Chapter 9
Water Quality

This chapter describes the environmental setting and study area for water quality; analyzes impacts that could result from construction, operation, and maintenance of the project; and provides mitigation measures to reduce the effects of potentially significant impacts. This chapter also analyzes the impacts that could result from implementation of the Compensatory Mitigation Plan (CMP) proposed for the project and describes any additional mitigation necessary to reduce those secondary impacts and analyzes the impacts that could result from other mitigation measures associated with other resource chapters in this Draft Environmental Impact Report (Draft EIR). This chapter addresses water quality of study area surface waters. Groundwater quality is addressed in Chapter 8, *Groundwater*.

9.0 Summary Comparison of Alternatives

The analysis of environmental impacts on surface water quality from the project alternatives addressed impacts from construction and from facility operations and maintenance. Impacts resulting from the proposed CMP are also described. In addition, the potential impacts from the release of pollutants from facility inundation, changes in drainage patterns, and consistency with water quality control plans (WQCPs) are described.

Construction of the project alternatives has the potential to affect water quality because activities would result in land disturbance and the transport and handling of a variety of hazardous and nonhazardous substances. California Department of Water Resources (DWR) would be required to obtain authorization for the construction activities under the State Water Resources Control Board (State Water Board) National Pollutant Discharge Elimination System (NPDES) Stormwater General Permit for Stormwater Discharges Associated with Construction and Land Disturbance Activities (Order No. 2009-0009-DWQ/NPDES Permit No. CAS000002). Furthermore, the project alternatives include on-site treatment of runoff and dewatering water prior to discharge and construction-related environmental commitments and best management practices (BMPs) defined in Appendix 3B, *Environmental Commitments and Best Management Practices*. The impact on water quality from construction of the project alternatives would be less than significant.

Operation of project alternatives' facilities has the potential to affect water quality through differences in Delta inflows from the Sacramento River, relative to existing conditions, resulting in increased proportions of the other Delta inflow waters (eastside tributaries, San Francisco Bay, San Joaquin River) in some regions of the Delta. The discussion of impacts on water quality from facility operations in this chapter addresses boron, bromide, chloride, electrical conductivity (EC), mercury, nutrients, organic carbon, dissolved oxygen, selenium, pesticides, trace metals, total suspended solids (TSS) and turbidity, and cyanobacteria harmful algal blooms (CHABs). The focus on these constituents within this chapter is based on an analysis presented in Appendix 9A, *Screening Analysis*. Impact assessments are based, in part, on modeling results presented in Appendix 9B, *Source Water Fingerprinting*; Appendix 9C, *Boron*; Appendix 9D, *Bromide*; Appendix 9E, *Cyanobacteria Harmful Algal Blooms*; Appendix 9F, *Chloride*; Appendix 9G, *Electrical Conductivity*; Appendix 9H, *Mercury*; Appendix 9I, *Organic Carbon*; Appendix 9J, *Selenium*; and Appendix 9K, *Trace*

Metals. Appendix 9L, *Water Quality 2040 Analysis*, provides information regarding projected conditions for the project alternatives at 2040 compared to the No Project Alternative at 2040 and the No Project Alternative at 2040 compared to existing conditions. Facility operations would have minimal effects on boron, mercury, nutrients, organic carbon, dissolved oxygen, selenium, pesticides, trace metals, and TSS and turbidity, relative to existing conditions, and impacts would be less than significant. There would be increases in bromide, chloride, and EC at some Delta locations, primarily in the western and southern Delta, relative to existing conditions, which also would be less than significant. Facility operations also could affect CHAB potential at some locations within the Delta, although impacts would be less than significant.

The impact on water quality from maintenance of the project alternatives would be less than significant.

Table 9-0 provides a summary comparison of important impacts on water quality by alternative. The table presents the CEQA findings after all mitigation is applied. If applicable, the table also presents quantitative results after all mitigation is applied. The information in Table 9-0 focuses on key aspects of the impact discussions presented in Section 9.3.3.2, *Impacts of the Project Alternatives on Water Quality*. The impact assessments for bromide, chloride, and EC relied on modeling output for 11 Delta locations. The CHABs impact assessment relied on modeling output for residence time, channel velocity, and temperature, among other factors. Because condensing the entirety of modeling output is difficult to present, a single key effect was selected for each constituent in this summary to illustrate the impacts of the project alternatives, relative to existing conditions. Refer to Section 9.3.3.2 for a detailed assessment of all potential water quality impacts.

The project alternatives would result in the potential for increased concentrations of bromide at some Delta locations. The assessment considered the potential frequency that bromide concentrations would exceed 300 micrograms per liter (μg/L), which is the concentration a panel of three water quality and treatment experts, engaged by the California Urban Water Agencies, determined would provide water suppliers adequate flexibility in their choice of drinking water treatment method (California Urban Water Agencies 1998:ES-2). The greatest potential increases in bromide at the Delta assessment locations would occur in the western Delta. In the San Joaquin River at Antioch, which is located in the western Delta, the frequency that monthly average bromide concentrations would potentially exceed 300 μg/L would not increase under the project alternatives, relative to existing conditions based on the modeling results shown in Table 9-0. Modeling results similarly show no increased exceedance of 300 μg/L at interior Delta locations, such as Barker Slough at the North Bay Aqueduct and South Fork Mokelumne River at Terminous, and a decrease of up to 5% at Banks Pumping Plant. The frequency that modeled monthly average bromide concentrations exceed 300 μg/L increased by 3% at Victoria Canal, 2% in the Sacramento River at Emmaton, and 1% or less at the remaining Delta assessment locations under the project alternatives, relative to existing conditions.

The project alternatives would potentially result in increased concentrations of chloride at some Delta locations. At Contra Costa Pumping Plant #1, which has an applicable chloride objective within the *Water Quality Control Plan for the San Francisco Bay/Sacramento–San Joaquin Delta Estuary* (Bay-Delta WQCP), modeled monthly average chloride concentrations under the project alternatives are up to 12 milligrams per liter (mg/L) higher than under existing conditions for the full simulation period (Table 9-0). Increases in modeled monthly chloride concentrations are higher at western Delta locations and lower at interior Delta locations. However, the project alternatives would not cause chloride concentrations to exceed water quality objectives for the protection of municipal and industrial uses contained in the Bay-Delta WQCP, as facility operations under the project alternatives would be operated to the chloride objectives, as implemented through State Water Board Water Right Decision 1641 (D-1641).

The project alternatives would potentially result in increased EC at some Delta locations. However, the project alternatives would not cause more frequent exceedance of the Bay-Delta WQCP water quality objectives for protection of agricultural, and fish and wildlife beneficial uses, as facility operations under the project alternatives would be operated to the EC objectives, as implemented through D-1641. In the Sacramento River at Threemile Slough, a compliance point specified in DWR's contract with the North Delta Water Agency, modeling indicates that long-term average EC would increase (Table 9-0). However, the increases in EC at Threemile Slough would not increase the frequency at which contract EC thresholds would be exceeded.

The CMP would have less-than-significant impacts on all constituents except for mercury. Implementation of the CMP (Appendix 3F, *Compensatory Mitigation Plan for Special-Status Species and Aquatic Resources*), which includes the creation of freshwater emergent perennial wetlands, seasonal wetlands, and tidal habitats, could result in new sources of methylmercury within the Delta relative to existing conditions. There is uncertainty regarding the compensatory mitigation sites becoming new sources for methylmercury loading to the Delta; the sites also could minimally affect methylmercury loading in the Delta. Thus, the compensatory mitigation impact on mercury is potentially significant. Mitigation, which consists of developing and implementing a Mercury Management and Monitoring Plan, would reduce the CMP mercury impact to less than significant for mercury.

Table ES-2 in the Executive Summary provides a summary of all impacts disclosed in this chapter.

Table 9-0. Summary Comparison of Impacts on Water Quality by Alternative

	Alternatives								
Chapter 9 – Water Quality	1	2a	2b	2c	3	4a	4b	4c	5
Impact WQ-3: Effects on Bromide Resulting from Facility Operations and Maintenance Frequency Monthly Average Concentrations would Exceed 300 µg/L in San Joaquin River at Antioch	69% LTS	69% LTS	69% LTS	69% LTS	69% LTS	69% LTS	69% LTS	69% LTS	69% LTS
Impact WQ-4: Effects on Chloride Resulting from Facility Operations and Maintenance Highest Monthly Average Increase in Chloride Concentration at Contra Costa Pumping Plant #1 [a]	10 mg/L LTS	10 mg/L LTS	8 mg/L LTS	12 mg/L LTS	10 mg/L LTS	10 mg/L LTS	8 mg/L LTS	12 mg/L LTS	10 mg/L LTS
Impact WQ-5: Effects on Electrical Conductivity Resulting from Facility Operations and Maintenance Highest Monthly Average Increase in Electrical Conductivity in the Sacramento River at Threemile Slough [a]	61 µmhos/cm LTS	61 µmhos/cm LTS	49 µmhos/cm LTS	54 µmhos/cm LTS	61 µmhos/cm LTS	61 µmhos/cm LTS	49 µmhos/cm LTS	54 µmhos/cm LTS	62 µmhos/cm LTS
Impact WQ-6: Effects on Mercury Resulting from Facility Operations and Maintenance	CMP tidal wetland PS/LTS [b]	CMP tidal wetland PS/LTS [b]	CMP tidal wetland PS/LTS [b]	CMP tidal wetland PS/LTS [b]	CMP tidal wetland PS/LTS [b]	CMP tidal wetland PS/LTS [b]	CMP tidal wetland PS/LTS [b]	CMP tidal wetland PS/LTS [b]	CMP tidal wetland PS/LTS [b]
Impact WQ-14: Effects on Cyanobacteria Harmful Algal Blooms Resulting from Facility Operations and Maintenance	LTS	LTS	LTS	LTS	LTS	LTS	LTS	LTS	LTS

CMP = Compensatory Mitigation Plan; LTS = less than significant; PS/LTS = potentially significant without mitigation/less than significant with mitigation; µg/L = micrograms per liter; µmhos/cm = micromhos per centimeter; mg/L = milligrams per liter.

[a] Average is for the water year 1923–2015 simulation period.

[b] The impact calls are for the CMP effects on mercury. Facility operations and maintenance impacts would be less than significant for all project alternatives.

9.1 Environmental Setting

This section describes the environmental setting and potential environmental impact area for surface water quality. The potential environmental impact area is defined as anywhere a project alternative could cause effects on water quality. This section provides an overview of the study area, describes the primary factors that affect surface water quality, beneficial uses of surface waters, water quality impairments, and existing surface water quality conditions for constituents that are assessed in detail in this chapter.

9.1.1 Study Area

The study area for surface water quality consists of waterbodies upstream of the Delta, the Delta, Suisun Marsh, Suisun Bay, San Francisco Bay, and State Water Project (SWP)/Central Valley Project (CVP) export service areas (i.e., the area in which impacts may occur). The portion of the study area that is upstream of the Delta consists of the portions of the Sacramento River and San Joaquin River watersheds that could be affected by project operations, which includes the Sacramento River from the Delta boundary to Shasta Lake, Feather River from the Sacramento River to Lake Oroville, American River from the Sacramento River to Folsom Lake, and San Joaquin River from the Delta boundary to Millerton Lake. Trinity Reservoir is also included in the study area, as water is diverted from this reservoir into the Sacramento River Basin via the CVP.

9.1.2 Primary Factors Affecting Existing Water Quality

Primary factors affecting water quality in the study area include patterns of land use in the upstream watersheds and the Delta, precipitation, SWP and CVP operations, and in-Delta and upstream point and nonpoint sources of pollutants. The magnitude of the effect that each factor has on water quality in the study area can differ for different constituents and conditions (e.g., hydrologic and climatic) during different times of a given year and across years.

Examples of point and nonpoint sources of pollutants to surface waters in the study area are described below.

- Drainage discharged from inactive and abandoned mines can contribute metals, such as mercury, cadmium, copper, and zinc.
- Stormwater runoff can contribute metals, sediment, pathogens, organic carbon, nutrients, pesticides, dissolved solids (i.e., salts), petroleum products, oil and grease, and other chemical residues.
- Discharges from wastewater treatment plants can contribute salts, metals, trace elements, nutrients, pathogens, organic carbon, and pesticides.
- Agricultural irrigation return flows and nonpoint discharges can contribute salts, organic carbon, methylmercury, nutrients, pesticides, pathogens, and sediment.
- Direct application of herbicides and insecticides for aquatic plant and mosquito control.
- Large dairies and feedlots can contribute nutrients, organic carbon, pesticides, sediment, and pathogens.

- Water-based recreational activities (such as boating) can contribute hydrocarbon compounds, nutrients, and pathogens.
- Atmospheric deposition can contribute metals, pesticides, and synthetic organic chemicals and may lower pH via precipitation.

Water quality in the portion of the study area upstream of the Delta, within the Sacramento River and San Joaquin River watersheds, is affected by the factors listed above as well as watershed hydrology and water management activities, such as reservoir operations and diversions, as they affect reservoir storage levels, releases to downstream rivers, and river flow rates. River flow rates can affect the amount of water available for dilution and assimilation of contaminant inputs from point and nonpoint sources.

Delta water quality is also affected by the point and nonpoint source contributions listed above, tributary inflow rates from the Sacramento River, San Joaquin River, and eastside tributaries (i.e., the Cosumnes, Mokelumne, and Calaveras Rivers), and the tides, which bring seawater from San Francisco Bay up through San Pablo Bay, Suisun Bay, and Suisun Marsh into the Delta. Each river system has its own water quality characteristics, with variable levels of constituents based on watershed characteristics and land use activities. These Delta inflows with different seasonal water quality characteristics mix in different proportions across the Delta, depending on the relative inflow rates (affected by hydrology, upstream diversions, and water management activities), in-Delta gate and barrier operations, CVP/SWP and other in-Delta diversions, and the tidal cycle. The extent of seawater intrusion into the Delta is affected by the tidal cycle and freshwater inflows and outflows that are a function of the combined river inflows into the Delta and in-Delta diversions, with the proportion of seawater being greatest in the western Delta.

9.1.3 Beneficial Uses

Table 9-1 lists the designated beneficial uses for waterbodies in the study area. Beneficial uses of surface waters are designated by California’s nine Regional Water Quality Control Boards (RWQCBs) for waters in their jurisdictions within their respective WQCPs. In addition, the State Water Board has designated beneficial uses for the statutory Delta in its Bay-Delta WQCP. The Delta also falls within the jurisdictions of the Central Valley and San Francisco Bay RWQCBs, which have designated uses for the Delta within their respective WQCPs, the *Water Quality Control Plan (Basin Plan) for Sacramento River Basin and San Joaquin River Basin* and *San Francisco Bay Basin (Region 2) Water Quality Control Plan (Basin Plan)*. Delta water exports are conveyed to service areas that lie within the jurisdictions of the Central Valley and San Francisco Bay RWQCBs, and jurisdictions of the Central Coast, Los Angeles, Santa Ana, and San Diego RWQCBs, which address several other beneficial uses that are unique to those geographic regions.

Table 9-1. Designated Beneficial Uses for Waterbodies in the Study Area

Name [a]	Abbreviation [a]	Beneficial Uses [a]
Designated Beneficial Uses Common to Inland Waters in All RWQCB WQCPs and the Bay-Delta WQCP		
Municipal and Domestic Supply	MUN	Uses of water for community, military, or individual water supply systems including drinking water supply
Agricultural Supply	AGR	Uses of water for farming, horticulture, or ranching including irrigation (including leaching of salts), stock watering, or support of vegetation for range grazing

Name [a]	Abbreviation [a]	Beneficial Uses [a]
Industrial Service Supply	IND	Uses of water for industrial activities that do not depend primarily on water quality, including mining, cooling water supply, hydraulic conveyance, gravel washing, fire protection, and oil well repressurization
Industrial Process Supply	PRO	Uses of water for industrial activities that depend primarily on water quality
Groundwater Recharge	GWR	Uses of water for natural or artificial recharge of groundwater for purposes of future extraction, maintenance of water quality, or halting of saltwater intrusion into freshwater aquifers
Navigation	NAV	Uses of water for shipping, travel, or other transportation by private, military, or commercial vessels
Water Contact Recreation	REC-1	Uses of water for recreational activities involving body contact with water where ingestion of water is reasonably possible, including swimming, wading, water-skiing, skin and scuba diving, surfing, white-water activities, fishing, and use of natural hot springs
Non-Contact Water Recreation	REC-2	Uses of water for recreational activities involving proximity to water but where there is generally no body contact with water or any likelihood of ingestion of water, including picnicking, sunbathing, hiking, beachcombing, camping, boating, tide pool and marine life study, hunting, sightseeing, and aesthetic enjoyment in conjunction with the above activities
Commercial and Sport Fishing	COMM	Uses of water for commercial or recreational collection of fish, shellfish, or other organisms, including uses involving organisms intended for human consumption or bait purposes
Warm Freshwater Habitat	WARM	Uses of water that support warm water ecosystems, including preservation or enhancement of aquatic habitats, vegetation, fish, and wildlife, including invertebrates
Cold Freshwater Habitat	COLD	Uses of water that support cold water ecosystems, including preservation or enhancement of aquatic habitats, vegetation, fish, and wildlife, including invertebrates
Wildlife Habitat	WILD	Uses of water that support terrestrial or wetland ecosystems, including preservation and enhancement of terrestrial habitats or wetlands, vegetation, wildlife (e.g., mammals, birds, reptiles, amphibians, invertebrates), and wildlife water and food sources
Preservation of Biological Habitats of Special Significance	BIOL	Uses of water that support designated areas or habitats, such as established refuges, parks, sanctuaries, ecological reserves, or Areas of Special Biological Significance, where the preservation or enhancement of natural resources requires special protection
Rare, Threatened, or Endangered Species	RARE	Uses of water that support aquatic habitats necessary, at least in part, for the survival and successful maintenance of plant and animal species established under state or federal law as rare, threatened, or endangered
Spawning, Reproduction, and/or Early Development	SPWN	Uses of water that support high quality aquatic habitats suitable for reproduction and early development of fish
Shellfish Harvesting	SHELL	Uses of water that support habitats suitable for the collection of filter feeding shellfish (e.g., clams, oysters, mussels) for human consumption, commercial, or sport purposes
Estuarine Habitat	EST	Uses of water that support estuarine ecosystems, including preservation or enhancement of estuarine habitats, vegetation, fish, shellfish, and wildlife (e.g., estuarine mammals, waterfowl, shorebirds)

Name [a]	Abbreviation [a]	Beneficial Uses [a]
Additional Beneficial Uses of Inland Waters (not common to all WQCPs)		
Migration of Aquatic Organisms [b]	MIGR	Uses of water that support habitats necessary for migration and other temporary activities by aquatic organisms, such as anadromous fish
Freshwater Replenishment [b]	FRSH	Uses of water for natural or artificial maintenance of surface water quantity or quality
Hydropower Generation [c]	POW	Uses of water for hydropower generation
Aquaculture [d]	AQUA	Uses of water for aquaculture or mariculture operations, including propagation, cultivation, maintenance, and harvesting of aquatic plants and animals for human consumption or bait purposes
Inland Saline Water Habitat [e]	SAL	Uses of water that support inland saline water ecosystems, including preservation or enhancement of aquatic saline habitats, vegetation, fish, and wildlife, including invertebrates
Limited Water Contact [f]	LREC-1	Uses of water for recreational activities involving body contact with water, where full REC-1 use is limited by physical conditions such as very shallow water depth and restricted access and, as a result, ingestion of water is incidental and infrequent.
Limited Warm Freshwater Habitat [g]	LWRM	Waters that support warm water ecosystems which are severely limited in diversity and abundance as the result of concrete-lined watercourses and low, shallow dry weather flows which result in extreme temperature, pH, and/or dissolved oxygen conditions. Naturally reproducing finfish populations are not expected to occur in LWRM waters.
Wetland Habitat [f]	WET	Uses of water that support wetland ecosystems, including, but not limited to, preservation or enhancement of wetland habitats, vegetation, fish, shellfish, or wildlife, and other unique wetland functions which enhance water quality, such as providing flood and erosion control, stream bank stabilization, and filtration and purification of naturally occurring contaminants

Sources: Central Coast Regional Water Quality Control Board 2019:8; Central Valley Regional Water Quality Control Board 2018:2-1–2-3; Los Angeles Regional Water Quality Control Board 2019:2-4–2-8; San Diego Regional Water Quality Control Board 2016:2-4; San Francisco Bay Regional Water Quality Control Board 2019:2-1–2-2; Santa Ana Regional Water Quality Control Board 2019:3-2–3-5; State Water Resources Control Board 2018:7–8.

[a] The names, abbreviations, and beneficial use descriptions are not identical in each WQCP.

[b] Beneficial use identified in Central Coast, Central Valley, Los Angeles, San Diego, and San Francisco Bay RWQCB WQCPs.

[c] Beneficial use identified in Central Coast, Central Valley, Los Angeles, San Diego, and Santa Ana RWQCB WQCPs.

[d] Beneficial use identified in Central Coast, Central Valley, Los Angeles, and San Diego RWQCB WQCPs.

[e] Beneficial use identified in Central Coast, Los Angeles, and San Diego RWQCB WQCPs.

[f] Beneficial use identified in Los Angeles RWQCB WQCP.

[g] Beneficial use identified in Santa Ana RWQCB WQCP.

9.1.4 Water Quality Impairments

Section 303(d) of the Clean Water Act (CWA) requires states, territories, and authorized Tribes to develop a ranked list of water quality–limited (impaired) segments of rivers and other waterbodies under their jurisdiction. Listed waters are those that do not meet water quality standards even after point sources of pollution have installed the minimum required levels of pollution control technology. The law requires that total maximum daily loads (TMDLs) be developed to monitor and improve water quality. A TMDL is the sum of the individual waste load allocations from point sources, load allocations from nonpoint sources and background loading, plus an appropriate margin of safety. A TMDL defines the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards. The CWA Section 303(d) list for California, compiled by the State Water Board, identifies Delta waterways, Suisun Marsh and Bay, and San Francisco Bay as impaired for a number of constituents, as shown in Table 9-2 and Table 9-3. The State Water Board's CWA Section 303(d) list also includes numerous other waterbodies or segments of waterbodies in the Sacramento River and San Joaquin River watersheds due to impairments associated with various constituents.

Table 9-2. Clean Water Act Section 303(d) Listed Pollutants and Sources in the Delta, Suisun Bay, and Suisun Marsh

		Delta Region									Specific Delta Waterways																		Suisun	
Pollutant	Listed Source	Central	Eastern	Export Area	Northern	Northwestern	Southern	Stockton DWSC	Western	SF Bay Region [a]	Lower Calaveras River	Bear Creek	Lower Cosumnes River	Duck slough	Five Mile Slough	French Camp Slough	Kellogg Creek	Marsh Creek	Middle River	Lower Mokelumne River	Mormon Slough	Mosher Slough	Old River	Pixley Slough	Sand Creek	Smith Canal	Tom Paine Slough	Walker Slough	Suisun Bay	Suisun Marsh
Arsenic	Source unknown								X																					
Chlordane	Source unknown				X				X																				X	
Chloride	Source unknown									X																	X			X
Chlorpyrifos	Source unknown, agriculture, urban runoff/storm sewers	X	X	X	X	X	X	X	X		X			X	X	X				X	X	X	X	X	X					
Copper	Source unknown											X								X										
DDE/DDT	Source unknown	X	X	X	X	X	X	X	X	X															X				X	
Diazinon	Source unknown, agriculture, urban runoff/storm sewers	X	X	X	X	X	X	X	X		X	X			X	X						X		X	X					
Dieldrin	Source unknown				X				X	X															X				X	
Dioxin	Source unknown							X		X																			X	
Disulfoton	Source unknown																							X	X					
Electrical conductivity/salinity	Source unknown			X		X	X		X								X						X		X		X			X
Furan compounds	Source unknown							X		X																			X	
Group A pesticides [b]	Source unknown	X	X	X	X	X	X	X	X																					
Organophosphorus Pesticides	Source unknown																									X				
Indicator bacteria	Source unknown, urban runoff/storm sewers										X	X	X		X	X	X	X			X	X		X	X	X		X		
Invasive species	Source unknown	X	X	X	X	X	X	X	X	X																			X	

		Delta Region									Specific Delta Waterways																		Suisun	
Pollutant	Listed Source	Central	Eastern	Export Area	Northern	Northwestern	Southern	Stockton DWSC	Western	SF Bay Region [a]	Lower Calaveras River	Bear Creek	Lower Cosumnes River	Duck slough	Five Mile Slough	French Camp Slough	Kellogg Creek	Marsh Creek	Middle River	Lower Mokelumne River	Mormon Slough	Mosher Slough	Old River	Pixley Slough	Sand Creek	Smith Canal	Tom Paine Slough	Walker Slough	Suisun Bay	Suisun Marsh
Mercury	Resource extraction, industrial-domestic wastewater, atmospheric deposition, nonpoint source	X	X	X	X	X	X	X	X	X	X							X		X		X							X	X
Nutrients	Source unknown																													X
Organic enrichment/low dissolved oxygen	Municipal point sources, urban runoff/storm sewers, hydromodification, source unknown							X			X	X			X	X	X		X	X	X	X	X	X		X	X			X
PAHs	Source unknown								X																					
PCBs	Source unknown				X			X	X	X																			X	
Temperature	Source unknown							X																						
TDS	Source unknown																						X							X
Toxicity [c]	Source unknown	X	X	X	X	X	X	X	X							X	X	X		X	X			X	X					
Selenium	Source unknown									X																			X	
Zinc	Source unknown																			X										

Source: State Water Resources Control Board 2021.

DDE = dichlorodiphenyldichloroethylene; DDT = dichlorodiphenyltrichloroethane; EC = electrical conductivity; PAHs = polynuclear aromatic hydrocarbons; PCBs = polychlorinated biphenyls; TDS = total dissolved solids.

[a] Separate listing of impairments for the Delta region within the jurisdiction of the San Francisco Bay RWQCB.

[b] Group A pesticides include aldrin, dieldrin, chlordane, endrin, heptachlor, heptachlor epoxide, benzene hexachloride (BHC) (including lindane), endosulfan, and toxaphene.

[c] Toxicity is known to occur, but the constituent(s) causing toxicity is unknown.

Table 9-3. Clean Water Act Section 303(d) Listed Pollutants and Sources for San Francisco Bay

Pollutant/Stressor	Listed Source	Carquinez Strait	San Pablo Bay	Central	Lower	South
Chlordane	Source unknown	X	X	X	X	X
DDT	Source unknown	X	X	X	X	X
Dieldrin	Source unknown	X	XD Se]	X	X	X
Dioxin	Source unknown	X	X	X	X	X
Furan compounds	Source unknown	X	X	X	X	X
Invasive species	Source unknown	X	X	X	X	X
Mercury	Resource extraction, industrial-domestic wastewater, atmospheric deposition, nonpoint source	X	X	X	X	X
PCBs	Source unknown	X	X	X	X	X
Trash	Source unknown			X	X	
Selenium	Source unknown	X	X	X		X

Source: State Water Resources Control Board 2021.
DDT = dichlorodiphenyltrichloroethane; PCBs = polychlorinated biphenyls.

9.1.5 Existing Surface Water Quality

This section describes the existing surface water quality conditions for constituents analyzed in detail later in this chapter, which was determined per methods described later in Section 9.3.1, *Methods for Analysis*. Constituents discussed include: boron, dissolved oxygen, salinity constituents (EC, chloride, bromide), mercury, nutrients, organic carbon, pesticides and herbicides, selenium, trace metals, TSS and turbidity, and cyanobacteria and cyanotoxins.

9.1.5.1 Boron

Boron is a naturally occurring compound found in sediments and sedimentary rocks in the form of borates (e.g., boron oxide, boric acid, borax). Because of boron's elemental nature, it is not subject to degradation through volatilization, breakdown, or uptake as it moves through the system. Boron, however, does adsorb to mineral soils and organic matter, which allows for its accumulation in soils irrigated with water containing boron. Because of its ability to leach through soils, this partitioning can be considered temporary.

The San Joaquin River is a significant source of boron to the Delta, as is the San Francisco Bay. Contributions of boron to the Delta also originate from the Sacramento River, the eastside tributaries, and Delta agricultural return drains. Agricultural supply, specifically crop irrigation, is the beneficial use most sensitive to boron.

The Central Valley and San Francisco Bay RWQCB WQCPs both contain numeric boron objectives for the protection of the agricultural supply beneficial use. The lower San Joaquin River is listed on the

State Water Board's CWA Section 303(d) list of impaired waterbodies for salt and boron (State Water Resources Control Board 2021). Boron is paired with salt in this listing due to its regular association with saline waters. The Central Valley RWQCB has adopted a TMDL with an implementation program where it assumes action taken to control salts will also control boron, as well-point source discharges containing boron contribute a small fraction of the boron burden to the lower San Joaquin River.

9.1.5.2 Dissolved Oxygen

Dissolved oxygen is oxygen that is present in water. Water gains oxygen from the atmosphere and from aquatic plant and algae photosynthesis. Dissolved oxygen is consumed through respiration by aquatic plants and algae, decomposition of plant and animal material, sediment oxygen demand, cyanobacteria, and various chemical processes. Water temperature and salinity affect water's maximum dissolved oxygen saturation level, which is the highest amount of oxygen water can dissolve. Water flow velocity affects turbulence and the rate at which oxygen from the atmosphere can be dissolved in water.

Dissolved oxygen depletion affects primarily aquatic life beneficial uses, which include warm freshwater habitat; cold freshwater habitat; migration of aquatic organisms and spawning, reproduction, and/or early development; estuarine habitat; and rare, threatened, or endangered species.

The Bay-Delta WQCP and Central Valley RWQCB WQCP contain numeric dissolved oxygen objectives applicable to the Delta, and the San Francisco Bay RWQCB WQCP contains numeric objectives applicable to Suisun Bay and Marsh, and San Francisco Bay for protection of beneficial uses.

Several Delta waterways in the eastern and southern Delta and Suisun Marsh are on the State Water Board's CWA Section 303(d) list for impairments due to low dissolved oxygen (Table 9-2). Notable low dissolved oxygen concentrations in the Delta occur in the Stockton Deep Water Ship Channel, most often during the months of June through October, although low dissolved oxygen conditions have also occurred in the winter months (Central Valley Regional Water Quality Control Board 2005:19). Historical low dissolved oxygen concentrations have been attributed to a combination of low flow and high nutrient loads (U.S. Environmental Protection Agency 2015a:2). Since adoption of the Stockton Deep Water Ship Channel TMDL in 2007, dissolved oxygen conditions have greatly improved. The duration and magnitude with which dissolved oxygen levels are lower than water quality objectives are substantially smaller than before the TMDL adoption (U.S. Environmental Protection Agency 2015a:3). The Port of Stockton operates two aeration facilities in the channel, constructed by DWR in 2007, to improve dissolved oxygen concentrations. The Port of Stockton operates the aerators whenever dissolved oxygen concentrations drop below 5.2 mg/L from December through July, or below 6.2 mg/L from August through November (Port of Stockton 2019:1).

Notable low dissolved oxygen conditions also occur in some locations within Suisun Marsh sloughs, and are attributed to aquatic plant material and detritus decomposition (San Francisco Bay Regional Water Quality Control Board 2018:13). Operations and discharges from managed wetlands within the marsh show a strong adverse effect on dissolved oxygen within the marsh sloughs (San Francisco Bay Regional Water Quality Control Board 2018:13). The San Francisco Bay RWQCB adopted a TMDL to address low dissolved oxygen in the marsh, which was approved by the U.S. Environmental Protection Agency (EPA) in July 2019. The TMDL aims to address low dissolved oxygen/organic enrichment and mercury problems, and evaluate the degree to which nutrients may contribute to dissolved oxygen deficit. The implementation plan is projected to attain the water quality standard within 20 years.

9.1.5.3 Salinity (Electrical Conductivity, Chloride, and Bromide)

Salinity is a measure of dissolved salts in water. Typical salts found in surface waters include the major cations (i.e., calcium, magnesium, sodium, and potassium) and anions (i.e., sulfate, chloride, fluoride, bromide, bicarbonate, and carbonate). The relative proportion of the anions and cations are different in typical freshwater and seawater, with sodium and chloride dominating seawater salinity. Salinity can be characterized in a variety of ways, including as total dissolved solids (TDS) concentrations, chloride concentrations, and EC.

The beneficial uses most affected by salinity levels are municipal, agricultural, and industrial water supply. Additionally, changes in salinity, including tidally influenced interfaces between fresh water and salt water in the Delta, directly affect aquatic organisms and indirectly affect aquatic and wildlife habitats (warm freshwater habitat, cold freshwater habitat, estuarine habitat). Related beneficial uses such as commercial and sport fishing and shellfish harvesting can also be affected by salinity levels.

Salinity can originate from natural sources such as seawater and rainfall-induced leaching of salts from soils. Anthropogenic sources of salinity include drainage from irrigated agricultural lands and managed wetlands, agricultural chemical soil additives, municipal and industrial wastewater discharges, and urban stormwater. Salinity in ditches, canals, and reservoirs increases through evaporative concentration, which occurs during the dry, warm months of the year.

Salinity in the Delta channels varies depending on several factors. The primary source of salinity in the Delta is seawater intrusion from the west, which occurs at greater magnitudes when freshwater Delta outflow to San Francisco Bay is low and/or when tidal flows are high. Hydrology and upstream water management operations influence Delta inflows, which in turn influence the balance with the highly saline seawater intrusion. Delta salinity conditions also are affected by inflow quality as well as in-Delta sources such as agricultural returns, natural leaching, and municipal and industrial discharges. Operation of various Delta gates and barriers and pumping rates of various diversions are other key factors influencing Delta salinity.

Salinity in Suisun Bay is primarily affected by Delta outflow to the bay and tidal inflows from San Francisco Bay. Salinity within Suisun Marsh is similarly affected by inflows from the Delta, Suisun Bay inflows, and the use of the Suisun Marsh Salinity Control Gates, which are located on Montezuma Slough near Collinsville. Gates are operated to restrict the inflow of high-salinity flood-tide water from Grizzly Bay into the marsh, but allow freshwater ebb-tide flow from the mouth of the Delta to pass through. Gate operations lower salinity in Suisun Marsh channels and results in a net movement of water from east to west. When Delta outflow is low to moderate and the gates are not operating, net movement of water is from west to east, resulting in higher-salinity water in Montezuma Slough.

Within San Francisco Bay, Delta waters flow in near the surface and gradually mix into the water column due to its lower density as compared to sea water (Cohen 2000:6). The Delta inflows also create horizontal salinity gradients, with lower-salinity water near the Delta and higher-salinity water near the mouth of the bay (Cohen 2000:6).

The Bay-Delta WQCP includes numeric salinity-related objectives for the Delta and Suisun Marsh. It includes chloride objectives to protect municipal and industrial water supply beneficial uses, and EC objectives for multiple western, interior, and south Delta compliance locations to protect agricultural supply beneficial uses (State Water Resources Control Board 2018:11–13). The Bay-Delta WQCP also specifies salinity objectives for fish and wildlife protection: EC objectives for the Delta and Suisun Marsh, a narrative salinity objective for brackish tidal marshes of Suisun Bay, and the “X2” standard that regulates the location and number of days of allowable encroachment into the west Delta of salinity exceeding 2 parts per thousand isohaline (2.64 milliSiemens per centimeter) (State Water Resources Control Board 2018:14–17). In general, the chloride and EC objectives vary depending on the month and water-year type. Applicable water quality objectives are discussed further in Appendices 9F, *Chloride*, and 9G, *Electrical Conductivity*.

Waterways within the Delta and Suisun Marsh are on the State Water Board’s CWA Section 303(d) list for impairments due to elevated salinity (Table 9-2). The Delta waterways listed as impaired due to elevated EC are within the southern, western, and northwestern portions of the Delta, the export area, the Stockton Deep Water Ship Channel, Old River, and Tom Paine Slough. Tom Paine Slough is also listed as impaired for chloride. Suisun Marsh is listed as impaired due to elevated chloride, EC, and TDS.

In addition to EC and chloride, the salinity-related constituent bromide is of concern in Delta waters because it reacts with ozone and other municipal drinking water treatment plant disinfectants to form bromate, bromoform and other brominated trihalomethanes, and haloacetic acids. The primary source of bromide in the Delta is seawater intrusion. Bromide concentrations also are generally higher in the lower San Joaquin River and Delta island agricultural drainage because of irrigation practices and evaporative concentration that occurs in water diverted from the Delta for irrigated agriculture. Recirculation, or the process of agricultural drainage entering the San Joaquin River and its subsequent and repetitive diversion for agricultural practices, also contributes to elevated bromide concentrations in the San Joaquin River. There are no federally promulgated criteria or state-adopted water quality objectives for bromide in surface waters. A panel of water quality and treatment experts engaged by the California Urban Water Agencies has developed bromide targets based on potential drinking water treatment regulatory scenarios, which are discussed further in Appendix 9D, *Bromide*.

9.1.5.4 Mercury

Mercury and its more biologically available methylated form (i.e., methylmercury) is an element of statewide concern. Elevated methylmercury concentrations in fish tissue produce subsequent exposure and risk to humans and wildlife that consume the fish. Consequently, the beneficial uses most directly affected by mercury are shellfish harvesting and commercial and sport fishing activities that pose a human health concern, and wildlife habitat and rare, threatened, and endangered species resources that can be exposed to bioaccumulation of mercury through the foodweb.

Mercury present in the Delta, its tributaries, Suisun Marsh, and San Francisco Bay today is derived both from current processes and as a result of historical deposition. The majority of the mercury present is the result of historical mining of mercury ore in the Coast Ranges (transported via Putah and Cache Creeks to the Yolo Bypass) and the extensive use of elemental mercury to aid gold extraction processes in the Sierra Nevada (transported via Sacramento, San Joaquin, Cosumnes, and

Mokelumne Rivers) (U.S. Geological Survey 2008:6). Residual mercury in soils affected by historical mining continues to contribute mercury in water and sediments of the Delta and its tributaries.

Over 80% of the total mercury flux to the Delta can be attributed to the Sacramento River and Yolo Bypass (Central Valley Regional Water Quality Control Board 2010a:iv). The Sacramento River is the primary tributary source of mercury to the Delta in dry years, but the proportion of mercury loading from the Yolo Bypass increases in wet years to the extent that it is comparable to that of the Sacramento River (Central Valley Regional Water Quality Control Board 2010a:134). Cache Creek is a major source of mercury to the Yolo Bypass where high mercury concentrations are transported in suspended sediment (Central Valley Regional Water Quality Control Board 2010a:197). Mercury loading from the Delta primarily drives mercury concentrations in northern San Francisco Bay, Suisun Bay, and Suisun Marsh (Central Valley Regional Water Quality Control Board 2010a:197; San Francisco Bay Regional Water Quality Control Board 2018:49).

The bioavailability and toxicity of elemental mercury (from whatever primary source) are greatly enhanced through the natural, bacterial conversion of mercury to methylmercury. This occurs primarily under conditions where oxygen concentrations are low (i.e., anoxic) in the sediment and shores of wetlands and to a lesser degree in the water column. Mercury methylation typically occurs to the greatest degree when associated with wetting and drying cycles and varies among wetland types. Within the Delta, flooded agricultural wetlands have been found to produce more methylmercury than seasonally flooded wetlands and permanently flooded wetlands (Alpers et al. 2014:282). The flux of methylmercury from Delta open water and wetland sediments is estimated to contribute 36% of the waterborne methylmercury load in the Delta (Central Valley Regional Water Quality Control Board 2010a:88). Tributary inflow sources contribute 58% of the methylmercury load in the Delta, and wastewater, agricultural lands, atmospheric deposition, and urban runoff contribute approximately 6% of the methylmercury load (Central Valley Regional Water Quality Control Board 2010a:80).

The EPA approved the Sacramento–San Joaquin Delta Estuary TMDL for methylmercury in 2011 to protect human health, wildlife, and aquatic life. The TMDL establishes methylmercury fish tissue objectives and waste load allocations for agricultural drainage, atmospheric deposition, open water, tributary inputs, wetlands, point source dischargers (e.g., municipal wastewater dischargers), and nonpoint source dischargers (i.e., municipal separate stormwater systems) in the Delta. In conjunction with the mercury and methylmercury load reduction goals of the Delta Methylmercury TMDL, the Central Valley RWQCB developed a Delta Mercury Exposure Reduction Program as an effort involving multiple interested parties to promote a better understanding of mercury bioaccumulation in Delta fish and support approaches for reducing human exposure to mercury from fish caught in the Delta. The Central Valley RWQCB is also developing a statewide mercury control program for reservoirs and a Central Valley mercury control program for rivers.

The San Francisco Bay Mercury TMDL, approved by the EPA in 2008, includes Suisun Bay and describes numeric targets for mercury in fish tissue. The San Francisco Bay Mercury TMDL was expanded to include Suisun Marsh; the Suisun Marsh TMDL is pending EPA approval.

Applicable water quality objectives for mercury and methylmercury in water and fish tissue are identified in Appendix 9H, *Mercury*.

9.1.5.5 Nutrients

Nutrients, primarily nitrogen (N) and phosphorus (P), play a complex role in water quality and the health of aquatic ecosystems. Nitrogen and phosphorus originate from natural sources and anthropogenic sources. Natural sources include rock and soil weathering, atmospheric deposition, and nutrient recycling in sediment. Anthropogenic sources include point and nonpoint source discharges from agricultural operations, wastewater treatment plants, septic systems, combined sewer overflows, and sediment mobilization. In the aquatic environment, nitrogen and phosphorus compounds may rapidly cycle between water, organisms, and sediments. Although nutrients are necessary for a healthy ecosystem, the over-enrichment of nitrogen and phosphorus can lead to a process known as eutrophication. Eutrophication is characterized by development of algae/cyanobacteria blooms, dense macrophyte growth, oxygen depletion, fish kills, and other water quality issues. Nitrogen and phosphorus water quality objectives have not been developed or adopted into WQCPs for waterbodies within the study area.

Phosphorus is generally considered a limiting nutrient in freshwater systems (Schindler et al. 2016:8923), while nitrogen is generally considered a limiting nutrient in marine systems (Paerl et al. 2018:5525). However, in many fresh and estuarine waterbodies it is increasingly recognized that summertime primary productivity (i.e., the process by which organisms make their own food from inorganic sources) may be co-limited by phosphorus and nitrogen (Chorus and Spijkerman 2021:96). A limiting nutrient is one that is in shorter supply for organisms that depend on nutrients for growth relative to the other nutrients, and thus increases or decreases in the limiting nutrient affect primary productivity. In freshwater rivers, phosphorus is usually bound to particles, complexing with elements such as iron. When freshwater enters estuaries and becomes more saline, the P-iron complex disassociates and the phosphorus is released in a form that can be readily absorbed by algae.

The beneficial uses most directly affected by nutrient concentrations include those relevant to aquatic organisms (cold freshwater habitat, warm freshwater habitat, migration habitat, estuarine habitat, and rare, threatened, or endangered species), drinking water supplies (municipal and domestic supply), and recreational activities (water contact recreation, noncontact water recreation), which can be indirectly affected by the nuisance eutrophication effects of nutrients such as excessive algae and macrophyte growth. Nonnative macrophyte growth (i.e., water hyacinth [*Eichhornia crassipes*] and Brazilian waterweed [*Egeria densa*]) stimulated by high nutrient concentrations in some areas of the Delta can cause clogging, pumping failure, and treatment issues during drinking water treatment (Delta Nutrient Drinking Water Workgroup 2017:13). Excessive algae and cyanobacteria growth associated with eutrophication can be a concern for beneficial uses. For example, municipal beneficial uses can be affected as a result of the elevated organic carbon from algal biomass that can affect the disinfection process and cause taste and odor issues.

Classical signs of eutrophication are often found in the central and southern Delta where nutrient enrichment feeds cyanobacteria blooms that can cause areas of oxygen depletion. High nutrient concentrations, warm temperatures, and low flow are conditions shown to be conducive to toxic cyanobacteria with CHABs becoming more prevalent in these central and southern Delta regions (Lehman et al. 2008:191, 199). Recent studies have shown that many of these CHABs are fueled by ammonium, not nitrate (Lehman et al. 2015:165, 2017:94). High nutrient concentrations have also been suggested as facilitating the spread of invasive macrophytes throughout the Delta; however, at this time the exact role of nutrients in driving macrophyte expansion remains unknown (Ta et al. 2017:3).

The highest inputs of phosphorus and nitrogen into the Delta come from the Sacramento and San Joaquin Rivers. South Delta water exports divert much of the San Joaquin River water away from the Delta, thus the Sacramento River delivers the largest supply of nutrients to the Delta (Dahm et al. 2016:1). Yet, despite low flows during summertime the San Joaquin River still contributes almost half of the total nitrogen load to the Delta (Dahm et al. 2016:3). This includes high annual inputs of nitrate-nitrogen to the Delta (3,135 tons of nitrate-nitrogen/year) (Wang et al. 2019:2845).

