensitive receptors to substantial pollutant concentrations	**Less than Significant** Lower reservoir levels could result in exposure to increased windblown dust emissions Agricultural land fallowing could result in exposure to increased fugitive dust on lands where soil is exposed Post-harvest rice burning and groundwater pumping could result in exposure to pollutant emissions	—
Impact AQ-e: Create objectionable odors affecting a substantial number of people	**Less than Significant** Formation of harmful algal blooms from reduced flows and reservoir levels could produce odor compounds Increases in odors from increased groundwater pumping	—
BIOLOGICAL RESOURCES—TERRESTRIAL		
Impact TER-a: Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations, or by the California Department	**Potentially Significant** Reduced Sacramento/Delta supply to agricultural lands could affect habitat for special-status species, including giant gartersnake, Swainson's hawk, greater sandhill crane, tricolored blackbird, and California black rail	**MM-TER-a: Mitigate impacts on special-status species** 2. Habitat Protection and Restoration Actions 4. Special-Status Species Management Measures 5. Diversify Water Portfolios

Impact	Impact Conclusions	Proposed Mitigation
of Fish and Game or U.S. Fish and Wildlife Service	**Less than Significant** Increased winter flows on the Sacramento and Feather Rivers could affect bank swallow habitat Changes in reservoir water levels could affect habitat for bald eagle, American white pelican, western pond turtle, and amphibians Lower groundwater levels could affect natural communities that are dependent on groundwater, and sensitive species that are reliant on groundwater dependent ecosystems	—
	Beneficial Restoration and maintenance of natural flow would improve conditions for special-status plants and wildlife Increased frequency and duration of floodplain inundation would improve habitat for wintering waterfowl and other wildlife species Changes in Delta inflows and Delta outflows would improve habitat conditions for freshwater and tidal marsh species in the Delta and Suisun Marsh	—
Impact TER-b: Have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, or regulations, or by the California Department of Fish and Game or U.S. Fish and Wildlife Service **Impact TER-c:** Have a substantial adverse effect on federally protected wetlands as defined by Section 404 of the Clean Water Act (including, but not limited to, marshes,	**Potentially Significant** Lower groundwater levels could affect riparian and wetland habitat, and sensitive groundwater-dependent natural communities and wetlands	**MM-TER-b,c: Mitigate impacts on riparian habitats or other sensitive natural communities, including wetlands** 2. Reduce Impacts on Groundwater (MM-GW-b, 1-6)
	Less than Significant Changes in reservoir levels and streamflow below reservoirs could affect associated wetland and riparian habitat Reduced Sacramento/Delta supply could affect water quality in some managed wetlands	—

Impact	Impact Conclusions	Proposed Mitigation
vernal pools, coastal wetlands, etc.) through direct removal, filling, hydrological interruption, or other means	**Beneficial** Providing higher flows could restore and maintain natural processes, such as sediment deposition, marsh accretion, nutrient transport, seed dispersal, and flow-related disturbance, which would benefit riverine and associated wetland and riparian habitat Increased frequency and duration of floodplain inundation would benefit riparian and wetland habitat and associated natural communities Changes in Delta inflows and Delta outflows would benefit freshwater marshes and tidal marshes	—
Impact TER-d: Interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites	**Less than Significant** Changes in reservoir levels could affect the amount of breeding habitat for resident or migratory waterfowl populations Changes in groundwater levels could affect habitat for resident or migratory waterfowl and shore birds	—
	Beneficial Providing higher flows could benefit native resident and migratory wildlife that use riverine and associated wetland and riparian habitat and natural communities as migratory corridors or nursery sites	—
Impact TER-e: Conflict with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance	**No Impact**	—
Impact TER-f: Conflict with the provisions of an adopted habitat conservation plan, natural community conservation plan, or other approved local, regional, or state habitat conservation plan	**No Impact**	—

Impact	Impact Conclusions	Proposed Mitigation
BIOLOGICAL RESOURCES—AQUATIC		
Impact AQUA-a: Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations, or by the California Department of Fish and Game or U.S. Fish and Wildlife Service **Impact AQUA-d:** Interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites	**Potentially Significant** Changes in reservoir levels could affect water temperatures below some reservoirs Lower groundwater levels could affect stream-aquifer interactions and streamflows in some locations	**MM-AQUA-a,d: Mitigate impacts on aquatic special-status species and wildlife movement or wildlife nurseries** 1. Temperature Control and Reservoir Management Habitat Protection and Restoration Actions 2. Reduce Impacts on Groundwater (MM-GW-b, 1-6) 3. Diversify Water Portfolios 4. Support and Approval of Groundwater Storage and Recovery
	Less than Significant Changes in wet season flows (geomorphic flows) on VA tributaries could cause some erosion Reduced Sacramento/Delta supply to agriculture could affect habitat for special status species that depend in part on Sacramento/Delta water supply for habitat (i.e., irrigation runoff in agricultural drain for desert pupfish)	—
	Beneficial Providing higher flows could support a connected and functioning ecosystem and benefit native fish in the Sacramento/Delta	—
Impact AQUA-f: Conflict with the provisions of an adopted habitat conservation plan, natural community conservation plan, or other approved local, regional, or state habitat conservation plan	**No Impact**	—
CULTURAL RESOURCES		
Impact CUL-a: Cause a substantial adverse change in the significance of a historical resource as defined in Section 15064.5	**Potentially Significant** Changes in reservoir levels could expose previously inundated cultural resources and/or significant historic or archaeological resources to	**MM-CUL-a,b: Mitigate impacts of project that could cause a substantial adverse change in the significance of a historical or archaeological resource**

Impact	Impact Conclusions	Proposed Mitigation
Impact CUL-b: Cause a substantial adverse change in the significance of an archaeological resource as defined in Section 15064.5	increased wave action, erosion, and human activity	1. Reservoir Management (MM-AQUA-a,d: 1.ii) 2. Implement or Adhere to Cultural Resource Management Measures for Lands Surrounding Reservoirs
	Less than Significant Changes in streamflows could result in inundation and exposure of historic or archaeological resources	—
Impact CUL-c: Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature	**No Impact**	—
Impact CUL-d: Disturb any human remains, including those interred outside of dedicated cemeteries	**Potentially Significant** Changes in reservoir levels could expose previously inundated land containing human burials, which could result in the disturbance of the burial and impacts from human activity	**MM-CUL-d: Mitigate impacts of project that could disturb any human remains, including those interred outside of dedicated cemeteries**
	Less than Significant Changes in river flows could alter the baseline conditions of human burials interred within or outside of dedicated cemeteries	—
ENERGY		
Impact EN-a: The effects of the project on energy resources **Impact EN-b:** The effect of the project on peak and base period demands for electricity and other forms of energy **Impact EN-c:** The effects of the project on local and regional energy supplies and requirements for additional capacity **Impact EN-d:** The degree to which the project complies with existing energy standards **Impact EN-e:** Energy requirements and	**Less than Significant** Changes in hydrology would result in a decrease in hydropower generation in the summer	—