Unlike most waterbodies where nutrients cause too much primary production, the problem affecting beneficial uses in parts of the Delta is insufficient primary production to support several resident fish populations (Hammock et al. 2019:705 [and references within]). Despite decades of monitoring and intensive research efforts, the cause of low productivity in certain regions remains unclear (Hammock et al. 2019:705). Several hypotheses to explain low productivity have been proposed. Jassby recognizes light as the limiting factor preventing high primary production in the Delta, rather than nutrients (Jassby et al. 2002:705–708; Jassby 2008:14, 19). Dugdale et al. (2007:17, 27) and Parker et al. (2012:574, 580–584) offer another hypothesis: that ammonium (a dominant form of nitrogen in the Delta and Suisun Bay) inhibits the uptake of nitrate, which is more conducive to beneficial algae blooms (i.e., diatoms). Glibert et al. (2011:358, 398–403) suggest that the current form and ratio of nutrients (i.e., elevated nitrogen, resulting in a high nitrogen to phosphorus ratio) in the Delta may give preferential advantage to smaller celled and less nutritious primary producers. Alternatively, other factors contributing to the low primary production may be caused by invasive clams (*Corbicula fluminea* and *Potamocorbula amurensis* [formerly *Corbula amurensis*]) introduced in the mid-1980s that consume algae, reducing food availability for zooplankton and fish (Lucas and Thompson 2012:1, 18–20; Kimmerer et al. 1994:81, 89). It has also been suggested that CVP and SWP exports may decrease phytoplankton abundance transporting the phytoplankton to other areas (Jassby et al. 2002:708; Durand 2015:6; Hammock et al. 2019).

The San Francisco Bay is recognized as a nutrient-enriched estuary. However, dissolved oxygen concentrations are much higher and phytoplankton biomass is much lower than what would be expected in an estuary with such nutrient enrichment (Cloern 1996:150, 159). The Bay has relatively low primary production rates compared to other estuarine coastal ecosystem around the world (Cloern et al. 2014:2483). Observations in recent years suggest that the San Francisco Bay's characteristic nutrient enrichment resilience is weakening (Sutula et al. 2017:107). In response to concerns over nutrient enrichment and low phytoplankton growth, the San Francisco Bay RWQCB worked collaboratively with interested parties to develop the San Francisco Bay Nutrient Management Strategy with goals to manage nutrient loads and maintain beneficial uses within the San Francisco Bay. The program seeks to determine how nutrient concentrations affect environmental conditions within the bay.

Large nutrient loads entering the San Pablo Bay from Suisun Bay, which includes Delta outflows, are the dominant source of nutrients to the San Pablo Bay throughout much of the year (Novick and Senn 2014:3). Therefore, nutrient loads to and transformations within the Delta, combined with Delta outflow, affect nutrient concentrations entering San Pablo Bay. The dissolved inorganic nitrogen and dissolved inorganic phosphorus loads from Suisun Bay dominate nutrient inputs throughout much of the year and are drivers of nutrient-dependent processes (e.g., algae growth).

The influence of Delta-derived freshwater flows is muted in the South Bay and Lower South Bay by oceanic flows in and out of the Golden Gate (Senn and Novick 2014:29–30, 47). The dominant source of dissolved inorganic nitrogen and dissolved inorganic phosphorus year-round in the lower South

Bay, South Bay, and Central Bay is discharge from municipal wastewater treatment plants (Novick and Senn 2014:3).

Suisun Marsh is currently listed as impaired due to nutrients (Table 9-2). Elevated chlorophyll-a and low dissolved oxygen may indicate nutrient-related impairments (Tetra Tech, Inc. and Wetlands and Water Resources 2013:6-16). Sources of nutrients to Suisun Marsh include drainage from agricultural and urban areas, the Delta, nutrient exchange with Suisun Bay, atmospheric deposition, and discharge of treated sewage (San Francisco Bay Regional Water Quality Control Board 2018:18–19).

9.1.5.6 Organic Carbon

In an aquatic system, organic carbon encompasses a broad range of compounds, all of which fundamentally contain carbon in their structure. Organic carbon is a critical part of the foodweb and sustains aquatic life. However, the presence of organic carbon in surface waters is of concern because it is a precursor contributing to disinfection byproduct formation in drinking water treatment plants.

Organic carbon may be contributed to the aquatic environment by degraded plant and animal materials and from anthropogenic sources. Sources of organic carbon in the study area include peat soils; upland, agricultural and urban runoff; wetlands; algae; and municipal wastewater discharges.

Organic carbon is present in all streams and rivers flowing into the Delta; between 50% and 90% of the dissolved organic carbon (DOC) load entering the Delta arrives from upstream sources (CALFED Bay-Delta Program 2008:60). Major in-Delta sources include peat islands (5%–40%), wetlands (5%–30%), and algae (approximately 5%) (CALFED Bay-Delta Program 2008:60). The upstream and internal loads, and their related sources, vary by season (CALFED Bay-Delta Program 2008:60). Approximately 5% to 50% of the in-Delta organic carbon is lost due to internal recycling (CALFED Bay-Delta Program 2008:60).

Across seasons, the San Joaquin River and Sacramento River organic carbon concentrations in inflows to the Delta exhibit a contrasting relationship. The highest concentrations in the Sacramento River occur in the wet months, whereas in the highest concentrations in the San Joaquin River occur in the dry months (Tetra Tech, Inc. 2006:ES-2). The higher dry month San Joaquin River concentrations are attributed to the relatively high contribution of agricultural drainage to total flows in the San Joaquin River during the dry season (Tetra Tech, Inc. 2006:ES-2).

Most organic carbon in the Delta is in the dissolved form, which is generally less bioavailable to the base of the foodweb compared with particulate organic carbon or organic carbon derived from primary production (Tetra Tech, Inc. 2006:2-10). Conversely, DOC has the greatest potential to form disinfectant byproducts in reactions with chlorine as part of drinking water treatment (Tetra Tech, Inc. 2006:2-10).

The Delta is an important source of organic carbon to Suisun Bay and the northern portion of San Francisco Bay, with Delta contributions ranging from 24,500 tons in dry years to 103,600 tons in wet years (Tetra Tech, Inc. 2006:ES-5). Within Suisun Marsh, managed wetlands are the largest direct source of organic carbon to the sloughs. The watersheds surrounding Suisun Marsh also contribute a substantial portion of the organic carbon load via stormwater (San Francisco Bay Regional Water Quality Control Board 2018:42). Organic carbon flows from the Delta into the San

Francisco Bay estuary where it supports microbial production at the base of the foodweb (CALFED Bay-Delta Program 2008:60).

There are no federal or state numeric water quality objectives for organic carbon. There is a state narrative water quality objective applicable to surface waters in the Sacramento River and San Joaquin River basins. In addition, there are federal drinking water treatment requirements related to total organic carbon levels in surface waters. These are discussed further in Appendix 9I, *Organic Carbon*.

9.1.5.7 Pesticides

A pesticide is any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any pest. Pesticides typically occur in the form of chemicals or biological agents (e.g., viruses or bacteria) and are often formulated for specific pests such as weeds (herbicides), insects (insecticides), and fungi (fungicides). Pesticides may be described in two general categories: current use pesticides and legacy pesticides.

Current use pesticides include carbamates (e.g., carbofuran), organophosphates (e.g., diazinon, methyl parathion, malathion), thiocarbamates (e.g., thiobencarb), neonicotinoids (e.g., imidacloprid), and pyrethroids (e.g., permethrin, cypermethrin), a class of synthetic insecticides applied in urban and agricultural areas. EPA has phased out certain organophosphates, or their uses, because of their potential toxicity in humans, which has led to their gradual replacement by pyrethroids.

Legacy pesticides are those that continue to persist in the environment despite being banned from use in the United States in the 1970s through 1990s due to adverse health and environmental effects. Legacy pesticides include primarily organochlorine pesticides like dichlorodiphenyltrichloroethane (DDT) and Group A Pesticides (aldrin, dieldrin, chlordane, endrin, heptachlor, heptachlor epoxide, hexachlorocyclohexane [including lindane], endosulfan, and toxaphene). Disulfoton use in the United States was restricted in 1990 and the manufacturer exited the market in 2009. Therefore, this organophosphate insecticide is considered among the legacy pesticides due its current lack of use. Some of these legacy pesticides are bioaccumulative and can cause adverse effects to wildlife. For example, DDT bioaccumulates in birds and can cause eggshell thinning. Organochlorine pesticides are hydrophobic and prone to accumulation in sediments.

Pesticides, including pyrethroids, organophosphates, carbamate insecticides, herbicides, and fungicides are used extensively throughout the Central Valley. Diazinon is used as an orchard dormant season spray in winter months while chlorpyrifos has been primarily applied to crops during the summer. In 2000, chlorpyrifos registrants entered into a voluntarily agreement with EPA to eliminate, phase out, and modify certain uses. EPA retained limited use in agriculture after it was banned from residential use as a result of this agreement. In 2019, the California Department of Pesticide Regulation and manufacturers agreed to end the sale of chlorpyrifos by 2020. Agricultural applications of diazinon have continued after it was banned from residential use in 2004 by the EPA.

The reduction in organophosphate pesticide use has led to their gradual replacement by pyrethroids over the past 20 years. Pyrethroid insecticide use in urban areas is relatively consistent throughout the year, while urban runoff transporting pyrethroids to surface waters is highest in the winter and spring. The majority of agricultural pyrethroid applications occurs in the dry season (March to November) and water management to control runoff and sediment capture can reduce pyrethroid transport to surface waters (Central Valley Regional Water Quality Control Board 2017a:10).

The critical pathways for pesticides entering rivers, streams, and the Delta include urban stormwater runoff, agricultural irrigation return water, drift from aerial or ground-based spraying, and periodic release of agricultural return flows from rice production (Werner and Oram 2008:3). Wastewater treatment plant discharges can be a source of pyrethroid pesticide inputs to surface waters (Weston and Lydy 2010:1836). Agricultural inputs are dominant, but urban inputs are also substantial in areas of high population density (CALFED Bay-Delta Program 2008:64). The timing of pesticide input to Delta waters is related to application rates, when pesticides are applied to land, runoff events, and other transport processes. The Central Valley RWQCB Irrigated Lands Regulatory Program aims to prevent agricultural runoff containing pesticides from impairing surface waters. Growers are required to implement management practices to protect surface water and must conduct farm evaluations to determine the effectiveness of farm practices in protecting water quality.

Pesticide-specific variables also determine their presence and magnitude in surface waters. Pesticides must be used in a location with hydrologic connectivity to surface water and in amounts that are not easily diluted in the environment if they are to be present in detectable concentrations. The pesticide must be transportable, which is largely determined by its individual chemical properties, such as water solubility, vaporization, and soil sorption. The pesticide must be sufficiently stable in the environment so that the applied pesticide or its degradates, which can also adversely affect beneficial uses, are present during runoff events. Higher degradation rates will result in lower concentrations of the parent compound and possibly greater concentrations of degradates.

Pyrethroid pesticide degradation rates vary but some, such as bifenthrin, can persist for years in the environment. They are highly hydrophobic and adsorb to surfaces of particulates and settle from the water column onto sediments or are transported while attached to particles. Pyrethroids are, therefore, found in sediments of smaller tributaries to a greater degree than they are found in surface waters of major rivers, but have nonetheless been identified as the cause of toxicity in both surface waters and sediment in the Central Valley (Central Valley Regional Water Quality Control Board 2017:57). Only a small fraction of total pyrethroids is freely dissolved in water where they can cause toxicity to aquatic organisms. The Central Valley RWQCB (2017b) Pyrethroid TMDL and Basin Plan Amendment considers this freely dissolved fraction of pyrethroids when determining compliance with concentration goals to account for reduced bioavailability of pyrethroids bound to suspended solids and dissolved organic matter.

Pyrethroids all have a similar mode of toxic action. Consequently, their combined concentrations can cause adverse effects to aquatic life even if each individual pyrethroid concentration is less than levels associated with its individual effects to aquatic life. This additive toxicity is taken into account by the Central Valley RWQCB's chronic and acute concentration goals (Central Valley Regional Water Quality Control Board 2017a:xxix). The sum of pyrethroid concentration-to-concentration goal ratios from six pyrethroids (bifenthrin, cyfluthrin, cypermethrin, esfenvalerate, lambda-cyhalothrin, and permethrin) is termed a concentration goal unit (CGU). A chronic or acute CGU of greater than 1 exceeds the chronic or acute pyrethroid trigger, respectively.

Concern about pesticides is primarily associated with nontarget-organism toxic effects. Pesticides that target insect pests also have the potential to harm other organisms. Pesticides can have toxic effects on the nervous systems of terrestrial and aquatic life, and some are toxic to the human nervous system. Consequently, the beneficial uses most directly affected by pesticides are aquatic organisms (cold freshwater habitat, warm freshwater habitat, and estuarine habitat); rare, threatened, and endangered species; harvesting activities (shellfish harvesting and commercial and sport fishing); and drinking water supplies (municipal and domestic supply).

The entire Delta region is on the State Water Board's CWA Section 303(d) list as impaired by Group A pesticides, DDE/DDT, chlorpyrifos, and diazinon (Table 9-2). Smith Canal within the Delta is impaired by organophosphorus pesticides. Pixie Slough and Sand Creek are impaired by disulfoton. The north and west Delta are impaired by chlordane and dieldrin, while Sand Creek is listed for dieldrin. Pesticide impairments in Suisun Bay include dieldrin and DDT, while Suisun Marsh is impaired by chlordane.

Pesticide data collected under the Delta Regional Monitoring Program reflects recent pesticide conditions in Delta waters. The Delta Regional Monitoring Program monitored 154 current use pesticides and toxicity monthly from July 2015–June 2017 at five major inputs to the Delta: the San Joaquin River at Vernalis, the San Joaquin River at Buckley Cove, the Sacramento River at Hood, Mokelumne River at New Hope Road, and Ulatis Creek at Browns Road (De Parsia et al. 2018:1, 3; Aquatic Science Center 2018:2). All of the water samples detected pesticides, with mixtures ranging from 2 to 25 pesticides. A total of 54 pesticide compounds were detected: 19 fungicides, 18 herbicides, 9 insecticides, 7 breakdown products, and 1 synergist (Aquatic Science Center 2018:1). The most frequently detected pesticide compounds were the herbicides hexazinone (95% of samples) and diuron (73% of samples) and the fungicides boscalid (93% of samples) and azoxystrobin (75% of samples) (Aquatic Science Center 2018:1). Monitoring also found infrequent detection of diazinon (8 of 120 samples) and chlorpyrifos (1 of 120) at five Delta locations (De Parsia et al. 2018:18–41; De Parsia et al. 2019:11–19). None of these detected concentrations exceeded water quality objectives for diazinon (0.1 μg/L) or chlorpyrifos (0.015 μg/L) either individually or when considering additive toxicity. Likewise, pyrethroids insecticides were infrequently detected (i.e., 8 detects) in 120 monthly surface water samples (De Parsia et al. 2018:18–41; De Parsia et al. 2019:11–19). Bifenthrin and cyhalothrin were the only pyrethroids detected. Bifenthrin was detected once in samples from the Sacramento River at Hood and the other detected concentrations of pyrethroids were in samples from Ulatis Creek.

Chronic CGUs for pyrethroids, which are more sensitive than acute CGUs, were exceeded in 1 of 24 samples from the Sacramento River at Hood collected by the Delta Regional Monitoring Program from 2015–2017 (De Parsia et al. 2018:18–41; De Parsia et al. 2019:11–19). Bifenthrin was detected in one sample with a CGU greater than 1. Likewise, the six samples from Ulatis Creek with detected concentrations of bifenthrin also exceeded the chronic CGU trigger. There were no detected pyrethroids in the 24 monthly samples collected by the Delta Regional Monitoring Program in the San Joaquin River at Vernalis, the San Joaquin River at Buckley Cove, and the Mokelumne River at New Hope Road.

Several pesticide control programs and monitoring efforts in the Central Valley aim to address past pesticide-related impairments and prevent potential future impairments within the Delta and in surface waters upstream of the Delta. The Central Valley RWQCB has adopted TMDLs for diazinon and chlorpyrifos for CWA Section 303(d)-listed segments of the Feather River, Sacramento River, and San Joaquin River. Likewise, the Central Valley RWQCB adopted a TMDL for waterbodies that are CWA Section 303(d)-listed as impaired by pyrethroids, including the American River and several tributaries to the Sacramento River, and a Basin Plan amendment for the control of pyrethroids in the entirety of the Sacramento River and San Joaquin River basins (Central Valley Regional Water Quality Control Board 2017b).

9.1.5.8 Selenium

Selenium is an essential trace element for human and other animal nutrition that occurs naturally in the environment. Substantial point sources of selenium do not exist upstream in the Sacramento River watershed or in the watersheds of the east-side tributaries (Cosumnes, Mokelumne, and Calaveras Rivers). Nonpoint sources of selenium within the watersheds of the Sacramento River and the eastside tributaries also are relatively low, resulting in generally low selenium concentrations in the reservoirs and rivers of those watersheds. Selenium occurs naturally on the west side of the San Joaquin River watershed, with elevated concentrations of selenium occurring in the shallow groundwater within the Grassland watershed, which is a valley floor subbasin of the San Joaquin River watershed. Subsurface agricultural drainage discharges from these areas are the major source of selenium to the San Joaquin River and Delta.

Selenium is a constituent of concern in the lower San Joaquin River, the Delta, and San Francisco Bay for potential effects on aquatic and terrestrial biological resources, and indirectly, human health. Selenium is bioaccumulative and is of concern because it can cause chronic toxicity (especially impaired reproduction) in fish and aquatic birds. Because of the known effects of selenium bioaccumulation from aquatic organisms to higher trophic levels in the food chain, the wildlife habitat and rare, threatened, or endangered species beneficial uses are the most sensitive to selenium exposure. Selenium also affects other aquatic life beneficial uses, including warm freshwater habitat; cold freshwater habitat; migration of aquatic organisms; spawning, reproduction, and/or early development; and estuarine habitat. Additional nonhabitat beneficial uses that may be affected include freshwater replenishment, municipal and domestic supply, and agricultural supply.

The San Joaquin River from Mud Slough to Merced River is on the State Water Board's CWA Section 303(d) list as impaired by selenium (Table 9-2). Other waterbodies that drain to the San Joaquin River upstream of this reach and are also listed as impaired by selenium include Mendota Pool, Panoche Creek from Silver Creek to Belmont Avenue, Agatha Canal, Grassland Marshes, and Mud Slough (north, downstream of San Luis Drain). EPA approved TMDLs for selenium for the San Joaquin River from Mud Slough to Merced River in 2002, for Grassland Marshes in 2000, for Agatha Canal in 2000, and for Mud Slough (i.e., north, downstream of San Luis Drain) in 2002. Water column selenium concentrations in the San Joaquin River have continued to decline since implementation of these TMDLs and selenium concentrations are less than the water quality objective of 2 μg/L most of the time (U.S. Environmental Protection Agency 2015b:4).

Suisun Bay is on the State Water Board's CWA Section 303(d) list as impaired due to elevated selenium concentrations (Table 9-2). The selenium impairment is attributed to discharge from natural sources, industrial point sources such as oil refineries, and the presence of exotic species, which increase selenium bioaccumulation into the foodweb (San Francisco Bay Regional Water Quality Control Board 2015:2).

The entire San Francisco Bay also is on the State Water Board's CWA Section 303(d) list as impaired by selenium (Table 9-2). Delta flows, local tributaries, and atmospheric deposition are the primary selenium sources to the northern portion of the bay (San Francisco Bay Regional Water Quality Control Board 2015:2). A selenium TMDL was adopted in 2016 for the North San Francisco Bay, defined to include a portion of the Delta, Suisun Bay, Carquinez Strait, San Pablo Bay, and the Central Bay. Existing selenium concentrations in the San Francisco Bay water column are below the TMDL target and have been declining since the late 1990s. Therefore, the TMDL does not require load reductions below current levels and the implementation plan's main goal is to prevent increases of selenium concentrations in the North Bay and attain safe levels of selenium in fish, specifically benthic feeders (e.g., Sacramento splittail [*Pogonichthys macrolepidotus*] and white sturgeon [*Acipenser transmontanus*]). The TMDL includes a load allocation for the Central Valley watershed (San Francisco Bay Regional Water Quality Control Board 2015:3). The TMDL does not include the South Bay because it is affected by local and watershed sources not associated with the Delta or refineries ; Stewart et al. 2013:41).

EPA developed national recommended chronic aquatic life criteria for selenium, promulgated criteria specific to the San Francisco Bay, Suisun Bay, and Delta, and in 2018 proposed separate selenium criteria for California and the Bay-Delta. The relevant water quality criteria are discussed further in Appendix 9J, *Selenium*.

9.1.5.9 Trace Metals

Trace metals are metals that occur at low levels in the environment and include aluminum, arsenic, cadmium, chromium, copper, iron, lead, manganese, nickel, silver, and zinc. Sources of these metals include natural crustal material, such as soils, and enriched ore deposits. Because of their industrial and commercial utility, trace metals also can be found in urban and agricultural stormwater runoff, landfill and mine leachate, and industrial and municipal wastewater discharges.

Many trace metals are necessary for healthy biological function, where deficiencies in certain trace metals can result in disease. At elevated levels in water, trace metals can be toxic to humans and aquatic life, where the concentration of concern is specific to each metal and each receptor (human or aquatic life). Thus, the beneficial uses of surface waters in the study area most affected by trace metals are aquatic life uses (cold freshwater habitat, warm freshwater habitat, and estuarine habitat), harvesting activities that depend on aquatic life (shellfish harvesting, commercial and sport fishing), and treatment of drinking water supplies (municipal and domestic supply).

Keswick Reservoir downstream of Spring Creek, and Shasta Lake in the area of West Squaw Creek, are listed as impaired on the State Water Board's CWA Section 303(d) list due to cadmium, copper, and zinc (State Water Resources Control Board 2021). The San Joaquin River from Bear Creek to Mud Slough is listed as impaired by arsenic (State Water Resources Control Board 2021). Trace metals impairments in the Delta include arsenic in the western Delta, copper in Bear Creek and the lower Mokelumne River, and zinc in the lower Mokelumne River (State Water Resources Control Board 2021).

Applicable water quality objectives for trace metals include California Toxics Rule criteria promulgated by EPA and narrative and numeric water quality objectives in the Central Valley RWQCB and San Francisco Bay RWQCB WQCPs. The relevant water quality objectives and criteria are discussed further in the effects assessment in Section 9.3, *Environmental Impacts*.

9.1.5.10 Turbidity and Total Suspended Solids

TSS is a measure of the particulate matter that is suspended in the water column, consisting of organic materials (e.g., decaying vegetation) and inorganic materials (e.g., inorganic components of soil). Turbidity is a measure of the optical property of water that causes light to be scattered and absorbed rather than transmitted through the water column. The scattering and absorption of light is caused by: (1) water itself; (2) suspended particulate matter (colloidal to coarse dispersions); and (3) dissolved chemicals. Although suspended solids are only one of the factors affecting turbidity, they are often the dominant one. Thus, there is typically, but not always, a good relationship between turbidity and TSS, but this relationship will vary by waterbody and within a waterbody spatially and seasonally.

Beneficial uses that have the potential to be affected by elevated concentrations of turbidity and TSS are drinking water supplies (municipal and domestic), aquatic life beneficial uses (warm freshwater habitat, cold freshwater habitat, migration of aquatic organisms and spawning, reproduction, and/or early development), and estuarine habitat. Turbidity is a critical measurement for drinking water treatment plants because the constituents suspended in the water affect the filtration systems used to remove disease-causing microorganisms such as viruses, parasites, and some bacteria (e.g., fecal coliform). Turbidity also can reduce the efficiency of disinfection techniques; disinfectants do not selectively target microbes, but rather react with many constituents within the water matrix. Elevated levels of turbidity and TSS limit light penetration into the water column, altering photosynthesis, primary production, and fish behavior (Schoellhamer et al. 2012:3; Bash et al. 2001:21). After runoff events, TSS can settle to cover streambed spawning sites for fish and alter macroinvertebrate habitat.

In the Delta, a declining turbidity trend has been observed. This trend has been attributed to a declining sediment supply and invasive submerged aquatic vegetation, and is believed to have caused, at least in part, changes in Delta ecology and the decline of delta smelt (*Hypomesus transpacificus*) (Hestir et al. 2013:311). The introduction of nonnative clams is believed to have reduced phytoplankton and zooplankton abundance in the western Delta and Suisun Bay (National Research Council 2012:233; Jassby et al. 2002:698; Kimmerer 2002:39, 41, 2004:5), which also may be contributing to increased water clarity and reduced turbidity in the Delta (Hasenbein et al. 2013:622). The Sacramento River supplies the greatest input of sediment to the Delta, followed by the Yolo Bypass, the San Joaquin River, and the eastside tributaries (Wright and Schoellhamer 2005:12). The largest contributor of sediment to San Francisco Bay from the Delta is the Sacramento River-Yolo Bypass system. A recent analysis examining future climate scenarios predicts significant increases in large flow events and sediment loading to the Delta from the Sacramento River over the next century for two representative greenhouse gas concentration pathways (Stern et al. 2020:1). The magnitude of the projected increases is 33% to 38% by years 2040–2069 and 39% to 69% by year 2070–2099, compared to the historical baseline (years 1980–2009) (Stern et al. 2020:9). Suspended sediment entering the Delta, primarily from the Sacramento River, can be transported throughout the system, settle, and be resuspended during increased flow events (Morgan-King and Wright 2016:6).

The human activity that most likely affects sediment delivery to the Delta is soil erosion associated with agricultural and urban land uses. These activities are pertinent because they occur downstream from the major dams on the Sacramento River and San Joaquin Rivers (Schoellhamer et al. 2012:9). Examples include crop production, livestock production, and construction activities. Stormwater runoff and overland flow are the likely mechanisms delivering sediment to streams and larger rivers, although erosion control practices may be implemented to minimize this contribution (Schoellhamer et al. 2012:9).

Water quality objectives for suspended sediment and turbidity are established in the Central Valley and San Francisco Bay RWQCB WQCPs.

9.1.5.11 Cyanobacteria Harmful Algae Blooms

Cyanobacteria (formerly called blue-green algae) are a phylum of bacteria that obtain their energy through photosynthesis. The term CHABs refers to cyanobacteria harmful algae blooms that have the potential to harm human health or aquatic biota. CHABs are a widespread problem in waterbodies worldwide. Although cyanobacteria occur naturally, cultural eutrophication from population growth and associated urban, industrial, and agricultural wastes combined with effects from global climate change have led to the global expansion of CHABs (e.g., Rastogi et al. 2015:1; Glibert 2020:1). Toxins produced by cyanobacteria (i.e., cyanotoxins) have been implicated in human and animal illness and death in over 50 countries, including at least 35 states within the United States (U.S. Geological Survey 2020:2). Cyanotoxins can cause toxicity to phytoplankton, zooplankton, and fish, and also can affect feeding success or food quality for zooplankton and fish (Ger et al. 2018:2384; Acuña et al. 2012a:1191; Acuña et al. 2012b:1). Cyanotoxins can also adversely affect human health (U.S. Environmental Protection Agency 2021:1-4).

CHABs in fresh and brackish water environments typically contain *Microcystis*, *Dolichospermum*, and *Aphanizomenon*. To date, the most common and well-studied cyanobacteria in the Delta is *Microcystis*. As such, most of the information included in this setting is related to *Microcystis*. *Microcystis* has an annual life cycle characterized by two phases. The first is a benthic phase, during which colonies overwinter in the sediment. In the second planktonic phase, which occurs during the summer and early fall months, *Microcystis* enters the water column and begins to grow. When temperatures reach 19 degrees Celsius (°C) (66.2 degrees Fahrenheit [°F]) active (i.e., sediment mixing) and passive processes (i.e., related to the physiological state of the cells) trigger *Microcystis* recruitment from the sediment, the organism is resuspended into the water column (Verspagen et al. 2004:269; Misson and Latour 2012:113; Lehman et al. 2013:141).

There are five primary environmental factors that have been related to the emergence and subsequent growth of *Microcystis* in the water column of Delta waters, which are as follows.

- Water temperatures greater than 19°C (66.2°F)
- Low flows and channel velocities resulting in low turbulence
- Long hydraulic residence times
- Water column irradiance and clarity greater than 50 micromoles per square meter per second (μmoles/m^2/s)
- Sufficient nutrient availability of nitrogen and phosphorus

Furthermore, in waterbodies influenced by salt water, salinity below 10 parts per thousand is more likely to support *Microcystis* growth than salinity above 10 parts per thousand.

The factors listed above have been related to *Microcystis* abundance throughout the Delta (Lehman et al. 2013:141; Berg and Sutula 2015:iii; Preece et al. 2017:33). Yet, the exact processes and interactions of factors that affect development of *Microcystis* blooms in the Delta are complex. There is growing evidence that blooms vary more with wet and dry water year type conditions than with nutrient availability (Lehman et al. 2020:2). However, *Microcystis* growth in the Delta was found to increase linearly when the percentage of ammonium within the total nitrogen pool increased (Lehman et al. 2015:175; Lehman et al. 2020:2). Recent research identified retention time in the Delta and water temperature as the key environmental correlates with *Microcystis* blooms in the Delta (Lehman et al. 2020:1).

In the Delta, CHABs are primarily comprised of the colonial form of *Microcystis* aeruginosa, but single cells are also present (Baxa et al. 2010:343). Other pelagic cyanobacteria including *Aphanizomenon* spp., *Dolichospermum* spp., *Planktothrix* spp., *Pseudanabaena* spp., and *Oscillatoria* have also been detected in the Delta, although generally to a lesser extent than *M. aeruginosa* (Lehman et al. 2010:229; Spier et al. 2013:8; Mioni et al. 2012:20; Berg and Sutula 2015:35; Kurobe et al. 2018:7; Lehman et al. 2020:8). From August through October 2011, *Aphanizomenon* was identified as the most common cyanobacteria genus in the Delta (Mioni et al. 2012:20); however, the species of *Aphanizomenon* that has been shown to occur in the Delta is typically not toxic (Kudela et al. 2015:196). Since it was first observed in the Delta in 1999, annual *Microcystis* blooms have occurred at varying levels throughout the Delta, with blooms typically beginning in the central and southern Delta and spreading seaward into saline environments (Lehman et al. 2008:199; Lehman et al. 2013:146; Lehman et al. 2020:1; California Water Quality Monitoring Council 2021).

Like other regions where *Microcystis* occurs, a mix of toxigenic and non-toxigenic strains occurs in the Delta and toxicity is variable (Baxa et al. 2010:342, 347). Toxigenic strains and appropriate environmental conditions must be present for cyanotoxins to occur (Marmen et al. 2016:9). A number of different secondary metabolites, designated as cyanotoxins, can be produced by cyanobacteria including liver toxins, neurotoxins, and dermatoxins. Production of cyanotoxins associated with CHABs is highly variable and not well understood. Nevertheless, *Microcystis* blooms often produce the liver toxin microcystin (Harke et al. 2016:4) and microcystin is the most frequently documented cyanotoxin in the Delta. Microcystins were first documented in the Delta in 2003 (Lehman et al. 2005:87, 97) and have been detected on numerous occasions since (Lehman et al. 2008:187; 2010:241, 245; 2013:146; 2015:169; 2017:94; Lehman et al. 2021; Spier et al. 2013:8). In addition to producing cyanotoxins, CHABs can create surface scums that interfere with recreation and cause aesthetic problems, produces taste and odor compounds, and lower oxygen levels within the water column (Sutula and Senn 2017:41). Increased microcystin concentrations are generally associated with higher *Microcystis* abundances (Lehman et al. 2013:146).

To date, monitoring for cyanotoxins has been dependent on funds that support bloom response, special projects, or opportunistically at other Delta locations when the Central Valley Water Board or local entities respond to reports of CHAB presence. As such, Delta CHAB and cyanotoxin monitoring has generally been inconsistent and incomplete in terms of geographic coverage, which makes it difficult to assess changes over time. Nevertheless, the California Cyanobacteria and Harmful Algal Bloom Network Harmful Algal Bloom incident report portal and published studies suggest that cyanotoxins are increasing since they were first detected in the Delta.

During the 2014 drought, microcystin concentrations frequently exceeded the World Health Organization provisional drinking water guideline value of 1 μg/L, the EPA 10-day Health Advisories drinking water guidelines of 0.3 μg/L for children under the age of 6 years old (Lehman et al. 2017:105), and the California Caution Action Trigger of 0.8 μg/L. Since 2014 microcystin concentrations have also exceeded EPA recreational guidelines of 8.0 μg/L and the California Danger Tier II trigger for recreational waters of 20 μg/L a number of times at different locations throughout the southern and central Delta including in Discovery Bay, at several locations along the San Joaquin River, and at locations along the Stockton waterfront (California Water Quality Monitoring Council 2021). The neurotoxins anatoxin-a and saxitoxin have also been documented in Delta waters, but concentrations have been low (i.e., below the California Warning Tier II trigger for recreational waters of 20 μg/L) (Central Valley Regional Water Quality Control Board 2019:3; Lehman et al. 2021:1, 8).

Microcystis blooms and associated microcystins have occurred in the SWP/CVP export service area waterbodies including San Luis Reservoir. However, only low levels (i.e., <1 μg/L reportable limit) of microcystins have been measured in Delta waters exported from Banks and Jones Pumping Plants to the SWP and CVP (Palencia Consulting Engineers and Starr Consulting 2017:ES-10). It is unknown if microcystin concentrations in Banks and Jones exports were below the California guidance levels or the EPA 10-day Health Advisory.

Hydrodynamic conditions of rivers in watersheds upstream of the Delta are less conducive to cyanobacteria bloom formation due to high velocity, high turbulence and mixing, and low residence times. Impacts from cyanobacteria blooms have been regularly documented in lakes such as Clear Lake, where high nutrient levels and a calm, stable water column give cyanobacteria a competitive advantage over other phytoplankton during the bloom season. Large reservoirs upstream of the Delta are typically characterized by low nutrient concentrations, where other phytoplankton outcompete cyanobacteria. Historically, cyanobacteria blooms have not occurred in these large reservoirs; however, in recent years cyanobacteria blooms have been documented in several upstream reservoirs. In 2016, which was the fourth year of a severe drought and also one of the hottest years on record, cyanobacteria blooms were documented in certain regions of Shasta Lake (in the Pit River arm) and Lake Oroville (in the Middle Fork of Feather River arm). Low levels of anatoxin-a (i.e., 0.53 μg/L; above the California Caution Action Trigger of "detection") were detected in the bloom located in the Pit River arm of Shasta Lake in 2016 (Pacific Gas and Electric Company 2016:15). In 2019, a cyanobacteria bloom was also noted in the Grizzly Gulch location of Whiskeytown Lake; however, no information on the cyanobacteria genera or toxins is available (California Water Quality Monitoring Council 2021). In 2017 State Water Board staff sampled nine locations in Folsom Lake based on satellite observations suggesting a cyanobacteria bloom was present. Samples indicated *Dolichospermum* spp. was present, and genetic analysis found a low presence of anatoxin-a producing genes, yet cyanotoxins were below detection limits (California Water Quality Monitoring Council 2021).

Microcystis has been observed in Suisun Marsh, but bloom size has remained very small and does not occur annually (Sommer et al. 2020:18; Hammock et al. 2015:319). Visible CHABs do not occur regularly in the embayments of the San Francisco Bay or Suisun Bay, likely due to the intolerance of genera like *Microcystis* to elevated salinity. In fact, moving west from Antioch *Microcystis* abundance decreases substantially and is almost not detectable by Chipps Island (Berg and Sutula 2015:47). However, low levels of microcystins have been detected throughout the San Francisco and Suisun Bay (Peacock et al. 2018:138). The origin of these microcystins is unknown, but the toxin may have come from the Delta, urban run-off, point-source, or smaller freshwater inputs (Peacock et al. 2018:145). Saline conditions can stimulate lysing of cells and cease growth of cyanobacteria species such as *Microcystis*. *Microcystis* growth ceases and breakdown of its cellular tissues starts at salinities of 10–12.6 ppt (Tonk et al. 2007; Black et al. 2011:669–674). Although *Microcystis* has been shown to grow for short periods of time in salinities of 35 ppt, the genera typically does not survive for long periods of time in waters with salinity greater than 10 ppt (Preece et al. 2017:33). San Pablo Bay is the only embayment of San Francisco Bay downstream of Suisun Bay that would experience salinities below 10 ppt for any significant duration of the year, although these and lower salinities would only occur under conditions of high Delta outflow, when cool waters and turbulence would prevent CHAB formation.

Additional information regarding CHABs and factors affecting their presence and abundance in surface waters is provided in Appendix 9E, *Cyanobacteria Harmful Algal Blooms*.

9.2 Applicable Laws, Regulations, and Programs

The applicable laws, regulations, and programs considered in the assessment of project impacts on water quality are indicated in this section, in Section 9.3.1, *Methods for Analysis*, or the impact analysis, as appropriate. Applicable laws, regulations and programs associated with state and federal agencies that have a review or potential approval responsibility have also been considered in the development of CEQA impact thresholds or are otherwise considered in the assessment of environmental impacts. A listing of some of the agencies and their respective potential review and approval responsibilities, in addition to those under CEQA, is provided in Chapter 1, *Introduction*, Table 1-1. A listing of some of the federal agencies and their respective potential review, approval, and other responsibilities, in addition to those under NEPA, is provided in Chapter 1, Table 1-2.

The following summarizes key federal and state laws, regulations, and plans directly related to regulating surface water quality in the study area.

- **Clean Water Act.** The CWA (33 United States Code § 1251 *et seq*.) establishes the basic structure for regulating discharges of pollutants into the waters of the United States (including wetlands) and regulating quality standards for surface waters and gave the EPA the authority to implement control programs. The CWA authorizes the EPA to delegate many permitting, administrative, and enforcement aspects of the CWA to state governments, with the EPA retaining oversight responsibilities. The EPA has delegated various authorities for establishing water quality standards and regulating controllable factors affecting water quality to the State of California. California's State Water Board and nine RWQCBs implement the state's water quality management responsibilities. Portions of the CWA relevant to implementing the project alternatives include Section 401 water quality certifications, Section 402 establishing the NPDES permit program, Section 404 regulating the discharge of dredged or fill material into waters of the United States, and Section 303(d) addressing water quality–related impairments of surface waters. The requirements established by these sections of the CWA were considered in the assessment of impacts in this chapter.
- **Porter-Cologne Water Quality Control Act.** The Porter-Cologne Water Quality Control Act is California's statutory authority for the protection of water quality. Under this act, California must adopt water quality policies, plans, and objectives that ensure beneficial uses of the state are reasonably protected. The Porter-Cologne Water Quality Control Act requires California's nine RWQCBs to adopt WQCPs and establish water quality objectives and authorizes the State Water Board and RWQCBs to issue and enforce permits containing requirements for the discharge of waste to surface waters and land. The project alternatives are within the jurisdiction of the Central Valley RWQCB and San Francisco Bay RWQCB. The State Water Board and RWQCBs have the authority and responsibility to adopt plans and policies, regulate discharges to surface water and groundwater, regulate waste disposal sites, and require cleanup of discharges of hazardous materials and other pollutants. The impact analysis in this chapter considers the water quality objectives and beneficial uses in adopted State Water Board and RWQCB WQCPs.
- ***Water Quality Control Plan for the San Francisco Bay/Sacramento–San Joaquin Delta Estuary*.** The Bay-Delta WQCP identifies beneficial uses of water in the Delta to be protected, water quality objectives for the reasonable protection of beneficial uses, and an implementation program to achieve the water quality objectives (State Water Resources Control Board 2018). Key elements of the Bay-Delta WQCP include salinity-related objectives. In D-1641, the State

Water Board amended the water right license and permits for the SWP and CVP to meet certain objectives in the Bay-Delta WQCP. Specifically, D-1641 places responsibility on DWR and Reclamation for measures to ensure that specified water quality objectives are met. The impact analysis in this chapter considers the water quality objectives and beneficial uses in the Bay-Delta WQCP and implementation of WQCP requirements in D-1641.

9.3 Environmental Impacts

This section describes the direct and cumulative environmental impacts associated with surface water quality that would result from construction and operation of the project alternatives and No Project Alternative. It describes the methods used to determine how project alternatives would cause changes in specified water quality parameters and lists the thresholds used to determine whether such changes in water quality would result in significant impacts to one or more beneficial uses within affected waterbodies. Measures to mitigate (i.e., avoid, minimize, rectify, reduce, eliminate, or compensate for) significant impacts are provided. Indirect impacts are discussed in Chapter 31, *Growth Inducement*.

9.3.1 Methods for Analysis

This section describes the qualitative and quantitative methods used to evaluate surface water quality-related impacts of the project alternatives within the study area. These impacts would be associated with construction and operation of the project and implementation of compensatory mitigation.

9.3.1.1 Evaluation of Construction Activities

Surface water quality effects associated with construction activities were assessed in a qualitative manner, considering the information provided in Chapter 3, *Description of the Proposed Project and Alternatives*, and supporting information cited therein. The potential construction-related water quality effects were assessed considering many aspects of the work involved and potential environmental exposure to contaminants, including the following factors.

- Types of materials and contaminants that may be handled, stored, used, or produced at project facilities during project construction, and which could be released to the environment, and the related fate, transport, and harmful characteristics of the contaminants.
- Magnitude, timing, and duration of the potential contaminant discharges, and exposure sensitivity of waterbodies and beneficial uses that could be affected by the discharge.
- Routes of exposure for contaminants, sediment and other constituents from the construction activity causing potential discharges to sensitive waterbodies, including likelihood of seasonal exposure to rainfall and runoff, proximity of inland work to drainage ways, and occurrence of direct instream discharges.

In addition, the analysis considered the environmental commitments and BMPs incorporated into the project alternatives and presented in Appendix 3B, *Environmental Commitments and Best Management Practices*.

9.3.1.2 Evaluation of Operations and Maintenance

The evaluation of facility operations addresses the surface water quality conditions that would occur following completion of project construction, when the project is operated to convey water through the proposed facilities.

The first step in the evaluation of facility operations effects to surface water quality was to compile and evaluate data for the three major source waters to the Delta—Sacramento River, San Joaquin River, and San Francisco Bay—and conduct a “screening analysis” to identify the appropriate level of analysis needed for each constituent. The screening analysis, detailed in Appendix 9A, provided the first level of analysis for constituents of concern that could be affected by the operation of each alternative. Those constituents and constituent groups identified through the screening analysis procedures as potentially being affected by the alternatives, thus requiring more detailed analysis, are addressed further in Section 9.3.3, *Impacts and Mitigation Approaches*.

The impact analysis in Section 9.3.3 presents a separate assessment for each constituent or constituent group. A combination of both quantitative and qualitative analyses was performed to characterize the changes in surface water quality attributable to facility operations under the alternatives.

The sections below provide additional details regarding the constituent-specific assessments in each portion of the study area.

Upstream of the Delta

Based on a screening level analysis, using CalSim and the HEC-5Q temperature model, there were only small, if any, changes in reservoir storage, river flows, and temperature between project alternatives and existing conditions (Appendix 5A, *Modeling Technical Appendix*). As such, this chapter focuses on water quality changes in the Delta, Suisun Marsh, Suisun Bay, San Francisco Bay, and the SWP/CVP export service areas. Additional discussion regarding impacts in the portion of the study area upstream of the Delta is provided in Section 9.3.3.2, *Impacts of the Project Alternatives on Water Quality*.

Analyses of reverse flow effects upstream of the project alternative intakes indicates that a very slight increase in reverse flows would be associated with intake operations. The results of these analyses are provided in Chapter 5, *Surface Water* and the potential for effects on the Freeport Regional Water Facility and Sacramento River Regional Wastewater Treatment Plant operations are addressed in Chapter 21, *Public Services and Utilities*.

Delta

Effects of facility operations on Delta surface water quality were assessed from modeled changes in constituent levels (i.e., quantitatively) to the extent that data and models were available to do so. Otherwise, effects of facility operations on Delta surface water quality were assessed qualitatively, utilizing modeled changes in factors that could affect the constituent level (e.g., channel velocity, temperature, changes in relative contribution of source waters). Table 9-4 lists the constituent impact categories addressed in detail in this chapter, and identifies whether the constituent assessment was conducted in a qualitative or quantitative manner. Appendix 9A provides additional detail regarding the process for identifying whether a constituent could be assessed quantitatively or had to be assessed qualitatively due to data or modeling tool adequacy.

Table 9-4. Identification of Constituents Analyzed Qualitatively versus Quantitatively for the Delta Region Assessment

Effects and Mitigation Approaches Impact Category	Impact Category Assessed Qualitatively	Impact Category Assessed Quantitatively
Boron	No	Yes
Bromide	No	Yes
Chloride	No	Yes
Dissolved Oxygen	Yes	No
Electrical Conductivity	No	Yes
Mercury/Methylmercury	No	Yes
Nutrients	Yes	No
Organic Carbon	No	Yes
Pesticides	Yes	No
Selenium	No	Yes
Trace Metals	Yes	No
Turbidity/TSS	Yes	No
Cyanobacteria and Cyanotoxins	Yes	No

TSS = total suspended solids.

Qualitative Assessments

The nature of the qualitative assessment was constituent-specific.

- **Dissolved Oxygen**. This assessment considered the environmental factors that affect dissolved oxygen concentrations in Delta channels (e.g., channel velocity, turbulence, temperature) and the degree to which the alternatives would alter these factors and cause substantial concentration reductions in Delta waters and associated adverse effects to beneficial uses. Channel velocity and temperature were modeled using Delta Simulation Model II (DSM2).
- **Nutrients**. This assessment considered the sources of nutrients to surface waters, transport and cycling mechanisms, the relative contributions of the primary Delta inflows (i.e., Sacramento River, San Joaquin River, San Francisco Bay), and the degree to which the alternatives would alter these factors and cause substantial concentration changes in Delta waters and associated adverse effects to beneficial uses.
- **Pesticides**. This assessment considered sources of pesticides to surface waters, pesticides that are in current use, current data regarding pesticide concentrations in Delta source waters and within the Delta, and the degree to which alternatives could affect these factors and result in substantial concentration changes in Delta waters and associated adverse effects to beneficial uses.
- **Trace Metals**. This assessment considered the sources of trace metals to Delta source waters, and concentrations of trace metals in the source waters relative to each other and applicable water quality criteria to make determinations regarding whether the alternatives could result in substantial changes in concentrations in Delta waters and associated adverse effects to beneficial uses.

- **Turbidity/TSS.** This assessment considered the relative source water contributions of suspended sediment to the Delta and environmental factors within the Delta that affect turbidity and TSS levels, and the degree to which the alternatives would affect these factors and result in adverse effects to beneficial uses.
- **Cyanobacteria and Cyanotoxins**. This assessment utilized DSM2-modeled temperature, velocity, and residence time, as well as qualitative changes in nutrients and water clarity to make determinations regarding whether the alternatives could result in substantial changes to these environmental factors in Delta waters. Additional details regarding the assessment methodology are provided in Appendix 9E, *Cyanobacteria Harmful Algal Blooms*.

Quantitative Assessments

Constituents assessed in a quantitative manner—boron, bromide, chloride, EC, mercury, methylmercury, organic carbon, and selenium—were assessed by modeling constituent concentrations (or levels) at multiple assessment locations across the Delta.

As described in Section 9.1.2, *Primary Factors Affecting Existing Water Quality*, Delta water quality is affected, in part, by inflow from the Sacramento River, San Joaquin River, eastside tributaries (i.e., the Cosumnes, Mokelumne, and Calaveras Rivers), San Francisco Bay, and in-Delta agricultural return waters. Modeling was conducted using CalSim 3 to quantify river inflows to the Delta under existing conditions and the alternatives. The modeling of constituent concentrations (or levels) within the Delta under existing conditions and the alternatives relied on output from the DSM2, a one-dimensional mathematical model for dynamic simulation of hydrodynamics, water quality, and particle tracking throughout the Delta. DSM2 can directly model EC and DOC, and also outputs the fraction of each Delta source water (e.g., Sacramento River, San Joaquin River, San Francisco Bay) at selected Delta locations. Details of the DSM2 modeling, including model development, input, and limitations, are provided in Appendix 5A, *Modeling Technical Appendix*.

The period of record modeled by DSM2 was 1923–2015 for boron, bromide, chloride, EC, mercury, methylmercury, and selenium, and results are summarized for the full simulation period and by water year type (i.e., wet, above normal, below normal, dry, and critical). The period of record modeled for organic carbon was 1976–1991, which is the period for which DSM2 can directly model this constituent, and results are summarized for the full simulation period and the 5-year drought period (1987–1991).

The specific Delta locations for which constituent concentrations (or levels) were quantified varied by constituent. The EC assessment locations included the Bay-Delta WQCP compliance locations and three northern Delta locations (additional details are provided in Appendix 9G, *Electrical Conductivity*). The chloride assessment locations also included Bay-Delta WQCP compliance locations, as well as drinking water intake locations (additional details are provided in Appendix 9F, *Chloride*). The boron, bromide, mercury, methylmercury, organic carbon, and selenium assessment locations coincided with the chloride assessment locations to provide a distribution of locations across the northern, western, southern, and interior Delta, as well as the SWP and CVP export area (additional details are provided in Appendix 9C, *Boron*; Appendix 9D, *Bromide*; Appendix 9H, *Mercury*; Appendix 9I, *Organic Carbon*; and Appendix 9J, *Selenium*).

The quantitative assessment method varied by constituent.

- **EC and Organic Carbon.** DSM2 directly models EC and DOC, thus no additional calculation step was necessary to determine these constituents' levels at each Delta assessment location.

Additional details regarding the methodology are provided in Appendix 9G, *Electrical Conductivity*, and Appendix 9I, *Organic Carbon*.

- **Boron.** Concentrations at the Delta assessment locations were calculated using a mass-balance methodology applied to the DSM2-modeled source water flow fractions at each assessment location. Additional details regarding the calculations to quantify concentrations are provided in Appendix 9C, *Boron*.
- **Mercury, Methylmercury, and Selenium.** Concentrations were calculated using a mass-balance methodology applied to the DSM2-modeled source water flow fractions at each assessment location. In addition, bioaccumulation modeling was conducted to quantify changes in biota concentrations. Additional details regarding the calculations to quantify water column and biota concentrations are provided in Appendix 9H, *Mercury*, and Appendix 9J, *Selenium*.
- **Bromide and Chloride.** Concentrations were calculated using a mass-balance methodology applied to the DSM2-modeled source water flow fractions at northern, interior, and export area Delta assessment locations. For western Delta locations and interior locations where concentrations are largely influenced by sea water contributions, concentrations were calculated from relationships between EC and chloride, and chloride and bromide. Additional details regarding the calculations applied to each location to quantify concentrations are provided in Appendix 9D, *Bromide*, and Appendix 9F, *Chloride*.

A key assumption for the constituent concentrations resulting from the mass-balance calculation is that the constituent acts in a conservative manner, meaning that there is no decay, uptake, transformation, sorption, or other losses of the constituent in the water column as the various source waters mix and flow through the Delta. The mass-balance method for calculating constituent concentrations in the Delta was validated in 2011 and 2012 for chloride and bromide (MWH 2011:21–34; California Department of Water Resources 2012:5-24). No formal studies have been performed to validate the mass-balance method for boron, mercury, and selenium, though the validation studies performed to date on chloride and bromide have validated the approach for using DSM2 to evaluate changes in mixing of Delta source waters on water quality constituents. Furthermore, although mercury and selenium do not behave conservatively in the Delta, the mass-balance method is believed valid for assessing comparative effects of changed source water mixing on constituent concentrations, because altered mixing of Delta source waters is one of the primary mechanisms by which the alternatives could change Delta water quality. The model results are not meant to be taken as predictions of future concentrations, since known mechanisms such as sorption, settling, and transformation are not quantitatively taken into account; rather, modeled water and biota tissue concentrations are to be used to assess water quality differences between alternatives and to make determinations regarding potential effects on beneficial uses relative to the assessment baseline (i.e., existing conditions), which is also a modeled condition to provide a consistent basis of comparison.

Modeling results were used in a comparative mode, rather than a predictive mode, to make determinations regarding potential effects of the project alternatives on boron, bromide, chloride, DOC, EC, mercury, and selenium, relative to existing conditions. As explained in Appendix 5A, *Modeling Technical Appendix*, Section A.15, *Appropriate Use of Modeling Results*, the models used for this assessment are generalized and simplified representations of a complex water resources system, not predictive models of project operations; thus, model results are only useful in a comparative analysis.

Suisun Marsh, Suisun Bay, and San Francisco Bay

Because net Delta flows move seaward, water quality constituents present in the Delta water column could potentially be transported to Suisun Marsh, Suisun Bay, and farther into San Francisco Bay. The assessment of effects to these waterbodies was conducted qualitatively, based on projected changes in constituent concentration/levels that would occur in the Delta and CalSim 3-modeled changes in Delta outflow under the alternatives.

SWP/CVP Export Service Areas

Water quality changes at the Banks and Jones Pumping Plants and Barker Slough at the North Bay Aqueduct export pumps served as the basis for making determinations of water quality changes within the SWP/CVP export service area waterbodies. Constituent concentrations/levels at these locations were determined using the same method of analysis—qualitative or quantitative—for each constituent or constituent group as defined for the Delta (Table 9-4).

Qualitative Assessments

Water quality changes in the SWP/CVP export service area waterbodies were assessed qualitatively, with consideration of the initial quality of water exported from the Delta and dilution, transformation, uptake, and loss in conveyance facilities, to the extent such factors were applicable to the constituents evaluated.

Quantitative Assessments

The quantitative assessment of effects of the project alternatives on the quality of water exported to the SWP/CVP export service areas was conducted relative to modeled changes in constituent concentrations and levels at the Banks and Jones Pumping Plants in the south Delta, and in Barker Slough at the North Bay Aqueduct.

Calculation of constituent concentrations for water exported at the Banks and Jones Pumping Plants to SWP/CVP export service areas required an additional mass-balance calculation step beyond that described above. DSM2 is not structured to directly model EC, DOC, or source water flow fractions at Banks and Jones Pumping Plants that account for water sourced from proposed north Delta intakes. To account for water from the north Delta intakes coming into the pumping plants and being exported, EC, DOC, and source water fractions at the export pumps were blended according to the following equation.

$$C_{EXP} = \frac{Q_N C_N + Q_S C_S}{Q_N + Q_S}$$

In the equation above, Q_N is the Sacramento River flow diverted at the north Delta intakes to either Banks or Jones pumping plants, C_N is the value of the water quality constituent (EC, DOC, or source water concentration) in the Sacramento River at Greene’s Landing (used as representative of intake water quality), Q_S is the Delta water pumped into either Banks or Jones pumping plants, C_S is the value of the water quality constituent (i.e., concentration or level) at the south Delta intakes for the pumping plants, and C_{EXP} is the concentration or level of the water quality constituent in the exported water.

Under Alternative 5, water diverted at the north Delta intakes would be conveyed directly to Bethany Reservoir, the upstream terminus of the California Aqueduct into which Banks Pumping

Plant water is pumped. Under all other project alternatives, North Delta intake water would be conveyed to the California Aqueduct through the Banks Pumping Plant. For purposes of graphically presenting modeling output and discussing effects of the project alternatives together, the term "Banks Pumping Plant" is used to label the export concentrations for the California Aqueduct. However, for Alternative 5, it should be noted that the modeling results are actually for water delivered to Bethany Reservoir from both the north Delta intakes and the Banks Pumping Plant.

9.3.2 Thresholds of Significance

The water quality effects of a project alternative would be significant under CEQA if implementation of the alternative would result in one of the numbered conditions below. As is explained in more detail below, the thresholds build on and add detail to general questions posed in the CEQA Guidelines Appendix G Environmental Checklist Form. The refinements to the language set forth in that document reflect the application of professional judgment and experience to the more general language found in the original. Thus, the water quality effects of a project alternative would be significant if the alternative would do any of the following things.

1. Cause exceedance of applicable state or federal numeric or narrative water quality objectives/criteria or other relevant water quality effects thresholds identified for this assessment from the scientific literature by frequency, magnitude, and geographic extent that would result in adverse effects on one or more beneficial uses of affected waterbodies.
2. Increase levels of a bioaccumulative pollutant by frequency, magnitude, and geographic extent such that the affected waterbody (or portion of a waterbody) would be expected to have measurably higher body burdens of the bioaccumulative pollutant in aquatic organisms that result in substantially increasing the health risks to wildlife (including fish) or humans consuming those organisms.
3. Cause long-term degradation of water quality in affected waterbodies that would result in substantially increased risk for adverse effects on one or more beneficial uses.
4. Further degrade water quality by measurable levels, on a long-term basis, for one or more parameters that is already impaired, and thus included on the State's CWA Section 303(d) list for the waterbody, such that beneficial use impairment would be made discernibly worse.
5. Risk release of pollutants from project facilities upon project facility inundation that would cause degradation of water quality in affected waterbodies at levels and duration that would result in substantially increased risk for adverse effects to one or more beneficial uses.
6. 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: (a) result in substantial erosion or siltation on- or off-site, or (b) create or contribute runoff water which would provide substantial additional sources of polluted runoff causing siltation or pollution to enter one or more affected waterbodies at levels and frequency that would adversely affect one or more beneficial use.
7. Violate waste discharge requirements issued to the project for construction-related activities.
8. Conflict with or obstruct implementation of a WQCP.

The third, fourth and fifth effects assessment criteria/thresholds listed above address water quality degradation. The third effects assessment criterion/threshold is triggered by demonstrated water quality degradation, on a long-term basis, that results in water quality conditions that substantially increase the likelihood of adverse effects to beneficial uses. The fourth effects assessment criterion/threshold above is included in recognition that an adverse effects determination should be more sensitive when water quality conditions are already impaired in a waterbody. This fourth effects assessment criterion/threshold provides meaningful sensitivity for already impaired conditions by requiring measurable changes, on a long-term basis, rather than “any” change at any time (i.e., a change that could be calculated, but may not be measurable in the actual environment, or may not occur frequently enough to measurably alter water quality on a long-term basis). The fifth effects assessment criterion/threshold listed above addresses the potential for release of pollutants that would degrade water quality in the event that project facilities become inundated by river flood flows.

9.3.2.1 Evaluation of Mitigation Impacts

CEQA also requires an evaluation of potential impacts caused by the implementation of mitigation measures. Following the CEQA conclusion for each impact, the chapter analyzes potential impacts associated with implementing both the CMP and the other mitigation measures required to address potential impacts caused by the project. Mitigation impacts are considered in combination with project impacts in determining the overall significance of the project. Additional information regarding the analysis of mitigation measure impacts is provided in Chapter 4, *Framework for the Environmental Analysis*.

9.3.3 Impacts and Mitigation Approaches

9.3.3.1 No Project Alternative

As described in Chapter 3, *Description of the Proposed Project and Alternatives,* CEQA Guidelines Section 15126.6 directs that an EIR evaluate a specific alternative of “no project” along with its impact. The No Project Alternative in this Draft EIR represents the circumstances under which the project (or project alternative) does not proceed and considers predictable actions, such as projects, plans, and programs, that would be predicted to occur in the foreseeable future if the Delta Conveyance Project is not constructed and operated. This description of the environmental conditions under the No Project Alternative first considers how water quality could change over time in the Delta and then discusses how other predictable actions could affect water quality.

Future Water Quality Conditions

Under the No Project Alternative, the greatest effect on Delta water quality in the future would be increases in salinity constituent levels, particularly in the western Delta. Seawater is a primary source of bromide, chloride, and higher EC levels, and anticipated effects of climate change on sea level rise would be a primary factor in the elevated levels of these constituents relative to existing conditions. Similarly, climate change–driven effects on water temperature and potentially lower inflows in the summer months would be expected to contribute to more frequent or more extensive cyanobacteria blooms in the Delta than occur under existing conditions. Climate change and associated large flow events could result in higher sediment loading to the Delta. The resulting effects on Delta TSS and turbidity levels are uncertain, but it is expected that TSS and turbidity levels would be at least as high as those under existing conditions given the additional sediment loading. Little change in boron, DOC, dissolved oxygen, mercury, pesticides, selenium, and trace metals within Delta waters relative to existing conditions is expected. Refer to Appendix 9L, *Water Quality 2040 Analysis*, for additional information regarding projected conditions under the No Project Alternative at 2040 compared to existing conditions.

No construction or modification to SWP or CVP facilities or operations would occur under the No Project Alternative. Under the No Project Alternative, DWR would continue to operate the SWP to divert, store, and convey SWP water consistent with applicable laws and contractual obligations. Because of the interrelated operation of the SWP and CVP, the No Project Alternative would also assume the current operation of the CVP would continue. However, public water agencies may pursue projects to ensure a reliable, secure, and safe water supply for the future. These potential projects and resulting impacts on water quality are discussed in the following section.

Predictable Actions by Others

A list and description of actions included as part of the No Project Alternative are provided in Appendix 3C, *Defining Existing Conditions, No Project Alternative, and Cumulative Impact Conditions*. As described in Chapter 4, *Framework for the Environmental Analysis,* the No Project Alternative analyses focus on identifying the additional water-supply related actions public water agencies may opt to follow if the Delta Conveyance Project does not occur.

Public water agencies participating in the Delta Conveyance Project have been grouped into four geographic regions. The water agencies within each geographic region would likely pursue a similar suite of water supply projects under the No Project Alternative (Appendix 3C). Construction and operation of water supply reliability projects have the potential to affect the water quality of surface waters within the four regions. Table 9-5 provides examples of how surface water quality could be affected.

Table 9-5. Examples of Effects on Water Quality from Construction and Operation of No Project Alternative Projects

Project Type	Potential Water Quality Impacts	Region(s) in Which Impact Would Likely Occur
Increased/ accelerated desalination	<u>Potential Construction Impacts</u>: Temporary water quality degradation as a result of erosion or siltation caused by earthmoving activities or by the accidental release of hazardous construction chemicals if the construction areas are not properly managed through implementation of construction best management practices. <u>Potential Operations and Maintenance Impacts</u>: Long-term water quality degradation (e.g., salinity, metals) from brine disposal in the zone of initial mixing with ocean waters.	Northern Coastal, Southern Coastal
Groundwater management	<u>Potential Construction Impacts</u>: Temporary water quality degradation as a result of groundwater discharges during well development and testing. <u>Potential Operations and Maintenance Impacts</u>: Temporary water quality degradation as a result of groundwater discharges during well maintenance.	Northern Coastal, Southern Coastal

Project Type	Potential Water Quality Impacts	Region(s) in Which Impact Would Likely Occur
Groundwater recovery (brackish water desalination)	Potential Construction Impacts: Temporary water quality degradation as a result of erosion or siltation caused by earthmoving activities or by the accidental release of hazardous construction chemicals if the construction areas are not properly managed through implementation of construction best management practices; temporary water quality degradation as a result of groundwater discharges during well development and testing. Potential Operations and Maintenance Impacts: Long-term water quality degradation (e.g., salinity, metals) from brine disposal in the zone of initial mixing with ocean waters.	Northern Inland, Southern Coastal, Southern Inland
Water recycling	Potential Construction Impacts: Temporary water quality degradation as a result of erosion or siltation caused by earthmoving activities or by the accidental release of hazardous construction chemicals if the construction areas are not properly managed through implementation of construction best management practices. Potential Operations and Maintenance Impacts: None	Northern Coastal, Northern Inland, Southern Coastal, Southern Inland
Water use efficiency measures	Potential Construction Impacts: Temporary water quality degradation as a result of erosion or siltation caused by earthmoving activities or by the accidental release of hazardous construction chemicals if the construction areas are not properly managed through implementation of construction best management practices; temporary water quality degradation as a result of groundwater discharges during well development and testing. Potential Operations and Maintenance Impacts: None	Northern Coastal, Northern Inland, Southern Coastal, Southern Inland

Desalination projects would most likely be pursued in the northern and southern coastal regions. The southern coastal regions would likely require larger and more desalination projects than the northern coastal region to replace the water yield that otherwise would have been received through the Delta Conveyance Project if suppliers were to pursue that means of meeting demands. These projects would be sited near the coast. Groundwater recovery (brackish water desalination) would involve similar types of construction but could occur across the northern inland, southern coastal, southern inland regions and in both coastal and inland areas, such as the San Joaquin Valley. Grading and excavation at the desalination and groundwater recovery plant sites would be necessary for construction of foundations, and trenching would occur for installation of water delivery pipelines and utilities. Ground-disturbing activities in these types of units would have the potential to temporarily degrade water quality as a result of runoff from construction sites containing silt or hazardous construction chemicals, if not properly managed through implementation of construction BMPs. Long-term surface water quality degradation (e.g., salinity, metals) from associated brine disposal could occur in the zone of initial mixing with ocean waters.

The northern and southern coastal regions are also most likely to explore constructing groundwater management projects. The southern coastal region would require more or larger projects than the northern coastal region under the No Project Alternative if suppliers were to pursue that means of meeting demands. Groundwater management projects would occur in association with an underlying aquifer but could occur in a variety of locations. Construction activities for each project could require excavation for the construction of the recharge basins, conveyance canals, and pipelines and drilling for the construction of recovery wells (with completion intervals between approximately 200 and 900 feet below ground surface). Construction activities would include site clearing; excavation and backfill; and construction of basins, conveyance canals, pipelines, pump stations, and the turnout. Grading activities associated with the construction of recharge basins would involve earthmoving, excavation, and grading. Canals and pipelines would likely be constructed using typical open trench construction methods. In some cases where siphons would be installed, jack and bore methods could be used to tunnel under and avoid disruption of surface features. Excavation of varying depths could be required, and these construction activities have the potential to affect water quality in waterbodies containing special status fish and aquatic resources, depending on location. Ground-disturbing activities in these types of units would have the potential to temporarily degrade water quality as a result of runoff from construction sites containing silt or hazardous construction chemicals, if not properly managed through implementation of construction BMPs. These projects would not be expected to result in long-term effects on surface water quality, as long as the groundwater projects were focused on deeper aquifers and did not affect stream recharge.

Groundwater recovery projects could be pursued in the northern inland, southern coastal, and southern inland regions. These types of projects would include construction activities similar to those described above for desalination and groundwater management projects. The construction-related ground-disturbing activities in these types of units also would have the potential to temporarily degrade water quality as a result of runoff from construction sites containing silt or hazardous construction chemicals, if not properly managed through implementation of construction BMPs. These projects would not be expected to result in long-term effects on surface water quality, as long as the groundwater projects were focused on deeper aquifers and did not affect stream recharge.

Water recycling projects could be pursued in all four regions. The northern inland region would require the fewest number of wastewater treatment/water reclamation plants, followed by the northern coastal region, followed by the southern coastal region if suppliers were to pursue that means of meeting demands. The southern inland region would require the greatest number of water recycling projects to replace the anticipated water yield that it would receive through the Delta Conveyance Project. These projects would be located near wastewater treatment and recycling facilities. Construction techniques for water recycling projects would vary depending on the type of project (e.g., for landscape irrigation, groundwater recharge, dust control, industrial processes) but could require earth moving activities, grading, excavation, and trenching. Ground-disturbing activities in these types of units would have the potential to temporarily degrade water quality as a result of runoff from construction sites containing silt or hazardous construction chemicals, if not properly managed through implementation of construction BMPs. In the southern inland region where a greater number of projects would be needed as a substitute for the Delta Conveyance Project, the potential for impact would also be greatly increased. Increased water reclamation could lead to reduced municipal wastewater treatment plant discharge rates to surface waters, which would have mixed results on surface water quality. Surface water discharges are required through compliance with NPDES permits to meet effluent limitation and not cause exceedance of water quality criteria/objectives. However, some of these discharges may currently be causing some water quality degradation, which would be reduced should there be a reduction in discharges associated with water recycling projects. There may be receiving waters where wastewater treatment plant discharges dilute other lower quality discharges, in which case there could be more degradation associated with those other discharges.

Water efficiency projects could be pursued in all four regions and would involve a wide variety of project types, such as flow measurement or automation in a local water delivery system, lining of canals, use of buried perforated pipes to water fields, and additional detection and repair of commercial and residential leaking pipes. These projects could occur anywhere in the regions and most would involve little ground disturbance or would occur in previously disturbed areas, thereby limiting their potential for construction and operations impacts on water quality.

All project types across all regions would involve relatively typical construction techniques and would be required to conform with the requirements of CEQA and other regulations protecting surface water quality. Environmental commitments and BMPs would be developed to protect water quality, such as those described in Appendix 3B.

Operations effects of the projects could be minimized through design and implementation of mitigation measures. Water quality impacts from the discharge of brine to ocean waters could be minimized by proper siting of outfalls and ensuring sufficient dilution of the discharges so as to not adversely affect beneficial uses. Water quality impacts from discharges of groundwater for well maintenance could be minimized through testing of water and identification of suitable receiving waters to receive the groundwater discharge.

9.3.3.2 Impacts of the Project Alternatives on Water Quality

This section presents the impacts of the project alternatives on the water quality within study area surface waterbodies. The impact of the construction of the project alternatives is presented first, followed by separate operations and maintenance impact discussions for the constituents carried forward for detailed analysis, per the results of the screening analysis presented in Appendix 9A, *Screening Analysis*. Impact discussions also are provided for the project alternatives' effects on the risk of release of pollutants from project inundation, drainage patterns, and consistency with WQCPs.

As stated in the Section 9.3.1, *Methods for Analysis*, a screening analysis of numerous water quality constituents was conducted. This analysis assessed the potential effects from facility operations for the project alternatives relative to existing conditions on 587 constituents and constituent classes. Constituents included in the screening analysis were identified based on availability of historical monitoring data, adopted federal water quality criteria or state water quality objectives, constituents on State Water Board's CWA Section 303(d) list for Delta impairments, public scoping comments, and professional judgment.

Of the 587 constituents and constituent forms or classes assessed in the screening analysis, 320 were never detected in the three primary Delta source waters (i.e., Sacramento River, San Joaquin River, and San Francisco Bay water) and 267 were detected at least once at a source water monitoring location. Of the 320 constituents never detected in Delta source waters, 9 were carried forward for further assessment because they are included on the State Water Board's CWA Section 303(d) list for the Delta. Of the 267 constituents detected in Delta source waters, 99 were carried forward for further assessment because their levels detected in the source waters were greater than water quality criteria/objectives, they are on the State Water Board CWA Section 303(d) list, they have the potential to contribute to water quality degradation, or are constituents of concern based on professional judgment or public scoping. In addition, constituents classified as being of emerging concern, such as endocrine disrupting compounds, were included based on professional judgment. Thus, a total of 100 constituents and constituent forms or classes were carried forward for further assessment beyond the screening analysis. These 100 constituents and constituent forms or classes represent 61 individual constituents or constituent classes when dissolved and total fractions (e.g., total mercury, dissolved mercury) or forms (e.g., BHC-alpha, BHC-beta, BHC-delta, and BHC-gamma are represented by BHC) are consolidated.

Ten of the 61 constituents and constituent classes are addressed further in Appendix 9A because they do not warrant alternative-specific analyses because of various factors, including insufficient data characterizing source water concentrations (e.g., endocrine disrupting compounds), the constituent is addressed via another constituent assessed in detail herein (e.g., sulfate and TDS are addressed via changes in EC), or the constituent would not be affected by the project alternatives due to its source(s). The remaining 51 constituents are addressed further.

The potential effects on CHABs formation potential from facility operations for the project alternatives also is addressed. Temperature is addressed within this chapter with respect to effects on dissolved oxygen and CHABs, and with respect to potential impacts on aquatic biological resources in Chapter 12, *Fish and Aquatic Resources*. Table 9-6 identifies the specific impact category in which each constituent analysis is presented.

Table 9-6. Water Quality Constituents for Which Detailed Assessments Are Performed

Effects and Mitigation Approaches Impact Category	Constituents Addressed
Boron	Boron
Bromide	Bromide
Chloride	Chloride
Dissolved Oxygen	Oxygen (Dissolved)
Electrical Conductivity	EC
Mercury	Mercury, Methylmercury
Nutrients	Ammonia, Nitrate, Nitrite, Kjeldahl Nitrogen, Organic Nitrogen, Phosphorus
Organic Carbon	Organic Carbon
Pesticides	Aldrin, BHC, BHC-alpha, BHC-beta, BHC-delta, BHC-gamma [lindane], chlordane, chlorpyrifos, diazinon, dieldrin, endosulfan [mixed isomers], endosulfan-I, endosulfan-II, endrin, heptachlor, p,p’-DDD, p,p’-DDE, p,p’-DDT, toxaphene
Selenium	Selenium
Trace Metals	Aluminum, Arsenic, Cadmium, Chromium, Copper, Iron, Lead, Manganese, Nickel, Silver, and Zinc
Turbidity/TSS	Turbidity, TSS
Cyanobacteria and Cyanotoxins	(Not part of screening analysis)

TSS = total suspended solids.

Within each constituent-specific assessment, the discussion is organized into separate regions of the study area—Delta, Suisun Marsh, Suisun Bay, San Francisco Bay, and SWP/CVP export service areas. When effects on a water quality constituent would be similar across project alternatives (i.e., Alternatives 1, 2a, 2b, 2c, 3, 4a, 4b, 4c, and 5), a single impact discussion is provided. For certain modeled constituents, separate impact discussion is provided for Alternatives 1 and 3, followed by discussion for the remaining alternatives. Alternatives 1 and 3 are grouped because the modeling representing these two alternatives is the same. Similarly, Alternatives 2a and 4a are represented by the same modeling, Alternatives 2b and 4b by the same modeling, and Alternatives 2c and 4c by the same modeling. Alternative 5 is represented by its own modeling. Discussion is in numeric order of project alternative (i.e., Alternatives 1 and 3 are discussed first).

The project alternatives would not affect surface water quality in the reservoirs and rivers upstream of the Delta for several reasons. First, external sources of constituents to reservoirs upstream of the Delta would not be affected because project alternatives would not affect watershed land uses and thus would not affect seasonal tributary inflow volume or quality to the reservoirs. Second, CalSim 3 modeling results for project alternatives show small average end-of-month storage changes for the full simulation period for Trinity Lake, Shasta Lake, Lake Oroville, and Folsom Lake, relative to existing conditions, thus there would not be substantial, if any, changes to reservoir seasonal thermal profiles, biochemical processes, or dilution capacity within the reservoirs (Appendix 5A). Third, the project alternatives would have small effects on flows in the Trinity River, Sacramento River, Feather River, American River, and San Joaquin River, relative to existing conditions (Appendix 5A). Little to no changes in reservoir water quality coupled with little, if any, changes in reservoir releases, river flows, and direct watershed runoff would result in little, if any, changes in water quality in the Trinity River, Sacramento River, Feather River, American River, and San Joaquin River for the project alternatives relative to existing conditions. Finally, modeling results show any changes in temperatures of study area rivers downstream of study area reservoirs would be negligible (Appendix 5A) Based on these findings, the project alternatives would result in less than significant, if any, effects on water quality constituents upstream of the Delta. As such, no further assessment of water quality impacts upstream of the Delta is warranted.

Impact WQ-1: Impacts on Water Quality Resulting from Construction of the Water Conveyance Facilities

This section addresses construction-related water quality effects on constituents of concern other than effects caused by alternatives facility operations, which are addressed in terms of constituent-specific impact assessments in Impacts WQ-2 through WQ-17. Construction of all structural components under the alternatives could occur over a period of up to 14 years, although construction of individual components would occur on shorter time scales (Chapter 3, *Description of the Proposed Project and Alternatives*).

Construction-related activities with the potential to affect water quality include all construction that would occur on the river side of levees and particularly in-river construction activities. The north Delta intakes involve the most extensive in-water work. This and other construction activities that could affect water quality include construction of facilities (e.g., the Southern Forebay emergency spillway, bridge crossings, and the Bethany Reservoir Discharge Structure), and associated construction activities (e.g., clearing and grubbing, cofferdam placement, and withdrawal and discharge of water for construction purposes).

Construction of water conveyance facilities would involve vegetation removal, material storage and handling, excavation, overexcitation for facility foundations, surface grading, trenching, road construction, levee construction, construction site dewatering, soil stockpiling, reusable tunnel material handling facilities, and other general facility construction activities (i.e., concrete, steel, carpentry, and other building trades). Land surface grading and excavation activities, or exposure of disturbed sites immediately following construction and prior to stabilization, could result in stormwater-related soil erosion and runoff. Construction would involve extensive excavation/trenching and other subsurface construction activities, or work in or near Delta channels requiring site dewatering operations to isolate the construction site from surface and groundwater. Construction activities also would involve the transport, handling, and use of a variety of hazardous substances and nonhazardous materials. Typical construction-related contaminants include petroleum products for refueling and maintenance of machinery (e.g., fuel, oils, solvents), concrete, paints and other coatings, cleaning agents, debris and trash, and human wastes. Construction activities also would involve large material storage and laydown areas.

Aquatic life beneficial uses are the beneficial uses likely to be the most sensitive to construction-related effects on water quality; refer to Chapter 12 for a full discussion of the effects of construction on aquatic life beneficial uses. Other beneficial uses, such as municipal/industrial water supplies, recreational activities, or livestock/agricultural irrigation, are generally anticipated to be less sensitive to water quality disturbances from construction activities than aquatic organisms.

As described in Chapter 3, Section 3.4.15.5, *Local Water Supply, Drainage, and Utilities*, all stormwater runoff and dewatering water generated at construction sites would be collected, treated, and stored on-site for reuse. Decant water from reusable tunnel material also would be collected and treated for direct on-site reuse or on-site storage. If treated stormwater, dewatering water, or decant water amounts exceed the on-site reuse demand or storage capacities, the water would be discharged into adjacent waterbodies in compliance with construction NPDES permits issued to DWR by the Central Valley RWQCB. In addition, DWR would implement construction-related environmental commitments and BMPs for water quality protection, as identified in Appendix 3B. Relevant environmental commitments and BMPs, and short descriptions of how they would reduce impacts on water quality are summarized in Table 9-7.

Table 9-7. Environmental Commitments That Address Construction-Related Water Quality Effects

Environmental Commitment	Elements Relevant to Water Quality Protection	Resulting Effect on Water Quality
EC-2: *Develop and Implement Hazardous Materials Management Plans*	• Database of on-site contaminants and hazardous chemicals • Cleanup and spill response procedures • Storage and handling practices	• Reduces likelihood of a spill of toxic chemicals and other hazardous materials occurring on-site and reduces likelihood of contaminants from a spill being discharged to adjacent waterbodies
EC-3: *Develop and Implement Spill Prevention, Containment, and Countermeasure Plans*	• Methods for prevention of, preparedness for, and response to spills of oil and oil-containing products	• Reduces likelihood of a spill of oil and oil-containing products occurring on-site and reduces likelihood of contaminants from a spill being discharged to adjacent waterbodies

Environmental Commitment	Elements Relevant to Water Quality Protection	Resulting Effect on Water Quality
EC-4a: *Develop and Implement Erosion and Sediment Control Plans*	• Best management practices for control of erosion and sedimentation during construction • Postconstruction erosion control and revegetation measures	• Reduces potential for discharge of suspended sediment to adjacent waterbodies, thus also reducing the potential for discharge of on-site contaminants and reducing potential for increased turbidity and TSS levels in adjacent waterbodies
EC-4b: *Develop and Implement Stormwater Pollution Prevention Plans*	• Erosion control measures • Sediment control measures • Management measures for construction materials • Waste management measures • Dewatering and pipeline testing measures • Accidental spill prevention and response measures • Nonstormwater management measures • Inspection, monitoring, and maintenance activities	• Reduces potential for discharge of suspended sediment, contaminants, human and other wastes, and trash to adjacent waterbodies

TSS = total suspended solids.

The Spill Prevention, Containment, and Countermeasure Plans would be developed in accordance with the regulatory requirements of Title 40 of the Code of Federal Regulations, Part 112, which must include specific measures and practices to prevent oil and oil containing products (i.e., gasoline, diesel fuel, motor oil, hydraulic fluid, aviation fuel, oil-based paint, oil-based paint thinner, roofing tar, and petroleum-based solvents) from being discharged to navigable waters of the United States and adjoining shorelines.

The Erosion and Sediment Control Plans and Storm Water Pollution Prevention Plans (SWPPPs) would be developed in accordance with the State Water Board's NPDES Stormwater General Permit for Stormwater Discharges Associated with Construction and Land Disturbance Activities (Order No. 2009-0009-DWQ/NPDES Permit CAS000002). The development of the SWPPPs, and applicability of other provisions of this General Construction Permit depends on the "risk" classification for the construction, which is determined based on the potential for erosion to occur as well as the susceptibility of the receiving water to potential adverse effects of construction. While the determination of project risk level, and planning and development of the SWPPPs and BMPs to be implemented, would be completed as a part of final design and contracting for the work, the responsibility for compliance with the provisions of the General Construction Permit necessitates that BMPs are applied to all disturbance activities. In addition to the BMPs, the SWPPPs would include BMP inspection and monitoring activities, and identify responsibilities of all parties, contingency measures, agency contacts, and training requirements and documentation for those personnel responsible for installation, inspection, maintenance, and repair of BMPs. The General Construction Permit contains numeric action levels for pH and turbidity, and specifies storm event water quality monitoring to determine if construction is resulting in elevated discharges of these constituents, and monitoring for any non-visible contaminants determined to have been potentially released. If a numeric action level is determined to have been exceeded, the General Construction Permit requires the discharger to conduct a construction site and runoff evaluation to determine whether contaminant sources associated with the site's construction activity may have caused or contributed to the exceedance and immediately implement corrective actions if they are needed.

With implementation of on-site treatment of runoff, dewatering water, and decant water prior discharge, implementation of construction-related environmental commitments and BMPs, and compliance with General Construction Permits, construction of the project alternatives would not cause constituent discharges of sufficient frequency and magnitude to result in a substantial increase of exceedances of water quality objectives/criteria, or substantially degrade water quality with respect to the constituents of concern, and thus would not adversely affect any beneficial uses in the Delta or downstream waterbodies.

There would be no impact on water quality in surface waterbodies upstream of the Delta because no construction activities would occur upstream of the Delta.

CEQA Conclusion—All Project Alternatives

The project alternatives include on-site treatment of runoff and dewatering water prior to discharge, and construction-related environmental commitments that would be developed in accordance with the relevant guidance, which have been identified through associated regulations (i.e., Code of Federal Regulations, NPDES permit system implementation) to be effective in avoiding and minimizing the potential water quality impacts. Thus, construction-related effects on study area water quality relative to existing conditions would not cause increased exceedances of water quality objectives/criteria by frequency, magnitude, and geographic extent that would result in adverse effects on one or more beneficial uses within affected waterbodies or cause long-term degradation of water quality in affected study area waterbodies that would result in substantially increased risk for adverse effects on one or more beneficial uses. Moreover, because the construction-related discharges would be minimized through reuse of water on site, construction activities would not increase levels of bioaccumulative pollutants by frequency, magnitude, and geographic extent such that affected study area waterbodies (or portions of waterbodies) would be expected to have measurably higher body burdens of a bioaccumulative pollutant in aquatic organisms that result in substantially increasing the health risks to wildlife (including fish) or humans consuming those organisms. Moreover, construction activities would not further degrade the water quality of study area waterbodies by measurable levels on a long-term basis for any State CWA Section 303(d)-listed constituent such that beneficial use impairment associated with the listed constituent would be made discernibly worse. Based on these findings, this impact would be less than significant.

Mitigation Impacts

Compensatory Mitigation

Although the CMP described in Appendix 3F, *Compensatory Mitigation Plan for Special-Status Species and Aquatic Resources*, does not act as mitigation for impacts on water quality from project construction or operations, its implementation could result in impacts on water quality.

CMP construction activities, through excavation, grading, and other soil disturbance in and around waterways, could cause temporary increases in suspended sediment or increased contaminant concentrations in runoff to adjacent surface waters. The relevant environmental commitments identified above in Table 9-7 would be implemented to minimize discharge of sediment and contaminants to surface waters. With implementation of the environmental commitments, construction of the freshwater and tidal wetland habitat proposed under the CMP would not cause increased exceedances of water quality objectives/criteria by frequency, magnitude, and geographic extent, or substantially degrade water quality with respect to the constituents of concern that would adversely affect any beneficial uses in study area waterbodies. Moreover, because the construction-related discharges would be relatively short-term, the construction activities would not result in increased levels of bioaccumulative pollutants that would substantially increase health risks to wildlife (including fish) or humans. Moreover, construction activities would not further degrade the water quality of study area waterbodies by measurable levels on a long-term basis for any CWA Section 303(d)-listed constituent such that beneficial use impairment associated with the listed constituent would be made discernibly worse. Based on these findings, this impact would be less than significant.

Other Mitigation Measures

Some mitigation measures, such as Mitigation Measure AG-3: *Replacement or Relocation of Affected Infrastructure Supporting Agricultural Properties* and tidal wetland inundation projects on Sherman and Twitchell Islands associated with Mitigation Measure AQ-9: *Develop and Implement a GHG Reduction Plan to Reduce GHG Emissions from Construction and Net CVP Operational Pumping to Net Zero*, could involve use of heavy equipment such as graders, excavators, dozers, and haul trucks that would have the potential to cause temporary increases in suspended sediment, or increased contaminant concentrations in runoff to adjacent surface waters or intercepted groundwater similar to those described for construction effects of the project and CMP impacts. All mitigation measures that may result in ground disturbance, dewatering, or possible release of contaminants have some potential to result in temporary increases in suspended sediment or contaminant concentrations.

Mitigation Measure AQUA-1a: *Develop and Implement an Underwater Sound Control and Abatement Plan* would occur in the water and could have more direct effects including increases in turbidity, disturbance of contaminated sediments, and accidental spills, particularly during installation and removal of the bubble curtain. These effects, however, would be temporary and local, and implementation of the BMPs would prevent significant impacts.

The BMPs described for construction of the water conveyance facilities would also be implemented for construction of other mitigation measures and would minimize discharge of sediment and contaminants. Furthermore, as described in Chapter 3, measures would be implemented to collect, treat, store, and reuse all runoff on-site. Additionally, treated runoff in excess of the amount that could be reused on site would be discharged into adjacent waterbodies in compliance with construction NPDES permits issued to DWR by the Central Valley RWQCB.

With implementation of the environmental commitments, construction of the other mitigation measures would not cause increased exceedances of water quality objectives/criteria by frequency, magnitude, and geographic extent that would result in adverse effects on beneficial uses of study area waterbodies or cause long-term degradation of water quality in study area waterbodies that would result in substantially increased risk for adverse effects on beneficial uses. Moreover, because the construction-related discharges would be relatively short-term, the construction activities would not result in increased levels of bioaccumulative pollutants that would substantially increase health risks to wildlife (including fish) or humans. Moreover, construction activities would not further degrade the water quality of study area waterbodies by measurable levels on a long-term basis for any CWA Section 303(d)-listed constituent such that beneficial use impairment associated with the listed constituent would be made discernibly worse. Based on these findings, the impact of construction of other mitigation measures on surface water quality would be less than significant.

Overall, water quality impacts resulting from construction of the CMP and other mitigation measures, combined with construction of project alternatives, would not change the impact conclusion of less than significant.

Impact WQ-2: Effects on Boron Resulting from Facility Operations and Maintenance

All Project Alternatives

Maintenance of project alternatives' facilities would not create new sources of boron or contribute toward a substantial change in existing sources of boron in the Delta. As such, maintenance activities would not cause any substantial change in boron in study area waterbodies that would adversely affect beneficial uses anywhere in the Delta.

All project alternatives (i.e., Alternatives 1, 2a, 2b, 2c, 3, 4a, 4b, 4c, and 5) described in Chapter 3 would have similar impact levels and are discussed together.

Delta

Boron concentrations would increase the most under the project alternatives in the Sacramento River at Mallard Island and the changes would be greatest during wet, above normal, and below normal water years (Appendix 9C, Tables 9C-4-2-4, 9C-4-3-4, 9C-4-4-4, 9C-4-5-4, and 9C-4-6-4). At Mallard Island, modeled monthly average boron concentrations under the project alternatives for the full-simulation period are up to 8 μg/L higher under the project alternatives relative to existing conditions (Appendix 9C, Tables 9C-4-2-4, 9C-4-3-4, 9C-4-4-4, 9C-4-5-4, and 9C-4-6-4). Modeled monthly average boron concentrations for the full simulation period are up to 5 μg/L higher under the project alternatives at Barker Slough at the North Bay Aqueduct, Sacramento River at Emmaton, San Joaquin River at Antioch, South Fork Mokelumne River at Terminous, San Joaquin River at Empire Tract, Contra Costa Water District Pumping Plant #1, Old River at SR 4, and Victoria Canal (Appendix 9C, Tables 9C-1-1-1 through 9C-9-6-4). At Banks Pumping Plant, modeled monthly average boron concentrations for the full simulation period under the project alternatives are lower than under existing conditions in nearly all months (Appendix 9C, Tables 9C-10-2-4, 9C-10-3-4, 9C-10-4-4, 9C-10-5-4, and 9C-10-6-4). At Jones Pumping Plant, differences in modeled monthly average boron concentrations under the project alternatives relative to existing conditions are variable, with decreases up to 3 μg/L in some months and increases up to 4 μg/L in some months, under Alternatives 1, 2b, 2c, 3, 4b, 4c, and 5 (Appendix 9C, Tables 9C-10-2-4, 9C-10-4-4, 9C-10-5-4, and 9C-10-6-4). Under Alternatives 2a and 4a, modeled monthly average boron concentrations at Jones Pumping Plant are up to 16 μg/L lower in some months under the project alternatives relative to existing conditions (Appendix 9C, 9C-10-3-4).