Impact	Impact Conclusions	Proposed Mitigation
energy use efficiencies by amount and fuel type for each stage of the project		
Impact EN-f: The project's projected transportation energy use requirements and its overall use of efficient transportation alternatives	**Less than Significant** Reduction in agricultural production could increase energy use for transportation	—
GEOLOGY AND SOILS		
Impact GEO-a: Expose people or structures to potential substantial adverse effects including the risk of loss, injury, or death involving: rupture of a known earthquake fault, strong seismic ground shaking, seismic-related ground failure including liquefaction, or landslides	**No Impact**	—
Impact GEO-b: Result in substantial soil erosion or the loss of topsoil	**Less than Significant** Agriculture fallowing could temporarily increase erosion and sedimentation	—
Impact GEO-c: Be located on a geologic unit or soil that is unstable or that would become unstable as a result of the project and potentially result in an onsite or offsite landslide, lateral spreading, subsidence, liquefaction, or collapse	**Potentially Significant** Lower groundwater levels could exacerbate existing problems associated with ground subsidence	**MM-GEO-c: Mitigate impacts associated with unstable soils and steep slopes (landslide, lateral spreading, subsidence, liquefaction, or collapse)** Actions to Reduce Subsidence 1. Reduce Impacts on Groundwater (MM-GW-b, 1-6)
I**mpact GEO-d:** Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial risks to life or property	**No Impact**	—
Impact GEO-e: Have soils incapable of adequately supporting the use of septic tanks or alternative wastewater disposal systems in areas where sewers are not available for the disposal of wastewater	**No Impact**	—

Impact	Impact Conclusions	Proposed Mitigation
GREENHOUSE GAS EMISSIONS		
Impact GHG-a: Generate greenhouse gas emissions, either directly or indirectly, that may have a significant impact on the environment	**Potentially Significant** Increased groundwater pumping from wells with diesel-powered pumps could generate additional greenhouse gas emissions	**MM-GHG-a: Mitigate impacts from greenhouse gas emissions** 1. Water Use Efficiency 2. Water Conservation 3. Energy Efficiency 4. Irrigation Systems 5. Restoration, Pricing Strategies, and Mitigation Credits 6. Implement Energy Mitigation (Mitigation Measure MM-EN-a–e: 1–6) 7. Implement Mitigation Measure MM-GHG-b, Comply with applicable greenhouse gas emissions reduction plans, policies, or regulations
	Less than Significant Changes in hydropower generation could result in additional energy generation at fossil-fuel facilities Increased groundwater pumping from wells with electric fuel pumps could generate additional greenhouse gas emissions	—
Impact GHG-b: Conflict with an applicable plan, policy or regulation adopted for the purpose of reducing the emissions of greenhouse gases	**Potentially Significant** Increased groundwater pumping from wells with diesel-powered pumps could result in emissions in excess of existing thresholds and could conflict with the state's long-term emission reduction trajectory	**MM-GHG-b: Comply with applicable greenhouse gas emission reduction plans, policies, or regulations** 1. Implement Air Quality Plans and Programs 2. Renewable Energy 3. Implement Mitigation Measure (MM-GHG-a): 1–6, Mitigate impacts from greenhouse gas emissions

Impact	Impact Conclusions	Proposed Mitigation
HAZARDS AND HAZARDOUS MATERIALS		
Impact HAZ-a: Create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials	**No Impact**	—
Impact HAZ-b: Create a significant hazard to the public or the environment through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment	**No Impact**	—
Impact HAZ-c: Emit hazardous emissions or handle hazardous or acutely hazardous materials, substances, or waste within one-quarter mile of an existing or proposed school	**No Impact**	—
Impact HAZ-d: Be located on a site which is included on a list of hazardous materials sites compiled pursuant to Government Code Section 65962.5 and, as a result, would it create a significant hazard to the public or the environment	**No Impact**	—
Impact HAZ-e: For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project result in a safety hazard for people residing or working in the project area	**No Impact**	—
Impact HAZ-f: For a project within the vicinity of a private airstrip, would the project result in a safety hazard for people residing or working in the project area	**No Impact**	—
Impact HAZ-g: Impair implementation of or physically interfere with an adopted emergency response plan or emergency	**No Impact**	—

Impact	Impact Conclusions	Proposed Mitigation
evacuation plan		
Impact HAZ-h: Expose people or structures to a significant risk of loss, injury or death involving wildland fires, including where wildlands are adjacent to urbanized areas or where residences are intermixed with wildlands	**Less than Significant** Changes in reservoir levels in areas likely to continue experiencing forest fires could affect wildland fire suppression practices	—
HYDROLOGY & WATER QUALITY—SURFACE WATER		
Impact SW-a: Violate any water quality standards or waste discharge requirements **Impact SW-f**: Otherwise substantially degrade water quality	**Potentially Significant** Reduced streamflows of streams below some reservoirs could result in less dilution and increased concentration of contaminants Increased flows could result in increased input of mercury and methylmercury production in some locations Changes in reservoir levels and lowered streamflows below reservoirs could result in increased temperature in some locations and times of year Changes in reservoir levels could result in increased production of harmful algal blooms in some locations Reductions in groundwater accretions could cause decreases in water quality associated with lower streamflows or higher temperatures	**MM-SW-a,f: Avoid or reduce violations of water quality standards or waste discharge requirements, and/or degradations of water quality** 1. Water Quality Contaminants and Regulation of Waste Discharges 2. Minimize Mercury Impacts 3. Temperature Control and Reservoir Management (MM-AQUA-a,d: 1.ii) 4. Avoid or Reduce Harmful Algal Blooms and Invasive Aquatic Weeds 5. Protect Municipal Water Quality 6. Reduce Impacts on Groundwater (MM-GW-b, 1-6) 7. Diversify Water Portfolios
	Less than Significant Changes in flows could result in moderately elevated turbidity and total suspended solids (TSS) levels in some locations, and reduced occurrence of the highest turbidity and TSS levels Increased Delta outflow would result in little change in electrical conductivity (EC) in the Delta Increased Delta outflow would result in little change in chloride and bromide at municipal intakes in the Delta	—

Impact	Impact Conclusions	Proposed Mitigation
	Lower flows at times in some Delta channels could result in incremental increased production of harmful algal blooms and invasive aquatic plants Increased floodplain inundation could have effects on nutrients, organic material, invasive aquatic plants, and harmful algal blooms Changes in water supply and indoor water conservation could result in site-specific exceedances of waste discharge requirements due to changes in wastewater treatment plant (WWTP) influent and effluent quality and quantity Reductions in delivery of higher quality	
Impact SW-c: Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, in a manner which would result in substantial erosion or siltation on- or off-site **Impact SW-d:** Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, or substantially increase the rate or amount of surface runoff in a manner which would result in flooding on- or off-site	**Less than Significant** Changes in high peak flows could increase risk of erosion and flooding	
Impact SW-e: Create or contribute runoff water which would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff	**No Impact**	**—**

Impact	Impact Conclusions	Proposed Mitigation
Impact SW-g: Place housing within a 100-year flood hazard area as mapped on a federal Flood Hazard Boundary or Flood Insurance Rate Map or other flood hazard delineation map **Impact SW-h:** Place within a 100-year flood hazard area structures which would impede or redirect flood flows	**No Impact**	—
Impact SW-i: Expose people or structures to a significant risk of loss, injury, or death involving flooding, including flooding as a result of the failure of a levee or dam	**Less than Significant** Increases in flow downstream of reservoirs could increase the risk of downstream flooding	—
Impact SW-j: Inundation by seiche, tsunami, or mudflow	**No Impact**	—
HYDROLOGY & WATER QUALITY—GROUNDWATER		
Impact GW-b: Substantially deplete groundwater supplies or interfere substantially with groundwater recharge, such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level (e.g., the production rate of pre-existing nearby wells would drop to a level that would not support existing land uses or planned uses for which permits have been granted)	**Potentially Significant** Increased groundwater pumping and reductions in incidental groundwater recharge from applied irrigation could lower groundwater levels and contribute to groundwater overdraft	**MM-GW-b: Mitigate the substantial depletion of groundwater supplies or the substantial interference with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level** 1. Implement the Sustainable Groundwater Management Act (SGMA) 2. SGMA Oversight 3. Diversify Water Portfolios 4. Support and Approval of Groundwater Storage and Recovery 5. Support and Approval of Recycled Water Projects 6. Oversight and Approval of Water Transfers
	Less than Significant Reduced flows downstream of reservoirs could affect stream-aquifer interaction	—

Impact	Impact Conclusions	Proposed Mitigation
Impact GW-a: Violate any water quality standards or waste discharge requirements **Impact GW-f:** Otherwise substantially degrade water quality	**Potentially Significant** Lower groundwater levels can result in changes in groundwater flow direction and gradients in localized areas, which could exacerbate the migration of contaminants In some locations, lower groundwater levels may concentrate salts and nutrients in groundwater over time through evaporative enrichment Lower groundwater levels could have localized effects on groundwater quality by concentrating pollutants where groundwater contamination already exists	**MM-GW-a,f: Mitigate impacts to groundwater quality from depletion of groundwater supplies or the substantial interference with groundwater recharge** 1. Drinking Water Programs 2. Implement the State and Regional Board's Irrigated Lands Regulatory Program (ILRP) 3. Reduce Impacts on Groundwater (MM-GW-b, 1-6)
LAND USE AND PLANNING		
Impact LU-a: Physically divide an established community	**No Impact**	—
Impact LU-b: Conflict with any applicable land use plan, policy, or regulation of an agency with jurisdiction over the project (including, but not limited to the general plan, specific plan, local coastal program, or zoning ordinance) adopted for the purpose of avoiding or mitigating an environmental effect	**No Impact**	—
Impact LU-c: Conflict with any applicable habitat conservation plan or natural community conservation plan	**Less than Significant** See Section 9.7.6.1, *Terrestrial Biological Resources*, Impact TER-f	—
MINERAL RESOURCES		
Impact MIN-a: Result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the state	**No Impact**	—
Impact MIN-b: Result in the loss of availability of a locally important mineral resource recovery site delineated on a local general plan, specific plan, or other land use	**No Impact**	—

Impact	Impact Conclusions	Proposed Mitigation
plan		
NOISE		
Impact NOI-a: Exposure of persons to or generation of noise levels in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies **Impact NOI-c:** A substantial permanent increase in ambient noise levels in the project vicinity above levels existing without the project **Impact NOI-d:** A substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project	**Potentially Significant** Increased groundwater pumping for replacement water supply, groundwater storage and recovery, or groundwater substitution transfers could result in higher noise levels	**MM-NOI-a,c,d: Mitigate exposure of persons to or generation of noise levels in excess of established standards and to substantial permanent or temporary increases in ambient noise levels in the project vicinity** 1. Applicable Policies and Regulations 2. Noise-Reduction Consideration in Operations
Impact NOI-b: Exposure of persons to or generation of excessive groundborne vibration or groundborne noise levels	**Less than Significant** Increased groundwater pumping could result in localized and intermittent perceptible vibration	—
Impact NOI-e: For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project expose people residing or working in the project area to excessive noise levels	**No Impact**	—
Impact NOI-f: For a project within the vicinity of a private airstrip, would the project expose people residing or working in the project area to excessive noise levels	**No Impact**	—
POPULATION AND HOUSING		
Impact POP-a: Induce substantial population growth in an area, either directly (for example, by proposing new homes and businesses) or indirectly (for example, through extension of roads or other	**No Impact**	—

Impact	Impact Conclusions	Proposed Mitigation
infrastructure)		
Impact POP-b: Displace substantial numbers of existing housing, necessitating the construction of replacement housing elsewhere	**No Impact**	—
Impact POP-c: Displace substantial numbers of people, necessitating the construction of replacement housing elsewhere	**No Impact**	—
PUBLIC SERVICES		
Impact PS-a: Result in substantial adverse physical impacts associated with the provision of new or physically altered governmental facilities, need for new or physically altered governmental facilities, the construction of which could cause significant environmental impacts, in order to maintain acceptable service ratios, response times or other performance objectives for any of the public services: fire protection, police protection, schools, parks, or other public facilities	**No Impact**	—
RECREATION		
Impact REC-a: Increase the use of existing neighborhood and regional parks or other recreational facilities such that substantial physical deterioration of the facility would occur or be accelerated	**Less than Significant** Changes in streamflows and reservoir levels could affect recreational facilities and opportunities Incremental increase in potential harmful algal blooms could cause closures to recreation in some waterbodies Changes in reservoir water surface area and elevation could affect sportfish populations and reduce fishing opportunities at some locations Reduced agricultural water supply could affect recreational opportunities (e.g., wildlife viewing)	—