The Central Valley RWQCB and the San Francisco Bay RWQCB WQCPs contain water quality objectives for boron. The Central Valley RWQCB WQCP objectives are for the San Joaquin River upstream of Vernalis and the San Francisco Bay RWQCB WQCP objectives apply to waters designated for agricultural beneficial uses, which include the Delta west of Broad Slough and east of Chipps Island (Appendix 9C, Section 9C.4, *Applicable Water Quality Criteria/Objectives*). The lowest objective in the Central Valley RWQCB WQCP is 800 μg/L as a monthly average during the irrigation season (March 15 through September 15). The lowest objective in the San Francisco Bay RWQCB WQCP is 500 μg/L for irrigation. Boron concentrations at all Delta assessment locations are less than 500 μg/L under existing conditions and would remain less than 500 μg/L under the project alternatives. Considering the minimal effects of the project alternatives on boron concentrations at the Delta assessment locations, the project alternatives would not increase the frequency with which applicable boron water quality criteria or objectives would be exceeded in the Delta, or substantially degrade the Delta water quality with regard to boron. Any minor increases in boron concentrations that would occur under the project alternatives would not be of sufficient magnitude to adversely affect any beneficial use of Delta waters.

Suisun Marsh, Suisun Bay, and San Francisco Bay

The project alternatives would not result in substantial increases in boron concentrations in Delta waters or in Delta outflows. As such, there would not be a substantial change in boron concentrations in Suisun Marsh, Suisun Bay, and San Francisco Bay under all project alternatives relative to existing conditions. Because boron concentrations in Delta outflows would not substantially increase, the project alternatives would not substantially degrade the quality of these waterbodies with regard to boron. The project alternatives would not substantially increase the frequency with which applicable water quality criteria or objectives for boron would be exceeded in Suisun Marsh, Suisun Bay, or San Francisco Bay because there are no applicable water quality criteria or objectives since irrigation supply is not a beneficial use of these waterbodies.

SWP/CVP Export Service Areas

The project alternatives would not result in substantial increases in boron concentrations in the water exported from the Delta or diverted from the Sacramento River through the proposed conveyance facilities. Boron concentrations would either be similar to or would decrease relative to existing conditions at those locations. As such, there would not be a substantial increase in boron concentrations in the SWP/CVP export service area waterbodies under all project alternatives relative to existing conditions, and the project alternatives would not substantially increase the frequency with which applicable water quality criteria or objectives would be exceeded in SWP/CVP export service area waterbodies or substantially degrade the quality of these waterbodies with regard to boron.

CEQA Conclusion—All Project Alternatives

Based on the above analysis, the project alternatives would not cause a substantial increase in boron concentrations in study area waterbodies relative to existing conditions. As such, the project alternatives would not cause additional exceedance of applicable boron water quality criteria/objectives by frequency, magnitude, and geographic extent that would result in adverse effects on any beneficial uses of study area waterbodies. Because boron concentrations are not expected to increase substantially, the project alternatives would not cause long-term degradation of boron in study area waterbodies that would result in substantially increased risk for adverse effects on any beneficial uses. Furthermore, the above described changes to boron concentrations would not further degrade water quality by measurable levels on a long-term basis in any study area waterbody on the State's CWA Section 303(d) list such that beneficial use impairment would be made discernibly worse. Boron is not a bioaccumulative constituent, thus any boron concentration increases under the project alternatives would not result in bioaccumulation of boron in aquatic organisms. Therefore, the impact of the project alternatives on boron would be less than significant.

Mitigation Impacts

Compensatory Mitigation

Although the CMP described in Appendix 3F does not act as mitigation for impacts on water quality from project construction or operations, its implementation could result in impacts on water quality.

Natural habitats proposed by the CMP are not substantial sources of boron to receiving waters relative to existing conditions and upper watershed contributions. Therefore, the CMP would result in negligible, if any, change in boron concentrations in study area waterbodies relative to existing conditions. As such, the CMP would not cause additional exceedance of applicable boron water quality criteria/objectives by frequency, magnitude, and geographic extent that would result in adverse effects on any beneficial uses of any study area waterbodies. Because boron concentrations are not expected to increase substantially, the CMP would not cause long-term degradation of boron in study area waterbodies that would result in substantially increased risk for adverse effects on any beneficial uses. Furthermore, the CMP would not further degrade boron by measurable levels on a long-term basis in any study area waterbody on the State's CWA Section 303(d) list such that beneficial use impairment would be made discernibly worse. Boron is not a bioaccumulative constituent; therefore, the CMP would not result in bioaccumulation of boron in aquatic organisms. Based on these findings, impacts from the CMP on boron would be less than significant.

Other Mitigation Measures

Most of the other mitigation measures would be static once constructed, with limited likelihood of producing contaminated runoff, including runoff contaminated with excessive levels of boron. Although drainage patterns may be modified for some other mitigation measures, this would not produce any substantial increase in runoff because, as described in Chapter 3, measures would be implemented to restrict drainage pattern alterations such that they would not result in substantial erosion or siltation on-site or off-site, or create or contribute runoff water that would provide substantial additional sources of polluted runoff causing sediment or pollution to enter one or more affected waterbodies at levels and frequency that would adversely affect beneficial uses. Furthermore, Environmental Commitment EC-4a: *Develop and Implement Erosion and Sediment Control Plans*, would limit postconstruction erosion.

A few mitigation measures would have an operational component, such as the wells, pipelines, and drainage systems potentially associated with Mitigation Measure AG-3: *Replacement or Relocation of Affected Infrastructure Supporting Agricultural Properties*; mosquito management associated with Mitigation Measure PH-1b: *Develop and Implement a Mosquito Management Plan for Compensatory Mitigation Sites on Bouldin Island and at I-5 Ponds*; and tidal wetland inundation projects on Sherman and Twitchell Islands associated with Mitigation Measure AQ-9: *Develop and Implement a GHG Reduction Plan to Reduce GHG Emissions from Construction and Net CVP Operational Pumping to Net Zero*. These mitigation measures would not add substantial levels of boron to receiving waters.

Because operation of other mitigation measures would not generate substantial discharges of boron, operation of other mitigation measures would not cause increased exceedances of boron water quality objectives/criteria by frequency, magnitude, and geographic extent that would result in adverse effects on beneficial uses of study area waterbodies. Moreover, operation of other mitigation measures would not cause long-term degradation of boron in study area waterbodies that would result in substantially increased risk for adverse effects on any beneficial uses. Moreover, the other mitigation measures would not further degrade boron by measurable levels on a long-term basis in any study area waterbody on the State's CWA Section 303(d) list such that beneficial use impairment would be made discernibly worse. Boron is not a bioaccumulative constituent; therefore, the CMP would not result in bioaccumulation of boron in aquatic organisms. As a result, impacts from other mitigation measures on boron in study area waterbodies would be less than significant.

Overall, the project alternatives, CMP, and other mitigation measures would have minimal effect on boron concentrations, and would not change the impact conclusion of less than significant.

Impact WQ-3: Effects on Bromide Resulting from Facility Operations and Maintenance

Maintenance of project alternatives' facilities would not create new sources of bromide or contribute toward a substantial change in existing sources of bromide in the Delta. As such, maintenance activities would not cause any substantial change in bromide in study area waterbodies that would adversely affect beneficial uses anywhere in the Delta.

Delta

There are no numeric federal water quality criteria or state water quality objectives for bromide applicable to Delta waters. To evaluate the effects of the project alternatives on bromide, the assessment considered work by a panel of three water quality and treatment experts, engaged by the California Urban Water Agencies, which determined that bromide concentrations up to 300 μg/L, and total organic carbon from 4 to 7 mg/L, is acceptable to provide drinking water suppliers adequate flexibility in their choice of treatment method (California Urban Water Agencies 1998:ES-2; also refer to Appendix 9D, *Bromide*, Section 9D.4, *Applicable Water Quality Criteria/Objectives*). The discussion below relates changes in bromide concentrations at Delta assessment locations relative to existing conditions to the bromide threshold of 300 μg/L.

<u>*Alternatives 1 and 3*</u>

Under Alternatives 1 and 3, modeled full simulation period monthly average bromide concentrations for Barker Slough at the North Bay Aqueduct are similar to those under existing conditions (Table 9-8; Appendix 9D). Modeled monthly average Barker Slough bromide concentrations for the full simulation period are 115 μg/L or less for all months and water year types under both existing conditions and Alternatives 1 and 3 (Appendix 9D, Tables 9D-1-1-2 and 9D-1-2-2). Modeled increases in monthly average bromide concentrations at Barker Slough are 1 μg/L or less for Alternatives 1 and 3 relative to existing conditions for the full simulation period (Table 9-8). Furthermore, the maximum modeled monthly average concentrations for Alternatives 1 and 3 are the same as or no more than 1 μg/L higher than those for existing conditions (Appendix 9D, Table 9D-1-2-3).

Banks Pumping Plant

At Banks Pumping Plant, modeled monthly average bromide concentrations for Alternatives 1 and 3 are less than those under existing conditions for the full simulation period (Table 9-8; Appendix 9D). Hence, Alternatives 1 and 3 would improve water quality with regard to bromide at Banks Pumping Plant relative to existing conditions.

Sacramento River at Emmaton

At the Sacramento River at Emmaton, the maximum modeled concentrations for Alternatives 1 and 3 are the same as or no more than 1 µg/L higher than those for existing conditions (Appendix 9D, Table 9D-2-2-3). Under existing conditions, modeled monthly average bromide concentrations are less than 300 µg/L during February through May of the full simulation period in all but critical years (Appendix 9D, Table 9D-2-1-2). In critical years, modeled average bromide concentrations are less than 300 µg/L only during March. Modeled monthly average bromide concentrations during wet years are less than 300 µg/L in December through July under existing conditions. For the months that modeled monthly average bromide concentrations are less than 300 µg/L under existing conditions, Alternatives 1 and 3 do not have increased modeled monthly average bromide concentrations above 300 µg/L, except for January in below normal years (Appendix 9D, Tables 9D-2-1-2 and 9D-2-2-2). In below normal years, modeled monthly average bromide concentrations in January are 352 µg/L under Alternatives 1 and 3, compared to 284 µg/L under existing conditions (Table 9-8; Appendix 9D, Tables 9D-2-1-2, 9D-2-2-2, and 9D-2-2-4). For the full simulation period, modeled monthly average bromide concentrations in January under Alternatives 1 and 3 are 438 µg/L, compared to 392 µg/L under existing conditions. Moreover, for the full simulation period, the frequency with which modeled monthly average concentrations exceed the 300 µg/L threshold at Emmaton under Alternatives 1 and 3 is 2% greater than for existing conditions (Table 9-9). Water year type-specific changes in the frequency of exceeding 300 µg/L are 1% or less in all but below normal water years (Table 9-9). As such, the frequency that bromide would exceed 300 µg/L in the Sacramento River at Emmaton would change minimally for Alternatives 1 and 3 relative to existing conditions.

1 **Table 9-8. Monthly Average Bromide (in micrograms per liter) at Delta Assessment Locations for the Full Simulation Period under Alternatives**
2 **1 and 3, and Difference from Existing Conditions**

Location/Parameter	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Barker Slough at North Bay Aqueduct												
Full Simulation Period Average	70	76	90	76	79	93	85	52	46	42	51	56
Difference from Existing Conditions	0	0	0	0	0	0	1	0	0	0	0	0
Sacramento River at Emmaton												
Full Simulation Period Average	1,469	1,554	935	438	165	100	126	195	357	517	977	1,399
Difference from Existing Conditions	64	117	52	45	16	5	1	-1	-2	45	36	115
San Joaquin River at Antioch												
Full Simulation Period Average	3,475	3,832	2,706	1,434	568	272	320	515	924	1,708	2,815	3,431
Difference from Existing Conditions	129	183	86	105	67	24	8	-2	7	102	102	123
Sacramento River at Mallard Island												
Full Simulation Period Average	9,669	9,938	7,017	4,035	1,896	1,328	1,779	2,542	4,179	6,387	8,868	9,637
Difference from Existing Conditions	226	297	227	298	232	166	52	29	82	324	235	262
South Fork Mokelumne River at Terminous												
Full Simulation Period Average	40	46	49	57	67	63	51	38	39	35	40	33
Difference from Existing Conditions	1	2	1	2	2	2	0	0	0	1	0	0
San Joaquin River at Empire Tract												
Full Simulation Period Average	173	206	208	191	151	138	131	113	103	83	109	125
Difference from Existing Conditions	5	17	7	7	7	4	2	0	0	1	1	-1
Contra Costa Pumping Plant #1												
Full Simulation Period Average	382	448	501	378	227	146	146	122	105	134	225	333
Difference from Existing Conditions	12	34	17	10	10	9	8	0	-1	-1	5	0
Old River at State Route 4												
Full Simulation Period Average	324	385	459	393	278	216	225	185	133	136	197	283
Difference from Existing Conditions	9	26	18	9	9	9	8	0	-1	0	4	1

Location/Parameter	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Victoria Canal												
Full Simulation Period Average	233	278	334	356	333	294	273	222	168	125	134	174
Difference from Existing Conditions	5	17	17	8	5	6	5	0	0	3	2	3
Banks Pumping Plant												
Full Simulation Period Average	291	269	299	221	155	115	138	109	127	131	213	248
Difference from Existing Conditions	-24	-71	-76	-95	-60	-63	-17	-21	-12	-14	-4	-49
Jones Pumping Plant												
Full Simulation Period Average	328	381	402	342	272	242	202	169	164	177	243	307
Difference from Existing Conditions	5	18	9	6	5	-1	1	-1	-1	0	3	0

Note: A positive difference denotes an increase from existing conditions, and a negative difference indicates a decrease from existing conditions.

Table 9-9. Frequency That Monthly Average Bromide Concentrations Exceed 300 Micrograms per Liter at Delta Assessment Locations under Alternatives 1 and 3, and Difference from Existing Conditions

Location/Parameter	Full Simulation Period	Wet Water Years	Above Normal Water Years	Below Normal Water Years	Dry Water Years	Critical Water Years
Barker Slough at North Bay Aqueduct						
Percent Greater Than 300 µg/L	0%	0%	0%	0%	0%	0%
Difference from Existing Conditions	0%	0%	0%	0%	0%	0%
Sacramento River at Emmaton						
Percent Greater Than 300 µg/L	44%	17%	31%	48%	57%	79%
Difference from Existing Conditions	2%	0%	1%	6%	1%	1%
San Joaquin River at Antioch						
Percent Greater Than 300 µg/L	69%	46%	59%	70%	85%	97%
Difference from Existing Conditions	0%	1%	0%	1%	1%	-1%
Sacramento River at Mallard Island						
Percent Greater Than 300 µg/L	84%	61%	78%	94%	100%	100%
Difference from Existing Conditions	1%	1%	1%	3%	0%	0%
South Fork Mokelumne River at Terminous						
Percent Greater Than 300 µg/L	0%	0%	0%	0%	0%	0%

Location/Parameter	Full Simulation Period	Wet Water Years	Above Normal Water Years	Below Normal Water Years	Dry Water Years	Critical Water Years
Difference from Existing Conditions	0%	0%	0%	0%	0%	0%
San Joaquin River at Empire Tract						
Percent Greater Than 300 μg/L	5%	2%	4%	2%	7%	13%
Difference from Existing Conditions	1%	1%	-1%	1%	1%	2%
Contra Costa Pumping Plant #1						
Percent Greater Than 300 μg/L	30%	11%	23%	33%	40%	51%
Difference from Existing Conditions	1%	-1%	2%	3%	-1%	0%
Old River at State Route 4						
Percent Greater Than 300 μg/L	31%	13%	26%	32%	41%	57%
Difference from Existing Conditions	1%	1%	2%	2%	1%	1%
Victoria Canal						
Percent Greater Than 300 μg/L	29%	14%	34%	32%	33%	42%
Difference from Existing Conditions	3%	1%	5%	3%	2%	3%
Banks Pumping Plant						
Percent Greater Than 300 μg/L	20%	5%	13%	22%	29%	36%
Difference from Existing Conditions	-5%	-3%	-6%	-5%	-6%	-10%
Jones Pumping Plant						
Percent Greater Than 300 μg/L	33%	11%	29%	35%	43%	61%
Difference from Existing Conditions	1%	0%	2%	1%	1%	2%

Note: A positive difference denotes an increase from existing conditions, and a negative difference indicates a decrease from existing conditions.

San Joaquin River at Antioch

At the San Joaquin River at Antioch, the maximum modeled concentrations for Alternatives 1 and 3 are the same as existing conditions in all but August, October, and December when the maximum concentration is up to 16 µg/L higher than for existing conditions (Appendix 9D, Table 9D-3-2-3). Under existing conditions, modeled monthly average bromide concentrations are less than 300 µg/L only during March of the full simulation period. Modeled average bromide concentrations are less than 300 µg/L in January through June of wet years, whereas no average for any month is below this level for critical years under existing conditions (Appendix 9D, Table 9D-3-1-2). For the months that modeled monthly average bromide concentrations are less than 300 µg/L under existing conditions, Alternatives 1 and 3 do not have increased modeled monthly average bromide concentrations above 300 µg/L, except for February of below normal years (Appendix 9D, Tables 9D-3-1-2 and 9D-3-2-2). In below normal years, modeled monthly average bromide concentrations in February are 341 µg/L under Alternatives 1 and 3, compared to 272 µg/L under existing conditions (Appendix 9D, Tables 9D-3-1-2 and 9D-3-2-2). For the full simulation period, modeled monthly average bromide concentrations in February under Alternatives 1 and 3 are 568 µg/L, compared to 501 µg/L under existing conditions. Moreover, for the full simulation period, the frequency with which modeled monthly average concentrations exceed the 300 µg/L threshold at Antioch under Alternatives 1 and 3 is the same as under existing conditions (Table 9-9). Water year type-specific changes in the frequency of exceeding 300 µg/L are 1% or less relative to existing conditions (Table 9-9). As such, the frequency that bromide would exceed 300 µg/L in the San Joaquin River at Antioch would change minimally for Alternatives 1 and 3 relative to existing conditions.

Sacramento River at Mallard Island

At the Sacramento River at Mallard Island, the maximum modeled concentrations for Alternatives 1 and 3 are the same as those for existing conditions in all but August through November, when differences range from a decrease of 6 µg/L in September to an increase of 230 µg/L in October (Appendix 9D, Table 9D-4-2-3). Under both existing conditions and Alternatives 1 and 3, modeled monthly average bromide concentrations are less than 300 µg/L only during the months of February through April of wet years and in March of above normal years (Appendix 9D, Tables 9D-4-1-2 and 9D-4-2-2). For the full simulation period monthly average bromide concentrations exceed 300 µg/L in every month (Appendix 9D, Tables 9D-4-1-2 and 9D-4-2-2). For the full simulation period, the frequency with which modeled monthly average concentrations exceed the 300 µg/L threshold at Mallard Island under Alternatives 1 and 3 is 1% higher than under existing conditions (Table 9-9). Water year type specific changes in the frequency of exceeding 300 µg/L range is 1% or less in all but below normal years, for which the increased frequency is 3% relative to existing conditions (Table 9-9). As such, the frequency that bromide would exceed 300 µg/L in the Sacramento River at Mallard Island would change minimally for Alternatives 1 and 3 relative to existing conditions.

South Fork Mokelumne River at Terminous

At the South Fork Mokelumne River at Terminous, modeled monthly average bromide concentrations for the full simulation period under Alternatives 1 and 3 are up to 2 µg/L higher relative to existing conditions (Table 9-8, Appendix 9D). Furthermore, the maximum modeled monthly average concentrations for Alternatives 1 and 3 are the same as or no more than 1 µg/L higher than those for existing conditions (Appendix 9D, Table 9D-5-2-3). Modeled monthly average bromide concentrations for the South Fork Mokelumne River at Terminous are well below 100 μg/L during all months in all water year types (Appendix 9D, Figures 9D-5-1 through 9D-5-6).

San Joaquin River at Empire Tract

At the San Joaquin River at Empire Tract, the maximum modeled concentrations for Alternatives 1 and 3 are the same as or no more than 3 μg/L higher than those for existing conditions (Appendix 9D, Table 9D-6-2-3). Under both existing conditions and Alternatives 1 and 3, modeled monthly average bromide concentrations are less than 300 μg/L during all months of the full simulation and all water year types (Table 9-8; Appendix 9D, Tables 9D-6-1-2 and 9D-6-2-2). For the full simulation period, the frequency with which modeled monthly average concentrations exceed the 300 μg/L threshold in the San Joaquin River at Empire Tract under Alternatives 1 and 3 is 1% higher than under existing conditions (Table 9-9). Water year type-specific changes in the frequency of exceeding 300 μg/L range from a 1% decrease in above normal years to a 2% increase in critical years relative to existing conditions (Table 9-9). As such, the frequency that bromide would exceed 300 μg/L in the San Joaquin River at Empire Tract would change minimally for Alternatives 1 and 3 relative to existing conditions.

Contra Costa Water District Pumping Plant #1

At Contra Costa Water District Pumping Plant #1, the maximum modeled concentrations for Alternatives 1 and 3 are the same as or no more than 1 μg/L higher than those for existing conditions (Appendix 9D, Table 9D-7-2-3). Under existing conditions, modeled monthly average bromide concentrations are less than 300 μg/L during February through August of the full simulation period, although this varies by water year type (Appendix 9D, Table 9D-7-1-2). During all months of wet years modeled monthly average bromide concentrations are less than 300 μg/L under existing conditions, while this occurs only during March through August of critical years. Alternatives 1 and 3 do not change the months within each water year type or within the full simulation period that modeled monthly average bromide concentrations are less than 300 μg/L, except for November of wet years (Appendix 9D, Table 9D-7-2-2). For the full simulation period, the frequency with which modeled monthly average concentrations exceed the 300 μg/L threshold at Contra Costa Water District Pumping Plant #1 under Alternatives 1 and 3 is 1% higher relative to existing conditions (Table 9-9). Water year type-specific changes in the frequency of exceeding 300 μg/L range from a 1% decrease in wet and dry years to a 3% increase in below normal years (Table 9-9). As such, the frequency that bromide would exceed 300 μg/L at Contra Costa Water District Pumping Plant #1 would change minimally for Alternatives 1 and 3 relative to existing conditions.

Old River at SR4

At Old River at SR4, the maximum modeled concentrations for Alternatives 1 and 3 are the same as or no more than 2 μg/L higher than those for existing conditions (Appendix 9D, Table 9D-8-2-3). Under existing conditions, modeled monthly average bromide concentrations are less than 300 μg/L during February through September of the full simulation period, although this varies by water year (Appendix 9D, Table 9D-8-1-2). Modeled monthly average bromide concentrations are less than 300 μg/L during all months of wet years under existing conditions, while this occurs only during March through August of critical years. Alternatives 1 and 3 do not change the months within each water year type that modeled monthly average bromide concentrations are less than 300 μg/L (Appendix 9D, Table 9D-8-2-2), except for October of below normal years and March of critical years. For the full simulation period, the frequency with which modeled monthly average concentrations exceed the 300 μg/L threshold in Old River at SR4 under Alternatives 1 and 3 is 1% higher relative to existing conditions (Table 9-9). Water year type-specific changes in the frequency of exceeding 300 μg/L range from 1% to 2% (Table 9-9). As such, the frequency that bromide would exceed 300 μg/L in the Old River at SR4 would change minimally for Alternatives 1 and 3 relative to existing conditions.

Victoria Canal

At Victoria Canal, the maximum modeled concentrations for Alternatives 1 and 3 are the same as or no more than 4 μg/L higher than those for existing conditions (Appendix 9D, Table 9D-9-2-3). Modeled monthly average bromide concentrations are less than 300 μg/L in Victoria Canal during March through November under both existing conditions and Alternatives 1 and 3 for the full simulation period, although this varies by water year type (Appendix 9D, Tables 9D-9-1-2 and 9D-9-2-2). Modeled monthly average bromide concentrations are less than 300 μg/L during all months of wet years under existing conditions and Alternatives 1 and 3, yet this occurs only during May through October of critical years. Alternatives 1 and 3 do not change the months that modeled monthly average bromide concentrations are less than 300 μg/L (Appendix 9D, Table 9D-9-2-2), except for December of below normal years. For the full simulation period, the frequency with which modeled monthly concentrations exceed the 300 μg/L threshold in Victoria Canal under Alternatives 1 and 3 is 3% higher relative to existing conditions (Table 9-9). Water year type specific changes in the frequency of exceeding 300 μg/L would range from 1% increase in wet years to a 5% increase in above normal years relative to existing conditions (Table 9-9). As such, the frequency that bromide would exceed 300 μg/L in Victoria Canal would change little for Alternatives 1 and 3 relative to existing conditions.

Jones Pumping Plant

At Jones Pumping Plant, the maximum modeled concentrations for Alternatives 1 and 3 are the same as or no more than 3 μg/L higher than those for existing conditions (Appendix 9D, Table 9D-11-2-3). Modeled monthly average bromide concentrations are up to 18 μg/L higher under Alternatives 1 and 3 relative to existing conditions (Table 9-8; Appendix 9D, Tables 9D-11-2-1 through 9D-11-4). The greatest increases occur in November and December (Table 9-8). Under both existing conditions and Alternatives 1 and 3, however, modeled monthly average bromide concentrations are less than 300 μg/L at Jones Pumping Plant only during February through August of the full simulation period, although this varies by water year type (Appendix 9D, Tables 9D-11-1-2 and 9D-11-2-2). For the full simulation period, the frequency with which modeled monthly concentrations exceed the 300 μg/L threshold at Jones Pumping Plant under Alternatives 1 and 3 is 1% higher relative to existing conditions (Table 9-9). Water year type-specific changes in the frequency of exceeding 300 μg/L range from zero change in wet years to a 2% increase in above normal and critical years (Table 9-9). As such, the frequency that bromide would exceed 300 μg/L at Jones Pumping Plant would increase minimally for Alternatives 1 and 3 relative to existing conditions.

Effects on Beneficial Uses

The potentially higher bromide concentrations under Alternatives 1 and 3 relative to existing conditions could result in greater potential for disinfection byproduct formation in drinking water supplies that use Delta source waters. But the degree to which this would occur is uncertain. There are numerous variables that affect disinfection byproduct formation potential in Delta-diverted waters, including diversion location and water treatment plant processes, and thus changes in disinfection byproduct formation cannot be definitively determined for this assessment. Nevertheless, disinfection byproducts in Delta-diverted, treated drinking water supplies are regulated via drinking water maximum contaminant levels (MCLs) on a running annual average basis, based on quarterly monitoring by the water treatment plants. Hence, although effects of Alternative 1 and 3 on monthly average bromide levels across years are of interest to determine the seasonality of effects and thus are discussed in this assessment, it is the annual, long-term full simulation period effects that are the most relevant to evaluate for impact determination purposes, based on how disinfection byproducts in drinking water supplies are regulated.

Treatment plants that use the Delta as a source for drinking water already experience highly variable bromide concentrations and, thus, must implement appropriate treatment technologies to ensure compliance with drinking water regulations for disinfection byproducts. Despite the potential for periodically higher bromide concentrations under Alternatives 1 and 3 relative to existing conditions at specific times and locations, it is expected that Alternatives 1 and 3 would not substantially degrade water quality at any Delta location with regard to bromide concentrations relative to existing conditions, given the relatively small increases in long-term average concentrations that would be observed at the locations assessed. The incremental increases in annual average bromide concentrations that may occur for Alternative 1 and 3 are not expected to be of sufficient magnitude to cause Delta diverters to exceed drinking water disinfection byproduct MCLs more often than under existing conditions, or cause exceedances of such MCLs where such exceedances would not occur for existing conditions.

Where the largest magnitude increases were modeled to occur for Alternatives 1 and 3 in November relative to existing conditions, such as at Emmaton, Antioch, or Mallard Island, it should be noted that bromide concentrations at these locations and time of year for existing conditions are high (i.e., typically about 1,000–13,000 μg/L) and water is generally not diverted for drinking water supplies at such locations and times due to high salinity, including high bromide levels. For example, Antioch diverts municipal and industrial water supplies from the San Joaquin River during months when water quality is conducive to such uses. Under existing conditions, the months when average bromide concentrations would be about 300 μg/L or less would be January through June in wet years, February through May in above normal and below normal years, March only for dry years, and in no months for critical years. These periods of opportunity to divert municipal and industrial water supplies based on bromide concentrations would not change under Alternatives 1 and 3 relative to existing conditions. Moreover, Alternatives 1 and 3 would not cause increased frequency of objective or criteria exceedances at any location because no objectives or criteria exist for bromide. Also, there are no CWA Section 303(d) listings for bromide in the Delta. Consequently, the bromide increases relative to existing conditions would not make any impairment discernably worse because no impairments for bromide exist in the Delta.

Alternatives 2a, 2b, 2c, 4a, 4b, 4c, and 5

Appendix 9D provides tables and figures presenting modeled bromide concentrations at the Delta assessment locations for existing conditions and Alternatives 2a, 2b, 2c, 4a, 4b, 4c, and 5. Tables 9-10 through 9-17 provide an overview of the changes in modeled bromide concentrations under Alternatives 2a, 2b, 2c, 4a, 4b, 4c, and 5 relative to existing conditions. Tables 9-10, 9-12, 9-14, and 9-16 present the modeled monthly average bromide concentrations at the Delta assessment locations under Alternatives 2a, 2b, 2c, 4a, 4b, 4c, and 5 for the 93-year simulation period, and the differences from existing conditions. Tables 9-11, 9-13, 9-15, and 9-17 present the frequency that modeled monthly average bromide concentrations are greater than 300 µg/L under Alternatives 1 and 3, and the differences from existing conditions.

Under Alternatives 2a, 2b, 2c, 4a, 4b, 4c, and 5, the changes in bromide concentrations relative to existing conditions would be similar to those that would occur under Alternatives 1 and 3 for Barker Slough at the North Bay Aqueduct (Appendix 9D, Figures 9D-1-1 through 9D-1-18), Sacramento River at Emmaton (Appendix 9D, Figures 9D-2-1 through 9D-2-18), San Joaquin River at Antioch (Appendix 9D, Figures 9D-3-1 through 9D-3-18), Sacramento River at Mallard Island (Appendix 9D, Figures 9D-4-1 through 9D-4-18), South Fork Mokelumne River at Terminous (Appendix 9D, Figures 9D-5-1 through 9D-5-18), San Joaquin River at Empire Tract (Appendix 9D, Figures 9D-6-1 through 9D-6-18), Contra Costa Water District Pumping Plant #1 (Appendix 9D, Figures 9D-7-1 through 9D-7-18), Old River at SR 4 (Appendix 9D, Figures 9D-8-1 through 9D-8-18), and Victoria Canal (Appendix 9D, Figures 9D-9-1 through 9D-9-18). Long-term monthly average bromide concentrations that would occur at Banks Pumping Plant under Alternative 2a and 4a would decrease relative to existing conditions (Appendix 9D, Figures 9D-10-1 through 9D-10-6), although the decrease would not be as great as under Alternatives 1 and 3. At Jones Pumping Plant, long-term average bromide concentrations for Alternative 2a and 4a also would decrease relative to existing conditions (Appendix 9D, Figures 9D-11-1 through 9D-11-6).

For the reasons described above for Alternatives 1 and 3, the increases in bromide concentrations under Alternatives 2a, 2b, 2c, 4a, 4b, 4c, and 5 would not substantially degrade water quality at any Delta location with regard to bromide relative to existing conditions, given the relatively small increases in concentrations that would be observed on a long-term average basis and minimal changes in the frequency of exceeding 300 µg/L. Moreover, Alternatives 2a, 2b, 2c, 4a, 4b, 4c, and 5 would not cause increased frequency of objective or criteria exceedances at any location because no objectives or criteria exist for bromide; therefore, potential impacts of bromide would be less than significant.

Table 9-10. Monthly Average Bromide (in micrograms per liter) at Delta Assessment Locations for the Full Simulation Period under Alternatives 2a and 4a, and Difference from Existing Conditions

Location/Parameter	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Barker Slough at North Bay Aqueduct												
Full Simulation Period Average	70	76	89	76	79	93	85	52	46	42	51	56
Difference from Existing Conditions	0	0	0	0	0	0	1	0	0	0	0	0
Sacramento River at Emmaton												
Full Simulation Period Average	1,468	1,552	938	442	158	100	126	195	357	518	977	1,394
Difference from Existing Conditions	62	115	54	50	9	5	1	-1	-2	46	36	110
San Joaquin River at Antioch												
Full Simulation Period Average	3,474	3,819	2,710	1,442	559	271	320	514	924	1,706	2,816	3,430
Difference from Existing Conditions	127	170	90	113	58	23	8	-2	6	101	102	122
Sacramento River at Mallard Island												
Full Simulation Period Average	9,661	9,920	7,022	4,061	1,877	1,332	1,779	2,542	4,180	6,388	8,867	9,635
Difference from Existing Conditions	217	279	232	324	213	170	53	29	83	325	234	260
South Fork Mokelumne River at Terminous												
Full Simulation Period Average	40	46	49	57	67	63	51	38	40	35	40	33
Difference from Existing Conditions	1	3	1	2	2	2	0	0	0	1	0	0
San Joaquin River at Empire Tract												
Full Simulation Period Average	173	207	208	192	150	139	131	114	103	84	109	125
Difference from Existing Conditions	5	19	7	7	6	5	2	1	0	2	1	-1
Contra Costa Pumping Plant #1												
Full Simulation Period Average	382	447	500	380	225	146	146	122	105	133	224	333
Difference from Existing Conditions	11	33	16	11	8	8	8	0	0	-2	4	1
Old River at State Route 4												
Full Simulation Period Average	324	384	459	395	277	215	225	185	133	136	196	283
Difference from Existing Conditions	9	25	17	10	7	8	8	0	0	0	4	1

Location/Parameter	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Victoria Canal												
Full Simulation Period Average	233	279	334	357	332	294	274	222	169	125	134	174
Difference from Existing Conditions	6	18	17	9	5	6	6	1	1	4	3	3
Banks Pumping Plant												
Full Simulation Period Average	301	286	320	225	158	121	138	111	131	135	217	267
Difference from Existing Conditions	-14	-53	-55	-90	-57	-57	-17	-20	-8	-9	0	-29
Jones Pumping Plant												
Full Simulation Period Average	319	354	387	320	261	223	202	168	161	172	240	290
Difference from Existing Conditions	-3	-8	-6	-17	-6	-20	0	-2	-4	-4	1	-17

Note: A positive difference denotes an increase from existing conditions, and a negative difference indicates a decrease from existing conditions.

Table 9-11. Frequency That Monthly Average Bromide Concentrations Exceed 300 Micrograms per Liter at Delta Assessment Locations under Alternatives 2a and 4a, and Difference from Existing Conditions

Location/Parameter	Full Simulation Period	Wet Water Years	Above Normal Water Years	Below Normal Water Years	Dry Water Years	Critical Water Years
Barker Slough at North Bay Aqueduct						
Percent Greater Than 300 µg/L	0%	0%	0%	0%	0%	0%
Difference from Existing Conditions	0%	0%	0%	0%	0%	0%
Sacramento River at Emmaton						
Percent Greater Than 300 µg/L	44%	17%	31%	48%	57%	79%
Difference from Existing Conditions	2%	0%	1%	6%	1%	1%
San Joaquin River at Antioch						
Percent Greater Than 300 µg/L	69%	46%	59%	70%	86%	98%
Difference from Existing Conditions	0%	1%	0%	1%	2%	0%
Sacramento River at Mallard Island						
Percent Greater Than 300 µg/L	84%	61%	78%	94%	100%	100%
Difference from Existing Conditions	1%	1%	1%	3%	0%	0%
South Fork Mokelumne River at Terminous						
Percent Greater Than 300 µg/L	0%	0%	0%	0%	0%	0%

Location/Parameter	Full Simulation Period	Wet Water Years	Above Normal Water Years	Below Normal Water Years	Dry Water Years	Critical Water Years
Difference from Existing Conditions	0%	0%	0%	0%	0%	0%
San Joaquin River at Empire Tract						
Percent Greater Than 300 µg/L	5%	3%	4%	2%	6%	12%
Difference from Existing Conditions	1%	2%	-1%	1%	0%	1%
Contra Costa Pumping Plant #1						
Percent Greater Than 300 µg/L	30%	11%	23%	33%	40%	52%
Difference from Existing Conditions	1%	-1%	2%	3%	-1%	1%
Old River at State Route 4						
Percent Greater Than 300 µg/L	31%	12%	26%	31%	41%	57%
Difference from Existing Conditions	1%	0%	2%	1%	1%	1%
Victoria Canal						
Percent Greater Than 300 µg/L	29%	14%	34%	32%	33%	42%
Difference from Existing Conditions	3%	1%	5%	3%	2%	3%
Banks Pumping Plant						
Percent Greater Than 300 µg/L	22%	6%	15%	24%	30%	42%
Difference from Existing Conditions	-3%	-2%	-4%	-3%	-5%	-4%
Jones Pumping Plant						
Percent Greater Than 300 µg/L	30%	11%	24%	31%	39%	58%
Difference from Existing Conditions	-2%	0%	-3%	-3%	-3%	-1%

Note: A positive difference denotes an increase from existing conditions, and a negative difference indicates a decrease from existing conditions.

Table 9-12. Monthly Average Bromide (in micrograms per liter) at Delta Assessment Locations for the Full Simulation Period under Alternatives 2b and 4b, and Difference from Existing Conditions

Location/Parameter	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Barker Slough at North Bay Aqueduct												
Full Simulation Period Average	70	76	89	76	79	93	84	52	46	42	51	56
Difference from Existing Conditions	0	0	0	0	0	0	0	0	0	0	0	0

Location/Parameter	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Sacramento River at Emmaton												
Full Simulation Period Average	1,469	1,519	931	435	165	99	126	195	358	512	972	1,381
Difference from Existing Conditions	63	82	48	43	15	5	1	-1	0	39	31	97
San Joaquin River at Antioch												
Full Simulation Period Average	3,479	3,790	2,687	1,423	569	271	320	516	927	1,696	2,806	3,414
Difference from Existing Conditions	133	142	67	94	68	23	8	-1	10	90	92	106
Sacramento River at Mallard Island												
Full Simulation Period Average	9,691	9,910	6,967	3,991	1,870	1,294	1,770	2,543	4,177	6,349	8,846	9,600
Difference from Existing Conditions	248	269	177	254	206	132	44	30	80	286	213	225
South Fork Mokelumne River at Terminous												
Full Simulation Period Average	40	46	49	57	67	63	51	38	39	35	40	33
Difference from Existing Conditions	1	2	1	1	1	1	0	0	0	1	0	0
San Joaquin River at Empire Tract												
Full Simulation Period Average	174	203	207	190	149	137	130	113	102	83	109	126
Difference from Existing Conditions	6	15	6	5	5	3	1	0	-1	1	1	-1
Contra Costa Pumping Plant #1												
Full Simulation Period Average	384	443	497	377	227	145	143	122	105	134	225	333
Difference from Existing Conditions	14	29	13	9	10	7	5	0	-1	-1	5	1
Old River at State Route 4												
Full Simulation Period Average	325	382	456	393	277	214	223	184	132	136	197	283
Difference from Existing Conditions	10	23	14	8	7	8	6	-1	-1	0	4	2
Victoria Canal												
Full Simulation Period Average	232	276	332	356	332	293	272	221	168	124	133	174
Difference from Existing Conditions	5	15	15	8	5	5	4	0	-1	2	2	3
Banks Pumping Plant												
Full Simulation Period Average	296	281	308	227	169	125	143	114	128	132	214	254
Difference from Existing Conditions	-19	-58	-67	-89	-46	-53	-11	-17	-10	-12	-4	-43
Jones Pumping Plant												
Full Simulation Period Average	329	379	400	342	271	245	201	170	164	177	243	308

Location/Parameter	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Difference from Existing Conditions	7	16	7	5	5	2	0	0	-1	0	3	0

Note: A positive difference denotes an increase from existing conditions, and a negative difference indicates a decrease from existing conditions.

Table 9-13. Frequency That Monthly Average Bromide Concentrations Exceed 300 Micrograms per Liter at Delta Assessment Locations under Alternatives 2b and 4b, and Difference from Existing Conditions

Location/Parameter	Full Simulation Period	Wet Water Years	Above Normal Water Years	Below Normal Water Years	Dry Water Years	Critical Water Years
Barker Slough at North Bay Aqueduct						
Percent Greater Than 300 µg/L	0%	0%	0%	0%	0%	0%
Difference from Existing Conditions	0%	0%	0%	0%	0%	0%
Sacramento River at Emmaton						
Percent Greater Than 300 µg/L	44%	18%	31%	47%	57%	79%
Difference from Existing Conditions	2%	1%	1%	5%	1%	1%
San Joaquin River at Antioch						
Percent Greater Than 300 µg/L	69%	46%	59%	70%	85%	98%
Difference from Existing Conditions	0%	1%	0%	1%	1%	0%
Sacramento River at Mallard Island						
Percent Greater Than 300 µg/L	84%	61%	77%	91%	100%	100%
Difference from Existing Conditions	1%	1%	0%	0%	0%	0%
South Fork Mokelumne River at Terminous						
Percent Greater Than 300 µg/L	0%	0%	0%	0%	0%	0%
Difference from Existing Conditions	0%	0%	0%	0%	0%	0%
San Joaquin River at Empire Tract						
Percent Greater Than 300 µg/L	5%	2%	4%	2%	8%	12%
Difference from Existing Conditions	1%	1%	-1%	1%	2%	1%
Contra Costa Pumping Plant #1						
Percent Greater Than 300 µg/L	30%	11%	22%	33%	40%	52%
Difference from Existing Conditions	1%	-1%	1%	3%	-1%	1%

Location/Parameter	Full Simulation Period	Wet Water Years	Above Normal Water Years	Below Normal Water Years	Dry Water Years	Critical Water Years
Old River at State Route 4						
Percent Greater Than 300 µg/L	31%	13%	25%	31%	41%	56%
Difference from Existing Conditions	1%	1%	1%	1%	1%	0%
Victoria Canal						
Percent Greater Than 300 µg/L	29%	16%	33%	33%	31%	42%
Difference from Existing Conditions	3%	3%	4%	4%	0%	3%
Banks Pumping Plant						
Percent Greater Than 300 µg/L	20%	6%	14%	22%	29%	38%
Difference from Existing Conditions	-5%	-2%	-5%	-5%	-6%	-8%
Jones Pumping Plant						
Percent Greater Than 300 µg/L	33%	12%	29%	36%	42%	59%
Difference from Existing Conditions	1%	1%	2%	2%	0%	0%

Note: A positive difference denotes an increase from existing conditions, and a negative difference indicates a decrease from existing conditions.

Table 9-14. Monthly Average Bromide (in micrograms per liter) at Delta Assessment Locations for the Full Simulation Period under Alternatives 2c and 4c, and Difference from Existing Conditions

Location/Parameter	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Barker Slough at North Bay Aqueduct												
Full Simulation Period Average	70	76	89	76	79	93	85	52	46	42	51	56
Difference from Existing Conditions	0	0	0	0	0	0	0	0	0	0	0	0
Sacramento River at Emmaton												
Full Simulation Period Average	1,470	1,543	934	436	167	99	126	195	358	516	977	1,390
Difference from Existing Conditions	64	105	51	44	17	5	1	-1	-1	44	36	106
San Joaquin River at Antioch												
Full Simulation Period Average	3,489	3,839	2,697	1,426	571	271	320	515	928	1,709	2,819	3,423
Difference from Existing Conditions	142	191	77	98	70	24	8	-2	10	103	105	115
Sacramento River at Mallard Island												
Full Simulation Period Average	9,707	9,956	6,985	4,012	1,891	1,313	1,774	2,544	4,184	6,387	8,873	9,620

Location/Parameter	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Difference from Existing Conditions	263	316	195	275	227	152	48	31	88	324	240	245
South Fork Mokelumne River at Terminous												
Full Simulation Period Average	40	46	49	57	67	63	51	38	39	35	40	33
Difference from Existing Conditions	1	3	1	2	1	2	0	0	0	1	0	0
San Joaquin River at Empire Tract												
Full Simulation Period Average	174	208	209	190	151	138	130	113	102	83	109	125
Difference from Existing Conditions	6	20	8	6	6	4	2	0	-1	1	1	-1
Contra Costa Pumping Plant #1												
Full Simulation Period Average	385	454	504	377	226	146	144	122	105	134	225	333
Difference from Existing Conditions	15	41	20	9	10	8	6	0	-1	-1	5	1
Old River at State Route 4												
Full Simulation Period Average	326	390	463	393	277	216	224	184	133	136	197	283
Difference from Existing Conditions	10	31	22	8	8	9	6	-1	-1	0	4	1
Victoria Canal												
Full Simulation Period Average	233	280	337	356	333	294	272	222	168	125	134	174
Difference from Existing Conditions	5	19	20	8	6	6	4	0	0	3	2	3
Banks Pumping Plant												
Full Simulation Period Average	294	276	306	223	162	118	137	112	127	131	213	250
Difference from Existing Conditions	-21	-63	-69	-93	-53	-59	-17	-19	-11	-14	-4	-47
Jones Pumping Plant												
Full Simulation Period Average	329	384	403	342	272	243	201	169	164	177	243	307
Difference from Existing Conditions	7	21	11	5	6	0	0	0	-1	0	3	0

Note: A positive difference denotes an increase from existing conditions, and a negative difference indicates a decrease from existing conditions.