Impact	Impact Conclusions	Proposed Mitigation
	Beneficial Changes in flow could improve recreational opportunities	—
Impact REC-b: Include recreational facilities or require the construction or expansion of recreational facilities that might have an adverse physical effect on the environment	**No Impact**	
TRANSPORTATION/TRAFFIC		
Impact TRA-a: Conflict with an applicable plan, ordinance, or policy establishing measures of effectiveness for the performance of the circulation system, taking into account all modes of transportation, including mass transit and non-motorized travel and relevant components of the circulation system, including, but not limited to, intersections, streets, highways and freeways, pedestrian and bicycle paths, and mass transit **Impact TRA-f:** Conflict with adopted policies, plans, or programs regarding public transit, bicycle, or pedestrian facilities, or otherwise decrease the performance or safety of such facilities	**Less than Significant** Increased intermittent inundation of floodplains bounded by levees where roads and pedestrian and bicycle paths exist could affect transportation Changes in agricultural land use or fallowing could lead to changes in agricultural product-related transportation	—
Impact TRA-b: Conflict with an applicable congestion management program, including, but not limited to, level of service standards and travel demand measures or other standards established by the county congestion management agency for designated roads or highways	**No Impact**	—
Impact TRA-c: Result in a change in air traffic patterns, including either an increase in traffic levels or a change in location that results in substantial safety risks	**No Impact**	—

Impact	Impact Conclusions	Proposed Mitigation
Impact TRA-d: Substantially increase hazards due to a design feature (e.g., sharp curves or dangerous intersections) or incompatible uses (e.g., farm equipment)	**No Impact**	—
Impact TRA-e: Result in inadequate emergency access	**No Impact**	—
UTILITIES AND SERVICE SYSTEMS		
Impact UT-a: Exceed wastewater treatment requirements of the applicable Regional Water Quality Control Board	**No Impact**	—
Impact UT-b: Require or result in the construction of new water or wastewater treatment facilities or expansion of existing facilities, the construction of which could cause significant environmental effects	**No Impact**	—
Impact UT-c: Require or result in the construction of new storm water drainage facilities or expansion of existing facilities, the construction of which could cause significant environmental effects	**No Impact**	—
Impact UT-d: Have sufficient water supplies available to serve the project from existing entitlements and resources, or are new or expanded entitlements needed	**Potentially Significant** Reduced groundwater levels could affect water supplies for communities that rely on groundwater as their primary municipal water source, including economically disadvantaged communities	**MM-UT-d: Avoid or reduce impacts on municipal supplies** 1. Diversify Water Portfolios 2. Increase Water Use Efficiency 3. Prioritize Water Supplies for Health and Safety 4. Reduce Impacts on Groundwater (MM-GW-b, 1-6)
	Less than Significant Reduced Sacramento/Delta supply to municipal use could affect municipal water supplies	

Impact	Impact Conclusions	Proposed Mitigation
Impact UT-e: Result in a determination by the wastewater treatment provider which serves or may serve the project that it has adequate capacity to serve the project's projected demand in addition to the provider's existing commitments	**No Impact**	**—**
Impact UT-f: Be served by a landfill with sufficient permitted capacity to accommodate the project's solid waste disposal needs **Impact UT-g:** Comply with federal, state, and local statutes and regulations related to solid waste	**No Impact**	**—**

Note:
[1] Additional impacts and mitigation measures associated with other water management actions are presented in Section 7.1, *Environmental Analysis*, Table 7.1-2; habitat restoration and other ecosystem projects, as well as new and modified facilities, are presented in Section 7.21, *Habitat Restoration and Other Ecosystem Projects* (Table 7.21-1) and Section 7.22, *New and Modified Facilities* (Table 7.22-1).

9.7.23 Ability to Achieve Project Purpose and Goals

The purpose and goals of the project are described in Section 7.1, *Introduction, Project Description, and Approach to Environmental Analysis*. As discussed in prior sections, the VAs propose flow assets and habitat restoration measures in the Sacramento/Delta for an 8-year period that are intended to provide for reasonable protection of fish and wildlife beneficial uses in the Sacramento/Delta. Flow assets and habitat restoration measures would support many of the purpose and goals of the Sacramento/Delta update to the Bay-Delta Plan. Section 9.6, *Beneficial Environmental Effects of Proposed VAs*, summarizes information supporting specific flow and non-flow habitat restoration actions in the tributaries, flood bypasses, and Delta outlined in the VAs. Overall, the proposed VAs are intended to provide improved tributary and in-Delta habitat conditions, improved migratory conditions, and increased floodplain inundation, which would promote habitat conditions that favor native fishes over nonnative fishes. The proposed VAs provide a voluntary pathway with flexibility for establishing beneficial habitat conditions for native fishes, addressing scientific uncertainty and changing conditions, and developing scientific information that will inform future management of flows. While not the only possible approach, the proposed VAs provide an approach that considers all of the demands being made and to be made on waters in the Sacramento/Delta and the factors to be considered for establishing water quality objectives in Water Code section 13241. These factors include, but are not limited to, past, present, and probable future beneficial uses and economic considerations. The proposed VAs include a monitoring and evaluation program to inform adaptive management of flows and future changes to the Plan.

9.8 Economic Analysis and Other Considerations

9.8.1 Introduction

Chapter 8, *Economic Analysis and Other Considerations*, analyzes the economic effects of changes in hydrology and water supply under the proposed Plan amendments on the agricultural and municipal use. Section 8.2, *Economic Profile*, describes the economic setting to inform the economic effects discussion in this section.

This section provides an analysis of the potential agricultural and municipal economic effects that may result from changes in water supply under the proposed VAs. The agricultural economic effects are considered in terms of the potential response by agricultural water users, which could result in changes in crop production or the fallowing of existing irrigated land. This section also includes an analysis of the estimated regional agricultural economic effects of the proposed VAs, for both the Sacramento/Delta and the State of California. A qualitative assessment of the potential effects of the proposed VAs on municipal water providers is also provided in this section.

This section also summarizes the funding sources and amounts identified in the VA Term Sheet that would be provided by public water agencies and state and federal public agencies to implement the proposed VAs.

9.8.2 Agricultural Water Supply Economic Effects

As discussed above under Section 9.5, *Changes in Hydrology and Water Supply*, implementation of the proposed VAs could result in changes in Sacramento/Delta surface water supply to agricultural users in the Sacramento/Delta and the San Joaquin Valley. The Sacramento/Delta water supply reductions under the proposed VAs would be based on voluntary measures that would be largely or entirely from agricultural supplies, reservoir reoperations, or based on groundwater substitution. The SacWAM results estimate that there would not be a reduction in water supplies to the San Francisco Bay Area, Central Coast, or Southern California regions.

Growers' responses to changes in water supply in the Sacramento/Delta and San Joaquin Valley are estimated using the SWAP model. SWAP is an economic decision model that estimates growers' responses to changes in water supply by determining the cropping pattern that maximizes the net returns to agricultural production. SacWAM model results for changes in hydrology are used as an input to SWAP. However, as discussed in Section 9.7.4, *Agriculture and Forest Resources*, the SWAP analysis does not utilize the postprocessed SacWAM model results of high and low bookend scenarios presented in Section 9.5, *Changes in Hydrology and Water Supply*, to quantify impacts of different sources of unspecified water purchases. Because sources of the flow assets that would be provided through the unspecified water purchases are not fully known at this time, SWAP estimates the possible sources and effects of the unspecified water purchases based on economic criteria. Actual grower responses may vary from the SWAP model results. In particular, the unspecified water purchases would be provided from willing sellers that choose to participate in the water purchase program; therefore, the effects on agricultural production may differ from the SWAP model results. In addition, SWAP results are provided for a scenario that does not consider the possible effects of unspecified water purchases. Additional information about SWAP and SWAP results for the proposed VAs are included in *Appendix A3, Agricultural Economic Effects: SWAP Methodology and Modeling Results.*

In response to reductions in Sacramento/Delta water supplies, individual water users could choose to increase groundwater pumping as a substitute supply, where available and not locally restricted. In addition, the VA proposal identifies that some VA flow assets could be provided through groundwater substitution. However, this analysis assumes that agricultural water users would not increase groundwater pumping in response to reductions in Sacramento/Delta water supplies. Reductions in crop acreage and crop revenues could be less if water users choose to increase groundwater pumping as a substitute supply. Therefore, the SWAP model results provide a conservative estimate of changes in crop acreage that could occur under the proposed VAs.

9.8.2.1 Sacramento/Delta

SWAP results for changes in crop revenues in the Sacramento/Delta are provided below for the proposed VAs, both with and without considering the effects of the unspecified water purchases. Results for the average year model runs are presented in Table 9.8-1. The model results indicate that there could be a decline of overall crop revenue for the proposed VAs, both with and without considering SWAP estimated effects of unspecified water purchases. The decrease in crop revenue could be about 0.5% when including unspecified water purchases, and about 0.3% without considering the SWAP estimated effects of the unspecified water purchases. A large portion of the estimated decrease in crop revenue is associated with reduced rice acreage. Additionally, estimated decreases in revenue and production of alfalfa and pasture, deciduous orchards, almonds and pistachios, and processing tomatoes could occur in the Sacramento/Delta watershed. Some crop shifting from higher to lower water-intensive crops could also take place. As a result, SWAP estimates that wheat and field crops, and (to a lesser extent) vegetables could see an increase in crop revenue under the proposed VAs.

Results for the dry year model runs are provided in Table 9.8-2 and show similar trends.

Table 9.8-1. Average Year: Crop Revenue in the Sacramento/Delta, SWAP Model Analysis (dollars)[a]

Crop Group	Existing	Proposed VAs With Unspecified Water Purchases	Proposed VAs Without Unspecified Water Purchases
Deciduous Orchards	3,650,086,900	3,642,798,800	3,645,469,600
Rice	1,495,391,700	1,472,747,800	1,473,554,600
Almonds & Pistachios	932,906,100	927,757,700	929,633,100
Vine	930,289,500	930,342,000	930,308,300
Vegetables	786,069,400	786,849,500	787,197,000
Alfalfa & Pasture	571,085,500	560,998,300	568,148,700
Corn and All Silage	438,058,400	436,453,000	438,238,700
Processing Tomatoes	383,723,000	381,136,500	381,981,800
Wheat & Field Crops	195,275,400	200,534,100	198,925,900
Cotton	10,566,600	10,561,200	10,561,200
TOTAL	9,393,452,700	9,350,178,800	9,364,018,800
Change from existing		-0.5%	-0.3%

[a] SWAP model crop revenue estimates for an average year by crop group for baseline and proposed VAs.

Table 9.8-2. Dry Year: Crop Revenue in the Sacramento/Delta, SWAP Model Analysis (dollars)[a]

Crop Group	Existing	Proposed VAs With Unspecified Water Purchases	Proposed VAs Without Unspecified Water Purchases
Deciduous Orchards	3,633,090,100	3,628,791,500	3,629,682,200
Rice	1,466,079,400	1,447,281,500	1,448,238,400
Almonds & Pistachios	914,717,700	912,550,800	912,859,000
Vine	924,882,200	924,541,500	924,855,800
Vegetables	784,640,800	784,321,700	785,187,100
Alfalfa & Pasture	539,409,100	528,764,600	535,168,200
Corn and All Silage	433,462,300	430,765,900	433,259,800
Processing Tomatoes	379,399,500	376,231,900	377,481,700
Wheat & Field Crops	198,351,100	199,691,500	200,172,100
Cotton	10,487,300	10,475,800	10,476,200
TOTAL	9,284,519,600	9,243,416,500	9,257,380,500
Change from existing		-0.4%	-0.3%

[a] SWAP model crop revenue estimates for an average year by crop group for baseline and proposed VAs.

9.8.2.2 San Joaquin Valley

SWAP results for changes in crop revenues in the San Joaquin Valley are provided below for the proposed VAs, both with and without considering the effects of the unspecified water purchases. Results for the average year model run are shown in Table 9.8-3. The model results for the average year model run indicate that there could be a decrease in total crop revenue, both with and without considering possible effects of unspecified water purchases. The decrease in crop revenue could be about 0.1% when considering the SWAP estimated effects of unspecified water purchases, and less than 0.05% without considering the SWAP estimated effects of the unspecified water purchases. A large portion of the decrease in crop revenue is estimated to occur as a result of reduced pasture acreage, and SWAP estimates that the reduction in pasture acreage would be greater when considering the possible effects of unspecified water purchases. Other crop categories, such as deciduous orchards and almonds and pistachios could also occur. SWAP estimates that there could be some crop shifting from higher to lower water-intensive crops under the proposed VAs, and certain crop types such as vegetables could experience an increase in crop revenue as a result.

Results for the dry year model run are provided in Table 9.8-4. Several crop types could experience reductions in crop revenues during dry years, such as processing tomatoes, cotton, alfalfa, and pasture. The overall reduction in crop revenue in the San Joaquin Valley is estimated to be greater under the dry year model run than the average year model run.

Table 9.8-3. Average Year: Crop Revenue in the San Joaquin Valley, SWAP Model Analysis (dollars)[a]

Crop Group	Existing	Proposed VAs With Unspecified Water Purchases	Proposed VAs Without Unspecified Water Purchases
Deciduous Orchards	7,882,217,500	7,876,527,800	7,881,453,400
Almonds & Pistachios	6,006,154,900	5,999,396,000	6,005,197,600
Vine	3,425,590,400	3,425,254,400	3,425,566,100
Vegetables	2,509,455,000	2,512,102,200	2,512,651,100
Corn and All Silage	1,876,603,400	1,872,671,600	1,877,485,100
Alfalfa & Pasture	1,498,599,400	1,478,184,100	1,494,686,500
Cotton	908,441,600	906,615,800	908,497,300
Processing Tomatoes	831,512,300	831,543,400	832,110,300
Wheat & Field Crops	440,146,600	440,191,800	441,035,700
Rice	25,842,900	25,568,100	25,616,200
TOTAL	25,404,564,000	25,368,055,200	25,404,299,300
Change from existing		-0.1%	- <0.05%

[a] SWAP model crop revenue estimates for an average year by crop group for baseline and proposed VAs.