1 **Table 9-15. Frequency That Monthly Average Bromide Concentrations Exceed 300 Micrograms per Liter at Delta Assessment Locations under**
2 **Alternatives 2c and 4c, and Difference from Existing Conditions**

Location/Parameter	Full Simulation Period	Wet Water Years	Above Normal Water Years	Below Normal Water Years	Dry Water Years	Critical Water Years
Barker Slough at North Bay Aqueduct						
Percent Greater Than 300 µg/L	0%	0%	0%	0%	0%	0%
Difference from Existing Conditions	0%	0%	0%	0%	0%	0%
Sacramento River at Emmaton						
Percent Greater Than 300 µg/L	44%	18%	31%	48%	57%	79%
Difference from Existing Conditions	2%	1%	1%	6%	1%	1%
San Joaquin River at Antioch						
Percent Greater Than 300 µg/L	69%	46%	59%	70%	85%	98%
Difference from Existing Conditions	0%	1%	0%	1%	1%	0%
Sacramento River at Mallard Island						
Percent Greater Than 300 µg/L	84%	61%	77%	93%	100%	100%
Difference from Existing Conditions	1%	1%	0%	2%	0%	0%
South Fork Mokelumne River at Terminous						
Percent Greater Than 300 µg/L	0%	0%	0%	0%	0%	0%
Difference from Existing Conditions	0%	0%	0%	0%	0%	0%
San Joaquin River at Empire Tract						
Percent Greater Than 300 µg/L	5%	2%	4%	2%	7%	12%
Difference from Existing Conditions	1%	1%	-1%	1%	1%	1%
Contra Costa Pumping Plant #1						
Percent Greater Than 300 µg/L	30%	11%	22%	33%	40%	52%
Difference from Existing Conditions	1%	-1%	1%	3%	-1%	1%
Old River at State Route 4						
Percent Greater Than 300 µg/L	31%	13%	25%	32%	41%	57%
Difference from Existing Conditions	1%	1%	1%	2%	1%	1%

Location/Parameter	Full Simulation Period	Wet Water Years	Above Normal Water Years	Below Normal Water Years	Dry Water Years	Critical Water Years
Victoria Canal						
Percent Greater Than 300 µg/L	29%	16%	33%	32%	33%	42%
Difference from Existing Conditions	3%	3%	4%	3%	2%	3%
Banks Pumping Plant						
Percent Greater Than 300 µg/L	20%	6%	14%	22%	29%	37%
Difference from Existing Conditions	-5%	-2%	-5%	-5%	-6%	-9%
Jones Pumping Plant						
Percent Greater Than 300 µg/L	32%	12%	29%	34%	43%	58%
Difference from Existing Conditions	0%	1%	2%	0%	1%	-1%

Note: A positive difference denotes an increase from existing conditions, and a negative difference indicates a decrease from existing conditions.

Table 9-16. Monthly Average Bromide (in micrograms per liter) at Delta Assessment Locations for the Full Simulation Period under Alternative 5, and Difference from Existing Conditions

Location/Parameter	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Barker Slough at North Bay Aqueduct												
Full Simulation Period Average	70	76	90	76	79	93	85	52	46	42	51	56
Difference from Existing Conditions	0	0	0	0	0	0	1	0	0	0	0	0
Sacramento River at Emmaton												
Full Simulation Period Average	1,473	1,557	937	438	167	100	126	195	357	517	976	1,399
Difference from Existing Conditions	67	119	54	46	17	5	1	-1	-2	45	35	115
San Joaquin River at Antioch												
Full Simulation Period Average	3,479	3,840	2,713	1,439	568	272	320	515	924	1,708	2,814	3,430
Difference from Existing Conditions	132	192	93	110	67	24	8	-2	7	102	100	122
Sacramento River at Mallard Island												
Full Simulation Period Average	9,676	9,961	7,031	4,050	1,899	1,328	1,778	2,542	4,180	6,386	8,864	9,639
Difference from Existing Conditions	233	320	241	313	235	166	52	29	83	323	232	264
South Fork Mokelumne River at Terminous												
Full Simulation Period Average	40	46	49	57	67	63	51	38	39	35	40	33

Location/Parameter	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Difference from Existing Conditions	1	2	1	2	2	2	0	0	0	1	0	0
San Joaquin River at Empire Tract												
Full Simulation Period Average	173	206	208	191	151	138	131	113	102	83	109	125
Difference from Existing Conditions	5	18	7	7	7	4	2	0	0	1	1	-1
Contra Costa Pumping Plant #1												
Full Simulation Period Average	382	449	502	379	227	146	146	122	105	134	225	333
Difference from Existing Conditions	12	35	18	11	11	8	8	0	-1	-1	5	0
Old River at State Route 4												
Full Simulation Period Average	325	385	460	394	279	216	225	185	133	136	197	282
Difference from Existing Conditions	9	26	19	10	9	9	8	0	-1	0	4	1
Victoria Canal												
Full Simulation Period Average	233	278	335	356	333	294	273	222	168	125	134	174
Difference from Existing Conditions	6	17	17	8	6	6	5	0	0	3	2	3
Banks Pumping Plant												
Full Simulation Period Average	291	269	299	221	155	115	138	109	127	130	213	248
Difference from Existing Conditions	-23	-70	-76	-95	-60	-63	-17	-21	-12	-14	-4	-49
Jones Pumping Plant												
Full Simulation Period Average	328	381	402	343	272	242	202	169	164	177	243	307
Difference from Existing Conditions	6	19	10	6	5	-1	1	-1	-1	0	3	0

Note: A positive difference denotes an increase from existing conditions, and a negative difference indicates a decrease from existing conditions.

Table 9-17. Frequency That Monthly Average Bromide Concentrations Exceed 300 Micrograms per Liter at Delta Assessment Locations under Alternative 5, and Difference from Existing Conditions

Location/Parameter	Full Simulation Period	Wet Water Years	Above Normal Water Years	Below Normal Water Years	Dry Water Years	Critical Water Years
Barker Slough at North Bay Aqueduct						
Percent Greater Than 300 µg/L	0%	0%	0%	0%	0%	0%
Difference from Existing Conditions	0%	0%	0%	0%	0%	0%

Location/Parameter	Full Simulation Period	Wet Water Years	Above Normal Water Years	Below Normal Water Years	Dry Water Years	Critical Water Years
Sacramento River at Emmaton						
Percent Greater Than 300 μg/L	44%	17%	31%	48%	57%	79%
Difference from Existing Conditions	2%	0%	1%	6%	1%	1%
San Joaquin River at Antioch						
Percent Greater Than 300 μg/L	69%	46%	59%	70%	85%	97%
Difference from Existing Conditions	0%	1%	0%	1%	1%	-1%
Sacramento River at Mallard Island						
Percent Greater Than 300 μg/L	84%	61%	78%	94%	100%	100%
Difference from Existing Conditions	1%	1%	1%	3%	0%	0%
South Fork Mokelumne River at Terminous						
Percent Greater Than 300 μg/L	0%	0%	0%	0%	0%	0%
Difference from Existing Conditions	0%	0%	0%	0%	0%	0%
San Joaquin River at Empire Tract						
Percent Greater Than 300 μg/L	5%	2%	4%	2%	7%	13%
Difference from Existing Conditions	1%	1%	-1%	1%	1%	2%
Contra Costa Pumping Plant #1						
Percent Greater Than 300 μg/L	30%	11%	23%	33%	40%	52%
Difference from Existing Conditions	1%	-1%	2%	3%	-1%	1%
Old River at State Route 4						
Percent Greater Than 300 μg/L	31%	13%	26%	32%	41%	57%
Difference from Existing Conditions	1%	1%	2%	2%	1%	1%
Victoria Canal						
Percent Greater Than 300 μg/L	29%	14%	34%	32%	33%	42%
Difference from Existing Conditions	3%	1%	5%	3%	2%	3%
Banks Pumping Plant						
Percent Greater Than 300 μg/L	20%	5%	13%	22%	29%	37%
Difference from Existing Conditions	-5%	-3%	-6%	-5%	-6%	-9%

Location/Parameter	Full Simulation Period	Wet Water Years	Above Normal Water Years	Below Normal Water Years	Dry Water Years	Critical Water Years
Jones Pumping Plant						
Percent Greater Than 300 µg/L	33%	11%	29%	35%	43%	61%
Difference from Existing Conditions	1%	0%	2%	1%	1%	2%

Note: A positive difference denotes an increase from existing conditions, and a negative difference indicates a decrease from existing conditions.

Suisun Marsh, Suisun Bay and San Francisco Bay—All Project Alternatives

Because Suisun Marsh, Suisun Bay, and San Francisco Bay are not designated for municipal and domestic supply use, and seawater is the primary source of bromide, minor changes in bromide concentrations in the Delta outflow that initially enters Suisun Marsh, Suisun Bay, and San Francisco Bay are not of concern relative to drinking water supplies or other beneficial uses.

SWP/CVP Export Service Areas—All Project Alternatives

As previously discussed, under all project alternatives, long-term average bromide concentrations at Banks Pumping Plant would decrease relative to existing conditions and would be similar to existing conditions in Barker Slough at the North Bay Aqueduct. At Jones Pumping Plant, bromide concentrations under Alternatives 1 and 3, 2b and 4b, 2c and 4c, and 5 were modeled to increase relative to existing conditions but would not result in substantial changes to the frequency that bromide exceeds 300 μg/L relative to existing conditions. Under Alternatives 2a and 4a, bromide concentrations at Jones Pumping Plant would decrease relative to existing conditions. Thus, the project alternatives would not result in increased bromide concentrations in SWP/CVP export service area waterbodies that would substantially degrade water quality relative to existing conditions. Moreover, any minor increases in bromide concentrations that would occur at Jones Pumping Plant under the project alternatives would not contribute to additional exceedances of applicable bromide objectives or criteria because none have been adopted/promulgated; therefore, bromide impacts in SWP/CVP export service areas would be less than significant.

CEQA Conclusion—All Project Alternatives

The project alternatives would not cause additional exceedance of applicable bromide water quality criteria/objectives because none exist for study area waterbodies. The above analysis indicates that bromide concentrations at all Delta assessment locations, except Banks Pumping Plant, could be higher in some months of some year types under the project alternatives relative to existing conditions, but there would not be substantial changes to the frequency that concentrations exceed 300 μg/L relative to existing conditions. The greatest magnitude increases in monthly average bromide concentrations could occur in the western Delta at times of the year when bromide concentrations are already high and not a suitable source water for drinking water treatment plants (i.e., typically greater than 1,000 μg/L). The project alternatives would not cause long-term degradation of bromide in study area waterbodies that would result in substantially increased risk for adverse effects on drinking water supplies or other beneficial uses. The project alternatives would improve bromide concentrations at Banks Pumping Plant. Bromide is not a bioaccumulative constituent, thus any bromide concentration increases would not result in bioaccumulation in aquatic organisms. Because there are no CWA Section 303(d) listings for bromide in the study area, any bromide concentration increases under the project alternatives would not make any associated beneficial use impairment discernably worse. Therefore, impacts of the project alternatives on bromide concentrations would be less than significant.

Mitigation Impacts

<u>*Compensatory Mitigation*</u>

Although the CMP described in Appendix 3F does not act as mitigation for impacts on water quality from project construction or operations, its implementation could result in impacts on water quality.

Natural habitats proposed by the CMP are not sources of bromide to receiving waters. Therefore, the CMP would result in negligible, if any, changes in bromide concentrations in study area waterbodies relative to existing conditions. The CMP would not cause additional exceedance of applicable bromide water quality criteria/objectives because none exist for study area waterbodies. Because bromide concentrations are expected to change negligibly, the CMP would not cause long-term degradation of bromide in study area waterbodies that would result in substantially increased risk for adverse effects on any beneficial uses. Bromide is not a bioaccumulative constituent; therefore, the CMP would not result in bromide bioaccumulation in aquatic organisms. Because there are no CWA Section 303(d) listings for bromide in the study area, the CMP would not make any associated bromide beneficial use impairment discernably worse. Based on these findings, impacts from the CMP on bromide would be less than significant.

<u>*Other Mitigation Measures*</u>

Impacts of other mitigation measures on bromide in study area waterbodies would be similar to those described for Impact WQ-2: *Effects on Boron Resulting from Facility Operations and Maintenance*. Operation of other mitigation measures would not cause additional exceedance of applicable bromide water quality criteria/objectives because none exist for study area waterbodies. Because other mitigation measures would not contribute substantial amounts of bromide in runoff, the other mitigation measures would not cause long-term degradation of bromide in study area waterbodies that would result in substantially increased risk for adverse effects on any beneficial uses. Bromide is not a bioaccumulative constituent; therefore, the other mitigation measures would not result in bromide bioaccumulation in aquatic organisms. Because there are no CWA Section 303(d) listings for bromide in the study area, the other mitigation measures would not make any associated bromide beneficial use impairment discernably worse. As a result, impacts from other mitigation measures on bromide would be less than significant.

Overall, the effects on bromide concentrations from the CMP and other mitigation measures, combined with project alternatives, would not change the impact conclusion of less than significant.

Impact WQ-4: Effects on Chloride Resulting from Facility Operations and Maintenance

Maintenance of project alternatives' facilities would not create new sources of chloride or contribute toward a substantial change in existing sources of chloride in the Delta. As such, maintenance activities would not cause any substantial change in chloride in study area waterbodies that would adversely affect beneficial uses anywhere in the Delta.

Delta

The Bay-Delta WQCP established two water quality objectives for chloride for the Delta (Appendix 9F, *Chloride*, Section 9F.4, *Applicable Water Quality Criteria/Objectives*). The chloride objectives are for the protection of municipal and industrial beneficial uses. One of the chloride objectives is 150 mg/L for a certain number of days per year, depending on water year type, and is to be met at either

Contra Costa Pumping Plant #1 or City of Antioch's drinking water intake on the San Joaquin River. The second chloride objective is 250 mg/L and applies at Contra Costa Pumping Plant #1, Banks and Jones Pumping Plants, and Barker Slough at the North Bay Aqueduct. These locations are source water intakes within the Delta for drinking water supplies.

The City of Stockton also has a drinking water supply intake on the San Joaquin River at Empire Tract. The Bay-Delta WQCP objectives do not specifically identify this as a compliance location. However, Central Valley RWQCB WQCP includes secondary MCLs as water quality objectives for waters designated for municipal and domestic supply use. The chloride secondary MCL consists of a recommended level of 250 mg/L for consumer acceptance, an upper level of 500 mg/L if it is neither reasonable nor feasible to provide more suitable waters, and a short-term level of 600 mg/L for existing community water systems on a temporary basis pending construction of treatment facilities or development of acceptable new water sources (Appendix 9F, Section 9F.4). The analysis of effects of the project alternatives on chloride in the San Joaquin River at Empire Tract considers these water quality objectives.

Alternatives 1 and 3

Overview

Appendix 9F provides tables and figures presenting modeled chloride concentrations at the Delta assessment locations for existing conditions and Alternatives 1 and 3. Table 9-18 presents the modeled monthly average chloride concentrations at the Delta assessment locations under Alternatives 1 and 3 for the 93-year simulation period, and the differences from existing conditions. Detailed discussions of the differences in chloride concentrations under Alternatives 1 and 3 relative to existing conditions follow.

Table 9-18. Monthly Average Chloride (in milligrams per liter) at Delta Assessment Locations for the Full Simulation Period under Alternatives 1 and 3, and Difference from Existing Conditions

Location/Parameter	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Barker Slough at North Bay Aqueduct												
Full Simulation Period Average	22	23	23	27	30	27	28	19	16	14	15	21
Difference from Existing Conditions	0	0	0	0	0	0	0	0	0	0	0	0
San Joaquin River at Antioch												
Full Simulation Period Average	993	1,095	773	410	162	78	92	147	264	488	804	980
Difference from Existing Conditions	37	52	25	30	19	7	2	-1	2	29	29	35
Sacramento River at Mallard Island												
Full Simulation Period Average	2,763	2,839	2,005	1,153	542	379	508	726	1,194	1,825	2,534	2,753
Difference from Existing Conditions	65	85	65	85	66	47	15	8	24	92	67	75
San Joaquin River at Empire Tract												
Full Simulation Period Average	51	60	59	59	49	39	39	34	31	25	31	40
Difference from Existing Conditions	1	5	2	2	2	1	1	0	0	0	0	0
Contra Costa Pumping Plant #1												
Full Simulation Period Average	109	128	143	108	65	42	42	35	30	38	64	95
Difference from Existing Conditions	3	10	5	3	3	2	2	0	0	0	1	0
Banks Pumping Plant												
Full Simulation Period Average	84	78	86	67	49	33	42	35	38	39	61	76
Difference from Existing Conditions	-7	-20	-21	-28	-19	-17	-5	-6	-3	-4	-1	-14
Jones Pumping Plant												
Full Simulation Period Average	94	110	114	101	83	68	59	50	48	52	69	92
Difference from Existing Conditions	2	5	3	2	2	0	0	0	0	0	1	0

Note: A positive difference denotes an increase from existing conditions, and a negative difference indicates a decrease from existing conditions.

North Bay Aqueduct

In Barker Slough at the North Bay Aqueduct, modeling results indicate there would be no change in monthly average chloride concentrations under Alternatives 1 and 3 relative to existing conditions (Table 9-18; Appendix 9F). Modeled monthly average chloride concentrations are 61 mg/L or less 99.9% of the time under both existing conditions and Alternatives 1 and 3 (Appendix 9F, Tables 9F-1-1-1 through 9F-1-2-4, Figures 9F-1-1 through 9F-1-18). Based on these modeled differences in chloride, Alternatives 1 and 3 would not cause any exceedances of the 250 mg/L chloride objective applicable to this location and would not substantially degrade water quality with regard to chloride on a long-term average basis.

San Joaquin River at Empire Tract

In the San Joaquin River at Empire Tract, monthly average chloride concentrations under Alternatives 1 and 3 would differ negligibly from existing conditions. Modeled monthly average chloride concentrations are up to 5 mg/L higher under Alternatives 1 and 3 for the full simulation period (Table 9-18; Appendix 9F). Furthermore, modeling results show no increased frequency of exceeding the secondary MCL recommended level of 250 mg/L under Alternatives 1 and 3 (Appendix 9F, Tables 9F-6-2-1 and 9F-6-2-3, Figures 9F-6-7 through 9F-6-18). Modeled concentrations at Empire Tract are 144 mg/L or less 99.9% of the time under Alternatives 1 and 3, compared to 148 mg/L or less under existing conditions (Appendix 9F, Tables 9F-6-1-1 and 9F-6-2-1). Based on these modeled differences in chloride, Alternatives 1 and 3 would not substantially degrade water quality with regard to chloride on a long-term average basis.

Contra Costa Water District Pumping Plant #1

At Contra Cost Water District Pumping Plant #1, monthly average chloride concentrations under Alternatives 1 and 3 for the full simulation period also would differ negligibly from existing conditions. Modeled monthly average chloride concentrations are up to 10 mg/L higher under Alternatives 1 and 3 for the full simulation period (Table 9-18; Appendix 9F). Based on these modeled differences in chloride, Alternatives 1 and 3 would not substantially degrade water quality with regard to chloride on a long-term average basis.

Furthermore, there would be no increased frequency of exceeding Bay-Delta WQCP chloride objectives applicable to the Contra Costa Pumping Plant #1. The modeled frequency of exceedance of the 250 mg/L objective was 1.81% under existing conditions and 2.11% under Alternatives 1 and 3 (Appendix 9F, Table 9F-7). Compliance with the 150 mg/L objective was modeled to be the same under both existing conditions and Alternatives 1 and 3; in only one out of 92 years would the objective be exceeded (Appendix 9F, Table 9F-8). The modeled exceedance of the Bay-Delta WQCP chloride objective is attributable to the monthly timestep of the hydrologic modeling conducted by CalSim 3, as compared to the 15-minute timestep of DSM2. CalSim 3 includes an algorithm to operate the SWP/CVP to meet Bay-Delta WQCP objectives, among other requirements. While CalSim 3 simulates operations on a monthly timestep, actual decisions associated with real-time system operations are conducted on a daily timestep to comply with this and other Bay-Delta WQCP objectives. As described in Chapter 3, Section 3.16.3, *Integration of North Delta Intakes with South Delta Facilities*, the project facilities would be operated to meet Bay-Delta WQCP chloride objectives, as implemented through D-1641. Thus, the increases are what is known as modeling artifacts and do not indicate that operations of Alternatives 1 and 3 would increase the frequency of exceeding Bay-Delta WQCP chloride objectives at the Contra Costa Pumping Plant #1 compliance location.

Jones Pumping Plant

At Jones Pumping Plant, monthly average chloride concentrations under Alternatives 1 and 3 also would differ negligibly from existing conditions. Modeled monthly average chloride concentrations are up to 5 mg/L higher under Alternatives 1 and 3 for the full simulation period (Table 9-18; Appendix 9F). Furthermore, there would be no increased frequency of exceeding the Bay-Delta WQCP chloride objective of 250 mg/L applicable to Jones Pumping Plant. The modeled frequency of exceedance of the 250 mg/L objective was 0.00% under both existing conditions and Alternatives 1 and 3 (Appendix 9F, Table 9F-7). Based on these modeled differences in chloride, Alternatives 1 and 3 would not cause any exceedances of the 250 mg/L chloride objective applicable to this location and would not substantially degrade water quality with regard to chloride on a long-term average basis.

Banks Pumping Plant

At Banks Pumping Plant, monthly average chloride concentrations under Alternatives 1 and 3 for the full simulation period would decrease relative to existing conditions. Modeled monthly average chloride concentrations are up to 28 mg/L lower under Alternatives 1 and 3 for the full simulation period (Table 9-18; Appendix 9F). Furthermore, there would be no increased frequency of exceeding the Bay-Delta WQCP chloride objective of 250 mg/L applicable to Banks Pumping Plant. The modeled frequency of exceedance of the 250 mg/L objective was 0.00% under both existing conditions and Alternatives 1 and 3 (Appendix 9F, Table 9F-7). Based on these modeled differences in chloride, Alternatives 1 and 3 would not cause any exceedances of the 250 mg/L chloride objective applicable to this location and would not substantially degrade water quality with regard to chloride on a long-term average basis.

San Joaquin River at Antioch

In the San Joaquin River at Antioch, in February through June, modeled monthly average chloride concentrations for the full simulation period increased 19 mg/L or less under Alternatives 1 and 3 relative to existing conditions (Table 9-18; Appendix 9F). Furthermore, modeling results show there would be no increase in the frequency of monthly average chloride concentrations exceeding the secondary MCL of 250 mg/L in March, May, June, August, and October, a 1% increase in April and November, a 2% increase in September, a 3% increase in January and February, and a 4% increase in December (Appendix 9F, Table 9F-3-7). In June through January, modeled monthly average chloride concentrations for the full simulation period are up to 52 mg/L higher under Alternatives 1 and 3 (Table 9-18; Appendix 9F). Modeled monthly average chloride concentrations at Antioch often exceed the secondary MCL of 250 mg/L in these months under existing conditions, at a frequency of 45% to 96%, depending on month (Appendix 9F, Table 9F-3-7, Figures 9F-3-7 through 9F-3-18). Under Alternatives 1 and 3, the modeled frequency of monthly average chloride concentrations exceeding 250 mg/L in June through January is 43% to 96% (Appendix 9F, Table 9F-3-7). Based on these modeled differences in chloride, Alternatives 1 and 3 would not substantially degrade water quality with regard to chloride on a long-term average basis.

During critical years, modeled monthly average chloride concentrations are less than 250 mg/L at Antioch primarily only in March under existing conditions (Appendix 9F, Figure 9F-3-6). The period during which modeled monthly average chloride concentrations are less than 250 mg/L expands as the water years get wetter (Appendix 9F, Figures 9F-3-2 through 9F-3-5). In wet years, modeled monthly average chloride concentrations are less than 250 mg/L only in January through July for existing conditions. Hence, this location is only seasonally suitable for diverting municipal and industrial water supplies presently. As indicated in the City of Antioch's 2019 consumer confidence report, Antioch does not divert San Joaquin River water for municipal and industrial uses once the river exceeds 250 mg/L (City of Antioch 2020:8). The small difference in frequency of exceeding the 250 mg/L chloride MCL for the project alternatives indicates that the frequency with which Antioch could divert and use San Joaquin River water for municipal and industrial uses would not change substantially for the project alternatives relative to existing conditions.

CWA Section 303(d)-Listed Waterbodies

Specific waterways located at least partially within the Delta that are CWA Section 303(d)-listed for chloride are Tom Paine Slough and Mountain House Creek, both of which were listed with respect to the secondary MCL of 250 mg/L (Table 9-2). Alternatives 1 and 3 would not affect chloride concentrations in Mountain House Creek given that this waterbody is mostly located upland and outside of the influence of Delta hydrodynamics. Chloride concentrations in Tom Paine Slough would not be further degraded on a long-term basis, based on small changes in EC for Old River at Tracy Road (Impact WQ-5: *Effects on Electrical Conductivity Resulting from Facility Operations and Maintenance*), which is correlated with chloride concentrations. Therefore, Alternatives 1 and 3 would not further degrade water quality in the CWA Section 303(d)-listed Tom Paine Slough and Mountain House Creek on a long-term basis such that the existing beneficial use impairment would be made discernibly worse.

Alternatives 2a, 2b, 2c, 4a, 4b, 4c, and 5

Appendix 9F provides tables and figures presenting modeled chloride concentrations at the Delta assessment locations for existing conditions and Alternatives 2a, 2b, 2c, 4a, 4b, 4c, and 5. Tables 9-19 through 9-22 present the modeled monthly average chloride concentrations at the Delta assessment locations under Alternatives 2a, 2b, 2c, 4a, 4b, 4c, and 5 for the 93-year simulation period, and the differences from existing conditions.

Under Alternatives 2a, 2b, 2c, 4a, 4b, 4c, and 5, the changes in chloride concentrations relative to existing conditions would have a similar seasonal pattern and magnitude to those that would occur under Alternatives 1 and 3 for Barker Slough at North Bay Aqueduct (Appendix 9F, Figures 9F-1-2 through 9F-1-18), San Joaquin River at Antioch (Appendix 9F, Figures 9F-3-1 through 9F-3-18), San Joaquin River at Empire Tract (Appendix 9F, Figures 9F-6-1 through 9F-6-18), Contra Cost Water District Pumping Plant #1 (Appendix 9F, Figures 9F-7-1 through 9F-7-18), Banks Pumping Plant (Appendix 9F, Figures 9F-10-1 through 9F-10-18), and Jones Pumping Plant (Appendix 9F, Figures 9F-11-1 through 9F-11-18).

Alternatives 2a, 2b, 2c, 4a, 4b, 4c, and 5 would not cause increased frequency of Bay-Delta WQCP chloride objective exceedances at any location (r Appendix 9F, Tables 9F-7 and 9F-8) and chloride degradation would be similar to that described for Alternatives 1 and 3 (Appendix 9F). Thus, these alternatives would not cause increased exceedance of applicable chloride objectives or criteria by frequency or magnitude that would result in adverse effect on any beneficial uses, nor would the project alternatives substantially degrade water quality with regard to chloride.

For the reasons described for Alternatives 1 and 3, the higher chloride concentrations that could occur in some months under Alternatives 2a, 2b, 2c, 4a, 4b, 4c, and 5 would not further degrade water quality in the CWA Section 303(d)-listed Tom Paine Slough and Mountain House Creek by measurable levels on a long-term basis such that beneficial use impairment would be made discernibly worse.

1 **Table 9-19. Monthly Average Chloride (in milligrams per liter) at Delta Assessment Locations for the Full Simulation Period under Alternatives**
2 **2a and 4a, and Difference from Existing Conditions**

Location/Parameter	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Barker Slough at North Bay Aqueduct												
Full Simulation Period Average	22	23	23	27	30	27	28	19	16	14	15	21
Difference from Existing Conditions	0	0	0	0	0	0	0	0	0	0	0	0
San Joaquin River at Antioch												
Full Simulation Period Average	993	1,091	774	412	160	77	92	147	264	488	805	980
Difference from Existing Conditions	36	49	26	32	16	7	2	-1	2	29	29	35
Sacramento River at Mallard Island												
Full Simulation Period Average	2,760	2,834	2,006	1,160	536	380	508	726	1,194	1,825	2,533	2,753
Difference from Existing Conditions	62	80	66	93	61	49	15	8	24	93	67	74
San Joaquin River at Empire Tract												
Full Simulation Period Average	51	60	59	59	48	39	39	35	31	25	31	40
Difference from Existing Conditions	1	5	2	2	2	1	1	0	0	0	0	0
Contra Costa Pumping Plant #1												
Full Simulation Period Average	109	128	143	108	64	42	42	35	30	38	64	95
Difference from Existing Conditions	3	10	5	3	2	2	2	0	0	-1	1	0
Banks Pumping Plant												
Full Simulation Period Average	87	83	91	69	51	34	42	35	39	40	62	81
Difference from Existing Conditions	-4	-15	-15	-27	-18	-15	-5	-6	-2	-3	0	-9
Jones Pumping Plant												
Full Simulation Period Average	92	102	110	95	79	63	59	50	47	50	68	87
Difference from Existing Conditions	-1	-2	-2	-5	-2	-5	0	-1	-1	-1	0	-5

3 Note: A positive difference denotes an increase from existing conditions, and a negative difference indicates a decrease from existing conditions.
4

Table 9-20. Monthly Average Chloride (in milligrams per liter) at Delta Assessment Locations for the Full Simulation Period under Alternatives 2b and 4b, and Difference from Existing Conditions

Location/Parameter	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Barker Slough at North Bay Aqueduct												
Full Simulation Period Average	22	23	23	27	30	27	28	19	16	14	15	21
Difference from Existing Conditions	0	0	0	0	0	0	0	0	0	0	0	0
San Joaquin River at Antioch												
Full Simulation Period Average	994	1,083	768	407	163	77	91	147	265	484	802	975
Difference from Existing Conditions	38	41	19	27	20	7	2	0	3	26	26	30
Sacramento River at Mallard Island												
Full Simulation Period Average	2,769	2,831	1,991	1,140	534	370	506	727	1,193	1,814	2,527	2,743
Difference from Existing Conditions	71	77	51	72	59	38	12	9	23	82	61	64
San Joaquin River at Empire Tract												
Full Simulation Period Average	51	59	59	58	48	38	39	34	31	25	31	40
Difference from Existing Conditions	2	4	2	2	1	1	0	0	0	0	0	0
Contra Costa Pumping Plant #1												
Full Simulation Period Average	110	126	142	108	65	41	41	35	30	38	64	95
Difference from Existing Conditions	4	8	4	3	3	2	2	0	0	0	1	0
Banks Pumping Plant												
Full Simulation Period Average	86	82	88	69	54	36	44	36	38	39	61	77
Difference from Existing Conditions	-5	-16	-18	-26	-14	-14	-3	-5	-3	-4	-1	-13
Jones Pumping Plant												
Full Simulation Period Average	95	109	113	101	82	69	59	50	48	52	69	92
Difference from Existing Conditions	2	5	2	2	1	1	0	0	0	0	1	0

Note: A positive difference denotes an increase from existing conditions, and a negative difference indicates a decrease from existing conditions.

1 **Table 9-21. Monthly Average Chloride (in milligrams per liter) at Delta Assessment Locations for the Full Simulation Period under Alternatives**
2 **2c and 4c, and Difference from Existing Conditions**

Location/Parameter	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Barker Slough at North Bay Aqueduct												
Full Simulation Period Average	22	23	23	27	30	27	28	19	16	14	15	21
Difference from Existing Conditions	0	0	0	0	0	0	0	0	0	0	0	0
San Joaquin River at Antioch												
Full Simulation Period Average	997	1,097	770	408	163	78	91	147	265	488	805	978
Difference from Existing Conditions	41	55	22	28	20	7	2	0	3	29	30	33
Sacramento River at Mallard Island												
Full Simulation Period Average	2,773	2,845	1,996	1,146	540	375	507	727	1,196	1,825	2,535	2,749
Difference from Existing Conditions	75	90	56	79	65	43	14	9	25	93	69	70
San Joaquin River at Empire Tract												
Full Simulation Period Average	51	61	59	59	49	39	39	34	31	25	31	40
Difference from Existing Conditions	2	6	2	2	2	1	0	0	0	0	0	0
Contra Costa Pumping Plant #1												
Full Simulation Period Average	110	130	144	108	65	42	41	35	30	38	64	95
Difference from Existing Conditions	4	12	6	3	3	2	2	0	0	0	1	0
Banks Pumping Plant												
Full Simulation Period Average	85	81	88	68	52	34	42	36	38	39	61	76
Difference from Existing Conditions	-6	-18	-19	-27	-17	-16	-5	-5	-3	-4	-1	-14

Location/Parameter	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Jones Pumping Plant												
Full Simulation Period Average	95	111	114	101	83	69	59	50	48	52	69	92
Difference from Existing Conditions	2	6	3	2	2	0	0	0	0	0	1	0

Note: A positive difference denotes an increase from existing conditions, and a negative difference indicates a decrease from existing conditions.

Table 9-22. Monthly Average Chloride (in milligrams per liter) at Delta Assessment Locations for the Full Simulation Period under Alternative 5, and Difference from Existing Conditions

Location/Parameter	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Barker Slough at North Bay Aqueduct												
Full Simulation Period Average	22	23	23	27	30	27	28	19	16	14	15	21
Difference from Existing Conditions	0	0	0	0	0	0	0	0	0	0	0	0
San Joaquin River at Antioch												
Full Simulation Period Average	994	1,097	775	411	162	78	92	147	264	488	804	980
Difference from Existing Conditions	38	55	27	31	19	7	2	0	2	29	29	35
Sacramento River at Mallard Island												
Full Simulation Period Average	2,765	2,846	2,009	1,157	543	379	508	726	1,194	1,825	2,533	2,754
Difference from Existing Conditions	66	91	69	89	67	48	15	8	24	92	66	75
San Joaquin River at Empire Tract												
Full Simulation Period Average	51	60	59	59	49	39	39	34	31	25	31	40
Difference from Existing Conditions	1	5	2	2	2	1	1	0	0	0	0	0
Contra Costa Pumping Plant #1												
Full Simulation Period Average	109	128	143	108	65	42	42	35	30	38	64	95
Difference from Existing Conditions	3	10	5	3	3	2	2	0	0	0	1	0
Banks Pumping Plant												
Full Simulation Period Average	85	79	86	67	49	33	42	35	38	39	61	76
Difference from Existing Conditions	-7	-20	-21	-28	-19	-17	-5	-6	-3	-4	-1	-14

Location/Parameter	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Jones Pumping Plant												
Full Simulation Period Average	94	110	114	101	83	68	59	50	48	52	69	92
Difference from Existing Conditions	2	5	3	2	2	0	0	0	0	0	1	0

Note: A positive difference denotes an increase from existing conditions, and a negative difference indicates a decrease from existing conditions.

Suisun Marsh—All Project Alternatives

Suisun Marsh is on the CWA Section 303(d) list for chloride in association with the Bay-Delta WQCP objectives for maximum allowable salinity during the months of October through May, which establish appropriate seasonal salinity conditions for fish and wildlife beneficial uses. The primary source of chloride to Suisun Marsh is seawater. However, modeled chloride concentrations increase in water exported from the Delta to Suisun Marsh, as assessed by chloride concentrations for the Sacramento River at Mallard Island. At Mallard Island, modeled monthly average chloride concentrations for the full simulation period for the project alternatives relative to existing conditions are up to 25 mg/L higher during April through June, and up to 93 mg/L higher during July through March (Tables 9-18 through 9-22; Appendix 9F). Chloride concentrations in Suisun Marsh are highly dynamic on a sub-daily basis as a result of tidal influences. The changes attributable to the project alternatives are small (i.e., an average of 5%) relative to the average Bay water chloride concentration (i.e., 6,500 mg/L; Appendix 9F, Table 9F-2) and normal day-to-day variability that occurs within Suisun Marsh. As a result, the small increases in chloride concentrations that could occur in Suisun Marsh under Alternatives 1, 2a, 2b, 2c, 3, 4a, 4b, 4c, and 5 would not be expected to measurably degrade water quality, adversely affect marsh beneficial uses, or make any beneficial use impairment discernibly worse.

Suisun Bay and San Francisco Bay—All Project Alternatives

Because Suisun Bay and San Francisco Bay are not designated for municipal and domestic supply use, and seawater is the primary source of chloride in these waterbodies, minor changes in chloride concentrations in the Delta outflow that initially enters Suisun Bay and San Francisco Bay are not of concern relative to drinking water supplies or other beneficial uses.

SWP/CVP Export Service Areas—All Project Alternatives

Modeled monthly average chloride concentrations at Jones Pumping Plant for the project alternatives for the full simulation period are no more than 6 mg/L higher than for existing conditions (Appendix 9F, Tables 9F-11-2-4, 9F-11-3-4, 9F-11-4-4. 9F-11-5-4, and 9F-11-6-4). Furthermore, modeled monthly average chloride concentrations at Banks Pumping Plant are lower for the project alternatives compared to existing conditions (Appendix 9F, Tables 9F-10-2-4, 9F-10-3-4, 9F-10-4-4. 9F-10-5-4, and 9F-10-6-4). The project alternatives would not contribute to additional exceedances of the Bay-Delta WQCP 250 mg/L chloride objective applicable at these locations (Appendix 9F, Table 9F-7). Thus, the project alternatives would not result in increased chloride concentrations in SWP/CVP export service area waterbodies that would substantially degrade water quality or cause increased frequency of exceeding water quality objectives relative to existing conditions.

CEQA Conclusion—All Project Alternatives

Based on the analysis above, the project alternatives would not cause substantial increases in chloride concentrations in study area waterbodies relative to existing conditions. As such, the project alternatives would not cause additional exceedance of applicable chloride water quality objectives/criteria by frequency, magnitude, and geographic extent that would result in adverse effects on any beneficial uses of study area waterbodies. Because chloride concentrations are not expected to increase substantially, the project alternatives would not cause long-term degradation of chloride in study area waterbodies that would result in substantially increased risk for adverse effects on any beneficial uses. Furthermore, the above described changes to chloride concentrations would not further degrade water quality by measurable levels on a long-term basis in any study area waterbody on the State's CWA Section 303(d) list such that beneficial use impairment would be made discernibly worse. Chloride is not bioaccumulative, thus any chloride concentration increases under the project alternatives would not result in bioaccumulation of chloride in aquatic organisms. Therefore, the impact of the project alternatives on chloride would be less than significant.

Mitigation Impacts

Compensatory Mitigation

Although the CMP described in Appendix 3F does not act as mitigation for impacts on water quality from project construction or operations, its implementation could result in impacts on water quality.

Natural habitats proposed by the CMP are not substantial sources of chloride to receiving waters relative to existing conditions and watershed and seawater contributions. Therefore, the CMP would result in negligible, if any, change in chloride concentrations in study area waterbodies relative to existing conditions. As such, the CMP would not cause additional exceedance of applicable chloride water quality criteria/objectives by frequency, magnitude, and geographic extent that would result in adverse effects on any beneficial uses of any study area waterbodies. Because chloride concentrations are not expected to increase substantially, the CMP would not cause long-term degradation of chloride in study area waterbodies that would result in substantially increased risk for adverse effects on any beneficial uses. Furthermore, the CMP would not further degrade chloride by measurable levels on a long-term basis in any study area waterbody on the State's CWA Section 303(d) list such that beneficial use impairment would be made discernibly worse. Chloride is not a bioaccumulative constituent; therefore, the CMP would not result in bioaccumulation of chloride in aquatic organisms. Based on these findings, impacts from the CMP on chloride would be less than significant.

Other Mitigation Measures

Impacts of other mitigation measures on chloride in study area waterbodies would be similar to those described for Impact WQ-2. Because operation of other mitigation measures would not generate substantial discharges of chloride, the other mitigation measures would not cause additional exceedance of applicable chloride water quality criteria/objectives by frequency, magnitude, and geographic extent that would result in adverse effects on any beneficial uses of any study area waterbodies. Because chloride concentrations are not expected to increase substantially, the other mitigation measures would not cause long-term degradation of chloride in study area waterbodies that would result in substantially increased risk for adverse effects on any beneficial uses. Furthermore, other mitigation measures would not further degrade chloride by measurable levels on a long-term basis in any study area waterbody on the State's CWA Section 303(d) list such that beneficial use impairment would be made discernibly worse. Chloride is not a bioaccumulative constituent; therefore, the other mitigation measures would not result in bioaccumulation of chloride in aquatic organisms. As a result, impacts from other mitigation measures on chloride would be less than significant.

Overall, the effects on chloride concentrations from the CMP and other mitigation measures, combined with project alternatives, would not change the impact conclusion of less than significant.

Impact WQ-5: Effects on Electrical Conductivity Resulting from Facility Operations and Maintenance

Maintenance of project alternatives' facilities would not create new sources of EC or contribute toward a substantial change in existing sources of EC in the Delta. As such, maintenance activities would not cause any substantial change in EC in study area waterbodies that would adversely affect beneficial uses anywhere in the Delta.

Delta

Alternatives 1 and 3

Overview

Appendix 9G, *Electrical Conductivity*, provides tables and figures presenting modeled EC levels at the Delta assessment locations for existing conditions and Alternatives 1 and 3. Table 9-23 presents the modeled monthly average EC levels at the Delta assessment locations under Alternatives 1 and 3 for the 93-year simulation period, and the differences from existing conditions. Detailed discussions of the differences in EC levels at these locations under Alternatives 1 and 3 relative to existing conditions follow.

Table 9-23. Monthly Average Electrical Conductivity (in micromhos per centimeter) at Delta Assessment Locations for the Full Simulation Period under Alternatives 1 and 3, and Difference from Existing Conditions

Location/Parameter	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Sacramento River at Emmaton												
Full Simulation Period Average	1,647	1,730	1,104	595	313	243	275	347	522	691	1,154	1,577
Difference from Existing Conditions	64	118	53	47	18	7	2	-1	-1	45	36	116
South Fork Mokelumne River at Terminous												
Full Simulation Period Average	188	197	205	215	224	215	200	188	185	184	185	182
Difference from Existing Conditions	0	0	0	3	2	0	0	0	0	0	0	-6
Banks Pumping Plant												
Full Simulation Period Average	421	416	473	425	379	321	379	358	322	292	338	370
Difference from Existing Conditions	-22	-70	-99	-144	-105	-104	-27	-38	-14	-13	-2	-36
Jones Pumping Plant												
Full Simulation Period Average	513	569	649	622	557	512	460	412	364	357	394	449
Difference from Existing Conditions	5	16	11	4	4	-2	1	0	-2	0	4	1
San Joaquin River at Jersey Point												
Full Simulation Period Average	1,175	1,377	1,185	747	416	278	262	286	338	574	931	1,170
Difference from Existing Conditions	34	72	16	29	24	8	4	0	-1	2	24	2
San Joaquin River at San Andreas Landing												
Full Simulation Period Average	388	439	428	361	266	227	226	223	209	225	275	324
Difference from Existing Conditions	10	31	6	8	8	4	2	0	0	0	2	1
San Joaquin River at Vernalis												
Full Simulation Period Average	598	768	747	680	651	610	465	433	515	578	580	563
Difference from Existing Conditions	1	1	1	1	1	0	0	0	0	1	1	1
San Joaquin River at Brandt Bridge												
Full Simulation Period Average	596	759	749	686	653	613	475	436	513	577	583	566
Difference from Existing Conditions	1	1	1	1	1	0	0	0	0	1	1	0

Location/Parameter	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Old River near Middle River												
Full Simulation Period Average	598	762	751	688	657	616	474	437	515	578	584	567
Difference from Existing Conditions	1	1	1	1	1	0	0	0	0	1	1	1
Old River at Tracy Bridge												
Full Simulation Period Average	598	742	760	711	685	637	495	448	487	523	519	537
Difference from Existing Conditions	1	0	1	1	1	0	0	0	1	-1	1	1
Steamboat Slough at Sutter Slough												
Full Simulation Period Average	176	177	179	179	180	179	177	176	176	176	176	176
Difference from Existing Conditions	0	0	0	0	0	0	0	0	0	0	0	0
Sacramento River at Rio Vista												
Full Simulation Period Average	294	316	262	216	195	189	189	190	202	209	244	283
Difference from Existing Conditions	5	15	6	4	2	1	0	0	0	2	2	12
Sacramento River at Threemile Slough												
Full Simulation Period Average	810	855	574	352	237	206	216	240	307	360	560	774
Difference from Existing Conditions	29	61	26	20	7	3	1	0	-1	14	12	57

Note: A positive difference denotes an increase from existing conditions, and a negative difference indicates a decrease from existing conditions.