Table 9.8-4. Dry Year: Crop Revenue in the San Joaquin Valley, SWAP Model Analysis (dollars)[a]

Crop Group	Existing	Proposed VAs With Unspecified Water Purchases	Proposed VAs Without Unspecified Water Purchases
Deciduous Orchards	7,815,644,900	7,812,929,200	7,814,968,300
Almonds & Pistachios	5,879,484,300	5,875,644,300	5,877,199,200
Vine	3,371,464,200	3,372,211,100	3,370,945,400
Vegetables	2,423,812,100	2,420,778,200	2,420,603,000
Corn and All Silage	1,740,652,200	1,738,019,600	1,740,858,600
Alfalfa & Pasture	1,382,287,900	1,366,196,300	1,382,602,400
Cotton	862,717,100	857,030,300	858,035,000
Processing Tomatoes	783,356,700	774,704,200	775,707,100
Wheat & Field Crops	377,208,000	374,320,300	374,533,900
Rice	25,363,800	25,229,700	25,329,500
TOTAL	24,661,991,100	24,617,063,100	24,640,782,500
Change from existing		-0.2%	-0.1%

[a] SWAP model crop revenue estimates for an average year by crop group for baseline and proposed VAs.

9.8.2.3 Effects on Farming-Dependent Industries

Providers of agricultural services, food processors, and other farming product–dependent industries such as dairies and livestock could be affected by changes in crop production in both the Sacramento/Delta and San Joaquin Valley under the proposed VAs. Section 9.7.4, *Agriculture and Forest Resources*, summarizes SWAP results for changes in crop acreage that could occur under the proposed VAs. As discussed in Section 9.7.4, SWAP estimates that rice and alfalfa and pasture could experience the largest decrease in crop acreage under the proposed VAs, although several other crop types could also experience some decreases in crop acreage. Overall, the changes in crop acreage would be expected to be less under the proposed VAs compared to the proposed Plan amendments, and effects on farming-dependent industries would likely be less. However, some effects on farming-dependent industries are possible as discussed below.

Agricultural service companies provide support activities for farms that produce crops. Suppliers for rice, alfalfa, and pasture farm types could be most affected by the proposed VAs. However, the changes in crop acreage would be expected to be less under the proposed VAs compared to the proposed Plan amendments, and effects on agricultural service companies would also likely be less.

For many food processors, there is a direct relationship between farm production levels and output (sales) and employment in value-added processing. Reductions in crop acreage and associated production could therefore adversely affect processing businesses. Economic effects of the proposed VAs on food processors would likely be small, but some effects are possible. For example, the SWAP results for the proposed VAs suggest that rice production could decline by about 1 percent, which could have an accompanying effect on rice millers in the Sacramento/Delta.

Dairy farms, dairy based processed foods, and beef cattle are among the industries highly reliant on irrigated crops in both the Sacramento/Delta and the San Joaquin Valley. The SWAP model results suggest that some crop types that are utilized by livestock could be affected by reductions in crop acreage under the proposed VAs, such as irrigated pasture. These changes could potentially result in some increased livestock feed costs in some locations.

9.8.2.4 Regional Economic Effects

Changes in agricultural production could result in additional economic effects that affect total industry output (sales), income, and employment. These effects are discussed and evaluated in this section, for the Sacramento/Delta watershed and for the State of California.

A regional economic analysis was conducted to estimate how changes in water supply and resulting changes to the local agricultural economy could affect regional economic activity in the Sacramento/Delta and the state as a whole. The regional economic analysis estimates how changes in agricultural production could affect total industry output (sales), personal income, and employment. The regional economic analysis relies on the IMPLAN Input-Output modeling system. IMPLAN is a widely-used, proprietary data and modeling software system.

Similar to the analysis in Section 8.4.3, *Regional Economic Effects*, two regional models were used to analyze regional economic effects: a Sacramento/Delta Regional Model and a State of California Model.

SWAP results for crop revenues and expenditures under the proposed VAs were used as inputs to IMPLAN, including the changes in crop revenues that could occur as a result of unspecified water purchases. IMPLAN also considers that participation in the VA water purchase programs could result in compensation for participants. The compensation received by growers represents an increase in proprietor income that is included in the modeling. The compensation rate for flow assets provided through the VA water purchase programs is unknown; however, for the purposes of the regional modeling only, a rate of $400 per AF is assumed. This rate is consistent with market prices for surface water in the Central Valley, although actual costs can vary. The selected unit price is also consistent with the proposed pricing for crop fallowing agreements in DWR's LandFlex Grant Program (DWR 2023a) as well as pricing for average water years under multi-year water purchase agreements.

Sacramento/Delta watershed regional analysis results are provided in Table 9.8-5. The results suggest reductions of approximately $55 million in economic output, $29 million in labor income, and 552 jobs (517 full time equivalent [FTE] jobs) in the Sacramento/Delta region compared with baseline. Most of the effects occur in the agriculture and agricultural support (i.e., Other Natural Resources & Mining) sectors. The IMPLAN results suggest that water purchase compensation could provide a positive economic effect on output, income, and jobs.

Table 9.8-5. Estimated Economic Effects of the Proposed VAs Compared with Baseline: Modeled Changes in Agricultural Production and Compensated Water Purchases in the Sacramento/Delta[a]

	Change in:		
Industry/Sector	Output ($ mil.)	Income ($ mil.)	No. of Jobs
Agriculture	-24	-23	-407
Other Natural Resources & Mining	-6	-4	-87
Utilities	-1	-0	-3
Construction	-3	-0	-3
Food Processing	-0	-0	-0
Other Non-Durables Manufacturing	-4	-0	-2
Durables Manufacturing	-0	-0	-0
Transportation & Warehousing	-2	-1	-9
Wholesale Trade	-1	-0	-6
Retail Trade	-3	-1	-34
Information & Communications Services	-1	-0	-2
Finance, Insurance, & Real Estate Services	-5	-1	-21
Legal, Rental, Professional, Scientific, Mgt & Tech Services	-5	-2	-32
Employment, Administrative, & Waste Services	-1	-0	-11
Education, Health & Social Services	-2	-1	-22
Arts, Entertainment & Recreation Services	-0	-0	-3
Accommodation & Food Service	-1	-0	-13
Other Services	-2	-1	-15
Government & Miscellaneous	-5	-2	-21
Water Purchases	*+9*	*+9*	*+138*
Totals	-55	-29	-552
Total FTE Jobs	-	-	*-517*

[a] IMPLAN model results. Combined direct, indirect, and induced effects on business, household, and government sectors in the Sacramento/Delta regional economy attributable to backward linkage effects of modeled agricultural production activities, expressed as change relative to estimated effects of baseline agricultural activity.
FTE = full time equivalent.