Sacramento River at Emmaton and Threemile Slough

In the Sacramento River at Emmaton, during the February through June period, modeled monthly average EC levels for the full simulation period under Alternatives 1 and 3 are no more than 18 µmhos/cm higher than EC levels under existing conditions (Table 9-23). In July through January, modeled monthly average EC levels for the full simulation period are up to 118 µmhos/cm higher under Alternatives 1 and 3 (Table 9-23). The modeled monthly average EC from July through January under existing conditions ranges from 549 µmhos/cm (in January) to 1,613 µmhos/cm (in November) for the full simulation period (Appendix 9G, Table 9G-1-1-2). Under Alternatives 1 and 3, the modeled monthly average EC ranges from 595 µmhos/cm (in January) to 1,730 µmhos/cm (in November) for the full simulation period (Table 9-23). Thus, on a long-term average basis, modeled monthly average EC levels are up to about 8% higher under Alternatives 1 and 3 relative to existing conditions. However, median monthly average EC levels increased the most in September for the full simulation period. In September, median average monthly EC increased from 1,183 µmhos/cm under existing conditions to 1,741 µmhos/cm under Alternatives 1 and 3, an increase of 47% (Appendix 9G, Tables 9G-1-1-1 through 9G-1-1-2, and 9G-1-2-1 through 9G-1-2-4). The greatest monthly average EC increases in September (341 µmhos/cm) would occur in below normal years (Appendix 9G, Table 9G-1-2-4).

In the Sacramento River at Threemile Slough, during the February through June period, modeled monthly average EC levels for the full simulation period are up to 7 µmhos/cm higher under Alternatives 1 and 3 relative to existing conditions (Table 9-23). In July through January, modeled monthly average EC levels for the full simulation period are up to 61 µmhos/cm higher under Alternatives 1 and 3 (Table 9-23). The modeled monthly average EC from July through January under existing conditions ranges from 332 µmhos/cm (in January) to 794 µmhos/cm (in November) for the full simulation period (Appendix 9G, Table 9G-14-1-2). Under Alternatives 1 and 3, the modeled monthly average EC ranges from 352 µmhos/cm (in January) to 855 µmhos/cm (in November) for the full simulation period (Table 9-23). Thus, on a long-term average basis, modeled monthly average EC levels are up to about 8% relative to existing conditions. However, median monthly average EC levels increased the most in September for the full simulation period. In September, median monthly average EC increased from 569 µmhos/cm to 780 µmhos/cm, an increase of 37% (Appendix 9G, Tables 9G-14-1-1 through 9G-14-1-2, and 9G-14-2-1 through 9G-14-2-4). Thus, there would be measurable degradation to EC at Threemile Slough, and there would be substantial increases in EC levels in certain years in September (Appendix 9G, Tables 9G-14-1-1 through 9G-14-1-2, and 9G-14-2-1 through 9G-14-2-4). The greatest monthly average EC increase in September (154 µmhos/cm) would occur in below normal years, and would be a 24% increase above existing conditions (Appendix 9G, Table 9G-14-2-4).

The Bay-Delta WQCP EC objectives for the Sacramento River at Emmaton, which are for protection of agricultural beneficial uses, apply only from April 1 to August 15, and the WQCP does not specify EC objectives for Threemile Slough. However, DWR entered into a contract with the North Delta Water Agency in 1981 that established contractual commitments for EC at Emmaton that was subsequently amended in 1997 to move the contractual compliance point to Threemile Slough (California Department of Water Resources 1981, 1997). Hence, to determine whether the above described degradation at Emmaton and Threemile Slough in September would result in EC levels that could adversely affect agricultural beneficial uses, modeled EC at Threemile Slough was compared to contractual commitments for EC defined in the DWR-North Delta Water Agency contract. Per the contract, from August 16 through November 30, EC levels on a 14-day running average basis at Threemile Slough shall not exceed 1,600 µmhos/cm to 1,900 µmhos/cm in above normal years, with the specific threshold within this range depending on the Four River Basin Index from DWR Bulletin 120. In below normal years, the EC criterion ranges from 1,900 µmhos/cm to 2,200 µmhos/cm, and in dry years the EC threshold ranges from 2,200 µmhos/cm to 2,600 µmhos/cm (California Department of Water Resources 1981:7). Under Alternatives 1 and 3, modeled average monthly EC at Threemile Slough is 799 µmhos/cm in September of below normal years (Appendix 9G, Table 9G-14-2-2). The modeled maximum monthly average EC level for each water year type is below the contract criteria for each water year type except in above normal years (Appendix 9G, Table 9G-14-7). However, in above normal years, the modeled frequency of exceeding the upper criterion of 1,900 µmhos/cm under Alternatives 1 and 3 is the same as under existing conditions, about 2% of the time (Appendix 9G, Figure 9G-14-19); thus, Alternatives 1 and 3 would not cause a more frequent exceedance of the North Delta Water Agency contract EC thresholds relative to existing conditions. Based on these findings, the increases in EC occurring at Threemile Slough and Emmaton under Alternatives 1 and 3 would not cause adverse effects on beneficial uses relative to existing conditions.

San Joaquin River at Jersey Point

At the San Joaquin River at Jersey Point, in March through July and in September, modeled monthly average EC levels for the full simulation period are up to 8 µmhos/cm higher under Alternatives 1 and 3 relative to existing conditions (Table 9-23). In August and October through February, modeled monthly average EC levels for the full simulation period are up to 72 µmhos/cm higher under Alternatives 1 and 3 (Appendix 9G, Table 9G-5-2-4). The modeled monthly average EC in August and October through February under existing conditions ranges from 391 µmhos/cm (in February) to 1,306 µmhos/cm (in November) for the full simulation period (Appendix 9G, Table 9G-5-1-2). Under Alternatives 1 and 3, the modeled monthly average EC ranges from 416 µmhos/cm (in February) to 1,377 µmhos/cm (in November) for the full simulation period (Table 9-23). Thus, on a long-term average basis, modeled monthly average EC levels are up to about 6% higher under Alternatives 1 and 3 relative to existing conditions, with increases occurring across all water year types (Appendix 9G, Figures 9G-5-2 through 9G-5-6). Increases in median monthly average EC levels were greatest in January for the full simulation period. In January, median monthly average EC increased from 486 µmhos/cm to 536 µmhos/cm, an increase of 10% (Appendix 9G, Tables 9G-5-1-1 through 9G-5-1-2, and 9G-5-2-1 through 9G-5-2-4). Thus, on a long-term average basis, there would not be substantial degradation to EC at Jersey Point.

Sacramento River at Rio Vista, and San Joaquin River at Prisoners Point and San Andreas Landing

Under Alternatives 1 and 3, modeled monthly average EC levels also increased under Alternatives 1 and 3 relative to existing conditions for the full simulation period in the Sacramento River at Rio Vista (Appendix 9G, Figures 9G-13-1 through 9G-13-6), and San Joaquin River at Prisoners Point and San Andreas Landing (Appendix 9G, Figures 9G-6-1 through 9G-6-6, and 9G-7-1 through 9G-7-6). The modeled increase in monthly average EC was 31 µmhos/cm or less at these locations for the full simulation period (Table 9-23). Modeled monthly average EC levels increased primarily during November. The greatest increases would occur in above normal and below normal years, particularly during the months of September through November (Appendix 9G, Tables 9G-6-2-4, 9G-7-2-4, and 9G-13-2-4). On a long-term average basis, these small changes would not result in substantial degradation to EC at these locations.

San Joaquin River at Vernalis and Brandt Bridge, Old River at Middle River and Tracy Bridge, Steamboat Slough, and South Fork Mokelumne at Terminous

In the San Joaquin River at Vernalis and Brandt Bridge, Old River at Middle River and Tracy Bridge, Steamboat Slough, and South Fork Mokelumne at Terminous, little change in monthly average EC levels would occur under Alternatives 1 and 3 relative to existing conditions regardless of water year type (Appendix 9G, Figures 9G-2-1 through 9G-2-6, 9G-8-1 through 9G-8-6, 9G-9-1 through 9G-9-6, 9G-10-1 through 9G-10-6, 9G-11-1 through 9G-11-6, and 9G-12-1 through 9G-12-6). The increase in modeled monthly average EC was 2 µmhos/cm or less at these locations for the full simulation period (Table 9-23). Median monthly average EC levels also would be similar to existing conditions (Appendix 9G, Tables 9G-2-2-3, 9G-8-2-3, 9G-9-2-3, 9G-10-2-3, 9G-11-2-3, and 9G-12-2-3). Thus, on a long-term average basis, there would not be substantial degradation to EC at these locations.

Banks and Jones Pumping Plants

At Banks Pumping Plant, monthly average EC levels would decrease relative to existing conditions for the full simulation period (Appendix 9G, Figures 9G-3-1 through 9G-3-6, Table 9G-3-2-4). At Jones Pumping Plant, modeled monthly average EC levels for the full simulation period are up to 16 µmhos/cm higher under Alternatives 1 and 3 (Appendix 9G, Figures 9G-4-1 through 9G-4-6, Table 9G-4-2-4).

Bay-Delta WQCP Objectives

The Bay-Delta WQCP includes water quality objectives for EC for protection of agricultural beneficial uses, and compliance with the objectives is evaluated at locations designated in the Bay-Delta WQCP (Appendix 9G, Table 9G-3). Despite the changes in EC that would occur under Alternatives 1 and 3 relative to existing conditions, there would be no increase in the percent of days the agricultural beneficial use EC objectives would be exceeded relative to existing conditions for the following compliance locations: South Fork Mokelumne River at Terminous, San Joaquin River at San Andreas Landing, San Joaquin River at Vernalis, San Joaquin River at Brandt Bridge, Old River near Middle River, Old River at Tracy Bridge, Banks Pumping Plant, and Jones Pumping Plant (Appendix 9G, Table 9G-6). For the Sacramento River at Emmaton and the San Joaquin River at Jersey Point, the modeled increase in percent of days the EC objective would be exceeded is 0.3% and 0.5%, respectively (Appendix 9G, Table 9G-6).

The Bay-Delta WQCP also includes water quality objectives for EC for protection of fish and wildlife applicable at the San Joaquin River at Jersey Point and San Joaquin River at Prisoners Point (Appendix 9G, Table 9G-4). Under Alternatives 1 and 3, the modeled increase in percent of days EC would exceed the Bay-Delta WQCP fish and wildlife objectives for EC at Jersey Point was 0.02%, while at Prisoners Point the modeled increase was 0.4% under Alternatives 1 and 3 (Appendix 9G, Table 9G-7).

The modeled increases in the frequency of exceeding the Bay-Delta WQCP objectives would not actually occur. As described in Chapter 3, Section 3.16.3, the project facilities would be operated to meet Bay-Delta WQCP EC objectives, as implemented through D-1641. The modeled increases are attributable to the monthly timestep of the hydrologic modeling conducted by CalSim 3, as compared to the 15-minute time step of DSM2. CalSim 3 includes an algorithm to operate the SWP/CVP to meet Bay-Delta WQCP objectives, among other requirements. While CalSim 3 simulates operations on a monthly timestep, actual decisions associated with real-time system operations are conducted on a daily timestep. The small modeled increased frequency of exceedance of objectives relative to the 93-year period of record modeled indicates that Alternatives 1 and 3 would not be expected to increase the frequency of exceeding Bay-Delta WQCP objectives with actual real-time operations. Thus, the increases are what is known as modeling artifacts and do not indicate that operation of Alternatives 1 and 3 would increase the frequency of exceeding Bay-Delta WQCP EC objectives.

CWA Section 303(d)-Listed Waterbodies

Regions of the Delta with CWA Section 303(d) listings for EC include the export area, and northwestern, southern, and western Delta (Table 9-2). Specific waterways located at least partially within the Delta that also are CWA Section 303(d)-listed for EC or salinity are Tom Paine Slough, Sand Creek, and Kellogg Creek (Table 9-2). Alternatives 1 and 3 would not affect EC levels in Sand Creek and Kellogg Creek given that these waterbodies are mostly located upland and outside of the influence of Delta hydrodynamics. EC levels in Tom Paine Slough would not be further degraded on a long-term basis. The modeled changes in monthly average EC for Old River at Tracy Road, which is the nearest modeled Delta assessment location, indicate there would be small changes in EC at the mouth of Tom Paine Slough where it meets Old River (Table 9-23). The southern and northwestern Delta also would not be further degraded on a long-term basis under Alternatives 1 and 3 relative to existing conditions based on small (2 μmhos/cm or less) modeled changes in EC that would occur in the San Joaquin River at Vernalis and Brandt Bridge, Old River at Middle River and Tracy Bridge, and Steamboat Slough (Table 9-23). Furthermore, as described above, the long-term average changes in EC in the export area and southern Delta would not be substantial. The above described increases in EC at Emmaton and Threemile Slough could further degrade water quality in the CWA Section 303(d)-listed western Delta by measurable levels, but, as demonstrated above, the degradation would not make the beneficial use impairment discernibly worse.

Alternatives 2a, 2b, 2c, 4a, 4b, 4c, and 5

Appendix 9G provides tables and figures presenting modeled EC levels at the Delta assessment locations for existing conditions and Alternatives 2a, 2b, 2c, 4a, 4b, 4c, and 5. Tables 9-24 through 9-27 present the modeled monthly average EC levels at the Delta assessment locations under Alternatives 2a, 2b, 2c, 4a, 4b, 4c, and 5 for the 93-year simulation period, and the differences from existing conditions.

Under Alternatives 2a, 2b, 2c, 4a, 4b, 4c, and 5, the changes in EC levels relative to existing conditions would have a similar seasonal pattern and magnitude to those that would occur under Alternatives 1 and 3 for Sacramento River at Emmaton (Appendix 9G, Figures 9G-1-1 through 9G-1-18), South Fork Mokelumne River at Terminous (Appendix 9G, Figures 9G-2-1 through 9G-2-18), Banks Pumping Plant (Appendix 9G, Figures 9G-3-1 through 9G-3-18), San Joaquin River at Jersey Point (Appendix 9G, Figures 9G-5-1 through 9G-5-18), San Joaquin River at Prisoners Point (Appendix 9G, Figures 9G-6-1 through 9G-6-18), San Joaquin River at San Andreas Landing (Appendix 9G, Figures 9G-7-1 through 9G-7-18), San Joaquin River at Vernalis (Appendix 9G, Figures 9G-8-1 through 9G-8-18), San Joaquin River at Brandt Bridge (Appendix 9G, Figures 9G-9-1 through 9G-9-18), Old River near Middle River (Appendix 9G, Figures 9G-10-1 through 9G-10-18), Old River at Tracy Bridge (Appendix 9G, Figures 9G-11-1 through 9G-11-18), Steamboat Slough (Appendix 9G, Figures 9G-12-1 through 9G-12-18), Sacramento River at Rio Vista (Appendix 9G, Figures 9G-13-1 through 9G-13-18), and Sacramento River at Threemile Slough (Appendix 9G, Figures 9G-14-1 through 9G-14-18).

At Jones Pumping Plant, the changes in EC levels under Alternatives 2b, 2c, 4b, 4c, and 5 relative to existing conditions would have a similar seasonal pattern and magnitude to those that would occur under Alternatives 1 and 3 (Appendix 9G, Figures 9G-4-1 through 9G-4-18). Under Alternatives 2a and 4a, EC levels would decrease during most months of the full simulation period relative to existing conditions by up to 31 µmhos/cm (Appendix 9G, Table 9G-4-3-4).

For the reasons described above for Alternatives 1 and 3, Alternatives 2a, 2b, 2c, 4a, 4b, 4c, and 5 would not cause increased frequency of Bay-Delta WQCP objective exceedances at any location. EC degradation in the Sacramento River at Emmaton and Threemile Slough under Alternatives 2a, 2b, 2c, 4a, 4b, 4c, and 5 would be similar to that described for Alternatives 1 and 3 (Appendix 9G, Figures 9G-1-15, 9G-1-16, 9G-14-15, and 9G-14-16). For the reasons described for Alternatives 1 and 3, the higher EC levels at Emmaton and Threemile Slough under Alternatives 2a, 2b, 2c, 4a, 4b, 4c, and 5 could further degrade water quality in the CWA Section 303(d)-listed western Delta by measurable levels, but that degradation would not make the beneficial use impairment discernibly worse.

1 **Table 9-24. Monthly Average Electrical Conductivity (in micromhos per centimeter) at Delta Assessment Locations for the Full Simulation**
2 **Period under Alternatives 2a and 4a, and Difference from Existing Conditions**

Location/Parameter	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Sacramento River at Emmaton												
Full Simulation Period Average	1,645	1,729	1,107	600	305	243	275	347	522	692	1,154	1,571
Difference from Existing Conditions	62	116	56	51	10	7	2	-1	-1	46	37	110
South Fork Mokelumne River at Terminous												
Full Simulation Period Average	188	197	205	215	224	215	200	188	185	184	185	182
Difference from Existing Conditions	0	2	1	2	1	2	0	0	0	0	0	0
Banks Pumping Plant												
Full Simulation Period Average	429	432	494	431	384	330	379	360	327	297	341	386
Difference from Existing Conditions	-13	-54	-78	-139	-100	-95	-27	-36	-9	-8	1	-21
Jones Pumping Plant												
Full Simulation Period Average	505	543	630	589	540	483	460	410	361	354	392	436
Difference from Existing Conditions	-3	-11	-8	-28	-13	-31	1	-2	-5	-3	3	-12
San Joaquin River at Jersey Point												
Full Simulation Period Average	1,175	1,370	1,186	748	413	278	262	285	338	572	931	1,172
Difference from Existing Conditions	34	65	18	30	22	8	4	0	-1	0	24	4
San Joaquin River at San Andreas Landing												
Full Simulation Period Average	387	439	428	362	265	227	226	223	209	225	275	325
Difference from Existing Conditions	9	31	6	9	7	4	2	0	0	-1	2	1
San Joaquin River at Vernalis												
Full Simulation Period Average	599	769	748	681	652	611	465	433	515	578	580	564
Difference from Existing Conditions	1	2	2	2	2	1	1	1	1	1	1	1
San Joaquin River at Brandt Bridge												
Full Simulation Period Average	597	760	750	687	654	614	475	437	513	577	583	567
Difference from Existing Conditions	1	2	2	2	2	1	1	1	1	1	1	1

Location/Parameter	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Old River near Middle River												
Full Simulation Period Average	599	763	752	689	658	616	475	437	515	579	584	568
Difference from Existing Conditions	1	2	2	2	2	1	1	1	1	1	1	1
Old River at Tracy Bridge												
Full Simulation Period Average	599	744	762	712	686	638	496	448	488	523	520	539
Difference from Existing Conditions	1	2	2	2	2	1	1	1	2	-2	1	3
Steamboat Slough at Sutter Slough												
Full Simulation Period Average	176	177	179	179	180	179	177	176	176	176	176	176
Difference from Existing Conditions	0	0	0	0	0	0	0	0	0	0	0	0
Sacramento River at Rio Vista												
Full Simulation Period Average	294	316	263	217	194	189	189	190	202	209	244	283
Difference from Existing Conditions	5	15	6	5	1	1	0	0	0	2	2	11
Sacramento River at Threemile Slough												
Full Simulation Period Average	809	855	575	354	233	206	216	240	307	361	561	771
Difference from Existing Conditions	28	61	27	22	3	3	1	0	-1	15	13	54

Note: A positive difference denotes an increase from existing conditions, and a negative difference indicates a decrease from existing conditions.

Table 9-25. Monthly Average Electrical Conductivity (in micromhos per centimeter) at Delta Assessment Locations for the Full Simulation Period under Alternatives 2b and 4b, and Difference from Existing Conditions

Location/Parameter	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Sacramento River at Emmaton												
Full Simulation Period Average	1,646	1,696	1,100	593	312	242	275	347	523	686	1,149	1,559
Difference from Existing Conditions	63	83	49	44	16	6	2	0	1	40	31	98
South Fork Mokelumne River at Terminous												
Full Simulation Period Average	188	197	205	215	223	214	200	188	185	184	185	182
Difference from Existing Conditions	0	1	1	1	1	1	0	0	0	0	0	0
Banks Pumping Plant												
Full Simulation Period Average	425	429	487	439	402	338	388	367	323	293	338	374
Difference from Existing Conditions	-17	-57	-85	-130	-82	-87	-18	-29	-13	-12	-2	-32

Location/Parameter	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Jones Pumping Plant												
Full Simulation Period Average	513	568	647	622	556	516	459	413	365	357	393	450
Difference from Existing Conditions	5	14	9	4	3	2	0	0	-1	0	4	1
San Joaquin River at Jersey Point												
Full Simulation Period Average	1,181	1,358	1,179	741	416	278	262	286	338	573	931	1,171
Difference from Existing Conditions	40	52	11	23	25	8	3	0	0	2	25	3
San Joaquin River at San Andreas Landing												
Full Simulation Period Average	390	432	427	359	265	226	225	222	209	225	275	324
Difference from Existing Conditions	12	24	5	6	7	3	1	0	-1	-1	2	1
San Joaquin River at Vernalis												
Full Simulation Period Average	598	767	746	679	650	610	465	433	515	577	580	563
Difference from Existing Conditions	0	0	0	0	0	0	0	0	0	0	0	0
San Joaquin River at Brandt Bridge												
Full Simulation Period Average	596	758	749	685	652	613	475	436	513	576	583	566
Difference from Existing Conditions	0	1	0	0	0	0	0	0	0	0	0	0
Old River near Middle River												
Full Simulation Period Average	598	761	750	687	657	615	474	437	515	578	583	567
Difference from Existing Conditions	0	0	0	0	0	0	0	0	0	0	0	0
Old River at Tracy Bridge												
Full Simulation Period Average	598	742	760	710	684	637	495	447	487	523	519	536
Difference from Existing Conditions	0	0	0	0	0	0	0	0	1	-2	0	0
Steamboat Slough at Sutter Slough												
Full Simulation Period Average	176	177	179	179	180	179	177	176	176	176	176	176
Difference from Existing Conditions	0	0	0	0	0	0	0	0	0	0	0	0
Sacramento River at Rio Vista												
Full Simulation Period Average	294	311	262	216	195	189	189	190	202	208	244	281
Difference from Existing Conditions	5	9	6	4	1	1	0	0	0	2	1	10
Sacramento River at Threemile Slough												
Full Simulation Period Average	810	835	573	351	236	206	215	240	308	359	559	765

Location/Parameter	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Difference from Existing Conditions	29	41	25	19	6	3	1	0	-1	13	11	49

Note: A positive difference denotes an increase from existing conditions, and a negative difference indicates a decrease from existing conditions.

Table 9-26. Monthly Average Electrical Conductivity (in micromhos per centimeter) at Delta Assessment Locations for the Full Simulation Period under Alternatives 2c and 4c, and Difference from Existing Conditions

Location/Parameter	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Sacramento River at Emmaton												
Full Simulation Period Average	1,647	1,719	1,103	593	314	242	274	347	522	690	1,154	1,568
Difference from Existing Conditions	64	106	52	45	19	7	1	-1	0	45	36	107
South Fork Mokelumne River at Terminous												
Full Simulation Period Average	188	197	205	215	224	214	200	188	185	184	185	182
Difference from Existing Conditions	0	2	1	1	1	1	0	0	0	0	0	0
Banks Pumping Plant												
Full Simulation Period Average	424	424	483	431	389	327	378	363	322	292	338	372
Difference from Existing Conditions	-18	-62	-89	-138	-95	-98	-28	-33	-14	-13	-2	-34
Jones Pumping Plant												
Full Simulation Period Average	514	572	651	622	557	513	460	412	365	357	394	450
Difference from Existing Conditions	6	19	14	4	4	-1	0	0	-1	0	4	1
San Joaquin River at Jersey Point												
Full Simulation Period Average	1,185	1,388	1,185	743	416	278	262	285	338	575	933	1,171
Difference from Existing Conditions	44	83	17	25	25	8	3	-1	0	4	27	2
San Joaquin River at San Andreas Landing												
Full Simulation Period Average	391	444	429	359	266	227	226	223	209	225	275	324
Difference from Existing Conditions	13	36	7	7	8	4	1	0	0	0	2	1
San Joaquin River at Vernalis												
Full Simulation Period Average	598	768	747	680	651	610	465	433	515	578	580	563
Difference from Existing Conditions	0	1	1	1	1	0	0	0	0	1	1	0
San Joaquin River at Brandt Bridge												
Full Simulation Period Average	596	759	749	685	653	613	475	436	513	576	583	566

Location/Parameter	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Difference from Existing Conditions	0	1	1	1	1	0	0	0	0	1	1	0
Old River near Middle River												
Full Simulation Period Average	598	762	751	688	657	615	474	437	515	578	583	567
Difference from Existing Conditions	0	1	1	1	1	0	0	0	0	1	1	1
Old River at Tracy Bridge												
Full Simulation Period Average	598	742	760	711	684	637	495	448	487	523	518	537
Difference from Existing Conditions	0	0	1	1	1	0	0	0	1	-1	0	1
Steamboat Slough at Sutter Slough												
Full Simulation Period Average	176	177	179	179	180	179	177	176	176	176	176	176
Difference from Existing Conditions	0	0	0	0	0	0	0	0	0	0	0	0
Sacramento River at Rio Vista												
Full Simulation Period Average	294	314	263	216	195	189	189	190	202	208	244	282
Difference from Existing Conditions	5	13	6	4	2	1	0	0	0	2	2	11
Sacramento River at Threemile Slough												
Full Simulation Period Average	810	848	575	351	237	206	215	240	307	360	560	769
Difference from Existing Conditions	29	54	26	19	8	3	1	0	-1	14	12	53

Note: A positive difference denotes an increase from existing conditions, and a negative difference indicates a decrease from existing conditions.

Table 9-27. Monthly Average Electrical Conductivity (in micromhos per centimeter) at Delta Assessment Locations for the Full Simulation Period under Alternative 5, and Difference from Existing Conditions

Location/Parameter	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Sacramento River at Emmaton												
Full Simulation Period Average	1,650	1,733	1,106	596	314	243	275	347	522	691	1,153	1,576
Difference from Existing Conditions	68	120	56	47	19	7	2	-1	-1	45	35	115
South Fork Mokelumne River at Terminous												
Full Simulation Period Average	188	197	205	215	224	215	200	188	185	184	185	182
Difference from Existing Conditions	0	2	1	2	2	2	0	0	0	0	0	0
Banks Pumping Plant												
Full Simulation Period Average	421	417	474	426	379	321	379	358	322	292	338	370

Location/Parameter	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Difference from Existing Conditions	-21	-69	-98	-144	-105	-103	-27	-38	-14	-13	-2	-36
Jones Pumping Plant												
Full Simulation Period Average	513	570	650	622	557	512	460	412	364	357	394	449
Difference from Existing Conditions	5	16	12	5	5	-2	1	0	-2	0	4	1
San Joaquin River at Jersey Point												
Full Simulation Period Average	1,176	1,380	1,188	748	415	278	262	286	338	574	930	1,170
Difference from Existing Conditions	35	74	19	30	24	8	4	0	-1	3	24	1
San Joaquin River at San Andreas Landing												
Full Simulation Period Average	388	439	429	361	266	227	226	223	209	225	275	324
Difference from Existing Conditions	10	31	7	8	8	4	2	0	0	0	2	1
San Joaquin River at Vernalis												
Full Simulation Period Average	598	768	747	680	651	610	465	433	515	578	580	563
Difference from Existing Conditions	1	1	1	1	1	0	0	0	0	1	1	1
San Joaquin River at Brandt Bridge												
Full Simulation Period Average	596	759	749	686	653	613	475	436	513	577	583	566
Difference from Existing Conditions	1	1	1	1	1	0	0	0	0	1	1	0
Old River near Middle River												
Full Simulation Period Average	598	762	751	688	657	616	474	437	515	578	584	567
Difference from Existing Conditions	1	1	1	1	1	0	0	0	0	1	1	1
Old River at Tracy Bridge												
Full Simulation Period Average	598	742	760	711	685	637	495	448	487	523	519	537
Difference from Existing Conditions	1	0	1	1	1	0	0	0	1	-1	1	1
Steamboat Slough at Sutter Slough												
Full Simulation Period Average	176	177	179	179	180	179	177	176	176	176	176	176
Difference from Existing Conditions	0	0	0	0	0	0	0	0	0	0	0	0
Sacramento River at Rio Vista												
Full Simulation Period Average	295	316	263	216	195	189	189	190	202	209	244	283
Difference from Existing Conditions	6	15	6	4	2	1	0	0	0	2	2	12

Location/Parameter	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Sacramento River at Threemile Slough												
Full Simulation Period Average	812	856	575	352	237	206	216	240	307	360	560	773
Difference from Existing Conditions	31	62	27	20	8	3	1	0	-1	14	12	57

Note: A positive difference denotes an increase from existing conditions, and a negative difference indicates a decrease from existing conditions.

Suisun Marsh—All Project Alternatives

For Suisun Marsh, October through May is the period when Bay-Delta WQCP EC objectives for protection of fish and wildlife apply; thus, the discussion of effects of the project alternatives on EC is focused on changes during these months. The purpose of the EC objectives is to protect habitat for waterfowl favored by hunters in managed wetlands (State Water Resources Control Board 2000:49). Appendix 9G provides tables and figures presenting modeled EC levels at the Suisun Marsh assessment locations for existing conditions and the project alternatives. Tables 9-28 through 9-32 present the monthly average EC levels at the Suisun Marsh assessment locations under the project alternatives for the 93-year simulation period, and the differences from existing conditions.

Modeled monthly average EC for the full simulation period increased in the Sacramento River at Collinsville during the months of October through April relative to existing conditions by 0.1–0.4 millimhos per centimeter (mmhos/cm). In Montezuma Slough at National Steel, modeled monthly average EC levels increased in November through May by 0.1–0.4 mmhos/cm. There were similar modeled increases in long-term average EC in the months of March through May in Montezuma Slough near Beldon Landing, Chadbourne Slough near Sunrise Duck Club, and Suisun Slough near Volanti Slough, ranging 0.1–0.3 mmhos/cm depending on month and location. The greatest increases in modeled monthly average EC occurred in March at Collinsville (14%), National Steel (11%), and Beldon Landing (13%). All other increases in monthly average EC were 10% or less. There were modeled decreases in monthly average EC of up to 3% in October at Beldon Landing, Chadbourne Slough, and Suisun Slough.

The Suisun Marsh EC objectives for fish and wildlife beneficial use protection are expressed as a monthly average of daily high tide EC, ranging from 8.0 mmhos/cm for February and March to 19.0 mmhos/cm for October, or demonstration that “equivalent or better protection will be provided at the location” (State Water Resources Control Board 2018:14). The objectives are implemented through water right actions (D-1641) because the salinity levels are determined by flows and control structure operations (State Water Resources Control Board 2018:33). As described in Chapter 3, Section 3.16.3, the project facilities would be operated to meet Bay-Delta WQCP objectives, as implemented through D-1641. Additionally, because marsh management factors also affect beneficial uses, including when wetlands are flooded, soil leaching cycles, how agricultural use of water is managed, and future actions taken with respect to the marsh, the above-described increases in long-term average EC under Alternatives 1 and 3 relative to existing conditions are not expected to contribute to adverse effects on Suisun Marsh beneficial uses or contribute to additional impairment.

Table 9-28. Monthly Average Electrical Conductivity (in micromhos per centimeter) at Suisun Marsh Assessment Locations for the Full Simulation Period under Alternatives 1 and 3, and Difference from Existing Conditions

Location/Parameter	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Sacramento River at Collinsville												
Full Simulation Period Average	6.4	6.7	4.6	2.5	1.1	0.7	1.0	1.4	2.4	3.7	5.5	6.2
Difference from Existing Conditions	0.2	0.3	0.2	0.2	0.1	0.1	0.0	0.0	0.0	0.2	0.2	0.2
Montezuma Slough at National Steel												
Full Simulation Period Average	7.3	7.5	5.4	2.8	1.2	1.0	1.4	2.2	3.5	4.7	6.7	7.5
Difference from Existing Conditions	0.0	0.3	0.2	0.2	0.1	0.1	0.1	0.0	0.0	0.3	0.2	0.2
Montezuma Slough near Beldon Landing												
Full Simulation Period Average	8.9	8.8	6.9	3.5	1.7	1.7	2.5	3.7	5.3	6.1	8.2	9.7
Difference from Existing Conditions	-0.3	0.2	0.2	0.2	0.1	0.2	0.2	0.1	0.1	0.3	0.3	0.1
Chadbourne Slough near Sunrise Duck Club												
Full Simulation Period Average	10.5	10.3	8.8	5.8	3.7	3.3	3.9	4.8	6.4	7.8	9.5	11.2
Difference from Existing Conditions	-0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.2	0.3	0.2
Suisun Slough 300 feet south of Volanti Slough												
Full Simulation Period Average	9.9	9.5	8.2	5.2	3.2	2.5	3.0	4.0	5.6	6.8	8.5	10.3
Difference from Existing Conditions	-0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.2	0.3	0.2

Note: A positive difference denotes an increase from existing conditions, and a negative difference indicates a decrease from existing conditions.

Table 9-29. Monthly Average Electrical Conductivity (in micromhos per centimeter) at Suisun Marsh Assessment Locations for the Full Simulation Period under Alternatives 2a and 4a, and Difference from Existing Conditions

Location/Parameter	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Sacramento River at Collinsville												
Full Simulation Period Average	6.4	6.7	4.6	2.5	1.1	0.7	1.0	1.4	2.4	3.7	5.5	6.2
Difference from Existing Conditions	0.2	0.3	0.2	0.2	0.1	0.1	0.0	0.0	0.0	0.2	0.2	0.2
Montezuma Slough at National Steel												
Full Simulation Period Average	7.3	7.4	5.5	2.8	1.2	1.0	1.4	2.2	3.5	4.7	6.7	7.5
Difference from Existing Conditions	0.0	0.2	0.2	0.2	0.1	0.1	0.1	0.0	0.0	0.3	0.2	0.2
Montezuma Slough near Beldon Landing												
Full Simulation Period Average	8.9	8.7	6.9	3.5	1.7	1.7	2.5	3.7	5.3	6.1	8.2	9.7

Location/Parameter	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Difference from Existing Conditions	-0.3	0.2	0.3	0.2	0.1	0.2	0.2	0.1	0.1	0.3	0.3	0.1
Chadbourne Slough near Sunrise Duck Club												
Full Simulation Period Average	10.5	10.2	8.8	5.9	3.7	3.3	3.9	4.8	6.4	7.8	9.5	11.1
Difference from Existing Conditions	-0.1	0.1	0.2	0.3	0.2	0.2	0.2	0.1	0.1	0.2	0.3	0.1
Suisun Slough 300 feet south of Volanti Slough												
Full Simulation Period Average	9.9	9.5	8.3	5.3	3.2	2.5	3.0	4.0	5.6	6.8	8.5	10.3
Difference from Existing Conditions	-0.2	0.0	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.2	0.3	0.1

Note: A positive difference denotes an increase from existing conditions, and a negative difference indicates a decrease from existing conditions.

Table 9-30. Monthly Average Electrical Conductivity (in micromhos per centimeter) at Suisun Marsh Assessment Locations for the Full Simulation Period under Alternatives 2b and 4b, and Difference from Existing Conditions

Location/Parameter	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Sacramento River at Collinsville												
Full Simulation Period Average	6.4	6.7	4.6	2.5	1.1	0.7	1.0	1.4	2.4	3.7	5.5	6.2
Difference from Existing Conditions	0.2	0.2	0.1	0.2	0.1	0.1	0.0	0.0	0.0	0.2	0.2	0.2
Montezuma Slough at National Steel												
Full Simulation Period Average	7.3	7.4	5.5	2.7	1.2	1.0	1.4	2.2	3.5	4.7	6.6	7.5
Difference from Existing Conditions	0.0	0.2	0.2	0.1	0.1	0.1	0.1	0.0	0.0	0.2	0.2	0.2
Montezuma Slough near Beldon Landing												
Full Simulation Period Average	8.9	8.8	7.0	3.4	1.7	1.6	2.4	3.6	5.3	6.1	8.2	9.7
Difference from Existing Conditions	-0.2	0.2	0.3	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.3	0.1
Chadbourne Slough near Sunrise Duck Club												
Full Simulation Period Average	10.6	10.3	8.9	5.8	3.6	3.2	3.9	4.8	6.4	7.8	9.4	11.1
Difference from Existing Conditions	0.0	0.1	0.3	0.2	0.2	0.2	0.2	0.1	0.1	0.2	0.3	0.1
Suisun Slough 300 feet south of Volanti Slough												
Full Simulation Period Average	10.0	9.6	8.3	5.2	3.1	2.5	3.0	4.0	5.6	6.8	8.4	10.3
Difference from Existing Conditions	-0.1	0.1	0.3	0.2	0.1	0.1	0.1	0.1	0.1	0.2	0.3	0.1

Note: A positive difference denotes an increase from existing conditions, and a negative difference indicates a decrease from existing conditions.

Table 9-31. Monthly Average Electrical Conductivity (in micromhos per centimeter) at Suisun Marsh Assessment Locations for the Full Simulation Period under Alternatives 2c and 4c, and Difference from Existing Conditions

Location/Parameter	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Sacramento River at Collinsville												
Full Simulation Period Average	6.4	6.7	4.6	2.5	1.1	0.7	1.0	1.4	2.4	3.7	5.5	6.2
Difference from Existing Conditions	0.2	0.3	0.1	0.2	0.1	0.1	0.0	0.0	0.0	0.2	0.2	0.2
Montezuma Slough at National Steel												
Full Simulation Period Average	7.3	7.5	5.5	2.7	1.2	1.0	1.4	2.2	3.5	4.7	6.7	7.5
Difference from Existing Conditions	0.0	0.3	0.2	0.1	0.1	0.1	0.1	0.0	0.1	0.3	0.2	0.2
Montezuma Slough near Beldon Landing												
Full Simulation Period Average	8.9	8.8	7.0	3.4	1.7	1.7	2.4	3.6	5.3	6.1	8.2	9.7
Difference from Existing Conditions	-0.2	0.2	0.3	0.1	0.1	0.2	0.2	0.1	0.1	0.3	0.3	0.1
Chadbourne Slough near Sunrise Duck Club												
Full Simulation Period Average	10.6	10.3	8.9	5.8	3.7	3.3	3.9	4.8	6.4	7.8	9.5	11.2
Difference from Existing Conditions	-0.1	0.1	0.3	0.2	0.2	0.2	0.2	0.1	0.1	0.2	0.3	0.2
Suisun Slough 300 feet south of Volanti Slough												
Full Simulation Period Average	10.0	9.6	8.3	5.2	3.1	2.5	3.0	4.0	5.6	6.8	8.5	10.3
Difference from Existing Conditions	-0.1	0.1	0.3	0.2	0.2	0.2	0.2	0.1	0.1	0.2	0.3	0.2

Note: A positive difference denotes an increase from existing conditions, and a negative difference indicates a decrease from existing conditions.

Table 9-32. Monthly Average Electrical Conductivity (in micromhos per centimeter) at Suisun Marsh Assessment Locations for the Full Simulation Period under Alternative 5, and Difference from Existing Conditions

Location/Parameter	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Sacramento River at Collinsville												
Full Simulation Period Average	6.4	6.7	4.6	2.5	1.1	0.7	1.0	1.4	2.4	3.7	5.5	6.2
Difference from Existing Conditions	0.2	0.3	0.2	0.2	0.1	0.1	0.0	0.0	0.0	0.2	0.2	0.2
Montezuma Slough at National Steel												
Full Simulation Period Average	7.3	7.5	5.4	2.7	1.2	1.0	1.4	2.2	3.5	4.7	6.7	7.5
Difference from Existing Conditions	0.0	0.3	0.2	0.1	0.1	0.1	0.1	0.0	0.0	0.3	0.2	0.2

Location/Parameter	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Montezuma Slough near Beldon Landing												
Full Simulation Period Average	8.9	8.8	6.9	3.4	1.7	1.7	2.5	3.6	5.3	6.1	8.2	9.7
Difference from Existing Conditions	-0.2	0.2	0.2	0.1	0.1	0.2	0.2	0.1	0.1	0.3	0.3	0.1
Chadbourne Slough near Sunrise Duck Club												
Full Simulation Period Average	10.6	10.3	8.8	5.8	3.7	3.3	3.9	4.8	6.4	7.8	9.5	11.2
Difference from Existing Conditions	-0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.2	0.3	0.2
Suisun Slough 300 feet south of Volanti Slough												
Full Simulation Period Average	10.0	9.6	8.2	5.2	3.1	2.5	3.0	4.0	5.6	6.8	8.5	10.3
Difference from Existing Conditions	-0.1	0.1	0.2	0.1	0.1	0.2	0.2	0.1	0.1	0.2	0.3	0.2

Note: A positive difference denotes an increase from existing conditions, and a negative difference indicates a decrease from existing conditions.

Suisun Bay and San Francisco Bay—All Project Alternatives

Salinity throughout Suisun Bay and San Francisco Bay is largely a function of the tides, as well as to some extent the freshwater inflow from upstream. Thus, Delta outflow is the main mechanism by which the alternative could affect salinity in Suisun Bay and San Francisco Bay. According to the Delta Atlas (California Department of Water Resources 1995:18), average historical tidal flow through the Golden Gate Bridge is 2,300,000 cfs and average historical tidal flow at Chipps Island is 170,000 cfs. The historical average tidal flows are two to three orders of magnitude larger than the largest mean monthly change in Delta outflow under Alternatives 1 and 3 (Appendix 5A, *Modeling Technical Appendix*). Thus, the changes in Delta outflow due to Alternatives 1 and 3 would be minor compared to tidal flows, and no substantial adverse effects on salinity or fish and wildlife beneficial uses would occur in Suisun Bay and San Francisco Bay.

SWP/CVP Export Service Areas—All Project Alternatives

As previously discussed, under all project alternatives, monthly average EC levels at Banks Pumping Plant would decrease and the monthly average EC increases at Jones Pumping Plant would be small (13 µmhos/cm or less) relative to existing conditions. These changes in EC levels would not contribute to additional exceedances of the Bay-Delta WQCP EC objectives for agriculture at these locations. Thus, the project alternatives would not result in increased EC levels in SWP/CVP export service area waterbodies that would substantially degrade water quality or cause increased frequency of exceeding water quality objectives relative to existing conditions.

CEQA Conclusion—All Project Alternatives

Based on the above analysis, the project alternatives would not cause additional exceedance of applicable EC water quality criteria/objectives by frequency, magnitude, and geographic extent that would result in adverse effects on any beneficial uses of study area waterbodies. As described in Chapter 3, Section 3.16.3, the project facilities would be operated to meet Bay-Delta WQCP EC objectives, as implemented through D-1641. Modeled EC levels for the Sacramento River at Emmaton and Threemile Slough for the project alternatives are higher than under existing conditions, indicating the potential for long-term degradation, particularly in September in below normal years. However, based on the analysis presented above, the EC degradation at Emmaton and Threemile Slough would not result in substantially increased risk for adverse effects on beneficial uses. The Sacramento River at Emmaton and Threemile Slough are in the western Delta, which is on the CWA Section 303(d) list as being impaired for EC. However, because the project facilities would continue to be operated to meet Bay-Delta WQCP EC objectives and project operations would meet DWR-North Delta Water Agency contract EC requirements at the same frequency that occurs under existing conditions, the project alternatives would not degrade EC by measurable levels on a long-term basis such that beneficial use impairment would be made discernibly worse. EC is not a bioaccumulative constituent, thus any EC increases under the project alternatives would not result in bioaccumulation in aquatic organisms. Therefore, the impact of the project alternatives on EC would be less than significant.

Mitigation Impacts

Compensatory Mitigation

Although the CMP described in Appendix 3F does not act as mitigation for impacts on water quality from project construction or operations, its implementation could result in impacts on water quality.

Natural habitats proposed by the CMP are not substantial sources of EC to receiving waters relative to existing conditions and watershed and seawater contributions. Therefore, the CMP would result in negligible, if any, change in EC in study area waterbodies relative to existing conditions. As such, the CMP would not cause additional exceedance of applicable EC water quality criteria/objectives by frequency, magnitude, and geographic extent that would result in adverse effects on any beneficial uses of any study area waterbodies. Because EC is not expected to increase substantially, the CMP would not cause long-term degradation of EC in study area waterbodies that would result in substantially increased risk for adverse effects on any beneficial uses. Furthermore, the CMP would not further degrade EC by measurable levels on a long-term basis in any study area waterbody on the State's CWA Section 303(d) list such that beneficial use impairment would be made discernibly worse. EC is not a bioaccumulative constituent; therefore, the CMP would not result in bioaccumulation of EC in aquatic organisms. Based on these findings, impacts from the CMP on EC would be less than significant.

Other Mitigation Measures

Impacts of other mitigation measures would be similar to those described for Impact WQ-2. Operation of other mitigation measures would not generate high salinity runoff. As such, the other mitigation measures would not cause additional exceedance of applicable EC water quality criteria/objectives by frequency, magnitude, and geographic extent that would result in adverse effects on any beneficial uses of any study area waterbodies. Because EC is not expected to increase substantially, the other mitigation measures would not cause long-term degradation of EC in study area waterbodies that would result in substantially increased risk for adverse effects on any beneficial uses. Furthermore, the other mitigation measures would not further degrade EC by measurable levels on a long-term basis in any study area waterbody on the State's CWA Section 303(d) list such that beneficial use impairment would be made discernibly worse. EC is not a bioaccumulative constituent; therefore, the other mitigation measures would not result in bioaccumulation of EC in aquatic organisms. As a result, impacts from other mitigation measures on EC would be less than significant.

Overall, the minimal effect on EC concentrations from the CMP and other mitigation measures, combined with project alternatives, would not change the impact conclusion of less than significant.

Impact WQ-6: Effects on Mercury Resulting from Facility Operations and Maintenance

Maintenance of project alternatives' facilities would not create new sources of mercury or contribute toward a substantial change in existing sources of mercury in the Delta. As such, maintenance activities would not cause any substantial change in mercury in study area waterbodies that would adversely affect beneficial uses anywhere in the Delta.

All Project Alternatives

This assessment of the effects on mercury from conveyance facility operations addresses both total mercury and total methylmercury in the water column, and methylmercury in fish tissues as modeled in 350 millimeter (mm) long largemouth bass.

All project alternatives (i.e., Alternatives 1, 2a, 2b, 2c, 3, 4a, 4b, 4c, and 5) described in Chapter 3 would have similar impact levels and are discussed together.

Delta

Average water column concentrations of total mercury for the full simulation period under the project alternatives would differ little from existing conditions at the Delta assessment locations (Table 9-33; Appendix 9H, *Mercury*). Among all Delta assessment locations, modeled total mercury concentrations range from 6.19 nanograms per liter (ng/L) to 7.86 ng/L under existing conditions and from 6.19 ng/L to 7.91 ng/L under the project alternatives. Thus, total mercury concentrations under the project alternatives would be well below the California Toxics Rule (CTR) criterion for protection of human health from consumption of water and organisms (50 ng/L; 60 *Federal Register* [FR] 2228 [May 4, 1995]; 65 FR 3162 [May 18, 2000]; 66 FR 9960 [February 13, 2001]) at all locations during all water year types. Modeled changes in average total mercury concentrations for the full simulation period range from a decrease of up to 0.01 ng/L at Jones Pumping Plant to an increase of 0.05 ng/L in Barker Slough at the North Bay Aqueduct (Table 9-33; Appendix 9H).

Table 9-33. Total Mercury Concentrations in Water (in nanograms per liter), Average for the Full Simulation Period (1923–2015)

Assessment Location	Existing Conditions	Alternatives 1 and 3	Alternatives 2a and 4a	Alternatives 2b and 4b	Alternatives 2c and 4c	Alternative 5
Barker Slough at North Bay Aqueduct	7.86	7.91	7.91	7.90	7.90	7.91
Sacramento River at Emmaton	7.03	7.06	7.06	7.05	7.06	7.06
San Joaquin River at Antioch	6.77	6.80	6.80	6.79	6.79	6.80
Sacramento River at Mallard Island	7.31	7.34	7.34	7.33	7.33	7.34
South Fork Mokelumne River at Terminous	6.19	6.19	6.19	6.19	6.19	6.19
San Joaquin River at Empire Tract	6.41	6.41	6.41	6.41	6.41	6.41
Contra Costa Water District Pumping Plant #1	6.31	6.32	6.33	6.32	6.32	6.33
Old River at State Route 4	6.31	6.32	6.32	6.31	6.32	6.32
Victoria Canal	6.39	6.39	6.40	6.39	6.39	6.39
Banks Pumping Plant	6.37	6.40	6.41	6.39	6.39	6.39
Jones Pumping Plant	6.56	6.55	6.56	6.56	6.56	6.56

Similarly, average water column concentrations of total methylmercury for the full simulation period under the project alternatives would differ little from existing conditions at the Delta assessment locations (Table 9-34; Appendix 9H). Among all Delta assessment locations, modeled total methylmercury concentrations range from 0.12 ng/L to 0.15 ng/L under both existing conditions and the project alternatives (Table 9-34; Appendix 9H).

Table 9-34. Total Methylmercury Concentrations in Water (in nanograms per liter), Average for the Full Simulation Period (1923–2015)

Assessment Location	Existing Conditions	Alternatives 1 and 3	Alternatives 2a and 4a	Alternatives 2b and 4b	Alternatives 2c and 4c	Alternative 5
Barker Slough at North Bay Aqueduct	0.13	0.13	0.13	0.13	0.13	0.13
Sacramento River at Emmaton	0.12	0.12	0.12	0.12	0.12	0.12
San Joaquin River at Antioch	0.12	0.12	0.12	0.12	0.12	0.12
Sacramento River at Mallard Island	0.13	0.13	0.13	0.13	0.13	0.13
South Fork Mokelumne River at Terminous	0.13	0.13	0.13	0.13	0.13	0.13
San Joaquin River at Empire Tract	0.14	0.14	0.14	0.14	0.14	0.14
Contra Costa Water District Pumping Plant #1	0.13	0.13	0.13	0.13	0.13	0.13
Old River at State Route 4	0.13	0.13	0.13	0.13	0.13	0.13
Victoria Canal	0.14	0.15	0.15	0.14	0.14	0.15
Banks Pumping Plant	0.14	0.13	0.13	0.13	0.13	0.13
Jones Pumping Plant	0.15	0.15	0.14	0.15	0.15	0.15

The changes in water column concentrations of total methylmercury under the project alternatives would have little to no measurable effect on Delta fish tissue concentrations, relative to existing conditions. All modeled fish tissue concentrations exceed the water quality objective of 0.24 milligrams per kilogram (mg/kg) wet weight in 350 mm largemouth bass under both existing conditions and the project alternatives (Table 9-35; Appendix 9H). Average modeled tissue concentrations for the full simulation period range from 0.59 mg/kg to 0.87 mg/kg wet weight under both existing conditions and the project alternatives. Modeled fish tissue methylmercury concentrations increased by no more than 0.01 mg/kg wet weight as averages over the full simulation period at all Delta assessment locations under the project alternatives, relative to existing conditions (Table 9-35; Appendix 9H).

Based on the small modeled changes in total mercury and methylmercury concentrations at all Delta assessment locations described above, the project alternatives would not contribute to measurable water quality degradation with respect to mercury and methylmercury, and thus would not increase health risks to wildlife or humans consuming wildlife from the Delta, as compared to existing conditions. Thus, the differences in mercury and methylmercury in the Delta under the project alternatives, relative to existing conditions, would not make the existing beneficial use impairment from mercury discernibly worse.

Table 9-35. Total Methylmercury Concentrations in Largemouth Bass (in milligrams per kilogram), Average for the Full Simulation Period (1923–2015)

Assessment Location	Existing Conditions	Alternatives 1 and 3	Alternatives 2a and 4a	Alternatives 2b and 4b	Alternatives 2c and 4c	Alternative 5
Barker Slough at North Bay Aqueduct	0.73	0.74	0.74	0.74	0.74	0.74
Sacramento River at Emmaton	0.59	0.59	0.59	0.59	0.59	0.59
San Joaquin River at Antioch	0.64	0.64	0.64	0.64	0.64	0.64
Sacramento River at Mallard Island	0.69	0.70	0.70	0.70	0.70	0.70
South Fork Mokelumne River at Terminous	0.73	0.74	0.74	0.73	0.74	0.74
San Joaquin River at Empire Tract	0.79	0.79	0.80	0.79	0.79	0.79
Contra Costa Water District Pumping Plant #1	0.68	0.68	0.68	0.68	0.68	0.68
Old River at State Route 4	0.75	0.75	0.75	0.75	0.75	0.75
Victoria Canal	0.85	0.86	0.86	0.86	0.86	0.86
Banks Pumping Plant	0.79	0.73	0.73	0.74	0.73	0.73
Jones Pumping Plant	0.87	0.87	0.86	0.87	0.87	0.87

Suisun Marsh, Suisun Bay, and San Francisco Bay

The project alternatives would not result in substantial increases in total mercury and methylmercury concentrations in Delta waters or in Delta outflows. As such, the project alternatives would not cause a substantial change in total mercury and methylmercury concentrations in Suisun Marsh, Suisun Bay, or San Francisco Bay under all project alternatives, relative to existing conditions, would not substantially increase the frequency with which applicable water quality criteria or objectives would be exceeded in these waters, would not substantially degrade the quality of these waters with regard to mercury, and would not make the CWA Section 303(d) impairment for mercury discernibly worse.

SWP/CVP Export Service Areas

Average water column mercury and methylmercury concentrations over the full simulation period at the Banks Pumping Plant would decrease under all project alternatives, relative to existing conditions, and would differ negligibly from existing conditions at Jones Pumping Plant and Barker Slough at North Bay Aqueduct, as previously discussed. Thus, the project alternatives would not result in increased mercury or methylmercury concentrations in SWP/CVP export service area waterbodies that would substantially degrade water quality in the SWP/CVP export service areas, relative to existing conditions. Total mercury concentrations in Delta waters diverted into the SWP/CVP export service areas would not exceed the 50 ng/L CTR criterion for protection of human health from consumption of water and organisms under all project alternatives.

CEQA Conclusion—All Project Alternatives

Based on the above analysis, the project alternatives would not cause additional exceedance of applicable water quality criteria or objectives by frequency, magnitude, and geographic extent that would cause significant impacts on any beneficial uses of waters in the study area. Because mercury concentrations are not expected to increase substantially, no long-term water quality degradation that would result in substantially increased risk for significant impacts on beneficial uses would occur. Furthermore, changes in long-term methylmercury concentrations that may occur in study area waterbodies would not make existing CWA Section 303(d) impairments measurably worse, or increase levels of mercury by frequency, magnitude, and geographic extent to cause measurably higher body burdens of mercury in aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish) or humans consuming those organisms. Thus, the impact of the project alternatives on mercury concentrations would be less than significant.

Mitigation Impacts

Compensatory Mitigation

The CMP described in Appendix 3F is not intended or needed as mitigation for impacts to water quality due to mercury from project construction or operations. Nevertheless, implementation of the CMP could affect Delta mercury levels in and near tidal habitats created as part of the plan, as analyzed in this chapter. CEQA requires analysis of the impacts of mitigation; therefore, this discussion is included here.

Implementation of the CMP, which includes the creation of freshwater emergent perennial wetlands, seasonal wetlands, and tidal habitats, could result in new sources of methylmercury within the Delta relative to existing conditions. Mercury methylation occurs under anoxic conditions in sediments, flooded shoreline soils, and to a lesser degree, in the water column. Increased methylmercury is also associated with wetting and drying cycles. These new sources of methylmercury could result in higher methylmercury concentrations in adjacent Delta waters and uptake into the tissues of fish residing within and immediately adjacent to these wetland habitats where elevated levels of methylmercury could be created.

The freshwater emergent perennial wetlands and seasonal wetlands would be located on Bouldin Island and would not be hydrodynamically connected with adjacent Delta waters. As part of management of the new wetlands, water may be discharged from the wetlands to adjacent Delta waterways through existing drains or outfalls. As part of adaptive management, monitoring of the discharge would be conducted and the discharges potentially modified (e.g., to a detention basin) should monitoring results show the wetland discharges to be a net exporter of methylmercury to Delta waters. Thus, the wetlands to be created on Bouldin Island would not contribute to measurable increases in methylmercury concentrations in waters and biota of the Delta or make the existing mercury-related CWA Section 303(d) impairment within the Delta measurably worse.

Location(s) and size(s) of the new tidal habitats are generally proposed for the lower Yolo Bypass and Cache Slough Complex and would be selected in accordance with the tidal habitat mitigation framework in Appendix 3F. The new tidal habitats would be hydrodynamically connected with adjacent Delta waters, and conditions that are conducive to increased mercury methylation and uptake from water into fish tissues could potentially occur within the new tidal habitats. However, not all types of wetland habitats have the same potential for methylmercury generation, and tidal wetlands in the Delta are not necessarily significant net producers or exporters of methylmercury to adjacent waterbodies (California Department of Water Resources 2020:7).

Regularly inundated tidal wetlands that do not fully dry between wetting cycles generate less methylmercury than seasonally flooded wetlands and high-tidal marsh (Alpers et al. 2008:10). Likewise, permanently flooded wetlands in the Delta managed for wildlife, and seasonally flooded wetlands to a lesser degree, produced far less methylmercury than do agricultural wetlands managed for rice production (Alpers et al. 2014:282). The degree to which methylmercury generation occurs in four Delta tidal wetlands, evaluated as part of methylmercury control studies for the Delta mercury TMDL, found that concentrations did not significantly increase on ebb tides over those entering the wetlands on flood tides (California Department of Water Resources 2020:7). Thus, these restored tidal wetlands are unlikely to significantly increase methylmercury concentrations in the wetlands themselves and adjacent Delta waters. Likewise, none of the four Delta tidal wetlands studied contributed significantly to net annual methylmercury loads in surrounding waters. Another study of a natural tidal marsh in the western Delta, Browns Island, found it to be a relatively small net source of methylmercury, and extrapolation of these results to all 33 square kilometers (km) of existing Delta tidal wetlands indicated they are a minor source, contributing only 3% of the external riverine methylmercury loads (Bergamaschi et al. 2011:1368). Studies outside the Delta have also found tidal wetlands to be net sinks for total mercury and methylmercury or only a minor source of methylmercury to nearby surface waters (Mitchell et al. 2012:7; Turner et al. 2018:153). Seasonal and spatial variability in methylmercury production and export were observed in all of these studies so that site-specific planning and monitoring should inform the design and management of CMP tidal habitat to understand hydrodynamic and biogeochemical interactions as part of mercury control actions (McCord and Heim 2015:738; Bergamaschi et al. 2011:1369).

The extent to which fish exposed to tidal wetlands bioaccumulate mercury has been monitored in the North San Francisco Bay where fish tissue concentrations within restored tidal wetlands were not higher than in reference tidal wetlands (Robinson et al. 2018:18). To estimate how fish tissue concentrations could be affected by aqueous methylmercury concentrations in four restored Delta tidal marshes, monthly tidal ebb and flow mercury concentration data from the California Department of Water Resources (2020) were used to model tissue concentrations in 350-mm largemouth bass filets using the Delta TMDL model (Central Valley Regional Water Quality Control Board 2010a:73). Modeled fish tissue mercury concentrations did not differ significantly between exposures to ebb and flood flow concentrations at three of the four tidal wetlands using Wilcoxon Signed Rank test ($p>0.05$) and were significantly greater in flood water concentrations (i.e., those entering the tidal marsh) at North Lindsay Slough ($p<0.01$). These calculations suggest that fish tissue mercury concentrations would not significantly increase within CMP tidal habitat or in the Delta waters surrounding these habitats.

While these studies suggest a low potential for increases in methylmercury in the waters and fish tissues in restored tidal wetlands, these conditions are site-specific and vary over time and therefore may not be predictive of mercury methylation in all tidal wetlands created within the Delta. Measurable increases in methylmercury concentrations in waters and fish within and near the new tidal habitats could potentially occur. Methylmercury is CWA Section 303(d)-listed within the Delta. As such, if the new tidal habitats have higher aqueous methylmercury concentrations than surrounding Delta water, they could make the existing CWA Section 303(d) mercury-related impairment discernably worse. Because mercury is bioaccumulative, elevated water-borne methylmercury concentrations that could occur in new tidal habitats would bioaccumulate in aquatic organisms that could, in turn, pose increased health risks to wildlife or humans consuming those organisms, relative to existing conditions. Thus, in an abundance of caution, DWR has determined that the impact of new tidal habitats created in accordance with the CMP on mercury concentrations in Delta organisms residing within the wetlands and immediately adjacent Delta waters is potentially significant.

Mitigation Measure WQ-6: *Develop and Implement a Mercury Management and Monitoring Plan* would be implemented with the goal to minimize generation of methylmercury within the new tidal habitats. Tidal habitat design would be guided by this mitigation measure, which requires development of a comprehensive Mercury Management and Monitoring Plan (MMMP) and a site-specific mercury management plan or plans.

Factors affecting methylmercury generation and transport would need to be considered in the design and management of CMP wetlands because methylmercury production in wetland habitats is complex and governed by site-specific conditions. Methylmercury production in wetland habitats is affected by organic matter in the sediments, organic carbon levels, dissolved oxygen levels, pH, sulfate concentration, iron concentrations, temperature, salinity, and available pools of inorganic mercury present. Wetlands can create ideal biogeochemical conditions for inorganic mercury to methylate to methylmercury since they are dominated by high organic matter soils/sediments and often receive sediment inputs, both of which are sources of dissolved organic carbon that is important to supporting the methylation process. Organic matter fuels microbial activity while also increasing biochemical oxygen demand (which depletes sediment oxygen levels) and decreasing oxidation-reduction potential in water and sediment. In anoxic sediments (where oxygen is absent), sulfate and iron-reducing bacteria methylate inorganic mercury in their cells. In a sense, these bacteria breathe sulfate rather than oxygen in a form of anaerobic respiration. The form of inorganic mercury present also determines the uptake rates by the sulfate and iron-reducing bacteria cells that methylate the inorganic mercury present. Finally, the exchange of water with areas of the Delta outside the restored habitat will affect sediment and mercury exchange.

The potential to control or reduce methylmercury generation and/or concentrations in tidal habitats exists based on past and ongoing research (California Department of Water Resources et al. 2020:7-1; McCord and Heim 2015:732; Alpers et al. 2014:285; California Department of Public Health 2013:12; Davis et al. 2012:20) and the MMMP will describe the need to consider the various environmental parameters as part of deciding where to site the restoration habitats, the size of tidal habitat to be developed at each site, design criteria, and how best to manage water and sediment exchange and vegetation to minimize the potential for mercury methylation. Restored tidal wetlands in the Delta are not necessarily significant net producers or exporters of methylmercury to adjacent waterbodies (California Department of Water Resources 2020:7). Thus, it is feasible for tidal habitat siting and design of restored tidal wetlands to create conditions that minimize sources of inorganic mercury available for methylation, provide for water and sediment exchange to minimize microbial methylation of mercury associated with anoxic conditions, or use other approaches informed by research to not make the existing Delta mercury impairment discernably worse.

Mercury and methylmercury concentration data collected as tidal habitats are created and managed, (e.g., water, sediment, and fish tissue concentrations) would inform the need to adaptively manage these tidal habitats cooperatively with input from the State Water Board and Central Valley RWQCB to ensure that methylmercury generation and concentrations in and around the new tidal habitats would not make the current CWA Section 303(d) Delta mercury-related impairment measurably worse. For example, vegetation management would lower the levels of organic matter in the sediments, reducing the carbon source used by bacteria in mercury methylation, and decreasing anoxic conditions (i.e., the lack of oxygen) in sediments so that the presence of oxygen creates conditions which limit methylation by bacteria. Hence, minimizing conditions conducive to mercury methylation in the siting, design, and adaptive management of CMP tidal wetlands as described by Mitigation Measure WQ-6 is the best available approach for controlling mercury methylation in tidal wetland restoration habitats (McCord and Heim 2015:734; Davis et al. 2012:20). This determination is made based on past research findings regarding creating/monitoring such habitats and implementing practicable measures to minimize mercury methylation rates and methylmercury concentrations in sediment and the water column, which is then available to aquatic organisms.

While there are uncertainties associated with the total acres of CMP tidal wetland to be created and the effectiveness of the siting and design criteria in controlling mercury methylation within these habitats, restored tidal wetlands in the Delta have not been found to be significant net sources of methylmercury to surrounding waters and are a relatively small contributor of total mercury and methylmercury in the Delta compared to upstream inputs. Therefore, based on the knowledge gained from creating and monitoring tidal wetland habitats in the Delta and elsewhere to date, this mitigation measure would ensure that the CMP wetlands are designed and sited and managed in a manner that is effective in preventing methylmercury levels in water and fish tissue of the new tidal habitats from becoming significantly greater than in comparable existing habitats elsewhere in the Delta, thereby not making the existing Delta mercury impairment discernably worse. Therefore, this impact is less than significant with mitigation.

Mitigation Measure WQ-6: Develop and Implement a Mercury Management and Monitoring Plan

This mitigation measure will be implemented as part of the CMP described further in Appendix 3F. DWR will minimize methylmercury generation and mobilization into the food chain resulting from CMP implementation by developing a Mercury Management and Monitoring Plan (MMMP) to guide tidal habitat siting, design, monitoring, and adaptive management. The MMMP will require evaluation of site-specific conditions to assess whether the creation and existence of new tidal habitats would make the current Delta mercury impairment discernibly worse and will include siting, design, monitoring, and adaptive management elements to minimize conditions within new tidal habitats that may be conducive to the creation or increased availability of methylmercury while still achieving most or all of the desired CMP benefits.

The MMMP objective will be to control levels of bioavailable methylmercury within the CMP tidal habitats such that aquatic organisms in waters within and immediately adjacent to the new tidal habitats will not have measurably higher body burdens compared to those in comparable reference locations in the Delta, and thus CMP implementation will not make the current Delta mercury impairment discernably worse. The MMMP will serve as the framework for site-specific mercury management plans to be prepared for each proposed new tidal habitat site that address the MMMP elements (defined below) based on site-specific conditions.

Current and ongoing research programs are providing information regarding mercury cycling in tidal wetlands. These include data from the Yolo Wildlife Area Tidal Wetland in the Yolo Bypass, Blacklock Tidal Wetland in Suisun Marsh, North Lindsey Slough Tidal Wetland in the Cache Slough Complex, and the Westervelt Cosumnes River Tidal Wetland east of the confluence of the Cosumnes and Mokelumne Rivers (California Department of Water Resources 2020:7). Several other tidal wetland restoration projects are being planned that will contribute to the available data informing management actions to minimize methylmercury generation and bioaccumulation in tidal wetlands. The CMP ecosystem restoration objectives will be considered throughout the development of the MMMP.

Mercury Management and Monitoring Plan Elements

1. DWR will retain a qualified water quality specialist, wildlife biologist, or fisheries biologist with expertise in methylmercury management to develop the MMMP.
2. The MMMP will address the following elements to minimize and control measured mercury methylation and methylmercury bioavailability within CMP tidal habitats.
    a. **Predesign field studies**—The MMMP will define the predesign field studies to be conducted at potential tidal habitat sites to characterize mercury sources and concentrations of mercury, methylmercury, organic carbon, iron, and sulfate in surface water and sediment to inform tidal habitat design and post-restoration monitoring.

    b. **Siting, design, source control, and management measures**—The MMMP will define tidal habitat siting, design, source control, and management measures to minimize mercury bioaccumulation into the foodweb so that mean tissue mercury concentrations in fish collected within and immediately adjacent to the CMP tidal habitats are not significantly greater than mercury tissue concentrations for the same species in similar tidal habitat elsewhere in the Delta. Siting, design, source control, and management measures that will be considered and evaluated in the MMMP will include, but not be limited to, the following.

        i. Avoid siting tidal habitats in areas that currently have high soil or sediment mercury levels and minimize exposure of mercury-containing soils.

        ii. Design for favorable water and sediment exchange with adjacent Delta waters to manage elemental mercury input and export of methylmercury over time (Davis et al. 2012:20).

        iii. Minimize microbial methylation of mercury associated with anoxic or near-anoxic conditions by managing the amount of organic material at a restoration site and dissolved oxygen levels. This can be affected by managing vegetation to reduce this organic carbon source, which fuels mercury methylation by bacteria (California Department of Water Resources et al. 2020:7-1; Alpers et al. 2014:285).

        iv. Manage vegetation to reduce organic carbon, which fuels mercury methylation by bacteria, by mechanical removal (California Department of Water Resources et al. 2020:7-1; Alpers et al. 2014:285; Windham-Myers et al. 2009:10).

        v. Minimize seasonal wetting/drying cycles that encourage mercury methylation (California Department of Public Health 2013:12).

        vi. Minimize drainage through soils where mercury methylation is greatest (Bergamaschi et al. 2011:1369).

        vii. Enhance photo-demethylation that converts methylmercury into a biologically unavailable, inorganic form of mercury (California Department of Public Health 2013:2).

   viii. Control sediment mobilization into the tidal habitat if particulates or sediment is determined to be a key source of mercury (California Department of Water Resources et al. 2020:7-1).

   ix. Remediate tidal habitat soils with iron to reduce methylation in sulfide rich soils (McCord and Heim 2015:732).

c. **Monitoring**—The MMMP will describe strategies to monitor and collect data to determine how well the design, source control, and management measures are affecting methylmercury concentrations in fish tissue at the new tidal habitats relative to comparable reference locations.

d. **Adaptive management**—The MMMP will describe actions to be taken to further reduce methylmercury concentrations in sediment, the water column, and fish tissues should they be shown to exceed performance standards. Adaptive management strategies will be fully developed as part of the MMMP and will inform future tidal habitat siting and initial and future management actions.

Site-Specific Mercury Management Plans

3. The MMMP will be implemented by DWR through development and implementation of site-specific mercury management plans for each CMP tidal habitat site. Relevant MMMP design elements will be integrated into project-specific designs or an explanation of why a particular element is not applicable to the site will be provided. Where site-specific siting, design, source control, and management measures could limit the ecosystem benefits of CMP tidal habitat, such as by limiting the amount of carbon supplied to the Delta as a whole or by requiring flows inconsistent with the habitat type, discussions among involved resource agencies will be held to resolve such technical issues. In addition to relevant design elements from the MMMP, the site-specific mercury management plans will include the following components.

   a. A review of predicted changes in hydrology at the new tidal habitat site, expected changes in conditions affecting mercury methylation, expected changes in bioavailable methylmercury concentrations, and possible changes in bioaccumulation by fish.

   b. A determination of whether preconstruction sampling for baseline characterization of mercury and methylmercury concentrations in water, sediment, and/or biota is warranted. If this work was recently completed for a comparable reference location, then repeating the preconstruction sampling may not be needed. Decisions will be made on a site-specific basis.

   c. A description of characterization sampling and post-restoration monitoring at each tidal habitat project site that includes a Quality Assurance/Project Plan specifying sampling procedures, analytical methods, data review requirements, data analysis approaches (e.g., statistical tools), and data management and reporting procedures.

Site-Specific Monitoring and Adaptive Management

4. DWR will conduct monitoring at the new tidal habitat sites in accordance with the site-specific mercury management plans.

5. DWR will implement adaptive management based on monitoring results.

a. Adaptive management will be implemented if monitoring results indicate that tissues of fish collected from within and immediately adjacent to the new tidal habitat have statistically significant and higher average mercury concentrations than tissues of the same species of fish collected from appropriate reference habitats elsewhere in the Delta. Conversely, if the mean mercury concentrations in fish tissues collected within and immediately adjacent to the new tidal habitat are not significantly greater than mercury concentrations in tissues of the same species collected from appropriate reference habitats in the Delta, then the new tidal habitat will be determined to not be making the current mercury impairment discernably worse. This statistical analysis serves as a performance standard for this mitigation measure and identifies when adaptive management actions will need to be implemented. This performance standard will be defined as an action level for adaptive management in the site-specific mercury management plans.

b. Adaptive management actions will be developed in coordination with the State Water Board and Central Valley RWQCB and based on monitoring findings. Adaptive management actions for newly created tidal habitats could include modifications to the type and frequency of monitoring being conducted and modifications to various ongoing management actions that affect vegetation, water and sediment exchange, dissolved oxygen levels, water depths, and sediment chemistry. Adaptive management actions for future CMP tidal habitats will be based on information gained from newly created tidal habitats and could include modifying criteria for siting future tidal habitats or modifying design criteria that affect tidal and sediment exchange, depth, dissolved oxygen levels, vegetation management, and sediment chemistry.

Oversight and Coordination

6. DWR will identify a qualified specialist in methylmercury cycling and biological effects who will oversee all aspects of implementing this mitigation measure. The methylmercury specialist will review and approve all mercury and methylmercury-related conclusions and recommendations generated from the tidal habitat component of the CMP, including site-specific mercury management plans. The methylmercury specialist will develop a Quality Assurance/Project Plan to describe all sampling, analyses, and reporting as part of any site-specific mercury management plan. The specialist will also be responsible for integrating new, relevant information generated by research over the course of this program.

7. DWR will develop and implement methylmercury management approaches consistent with the Delta Methylmercury TMDL (Central Valley Regional Water Quality Control Board 2010a:iv, 73, 80, 88, 134, 197) developed to control methylmercury generation and loading in the Delta. The Delta Mercury Control Program in the Central Valley RWQCB WQCP, which establishes an implementation program for the TMDL, states, in part, “In subareas needing reductions in methylmercury, proponents of new wetland and wetland restoration projects scheduled for construction after 20 October, 2011 shall (a) participate in methylmercury Control Studies, or shall implement site-specific study plans, that evaluate practices to minimize methylmercury discharges, and (b) implement methylmercury controls as feasible. New wetland projects may include pilot projects and associated monitoring to evaluate management practices that minimize methylmercury discharges.” (Central Valley Regional Water Quality Control Board 2018:4-93) DWR has participated in these studies.

Timing and Phasing

8. DWR will develop the MMMP prior to siting any CMP tidal habitat. Site-specific mercury management plans will be developed by DWR as part of the design and implementation of individual CMP tidal habitat projects.

Other Mitigation Measures

Drainage patterns may be modified for some other mitigation measures, but as described for Impact WQ-2, this would not produce any substantial increase in runoff, including runoff contaminated with mercury or methylmercury.

Tidal wetland projects on Sherman and Twitchell Islands are an optional component of Mitigation Measure AQ-9: *Develop and Implement a GHG Reduction Plan to Reduce GHG Emissions from Construction and Net CVP Operational Pumping to Net Zero*. These projects could potentially cause increases in methylmercury concentrations. Construction of tidal wetlands for the purpose of reversing subsidence and sequestering carbon could enhance conversion of mercury to methylmercury, thereby potentially increasing concentrations of the more bioavailable and harmful form of mercury. As described for CMP mitigation measures, which also include construction of tidal wetlands, Mitigation Measure WQ-6: *Develop and Implement a Mercury Management and Monitoring Plan* would be implemented to limit methylmercury concentrations, and would be applied to tidal wetland projects on Sherman and Twitchell Islands, as appropriate. This mitigation measure is expected to be effective in preventing methylmercury levels in water and fish tissue at new tidal habitats from becoming significantly greater than comparable existing habitats elsewhere in the Delta. Therefore, implementation of the optional tidal wetland components of Mitigation Measure AQ-9 would result in less than significant impacts to mercury bioaccumulation in the Delta after Mitigation Measure WQ-6.

The impact of operations of the project alternatives on mercury concentrations and bioaccumulation into aquatic life in the Delta would be less than significant. Also, impacts to Delta mercury concentrations and bioaccumulation from implementation of the CMP wetland mitigation measures and any optional tidal wetland projects associated with Mitigation Measure AQ-9, would be less than significant after Mitigation Measure WQ-6.

Impact WQ-7: Effects on Nutrients Resulting from Facility Operations and Maintenance

Nitrogen and phosphorus are the focus of this nutrient analysis because in aquatic ecosystems these nutrients are the most important and abundant. Nitrogen and phosphorus are essential for aquatic plant growth. However, when these nutrients are in excess, they can cause biological responses, such as excessive plant and algae growth, which lead to water quality issues including depletion of dissolved oxygen, pH fluctuations, and changes in the taxonomic composition and structure of aquatic biological communities.

Maintenance of project alternatives' facilities would not create new sources of nutrients or contribute toward a substantial change in existing sources of nutrients in the Delta. As such, maintenance activities would not cause any substantial change in nutrients in study area waterbodies that would adversely affect beneficial uses anywhere in the Delta.

All Project Alternatives

All project alternatives (Alternatives 1, 2a, 2b, 2c, 3, 4a, 4b, 4c, and 5) described in Chapter 3 would have similar impact levels and, therefore, are discussed together.

Delta

The two primary anthropogenic sources of phosphorus and nitrogen in the Delta are urban point sources (e.g., wastewater effluent, stormwater), and agricultural nonpoint sources (e.g., agricultural runoff and return flows containing fertilizers mixed in irrigation water). Nutrient removal projects by two major wastewater treatment plants that discharge into the Delta (i.e., Sacramento Regional Wastewater Treatment Plant EchoWater Project and Stockton Regional Wastewater Control Facility Modifications Project) will be complete by 2025. These projects will substantially decrease total nitrogen inputs from these wastewater treatment plants in the future, but will not reduce total phosphorus levels in their respective discharges. Agricultural nonpoint-source discharges are regulated under Central Valley RWQCB's Irrigated Lands Regulatory Program waste discharge requirements, which mandate nutrient monitoring in the major agricultural reaches, implementing BMPs to reduce nutrient discharges to streams, and controlling fertilizer application and management.

Even with the Central Valley RWQCB's irrigated lands regulatory program efforts and point-source discharge regulations to decrease and control sources of nutrient loading, nutrient levels throughout the Delta are not a limiting factor to macrophyte or algae growth in Delta waters (Dahm et al. 2016:15). Nevertheless, subregions and individual habitats within the Delta respond differently to nutrient inputs, and also influence nutrient concentrations differently (Dahm et al. 2016:1).

The two main mechanisms by which the project alternatives could change total phosphorus and total nitrogen concentrations in the Delta are: (1) changing total phosphorus and total nitrogen concentrations in the source water inflows to the Delta; and (2) changing the proportions of source waters fractions at specific Delta locations.

The project alternatives would result in some seasonal differences in Delta inflow rates from the Sacramento River relative to existing conditions. However, for many months, there would be little to no change in flow under the project alternatives relative to existing conditions, and for those months when there are changes in flow the flow rates would be within the range occurring under existing conditions. Winter flows would continue to remain higher than summer flows, and storm events would continue to be the primary cause of higher nitrogen and phosphorus concentrations in the winter months relative to the summer months under the project alternatives. Consequently, there would be negligible, if any, flow-related changes to nitrogen and phosphorus concentrations in rivers upstream of the Delta.

As such, total phosphorus and total nitrogen concentrations in Delta inflows would differ negligibly, if at all, from existing conditions. Therefore, the remaining assessment focuses on the changing proportions of source water fractions at specific Delta locations and how any project alternative-related changes would affect nutrient concentrations relative to existing conditions.

The San Joaquin River has considerably less discharge to the Delta than the Sacramento River and overall delivers less phosphorus to the Delta. Modeling estimates the total annual phosphorus load entering the Delta is 1,944 tons from the Sacramento River and 732 tons from the San Joaquin River watershed (Domagalski and Saleh 2015:1479). However, total phosphorus concentrations within the San Joaquin River are substantially higher than those in the Sacramento River (Table 9-36).

Table 9-36. Summary of Delta Source Water Concentrations for Total Phosphorus (in micrograms per liter)

Source Water	Sacramento River	San Joaquin River	San Francisco Bay	East Side Tributaries	Agriculture Drains
Mean	100	204	136	50	503
Minimum	20	10	35	7	100
Maximum	371	970	1,400	470	810
75th percentile	120	260	155	67	678
99th percentile	249	610	390	324	805
Data source	CEDEN 2020	CEDEN 2020	CEDEN 2020	CEDEN 2020	DWR 2020
Station(s)	Sacramento River at Greene's Landing, Sacramento River at Hood	San Joaquin River at Vernalis	Sacramento River at Chipps Island and Mallard Island, Suisun Bay at Bulls Head near Martinez	Cosumnes River at Twin Cities Road, Mokelumne River at Bruella Road, New Hope Road, Georgiana Slough	Staten Island
Date range	1975–2000	1975–2000	1975–2019	2000–2018	2004
Data omitted	No	No	No	No	No
Detected	915	780	981	133	6
Number of data points	915	780	981	169	6

Note: Non-detects replaced with reporting limit for these calculations.
CEDEN = California Environmental Data Exchange Network; DWR = California Department of Water Resources.

Nitrogen loads from the Sacramento River are substantially higher than from the San Joaquin River because of the higher annual average discharge of the Sacramento River to the Delta (Saleh and Domagalski 2015:1502). However, like phosphorus, nitrogen concentrations in the San Joaquin River are higher than those from the Sacramento River (Table 9-37).

Table 9-37. Summary of Source Water Concentrations for Total Nitrogen (in milligrams per liter)

Source Water	Sacramento River	San Joaquin River	San Francisco Bay	East Side Tributaries	Agriculture Drains
Mean	0.664	2.03	0.779	0.780	3.29
Minimum	0.100	0.280	0.130	0.330	2.47
Maximum	2.44	5.80	2.90	1.19	4.31
75th percentile	0.800	2.61	0.930	0.980	3.76
99th percentile	1.56	4.30	1.44	1.18	4.29
Data source	CEDEN 2020	CEDEN 2020	CEDEN 2020	CEDEN 2020	DWR 2020
Station(s)	Sacramento River at Greene's Landing,	San Joaquin River at Vernalis	Sacramento River at Chipps Island and Mallard Island, Suisun Bay	Cosumnes River at Twin Cities Road, Mokelumne River at Bruella Road,	Staten Island

Source Water	Sacramento River	San Joaquin River	San Francisco Bay	East Side Tributaries	Agriculture Drains
	Sacramento River at Hood		at Bulls Head near Martinez	New Hope Road, Georgiana Slough	
Date range	1975–2020	1975–2020	1975–2020	2009–2010	2004
Data omitted	Yes	Yes	Yes	Yes	Yes
Detected	969	803	759	16	6
No. of data points	969	803	759	16	6

Notes: Data omitted where concentrations of all fractions were not detected to calculate total N. Non-detects replaced with reporting limit for these calculations.

CEDEN = California Environmental Data Exchange Network; DWR = California Department of Water Resources.

As shown in Appendix 9B, *Source Water Fingerprinting,* the Sacramento River is the dominant water source throughout all Delta subregions except the south Delta, where various locations can be seasonally dominated by San Joaquin River water. Water quality in the south Delta is also strongly influenced by agricultural drains. Based on a limited data set (n = 6) these agricultural drains have the highest nutrient concentrations of all the source waters to the Delta (Tables 9-36 and 9-37). At the south Delta assessment locations of Victoria Canal, Old River, Banks Pumping Plant, and Jones Pumping Plant, the modeled percentage of agricultural drainage is 9% to 17% during some months of the year. In addition to high fractions of Sacramento River water, the South Fork Mokelumne River at Terminous has substantial influence from the eastside tributaries with modeled percentages ranging from 27% to 36% of the river water from January to May. The eastside tributaries have the lowest nutrient concentrations of all Delta source waters. The Sacramento River at Mallard Island, located in the western Delta, is highly influenced by tidal exchange, where the modeled percentage of San Francisco Bay water ranges from 42% to 51% of the river water from July through November.

Under the project alternatives, there would generally be very small changes in source water fractions relative to existing conditions (Appendix 9B). At all assessment locations, except Banks Pumping Plant and Jones Pumping Plant, the project alternatives would cause long-term average decreases of Sacramento River water and increases in San Joaquin River water and/or other source waters. With the exception of the Banks and Jones Pumping Plants, the modeled major source water fractions (i.e., Sacramento River, San Joaquin River, San Francisco Bay) under all project alternatives differ by no more than 2% on a long-term average relative to existing conditions. Modeled differences for the other source waters (i.e., eastside tributaries, agricultural drainage, and Yolo Bypass) are even smaller (Appendix 9B).

Since changes in source water fractions are larger at Banks and Jones Pumping Plants relative to the other nine assessment locations, these two locations are described separately below. At the other nine assessment locations, the greatest changes in source water fractions would occur under Alternatives 2a and 4a during the winter months (i.e., November through January). Three of the nine assessment locations where the greatest changes in source water fractions would occur under Alternatives 2a and 4a are described below. To determine how these changes in source water fractions would affect nutrient concentrations, the differences in individual source water fractions between existing conditions and the project alternatives were applied to the total nitrogen and total phosphorus concentrations in Tables 9-36 and 9-37.

The largest decreases in Sacramento River flows (i.e., 2.3% decrease) would occur under Alternatives 2a, 4a, and 5 in January in the Sacramento River at Mallard Island where the proportion of Bay water would comparably increase. This would result in an increase of 1.1 µg/L of total phosphorus under Alternatives 2a and 4a and an increase of 0.9 µg/L of total phosphorus under Alternative 5. There would be no measurable change in total nitrogen under Alternatives 2a, 4a, and 5 relative to existing conditions. The largest increase in San Joaquin River and other source water would occur at Empire Tract in November under Alternatives 2a and 4a. Here, Sacramento River flows would decrease by 1.8% and be replaced by San Joaquin River water (1.6% increase) and agricultural drainage water (0.1% increase). These changes in source water fractions at Empire Tract would result in a 2.0 µg/L increase of total phosphorus and 0.02 mg/L increase of total nitrogen relative to existing conditions. A similar change in source waters would occur at Victoria Canal in December under Alternatives 2a and 4a. Here, Sacramento River waters would decrease by 1.9% and be replaced by San Joaquin River water (1.2% increase), eastside tributary water (0.2% increase), and agricultural drainage water (0. % increase). This would result in increases of 2.7 µg/L of total phosphorus and an increase of 0.03 mg/L total nitrogen at Victoria Canal relative to existing conditions. Other small changes in source water fractions under the different alternatives at the assessment locations would result in similar or smaller changes in nutrient concentrations than these three locations. Consequently, small changes in source water fractions during some months of the year would have negligible effects on nutrient concentrations in the Delta because the relative difference in source water fractions is so small that it would not lead to substantial changes in nutrient concentrations relative to existing conditions.

At Jones Pumping Plant, changes in source water fractions under all project alternatives (except Alternatives 2a and 4a) would be very small, with up to a 2% increase or decrease in major (i.e., Sacramento River and San Joaquin River) source water fractions as a long-term average relative to existing conditions. Changes in other source water fractions would be even smaller (i.e., ≤ 0.3% increases in some months). However, under Alternatives 2a and 4a, changes in source water fractions would be more pronounced. The long-term average Sacramento River water fraction were modeled to increase by up to 5.5% in March while San Joaquin River water would decrease up to 4.5% and agricultural drainage waters would decrease by up to 0.7% in March, as a long-term average. Changes in fractions of source waters in other months would be substantially smaller. Sacramento River water has lower concentrations of total phosphorus and total nitrogen. Thus, there would be a small decrease in total phosphorus (7.0 µg/L decrease) and total nitrogen (0.08 mg/L) concentrations in March under Alternatives 2a and 4a at Jones Pumping Plant relative to existing conditions. During other months there would be negligible effects on nutrient concentrations because changes in the source water fractions would be even smaller than those modeled for March.

At Banks Pumping Plant, there would be substantial seasonal increases in the fraction of Sacramento River water. Although Sacramento River water inputs would generally increase in all months, the greatest changes would occur in March, with the Sacramento River long-term average water fraction increases ranging from 16.5% to 18.8% for the alternatives relative to existing conditions. All other source waters would decrease, but the greatest decreases would be in San Joaquin River inputs in March and May (i.e., 7.4% to 10.8% decrease) relative to existing conditions (Appendix 9B). Based on the lower concentrations of nutrients in the Sacramento River, relative to the San Joaquin River and other source waters, there could be small decreases in nutrient concentrations during some months of the year at Banks Pumping Plant relative to existing conditions. For example, when the greatest increase in Sacramento River water fractions would occur (i.e., 18.8%) in March under

Alternatives 1 and 3, total phosphorus would decrease by 28.7 µg/L and total nitrogen would decrease by 0.26 mg/L.

Although the project alternatives would create differences in the proportion of source water fractions at various Delta locations, for the reasons described above there would be no substantial differences in nutrient distributions from these changes in source water inputs relative to existing conditions. At Banks Pumping Plant there would be small decreases in nutrient concentrations during November through June because fractions of Sacramento River water were modeled to increase substantially while other source waters that have higher concentrations of nutrients were modeled to decrease. There would also be some small decrease in nutrient concentrations during some months at Jones Pumping Plant when Sacramento River waters were modeled to increase. Nevertheless, under the project alternatives total phosphorus and total nitrogen would be present in excess (i.e., non-limiting amounts for aquatic plant and algae growth) throughout the Delta, as they are under existing conditions.

In summary, the project alternatives would not cause exceedances of any state or federal objectives/criteria for nutrients because there are none. Algal and macrophyte growth rates are not phosphorus- or nitrogen-limited in the Delta because these nutrients are available in excess. Thus, potential minor increases or decreases in these nutrient concentrations that may occur at some locations and times within the Delta would have negligible, if any, effects on macrophyte and algae growth in the Delta. Hence, any potential small changes in nutrient concentrations would be of magnitude that would not adversely affect any beneficial uses or substantially degrade Delta water quality with regard to nutrients.