State of California analysis results are presented in Table 9.8-6. Results indicate net decreases of approximately $54 million in economic output, $19 million in labor income, and 353 jobs (289 FTE jobs) in the State of California compared with baseline. Similar to the results presented above for the Sacramento/Delta watershed, most of the effects occur in the agricultural and agricultural support (i.e., “Other Natural Resources & Mining”) sectors. The IMPLAN results suggest that water purchase compensation could results in induced effects; that is, compensation for water purchases could provide a positive economic effect on economic output, income, and number of jobs.

Table 9.8-6. Estimated Economic Effects of the Proposed VAs Compared with Baseline: Modeled Changes in Agricultural Production and Compensated Water Purchases California Statewide [a]

Industry/Sector	Change in: Output ($ mil.)	Change in: Income ($ mil.)	Change in: No. of Jobs	Percent Change in: Output	Percent Change in: Income	Percent Change in: No. of Jobs
Voluntary Agreement (compensated water purchases included)						
Agriculture	-37	-36	-548	-0.2%	-0.2%	-0.2%
Other Natural Resources & Mining	-9	-5	-131	-0.2%	-0.2%	-0.2%
Utilities	-1	-0	-6	-0.2%	-0.2%	-0.2%
Construction	-13	-3	-15	-0.7%	-0.7%	-0.7%
Food Processing	-0	+0	+0	-0.0%	+0.0%	+0.0%
Other Non-Durables Manufacturing	-7	-0	-4	-0.2%	-0.1%	-0.1%
Durables Manufacturing	-0	-0	-1	-0.1%	-0.1%	-0.1%
Transportation & Warehousing	-2	-1	-9	-0.1%	-0.1%	-0.1%
Wholesale Trade	-1	-0	-5	-0.1%	-0.1%	-0.1%
Retail Trade	-2	-1	-23	-0.1%	-0.1%	-0.1%
Information & Communications Services	-1	-0	-1	-0.0%	-0.0%	-0.0%
Finance, Insurance, & Real Estate Services	-3	-1	-12	-0.1%	-0.1%	-0.1%
Legal, Rental, Professional, Scientific, Mgt & Tech Services	-7	-4	-43	-0.1%	-0.1%	-0.1%
Employment, Administrative, & Waste Services	-1	-0	-7	-0.1%	-0.1%	-0.1%
Education, Health & Social Services	+1	+0	+9	+0.0%	+0.0%	+0.0%
Arts, Entertainment & Recreation Services	+0	+0	+1	+0.0%	+0.0%	+0.0%
Accommodation & Food Service	+0	+0	+2	+0.0%	+0.0%	+0.0%
Other Services	-1	-0	-4	-0.0%	-0.0%	-0.0%
Government & Miscellaneous	-7	-3	-29	-0.1%	-0.2%	-0.2%
Water Purchases	*+37*	*+37*	*+475*			
Totals	-54	-19	-353	-0.1%	-0.1%	-0.1%
Total FTE Jobs	-	-	*-289*	-	-	*-0.1%*

[a] IMPLAN model results. Combined direct, indirect, and induced effects on business, household, and government sectors in the California statewide economy attributable to backward linkage effects of modeled agricultural production activities, expressed as change relative to estimated effects of baseline agricultural activity.
FTE = full time equivalent.

9.8.3 Municipal Water Supply Economic Effects

This section addresses the economic effects of the proposed VAs on municipal water providers. As discussed in previous sections, because the Sacramento/Delta water supply reductions under the proposed VAs would be based on voluntary measures that would be largely or entirely from agricultural supplies or based on groundwater substitution, or reservoir reoperations the proposed VAs would not be expected to result in substantial changes in Sacramento/Delta supplies for municipal uses. As a result, municipal water supply economic effects would be limited.

However, as discussed in Section 9.7, *Environmental Analysis*, lower groundwater levels could occur in localized areas if flows are provided through groundwater substitution or from reduced incidental recharge from the application of applied irrigation water, which could potentially impact communities in the Sacramento River watershed, Delta eastside tributaries, and San Joaquin Valley regions that rely on groundwater as their primary water supply source. If this happens, it is possible that some municipal water users could incur additional expenses to access lower groundwater levels. If wells are already deep enough to accommodate lowered static water levels, the additional expense is very small. However, if existing wells must be deepened, or new wells drilled, additional capital expense would be incurred. This could potentially also be the case for self-supplied households on domestic wells if the well depth was insufficient to accommodate lowered groundwater levels, should they occur. Chapter 8, *Economic Analysis and Other Considerations*, provides discussion of costs to construct new wells and to deepen existing wells.

9.8.4 Costs to Implement Proposed VAs

Appendix 3 of The VA Term Sheet identifies that the total cost for implementing the proposed VAs is $2,589 million. The costs are organized in two tables in Appendix 3 of the VA Term Sheet: (1) costs in planning agreement; and (2) additional costs to achieve VAs as described in the VA Term Sheet; these costs are also summarized below in Table 9.8-7 and Table 9.8-8.

Table 9.8-7. Costs to Implement the Proposed VAs: Costs in Planning Agreement ($ millions)

Category of Expenditure	Total
Habitat Construction	$477
Voluntary Fallowing	$268
Water Purchases in Various Water Years	$125
American River Recharge Project	$40
Science and Adaptive Management Programs	$104
Subtotal	$1,014

Source: Appendix G1, VA Term Sheet, Appendix 3.

Table 9.8-8. Additional Costs to Achieve VAs as Described in VA Term Sheet ($ millions)

Category of Expenditure	Total
Water Development Costs	$370
Additional Water Purchase on Market	$64
Additional Water Purchase with Fixed Price	$208
Additional Habitat Restoration per VA Term Sheet	$381
Adjusted Science and Adaptive Management Program	$24
Permanent State water purchases (no defined source)	$490
Total Estimated Cost Refill	$25
Mokelumne AN Water Purchase (30 TAF)	$13
Subtotal	$1,575

Source: Appendix G1, VA Term Sheet, Appendix 3.

Appendix 4 of the VA Term Sheet identifies funding sources from the state of California, the federal government, and Public Water Agencies. Some of the funding sources identified in Appendix 4 are identified as secured funding sources, and some funding sources are identified as unsecured.

9.9 Modular Alternatives for Proposed VAs

9.9.1 Introduction

Section 7.2, *Description of Alternatives*, describes several other project alternatives that are being evaluated for the Bay-Delta Plan update and may be considered by the State Water Board, including both stand-alone alternatives and modular alternatives that could be layered onto the stand-alone alternatives. Section 7.2 identifies modular drought alternatives that could be adopted in combination with the proposed VAs, including two modular drought alternatives. These two alternatives, the Instream Flow Protection Provision Alternative (Alternative 5a) and Shared Water Shortage Provision (Alternative 5b) present variations to help address limited water supplies during drought. These alternatives are further described in Section 7.2. The environmental impacts of Alternatives 5a and 5b are evaluated in Section 7.24, *Alternatives Analysis*.

Section 7.2, *Description of Alternatives*, identifies an additional modular alternative, the Protection of Voluntary Agreement Flows Alternative (Alternative 6a) that could be adopted in combination with the proposed VAs. Modular Alternative 6a would identify as part of the Bay-Delta Plan program of implementation additional measures to protect the base flows upon which the VAs are intended to be added from new or expanded water diversions. The environmental impacts of the Protection of Voluntary Agreement Flows Alternative are evaluated in this section.

9.9.2 Protection of Voluntary Agreement Flows Alternative

The VA Term Sheet identifies that the State Water Board will use its legal authorities to protect VA flows against diversions for other purposes for the term of the VAs. Protection of the VA flows is proposed as part of the VA alternative. The VA Term Sheet also identifies that all San Joaquin River watershed flows required as a result of implementing the 2018 Bay Delta Plan Update or VAs will be protected as Delta outflows. It is expected that the accounting developed for the VAs that is required to be approved by the State Water Board will provide for these flows to be bypassed by the SWP and CVP and contribute to Delta outflows. Because the VA flows are intended to be additive to required flows under D-1641 and resulting flows under the 2019 BiOps, additional mechanisms are needed to protect the base upon which the VA flows are intended to be additive from diversion because as described in prior chapters, D-1641 Delta outflow requirements are very minimal and the 2019 BiOps do not include Delta outflow requirements, with the exception of some fall Delta outflows. Further, the BiOp requirements do not apply to other water users outside of the SWP And CVP, which is also largely the case for D-1641. Accordingly, it is possible that the expected flows under the 2019 BiOps would be reduced over time with new water diversions. As described in other chapters, there are currently applications on file with the State Water Board requesting millions of acre-feet of new water diversions that if approved without appropriate conditions, could reduce the additive benefits of the VAs.

Modular Alternative 6a, Protection of Voluntary Agreement Flows, would identify as part of the program of implementation additional measures to protect the base upon which the VA flows are intended to be added from new or expanded water diversions. Specifically, under this modular alternative, any new point of diversion of water or expanded point of diversion of water would not be authorized to divert water during the January-through-June period unless Delta outflows were at levels determined in the State Water Board's 2017 Scientific Basis Report, or future equivalent analyses, to provide conditions expected to result in the recovery of a wide array of native fish and wildlife species. The Delta above Collinsville is already included in the State Water Board's list of Fully Appropriated Streams (FAS) from June 15 through August 31. This FAS listing also would be proposed to be expanded to include September through December except during high-flow events defined as the wettest 5 percent of historical hydrologic conditions. This alternative also could include an exception for *de minimis* diversions.

The environmental impacts of this modular alternative are evaluated in isolation compared to baseline to properly characterize changes that could occur from the modular alternative, as distinguished from impacts of the proposed VAs.

Overall, the Protection of Voluntary Agreement Flows Alternative would be intended to protect the base upon which VA flows are additive and would not result in changes in hydrology or changes in water supply. Accordingly, the environmental impacts of the Protection of Voluntary Agreement Flows Alternative are not evaluated further because there would not be a change from baseline. However, the Protection of Voluntary Agreement Flows Alternative would have policy-related implications and could constrain future surface water development efforts in California.

9.9.3 Economic Effects

The Protection of Voluntary Agreement Flows Alternative is a modular alternative that would be intended to protect the base upon which the VAs are intended to be added from new or expanded water diversions. This would not result in changes from baseline and therefore no economic effects are identified. It is possible that implementation of this alternative could limit growth in some locations which could also limit future economic growth to some extent.

9.9.4 Achievement of Project Purpose and Goals

The purpose and goals of the project are described in Section 7.1, *Introduction, Project Description, and Approach to Environmental Analysis*. The Protection of Voluntary Agreement Flows Alternative would be intended to protect the base upon which the VAs are intended to be added from new or expanded water diversions, which would help to ensure that fish and wildlife beneficial uses would be protected in the future. However, the alternative could also limit future water development which may not be considered to be reasonable from a policy perspective.

9.10 References Cited

9.10.1 Common References

^National Marine Fisheries Service (NMFS). 2009. Biological Opinion on the Long-Term Central Valley Project and State Water Project Operations Criteria and Plan. Long Beach, CA: Southwest Region. Available: https://www.fisheries.noaa.gov/resource/document/biological-opinion-and-conference-opinion-long-term-operations-central-valley.

^Voluntary Agreements Parties, 2022. Memorandum of Understanding Advancing a Term Sheet for the Voluntary Agreements to Update and Implement the Bay-Delta Water Quality Control Plan, and Other Related Actions. California Natural Resource Agency, California Environmental Protection Agency, State Water Contractors, et. al.

^State Water Resources Control Board (SWRCB). 2017. *Scientific Basis Report in Support of New and Modified Requirements for Inflows from the Sacramento River and its Tributaries and Eastside Tributaries to the Delta, Delta Outflows, Cold Water Habitat, and Interior Delta Flows*.

9.10.2 Section References

California Department of Water Resources (DWR). 2023. Tisdale Weir Rehabilitation and Fish Passage Project. Available: https://water.ca.gov/Programs/Flood-Management/Flood-Projects/Tisdale-Weir. Accessed: August 4, 2023.

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State Water Resources Control Board (State Water Board) 2018. Resolution No. 2018_0059 Adoption of Amendments to the Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary and Final Substitute Environmental Document. Available: https://www.waterboards.ca.gov/board_decisions/adopted_orders/resolutions/2018/rs2018_0059.pdf. Accessed: August 4, 2023.

State Water Resources Control Board. 2020. Tribal Beneficial Uses Fact Sheet. Updated November 2020. Available: https://www.waterboards.ca.gov/tribal_affairs/docs/tbu_fact_sheet_v04.pdf. Accessed: September 20, 2023.

Voluntary Agreement documents submitted by the VA Parties to the State Water Board: please see Appendix G.