Suisun Marsh, Suisun Bay, San Francisco Bay, and SWP/CVP Export Service Areas

The project alternatives would not result in substantial increases in nutrient concentrations in Delta waters, including Delta outflows. As such, the project alternatives would not cause any substantial changes in nutrient concentrations in Suisun Marsh, Suisun Bay, San Francisco Bay, or SWP/CVP export service area waterbodies relative to existing conditions. The project alternatives would not substantially increase the frequency with which applicable water quality criteria or objectives for phosphorus or nitrogen levels would be exceeded in Suisun Marsh, Suisun Bay, San Francisco Bay, or SWP/CVP export service area waterbodies because there are none, nor would the alternatives substantially degrade the quality of these waterbodies, with regard to nutrients.

CEQA Conclusion—All Project Alternatives

Based on the above analysis, the project alternatives would not cause substantial long-term changes in nutrient concentrations in study area waterbodies relative to existing conditions. As such, the project alternatives would not cause additional exceedance of applicable nutrient water quality criteria/objectives by frequency, magnitude, and geographic extent that would result in adverse effects on any beneficial uses of study area waterbodies. Because nutrient concentrations are not expected to change substantially, the project alternatives would not cause long-term degradation from nutrients that would result in substantially increased risk for adverse effects on any beneficial uses. Any minor increases in nutrient levels that could occur in the Delta due to changes in source water fractions at specific locations would not cause greater aquatic plant or algae growth in the Delta because nutrients are not present at levels that limit such growth under existing conditions. Hence, small increases would be expected to have no effect on aquatic plant and algae growth in the Delta. Nutrients are not bioaccumulative, thus any nutrient increases would not result in bioaccumulation in aquatic organisms. Because there are no CWA Section 303(d) listings for nutrients for study area waterbodies, any minor changes in nutrient levels that may occur in some areas under the project alternatives would not make any associated beneficial use impairment discernibly worse. Therefore, impacts of the project alternatives on nutrients would be less than significant**.**

Mitigation Impacts

Compensatory Mitigation

Although the CMP described in Appendix 3F does not act as mitigation for impacts on water quality from project construction or operations, its implementation could result in impacts on water quality.

Some CMP activities would occur on land within the Delta that was formerly used for agriculture. Reducing agricultural lands would decrease the use of fertilizers further reducing nutrient inputs. Any newly created wetlands or enhanced habitat would filter stormwater to remove nutrients and either improve (i.e., decrease) or have little to no effect on nutrient concentrations relative to existing conditions. The creation of additional aquatic plant life could have minor impacts on nutrient dynamics and speciation. For example, water column concentrations of total phosphorus and nitrogen may increase or decrease in localized areas as a result of increased or decreased suspended solids while dissolved nutrient concentrations may be locally changed as result of plant decay or nutrient sequestration. Overall, nutrient concentrations are not expected to change substantially relative to existing conditions.

Consequently, the CMP would not result in substantially higher nutrient concentrations in study area waterbodies relative to existing conditions. As such, the CMP would not cause additional exceedance of applicable nutrient water quality criteria/objectives by frequency, magnitude, and geographic extent that would result in adverse effects on any beneficial uses of any study area waterbodies. Because nutrient concentrations are not expected to increase substantially, the CMP would not cause long-term degradation of nutrients in study area waterbodies that would result in substantially increased risk for adverse effects on any beneficial uses. Because there are no CWA Section 303(d) listings for nutrients in the study area, the CMP would not make any associated beneficial use impairment discernably worse. Nutrients are not bioaccumulative; therefore, the CMP would not result in bioaccumulation of nutrients in aquatic organisms. Based on these findings, impacts from the CMP on nutrients would be less than significant.

Other Mitigation Measures

Most of the other mitigation measures would be static once constructed and as described for Impact WQ-2 would have limited likelihood of producing substantial runoff, including nutrient laden runoff. A few mitigation measures would have an operational component, such as the wells, pipelines, and drainage systems potentially associated with Mitigation Measure AG-3: *Replacement or Relocation of Affected Infrastructure Supporting Agricultural Properties*; mosquito management associated with Mitigation Measure PH-1b: *Develop and Implement a Mosquito Management Plan for Compensatory Mitigation Sites on Bouldin Island and at I-5 Ponds*; and tidal wetland inundation projects on Sherman and Twitchell Islands associated with Mitigation Measure AQ-9: *Develop and Implement a GHG Reduction Plan to Reduce GHG Emissions from Construction and Net CVP Operational Pumping to Net Zero*. The tidal inundation projects, which are only one optional component of Mitigation Measure AQ-9, could cause variations in nutrient concentrations similar to what is described above for the CMP. Vegetation removal that may be one of the measures implemented for mosquito control for Mitigation Measure PH-1b could cause small reductions in nutrients in the wetlands on Bouldin Island and the I-5 ponds, which would not be connected to other Delta waters.

Because operation of other mitigation measures would have minimal effect on nutrients, the other mitigation measures would not cause additional exceedance of applicable nutrient water quality criteria/objectives by frequency, magnitude, and geographic extent that would result in adverse effects on any beneficial uses of any study area waterbodies. Because nutrient concentrations are not expected to increase substantially, the other mitigation measures would not cause long-term degradation of nutrients in study area waterbodies that would result in substantially increased risk for adverse effects on any beneficial uses. Because there are no CWA Section 303(d) listings for nutrients in the study area, the other mitigation measures would not make any associated beneficial use impairment discernably worse. Nutrients are not bioaccumulative; therefore, the other mitigation measures would not result in bioaccumulation of nutrients in aquatic organisms. As a result, impacts from other mitigation measures on nutrients would be less than significant.

Overall, the minimal effect on nutrient concentrations from the CMP and other mitigation measures, combined with project alternatives, would not change the impact conclusion of less than significant.

Impact WQ-8: Effects on Organic Carbon Resulting from Facility Operations and Maintenance

Maintenance of project alternatives' facilities would not create new sources of DOC or contribute toward a substantial change in existing sources of DOC in the Delta. As such, maintenance activities would not cause any substantial change in DOC in study area waterbodies that would adversely affect beneficial uses anywhere in the Delta.

All project alternatives (i.e., Alternatives 1, 2a, 2b, 2c, 3, 4a, 4b, 4c, and 5) described in Chapter 3 would have similar impact levels and are discussed together.

All Project Alternatives

Delta

DSM2 modeling of organic carbon is DOC. Thus, the discussion below addresses changes in DOC with the project alternatives relative to existing conditions.

Under the project alternatives, monthly average DOC concentrations at Delta assessment locations would change minimally relative to existing conditions for the full simulation period. The modeled monthly average concentrations of DOC in Barker Slough at the North Bay Aqueduct, Sacramento River at Emmaton, San Joaquin River at Antioch, Sacramento River at Mallard Island, and South Fork Mokelumne River at Terminous for the full simulation period under the project alternatives are the same as under existing conditions (Appendix 9I, Tables 9I-1-1-1 through 9I-6-6-4). The project alternatives could result in slight changes in full simulation period monthly average DOC concentrations at San Joaquin River at Empire Tract (increases up to 0.1 mg/L), Contra Costa Pumping Plant #1 (increases up to 0.1 mg/L), Old River at SR4 (increases up to 0.1 mg/L), and Victoria Canal (increases up to 0.1 mg/L) (Appendix 9I, Tables 9I-7-1-1 through 9I-9-6-4). At Banks Pumping Plant, modeled monthly average DOC concentrations are the same as those under existing conditions or up to 0.8 mg/L lower, depending on the month (Appendix 9I, Tables 9I-10-1-1 through 9I-10-6-4). At Jones Pumping Plant, modeled monthly average DOC concentrations are the same as existing conditions or 0.1 mg/L lower, depending on the month (Appendix 9I, Tables 9I-11-1-1 through 9I-11-6-4). During the drought years assessed, the project alternatives would result in similar small changes in monthly average DOC concentrations at the Delta assessment locations (Appendix 9I, Tables 9I-1-1-1 through 9I-11-6-4).

The Stage 1 Disinfectants and Disinfection Byproduct Rule adopted by EPA in 1998, as part of the Safe Drinking Water Act, requires drinking water utilities to reduce total organic carbon concentrations by specified percentages prior to disinfection. EPA's action thresholds related to total organic carbon begin at 2 to 4 mg/L and, depending on source water alkalinity, may require a drinking water utility to employ treatment to achieve as much as a 35% reduction in total organic carbon. These requirements were adopted because organic carbon can react with disinfectants during the water treatment disinfection process to form disinfection byproducts, such as trihalomethane compounds, which pose potential lifetime carcinogenic risks to humans. A California Urban Water Agencies expert panel convened to review Delta water quality and disinfection formation potential found that total organic carbon concentrations ranging from 4 to 7 mg/L would allow continued flexibility in treatment technology necessary to achieve existing drinking water criteria for disinfection byproducts (California Urban Water Agencies 1998:ES-2). There are no numeric water quality criteria for DOC for the Delta (Appendix 9I, Section 9I.3, *Applicable Water Quality Criteria/Objectives*).

Drinking water treatment plants that utilize Delta source waters are currently designed and operated to meet EPA's 1998 requirements based on the ambient concentrations or organic carbon and seasonal variability that currently exists in the Delta. Substantial increases in ambient DOC concentrations would need to occur with substantial frequency for significant changes in plant design or operations to be triggered. The increases in long-term average DOC concentrations that would occur with the project alternatives would be of sufficiently small magnitude that modifications to existing drinking water treatment plants to employ additional DOC removals would not be necessary. Likewise, any increases in maximum DOC concentrations at the Delta locations assessed for the project alternatives relative to existing conditions would not be of sufficient magnitude and frequency for existing drinking water treatment plants to employ additional DOC removal actions which, themselves, could cause environmental impacts.

Based upon the above findings, the project alternatives would not result in increased Delta DOC concentrations that would substantially degrade water quality or cause increased frequency of exceeding water quality objectives (because none exist) relative to existing conditions.

Suisun Marsh, Suisun Bay, and San Francisco Bay

The project alternatives would not result in substantial changes in organic carbon concentrations in Delta waters or in Delta outflows. As such, there would not be a substantial change in organic carbon concentrations in Suisun Marsh, Suisun Bay, and San Francisco Bay under all project alternatives relative to existing conditions. Therefore, the project alternatives would not substantially degrade the quality of these waterbodies with regard to organic carbon, nor would the project alternatives cause increased exceedance of applicable DOC objectives or criteria in these waterbodies because none currently exist.

SWP/CVP Export Service Areas

As discussed above, there would be no changes in long-term monthly average DOC concentrations in Barker Slough at the North Bay Aqueduct for the full simulation period. Long-term monthly average DOC concentrations at Banks and Jones Pumping Plants would be similar to or lower than those for existing conditions, depending on month. Therefore, the project alternatives would not result in increased DOC concentrations in waters exported into the SWP/CVP export service areas. The project alternatives, therefore, would not substantially degrade SWP/CVP export service area water quality with regard to DOC or cause increased frequency of exceeding water quality objectives (because none exist) relative to existing conditions.

CEQA Conclusion—All Project Alternatives

The project alternatives would not cause additional exceedance of applicable organic carbon water quality criteria/objectives because none exist for study area waterbodies. Based on the above analysis, the project alternatives would not cause substantial long-term increases in DOC concentrations in study area waterbodies relative to existing conditions. Because DOC concentrations are not expected to change substantially, the project alternatives would not cause long-term degradation of organic carbon in study area waterbodies that would result in substantially increased risk for adverse effects on any beneficial uses. Any minor increases in DOC concentrations that could occur in the Delta would not cause additional treatment operations or facilities for drinking water treatment plants that utilize Delta waters in order to comply with drinking water regulations. Organic carbon is not bioaccumulative, thus any organic carbon increases would not result in bioaccumulation in aquatic organisms. Because there are no CWA Section 303(d) listings for organic carbon in the study area, any organic carbon increases under the project alternatives would not make any associated beneficial use impairment discernibly worse. Therefore, impacts of the project alternatives on organic carbon would be less than significant**.**

Mitigation Impacts

Compensatory Mitigation

Although the CMP described in Appendix 3F does not act as mitigation for impacts on water quality from project construction or operations, its implementation could result in impacts on water quality.

The contributions of organic carbon to the Delta from all sources is highly variable, with rivers contributing the most (50%–90%) and wetlands contributing the least (5%–30%) (CALFED Bay-Delta Program 2008:60). Under existing conditions, the three primary sources of organic carbon generated within the Delta are primary production within the water column, export from agricultural sources, and export from Delta wetlands (Tetra Tech, Inc. 2006:5-13). Regardless of the habitat type where organic carbon is generated, once organic carbon enters an aquatic system it undergoes multiple transformations, degrades through photolytic exposure, and/or become diluted as it moves through Delta waters. Bacteria convert organic carbon to bacterial biomass or metabolize DOC to carbon dioxide, which leaves the aquatic system and represents a significant loss of DOC from aquatic systems (Tetra Tech, Inc. 2006:2-3).

The conversion of lands from agriculture to tidal wetlands and other natural habitats could result in no net change, a decrease, or increase in organic carbon loading to the Delta in the vicinity of restoration sites. Many factors affect the potential for wetlands to form carbon that is reactive and forms disinfection byproducts, including soil type, amount and type of vegetation, method of construction, and age of wetland. To ensure that the new tidal wetlands do not generate additional organic carbon that could affect municipal water supplies utilizing the Delta for source waters, relative to that generated under existing conditions, the siting of tidal wetlands would take into consideration location of nearby drinking water supply intakes. DOC is a concern in drainage water from oxidizing peat soils (Fleck et al. 2007:3). However, likely new tidal wetland sites with suitable elevations would have more mineral-based soils, either due to natural geography (Cache Slough and lower Yolo Bypass areas) or design (e.g., build up elevations with reusable tunnel material or dredge spoil). Also, the hydrologic regime that would occur in the new tidal wetlands would create a consistently anoxic environment in the soils, which would minimize conditions that could foster oxidation of soil organic carbon (Fleck et al. 2007:4, 21).

Consequently, the CMP would not result in substantially higher organic carbon concentrations in study area waterbodies relative to existing conditions that would adversely affect beneficial uses, including municipal drinking water supply uses. The CMP would not cause additional exceedance of applicable organic carbon water quality criteria/objectives because none exist for study area waterbodies. Furthermore, the CMP would not cause long-term degradation of organic carbon in study area waterbodies that would result in substantially increased risk for adverse effects on any beneficial uses. Organic carbon is not a bioaccumulative constituent; therefore, the CMP would not result in organic carbon bioaccumulation in aquatic organisms. Because there are no CWA Section 303(d) listings for organic carbon in the study area, the CMP would not make any associated beneficial use impairment discernably worse. Based on these findings, impacts from the CMP on organic carbon would be less than significant.

Other Mitigation Measures

Most of the other mitigation measures would be static once constructed, and as described for Impact WQ-2, would have limited likelihood of producing substantial runoff, including runoff with high organic content. A few mitigation measures would have an operational component, such as the mosquito management associated with Mitigation Measure PH-1b: *Develop and Implement a Mosquito Management Plan for Compensatory Mitigation Sites on Bouldin Island and at I-5 Ponds* and tidal wetland inundation projects on Sherman and Twitchell Islands associated with Mitigation Measure AQ-9: *Develop and Implement a GHG Reduction Plan to Reduce GHG Emissions from Construction and Net CVP Operational Pumping to Net Zero*. The tidal inundation projects, which are only one optional component of Mitigation Measure AQ-9, would cause increases in organic carbon concentrations similar to what is described above for the CMP. Vegetation removal that may be one of the measures implemented for mosquito control for Mitigation Measure PH-1b could cause small reductions in organic carbon in wetlands on Bouldin Island and the I-5 ponds, which would not be connected to other Delta waters.

Operation of other mitigation measures would not cause additional exceedance of applicable organic carbon water quality criteria/objectives because none exist for study area waterbodies. Because other mitigation measures would not contribute substantial amounts of organic carbon in runoff, the other mitigation measures would not cause long-term degradation of organic carbon in study area waterbodies that would result in substantially increased risk for adverse effects on any beneficial uses. Organic carbon is not a bioaccumulative constituent; therefore, the other mitigation measures would not result in organic carbon bioaccumulation in aquatic organisms. Because there are no CWA Section 303(d) listings for organic carbon in the study area, the other mitigation measures would not make any associated organic carbon beneficial use impairment discernably worse. As a result, impacts from other mitigation measures on organic carbon would be less than significant.

Overall, the minimal effect on organic carbon concentrations from the CMP and other mitigation measures, combined with project alternatives, would not change the impact conclusion of less than significant.

Impact WQ-9: Effects on Dissolved Oxygen Resulting from Facility Operations and Maintenance

Maintenance of project alternatives' facilities would not affect factors that contribute to low dissolved oxygen conditions in the Delta. As such, maintenance activities would not cause any substantial change in dissolved oxygen concentrations or concentrations of oxygen-consuming substances in study area waterbodies that would adversely affect beneficial uses anywhere in the Delta. All project alternatives (i.e., Alternatives 1, 2a, 2b, 2c, 3, 4a, 4b, 4c, and 5) described in Chapter 3 would have similar impact levels and are discussed together.

All Project Alternatives

Delta

Dissolved oxygen concentrations in Delta waters are primarily affected by water temperature, which affects oxygen solubility, channel velocities, which affect turbulence and reaeration, macrophyte and algae photosynthetic activity, and amounts of oxygen-demanding substances present (e.g., organic matter in the water column and sediment).

The potential for differences in these factors to occur under the project alternatives relative to existing conditions are addressed below.

- *Temperature*: Atmospheric exchange processes primarily drive Delta temperature on both short and long timescales (Kimmerer 2004:19; Wagner et al. 2011:12; Vroom et al. 2017:9919–9920). Temperature modeling results show that the project alternatives would have little effect on Delta water temperatures relative to existing conditions. The greatest temperature increases (0.5°F increase) would occur in the Sacramento River at Freeport and Sacramento River at I street Bridge in November under Alternatives 2a, 2b, 2c, 4a, 4b, 4c, and 5. The greatest decrease (0.8°F decrease) would occur in the Sacramento River at I Street Bridge in June and July under Alternatives 2a, 2b, 2c, 4a, 4b, 4c, and 5 (Appendix 9E, *Cyanobacteria Harmful Algal Blooms*, Figures 9E-1-1-1 through 9E-1-11-6). Thus, differences in Delta inflows that would occur under the project alternatives relative to existing conditions would not result in water temperature differences what would lead to lower dissolved oxygen concentrations.
- *Channel Velocities*: The relative degree of tidal exchange, flows, and turbulence that contributes to exposure of Delta waters to the atmosphere for reaeration under the project alternatives would not be substantially different from existing conditions. The waterbodies would continue to experience the daily ebb and flood tides that contribute to water movement within the channels, which contributes to the water column's reaeration.
- *Oxygen-Demanding Substances*: Nutrients can affect dissolved oxygen by promoting aquatic plants biostimulation. However, as described in Impact WQ-7: *Effects on Nutrients Resulting from Facility Operations and Maintenance*, the project alternatives would not result in substantial changes in nutrient concentrations within Delta waters relative to existing conditions that would encourage additional biostimulation of algae or aquatic plants. Also, the differences in Delta inflows that would occur with the project alternatives relative to existing

conditions would not result in higher concentrations of organic material in the Delta sediments that would lead to higher oxygen demand.

The State Water Board's CWA Section 303(d) list identifies some waterways in the eastern, southern, and western Delta as impaired by low oxygen concentrations (Section 9.1.4, *Water Quality Impairments*). A TMDL has been approved for the Stockton Deep Water Ship Channel in the eastern Delta to control the discharge of oxygen-demanding substances, and aerators operated by the Port of Stockton improved dissolved oxygen conditions within the channel. The project alternatives would not result in changes in San Joaquin River inflows relative to existing conditions that would make these impairments discernably worse (Appendix 5A).

Suisun Marsh

Notable low dissolved oxygen conditions occur in Suisun Marsh sloughs, and are attributed to aquatic plant material and detritus decomposition. Operations and discharges from managed wetlands within the Marsh show a strong effect on dissolved oxygen within the Marsh sloughs (San Francisco Bay Regional Water Quality Control Board 2018:69). The San Francisco Bay RWQCB adopted a TMDL to address low dissolved oxygen in the Marsh, which aims to address low dissolved oxygen/organic enrichment and evaluate the degree to which nutrients may contribute to dissolved oxygen deficit. The implementation plan is projected to attain the water quality standard within twenty years.

As described above, the project alternatives would not cause substantial changes in Delta dissolved oxygen concentrations, or concentrations of oxygen-consuming substances. Furthermore, the project alternatives would not affect factors that contribute to low dissolved oxygen conditions in Suisun Marsh.

Suisun Bay and San Francisco Bay

The project alternatives would not result in substantial decreases in dissolved oxygen concentrations in Delta waters or in Delta outflows, or increases in oxygen-demanding substances in Delta outflow. As such, there would not be a substantial change in dissolved oxygen concentrations in Suisun Bay and San Francisco Bay for all project alternatives relative to existing conditions. Furthermore, the project alternatives would not substantially increase the frequency with which applicable water quality criteria or objectives would be exceeded in Suisun Bay and San Francisco Bay or substantially degrade the quality of these waterbodies with regard to dissolved oxygen.

SWP/CVP Export Service Areas

A key factor that would affect dissolved oxygen in the conveyance channels and ultimately the receiving reservoirs in the SWP/CVP export service areas would be changes in the concentrations of dissolved oxygen and oxygen-demanding substances in the exported water. For reasons provided above, exported Delta waters for all project alternatives would not contain substantially higher oxygen-demanding substances or have lower dissolved oxygen concentrations compared to existing conditions. Because the oxygen demand and dissolved oxygen concentrations in the exported water would not substantially differ from existing conditions, turbulence and exposure of the water to the atmosphere and the algal communities that exist within the canals would continue to establish equilibrium for dissolved oxygen concentrations within the canals. The same would occur in export service area reservoirs. Consequently, the project alternatives would have negligible, if any, effects on dissolved oxygen levels in SWP/CVP export service area canals and reservoirs relative to existing conditions.

CEQA Conclusion—All Project Alternatives

Based on the above analysis, the project alternatives would not cause substantial decreases in dissolved oxygen concentrations in study area waterbodies relative to existing conditions. As such, the project alternatives would not cause additional exceedance of applicable dissolved oxygen water quality objectives/criteria by frequency, magnitude, and geographic extent that would result in adverse effects on any beneficial uses of study area waterbodies. Because dissolved oxygen concentrations are not expected to decrease substantially, the project alternatives would not cause long-term degradation of dissolved oxygen in study area waterbodies that would result in substantially increased risk for adverse effects on any beneficial uses. Furthermore, the above described changes in dissolved oxygen concentrations would not further degrade water quality by measurable levels on a long-term basis in any study area waterbody on the State's CWA Section 303(d) list such that beneficial use impairment would be made discernibly worse. Dissolved oxygen is not a constituent of concern for bioaccumulation, thus any dissolved oxygen changes would not directly cause adverse bioaccumulative effects in aquatic organisms. Therefore, the impact of the project alternatives on dissolved oxygen would be less than significant**.**

Mitigation Impacts

Compensatory Mitigation

Although the CMP described in Appendix 3F does not act as mitigation for impacts on water quality from project construction or operations, its implementation could result in impacts on water quality.

Any newly created wetlands and enhanced habitat would filter stormwater to remove solids that can contribute oxygen-demanding substances to waterbodies. Through filtration and removal of solids in runoff to adjacent waterbodies, the newly created wetland and enhanced habitat would either improve or have little to no effect on dissolved oxygen concentrations relative to existing conditions. Therefore, the CMP would not result in substantially lower dissolved oxygen concentrations in study area waterbodies relative to existing conditions. As such, the CMP would not cause additional exceedance of applicable dissolved oxygen water quality criteria/objectives by frequency, magnitude, and geographic extent that would result in adverse effects on any beneficial uses of any study area waterbodies. Because dissolved oxygen concentrations are not expected to change substantially, the CMP would not cause long-term degradation of dissolved oxygen in study area waterbodies that would result in substantially increased risk for adverse effects on any beneficial uses. Furthermore, the CMP would not further degrade dissolved oxygen by measurable levels on a long-term basis in any study area waterbody on the State's CWA Section 303(d) list such that beneficial use impairment would be made discernibly worse. Dissolved oxygen is not a bioaccumulative constituent; therefore, the CMP would not result in bioaccumulation of dissolved oxygen in aquatic organisms. Based on these findings, impacts from the CMP on dissolved oxygen would be less than significant.

Other Mitigation Measures

Most of the other mitigation measures would be static once constructed, and as described for impact WQ-2, would have limited likelihood of producing substantial runoff, including runoff with high oxygen demand. A few mitigation measures would have an operational component, such as the mosquito management associated with Mitigation Measure PH-1b: *Develop and Implement a Mosquito Management Plan for Compensatory Mitigation Sites on Bouldin Island and at I-5 Ponds* and tidal wetland inundation projects on Sherman and Twitchell Islands associated with Mitigation Measure AQ-9: *Develop and Implement a GHG Reduction Plan to Reduce GHG Emissions from Construction and Net CVP Operational Pumping to Net Zero*. The tidal inundation projects, which are only one optional component of Mitigation Measure AQ-9, would cause effects on dissolved oxygen concentrations similar to what is described above for the CMP. Vegetation removal that may be one of the measures implemented for mosquito control for Mitigation Measure PH-1b could cause small changes in the presence of oxygen-demanding substances in wetlands on Bouldin Island and the I-5 ponds, which would not be connected to other Delta waters.

Because operation of other mitigation measures would have minimal effect on dissolved oxygen, the other mitigation measures would not cause additional exceedance of applicable dissolved oxygen water quality criteria/objectives by frequency, magnitude, and geographic extent that would result in adverse effects on any beneficial uses of any study area waterbodies. Moreover, because dissolved oxygen concentrations are not expected to change substantially, the other mitigation measures would not cause long-term degradation of dissolved oxygen in study area waterbodies that would result in substantially increased risk for adverse effects on any beneficial uses. Furthermore, the other mitigation measures would not further degrade dissolved oxygen by measurable levels on a long-term basis in any study area waterbody on the State's CWA Section 303(d) list such that beneficial use impairment would be made discernibly worse. Dissolved oxygen is not a bioaccumulative constituent; therefore, the other mitigation measures would not result in bioaccumulation of dissolved oxygen in aquatic organisms. As a result, impacts from other mitigation measures on dissolved oxygen would be less than significant.

Overall, the minimal effect on dissolved oxygen concentrations from the CMP and other mitigation measures, combined with project alternatives, would not change the impact conclusion of less than significant.

Impact WQ-10: Effects on Selenium Resulting from Facility Operations and Maintenance

Maintenance of project alternatives' facilities would not create new sources of selenium or contribute toward a substantial change in existing sources of selenium in the Delta. As such, maintenance activities would not cause any substantial change in selenium in study area waterbodies that would adversely affect beneficial uses anywhere in the Delta.

The following assessment of the effects on selenium from facility operations addresses selenium concentrations in the water column, in bird eggs, and in the tissues of piscivorous fish and sturgeon.

All project alternatives (i.e., Alternatives 1, 2a, 2b, 2c, 3, 4a, 4b, 4c, and 5) described in Chapter 3 would have similar impact levels and are discussed together.

All Project Alternatives

Delta

Water Column Concentrations

Average water column concentrations of selenium for the full simulation period under the project alternatives would differ negligibly from existing conditions at the Delta assessment locations.

Modeled average selenium concentrations in surface water range from 0.08 µg/L to 0.21 µg/L among all Delta assessment locations under both existing conditions and the project alternatives (Table 9-38; Appendix 9J, *Selenium*, Tables 9J-12 through 9J-17-2). Thus, average selenium concentrations under the project alternatives would be well below the 5 µg/L freshwater chronic CTR criterion (60 FR 2228 [May 4, 1995]; 65 FR 3162 [May 18, 2000]; 66 FR 9960 [February 13, 2001]) at all Delta locations and water year types. Likewise, modeled selenium water column concentrations in the Sacramento River at Mallard Island, where the North Bay Selenium TMDL applies (San Francisco Bay Regional Water Quality Control Board 2019:7-53), are lower than the 0.5 µg/L target for existing conditions and the project alternatives, for all water year types. Based on the sources of selenium to Delta waters and Delta hydrodynamics, selenium concentrations are not expected to vary widely on shorter (e.g., daily) time steps. Nevertheless, even if four-day average selenium concentrations were as much as ten times higher than the long-term averages reported above, they would still be well below the 5 µg/L freshwater chronic CTR criterion at all Delta locations. Modeled average selenium concentrations for the full simulation period under the project alternatives relative to existing conditions do not increase at any location and decrease up to 0.01 µg/L at Banks Pumping Plant (Table 9-38; Appendix 9J, Tables 9J-12 through 9J-17-2).

Table 9-38. Selenium Concentrations in Water (in micrograms per liter), Average for the Full Simulation Period (Water Years 1923–2015)

Assessment Location	Existing Conditions	Alternatives 1 and 3	Alternatives 2a and 4a	Alternatives 2b and 4b	Alternatives 2c and 4c	Alternative 5
Barker Slough at North Bay Aqueduct	0.09	0.09	0.09	0.09	0.09	0.09
Sacramento River at Emmaton	0.09	0.09	0.09	0.09	0.09	0.09
San Joaquin River at Antioch	0.10	0.10	0.10	0.10	0.10	0.10
Sacramento River at Mallard Island	0.10	0.10	0.10	0.10	0.10	0.10
South Fork Mokelumne River at Terminous	0.08	0.08	0.08	0.08	0.08	0.08
San Joaquin River at Empire Tract	0.13	0.13	0.13	0.13	0.13	0.13
Contra Costa Water District Pumping Plant #1	0.11	0.11	0.11	0.11	0.11	0.11
Old River at State Route 4	0.12	0.12	0.12	0.12	0.12	0.12
Victoria Canal	0.15	0.15	0.15	0.15	0.15	0.15
Banks Pumping Plant	0.14	0.13	0.13	0.13	0.13	0.13
Jones Pumping Plant	0.21	0.21	0.20	0.21	0.21	0.21

Whole-Body Fish Concentrations

Negligible changes in water column concentrations of selenium under the project alternatives would not have a measurable effect on tissue concentrations of whole piscivorous fish, such as largemouth bass, in the Delta relative to existing conditions. Modeled average selenium concentrations in whole fish tissue for the full simulation period range from 1.81 mg/kg dry weight to 1.82 mg/kg dry weight among all Delta assessment locations under existing conditions and all project alternatives (Table 9-39; Appendix 9J). Thus, modeled whole-body fish tissue selenium concentrations under the project alternatives do not exceed the lowest whole-body tissue benchmark of 4 mg/kg dry weight from Beckon (2017:133) at any Delta location for any water year type. Moreover, modeled whole-body fish tissue selenium concentrations for the project alternatives do not exceed the U.S. Environmental Protection Agency (2016:xv; 2018:xi) water quality criterion of 8.5 mg/kg dry weight for fish tissue at any Delta location for water year type. Modeled whole-body fish tissue selenium concentrations do not change by more than 0.01 mg/kg dry weight as averages over the full simulation period and in all water year-types at all Delta assessment locations under the project alternatives relative to existing conditions (Table 9-39; Appendix 9J).

Table 9-39. Selenium Concentrations in Whole-Body Fish (in milligrams per kilogram, dry weight), Average for the Full Simulation Period (Water Years 1923–2015)

Assessment Location	Existing Conditions	Alternatives 1 and 3	Alternatives 2a and 4a	Alternatives 2b and 4b	Alternatives 2c and 4c	Alternative 5
Barker Slough at North Bay Aqueduct	1.82	1.82	1.82	1.82	1.82	1.82
Sacramento River at Emmaton	1.82	1.82	1.82	1.82	1.82	1.82
San Joaquin River at Antioch	1.82	1.82	1.82	1.82	1.82	1.82
Sacramento River at Mallard Island	1.82	1.82	1.82	1.82	1.82	1.82
South Fork Mokelumne River at Terminous	1.82	1.82	1.82	1.82	1.82	1.82
San Joaquin River at Empire Tract	1.81	1.81	1.81	1.81	1.81	1.81
Contra Costa Water District Pumping Plant #1	1.82	1.82	1.82	1.82	1.82	1.82
Old River at State Route 4	1.82	1.82	1.82	1.82	1.82	1.82
Victoria Canal	1.81	1.81	1.81	1.81	1.81	1.81
Banks Pumping Plant	1.81	1.81	1.81	1.81	1.81	1.81
Jones Pumping Plant	1.81	1.81	1.81	1.81	1.81	1.81

Bird Egg Concentrations

Similarly, selenium concentrations in bird eggs under the project alternatives would differ negligibly from existing conditions. Modeled average selenium concentrations in the eggs of birds consuming invertebrates for the full simulation period range from 2.69 mg/kg dry weight to 2.71 mg/kg dry weight among all Delta assessment locations under existing conditions and all project alternatives (Table 9-40; Appendix 9J). For birds consuming fish, modeled average selenium concentrations in eggs range from 3.26 mg/kg dry weight to 3.28 mg/kg dry weight among all Delta assessment locations under existing conditions and all project alternatives (Table 9-41; Appendix 9J). Thus, modeled bird egg selenium concentrations under the project alternatives do not exceed the lowest

Level of Concern benchmark of 6 mg/kg dry weight from Beckon (2017:133) at any Delta location for any water year type. Modeled selenium concentrations in the eggs of birds consuming either invertebrates or fish do not change by more than 0.02 mg/kg dry weight as averages over the full simulation period and for all water year-types at all Delta assessment locations under the project alternatives relative to existing conditions (Tables 9-40 and 9-41; Appendix 9J).

Table 9-40. Selenium Concentrations in Bird Eggs, Invertebrate Diet (in milligrams per kilogram dry weight), Average for the Full Simulation Period (Water Years 1923–2015)

Assessment Location	Existing Conditions	Alternatives 1 and 3	Alternatives 2a and 4a	Alternatives 2b and 4b	Alternatives 2c and 4c	Alternative 5
Barker Slough at North Bay Aqueduct	2.71	2.71	2.71	2.71	2.71	2.71
Sacramento River at Emmaton	2.71	2.71	2.71	2.71	2.71	2.71
San Joaquin River at Antioch	2.71	2.71	2.71	2.71	2.71	2.71
Sacramento River at Mallard Island	2.71	2.71	2.71	2.71	2.71	2.71
South Fork Mokelumne River at Terminous	2.71	2.71	2.71	2.71	2.71	2.71
San Joaquin River at Empire Tract	2.70	2.70	2.70	2.70	2.70	2.70
Contra Costa Water District Pumping Plant #1	2.71	2.70	2.70	2.70	2.70	2.70
Old River at State Route 4	2.70	2.70	2.70	2.70	2.70	2.70
Victoria Canal	2.70	2.70	2.70	2.70	2.70	2.70
Banks Pumping Plant	2.70	2.70	2.70	2.70	2.70	2.70
Jones Pumping Plant	2.69	2.69	2.69	2.69	2.69	2.69

Table 9-41. Selenium Concentrations in Bird Eggs, Fish Diet (in milligrams per kilogram dry weight), Average for the Full Simulation Period (Water Years 1923–2015)

Assessment Location	Existing Conditions	Alternatives 1 and 3	Alternatives 2a and 4a	Alternatives 2b and 4b	Alternatives 2c and 4c	Alternative 5
Barker Slough at North Bay Aqueduct	3.28	3.28	3.28	3.28	3.28	3.28
Sacramento River at Emmaton	3.28	3.28	3.28	3.28	3.28	3.28
San Joaquin River at Antioch	3.28	3.28	3.28	3.28	3.28	3.28
Sacramento River at Mallard Island	3.28	3.28	3.28	3.28	3.28	3.28
South Fork Mokelumne River at Terminous	3.28	3.28	3.28	3.28	3.28	3.28

Assessment Location	Existing Conditions	Alternatives 1 and 3	Alternatives 2a and 4a	Alternatives 2b and 4b	Alternatives 2c and 4c	Alternative 5
San Joaquin River at Empire Tract	3.26	3.26	3.26	3.26	3.26	3.26
Contra Costa Water District Pumping Plant #1	3.28	3.28	3.28	3.28	3.28	3.28
Old River at State Route 4	3.28	3.28	3.28	3.28	3.28	3.28
Victoria Canal	3.26	3.26	3.26	3.26	3.26	3.26
Banks Pumping Plant	3.26	3.26	3.26	3.26	3.26	3.26
Jones Pumping Plant	3.26	3.26	3.26	3.26	3.26	3.26

Fish Fillet Concentrations

Modeled average selenium concentrations in fillets of piscivorous fish, such as largemouth bass, for the full simulation period were calculated based on wet weight and on dry weight for comparison with relevant benchmarks and objectives.

Modeled average selenium concentrations on a wet weight basis range from 0.60 mg/kg to 0.61 mg/kg among all Delta assessment locations under existing conditions and all project alternatives (Table 9-42; Appendix 9J). These modeled fish fillet selenium concentrations do not exceed the Office of Environmental Health Hazard Assessment (2017:61) Advisory Tissue Level of 2.5 mg/kg wet weight at any Delta location or water year type. Modeled fish fillets selenium concentrations do not change by more than 0.01 mg/kg wet weight as averages over the full simulation period and in each water year-type at all Delta assessment locations under the project alternatives relative to existing conditions (Table 9-42; Appendix 9J).

Modeled average selenium concentrations in fillets on a dry weight basis range from 2.00 mg/kg to 2.02 mg/kg among all Delta assessment locations under existing conditions and all project alternatives (Table 9-43; Appendix 9J). These modeled fish fillet selenium concentrations do not exceed the U.S. Environmental Protection Agency (2016:xv; 2018:xi) criterion or North Bay TMDL Target of 11.3 mg/kg dry weight (San Francisco Bay Regional Water Quality Control Board 2019:7-53) at any Delta location or under any water year type. Modeled fish fillet selenium concentrations do not change by more than 0.02 mg/kg dry weight as averages over the full simulation period and in all water year-types at all Delta assessment locations under the project alternatives relative to existing conditions (Table 9-43; Appendix 9J).

Table 9-42. Selenium Concentrations in Fish Fillets (in milligrams per kilogram wet weight), Average for the Full Simulation Period (Water Years 1923–2015)

Assessment Location	Existing Conditions	Alternatives 1 and 3	Alternatives 2a and 4a	Alternatives 2b and 4b	Alternatives 2c and 4c	Alternative 5
Barker Slough at North Bay Aqueduct	0.61	0.61	0.61	0.61	0.61	0.61
Sacramento River at Emmaton	0.61	0.61	0.61	0.61	0.61	0.61

Assessment Location	Existing Conditions	Alternatives 1 and 3	Alternatives 2a and 4a	Alternatives 2b and 4b	Alternatives 2c and 4c	Alternative 5
San Joaquin River at Antioch	0.61	0.61	0.61	0.61	0.61	0.61
Sacramento River at Mallard Island	0.61	0.61	0.61	0.61	0.61	0.61
South Fork Mokelumne River at Terminous	0.61	0.61	0.61	0.61	0.61	0.61
San Joaquin River at Empire Tract	0.60	0.60	0.60	0.60	0.60	0.60
Contra Costa Water District Pumping Plant #1	0.61	0.61	0.61	0.61	0.61	0.61
Old River at State Route 4	0.61	0.61	0.61	0.61	0.61	0.61
Victoria Canal	0.60	0.60	0.60	0.60	0.60	0.60
Banks Pumping Plant	0.60	0.60	0.60	0.60	0.60	0.60
Jones Pumping Plant	0.60	0.60	0.60	0.60	0.60	0.60

Table 9-43. Selenium Concentrations in Fish Fillets (in milligrams per kilogram dry weight), Average for the Full Simulation Period (Water Years 1923–2015)

Assessment Location	Existing Conditions	Alternatives 1 and 3	Alternatives 2a and 4a	Alternatives 2b and 4b	Alternatives 2c and 4c	Alternative 5
Barker Slough at North Bay Aqueduct	2.02	2.02	2.02	2.02	2.02	2.02
Sacramento River at Emmaton	2.02	2.02	2.02	2.02	2.02	2.02
San Joaquin River at Antioch	2.02	2.02	2.02	2.02	2.02	2.02
Sacramento River at Mallard Island	2.02	2.02	2.02	2.02	2.02	2.02
South Fork Mokelumne River at Terminous	2.02	2.02	2.02	2.02	2.02	2.02
San Joaquin River at Empire Tract	2.00	2.00	2.00	2.00	2.00	2.00
Contra Costa Water District Pumping Plant #1	2.02	2.02	2.02	2.02	2.02	2.02
Old River at State Route 4	2.02	2.02	2.02	2.02	2.02	2.02
Victoria Canal	2.00	2.00	2.00	2.00	2.00	2.00
Banks Pumping Plant	2.00	2.00	2.00	2.00	2.00	2.00
Jones Pumping Plant	2.00	2.00	2.00	2.00	2.00	2.00

Whole Sturgeon Tissue Concentrations

Modeled average selenium concentrations in whole sturgeon tissue for the full simulation period would differ negligibly from existing conditions. Modeled average selenium concentrations range from 0.72 mg/kg dry weight at Emmaton to 3.96 mg/kg dry weight in the Sacramento River at Mallard Island under existing conditions and all project alternatives (Table 9-44; Appendix 9J). These modeled whole sturgeon tissue selenium concentrations for the full simulation period do not exceed the low effect (i.e., concern level) concentration of 5 mg/kg dry weight from Presser and Luoma (2013:25), although, whole sturgeon tissue selenium concentrations were modeled to exceed this low effect concentration in below normal, dry, and critical years in the San Joaquin River at Antioch and the Sacramento River at Mallard Island for existing conditions and all project alternatives (Appendix 9J, Tables 9J-48 through 9J-47-2). Modeled whole sturgeon tissue concentrations do not exceed the high effect (i.e., toxicity) concentration of 8 mg/kg dry weight from Presser and Luoma (2013:25) or the North San Francisco Bay TMDL target of 8 mg/kg dry weight (San Francisco Bay Regional Water Quality Control Board 2019:7-53) at any Delta location for any water year type. Modeled whole sturgeon tissue selenium concentrations would not change by more than 0.03 mg/kg dry weight or less as averages over the full simulation period and each water year type under the project alternatives relative to existing conditions (Table 9-44; Appendix 9J).

Table 9-44. Selenium Concentrations in Whole Sturgeon Tissue (in milligrams per kilogram dry weight), Average for the Full Simulation Period (Water Years 1923–2015)

Assessment Location	Existing Conditions	Alternatives 1 and 3	Alternatives 2a and 4a	Alternatives 2b and 4b	Alternatives 2c and 4c	Alternative 5
Sacramento River at Emmaton	0.72	0.72	0.72	0.72	0.72	0.72
San Joaquin River at Antioch	3.78	3.80	3.80	3.79	3.80	3.80
Sacramento River at Mallard Island	3.94	3.96	3.96	3.95	3.96	3.96

Delta Summary

Based on the negligible changes in modeled selenium concentrations in surface water and biota (whole-body fish, bird eggs [invertebrate diet], bird eggs [fish diet], fish fillets, and sturgeon) at all Delta assessment locations, the project alternatives would not substantially increase the frequency with which applicable water quality criteria, objectives, or tissue concentration benchmarks for selenium would be exceeded in the Delta. Consequently, these low-level effects would not increase health risks to aquatic life or wildlife in the Delta, as compared to existing conditions. Thus, the changes to selenium concentrations that may occur in the Delta under the project alternatives relative to existing conditions would not be of sufficient magnitude to cause more frequent or greater toxicity to aquatic life or wildlife, or increase health risks to aquatic life, wildlife or humans consuming Delta fish relative to existing conditions, or adversely affect any other Delta beneficial uses and would not make the CWA Section 303(d) impairment for selenium discernibly worse.

Suisun Marsh, Suisun Bay, and San Francisco Bay

The project alternatives would not result in substantial increases in selenium concentrations in Delta waters or in Delta outflows. As such, the project alternatives would not cause a substantial change in selenium concentrations in Suisun Marsh, Suisun Bay, or San Francisco Bay under all project alternatives relative to existing conditions. Furthermore, the project alternatives would not substantially increase the frequency with which applicable water quality criteria or objectives would be exceeded in these waters, would not substantially degrade the quality of these waters with regard to selenium, and would not make the CWA Section 303(d) impairment for selenium discernibly worse.

SWP/CVP Export Service Areas

Average water column selenium concentrations over the full simulation period at the Banks Pumping Plant would decrease under all project alternatives relative to existing conditions and would differ negligibly from existing conditions at Jones Pumping Plant and Barker Slough at the North Bay Aqueduct, as previously discussed. Thus, the project alternatives would not result in increased selenium concentrations in SWP/CVP export service area waterbodies that would substantially degrade water quality relative to existing conditions. Selenium concentrations in Delta waters diverted into the SWP/CVP export service areas would not exceed the 5 μg/L freshwater chronic CTR criterion for protection of aquatic life under all project alternatives and water-year types.

CEQA Conclusion—All Project Alternatives

Based on the above analysis, the project alternatives would not cause a substantial increase in selenium concentrations in study area waterbodies relative to existing conditions. As such, the project alternatives would not cause additional exceedance of applicable selenium water quality criteria/objectives by frequency, magnitude, and geographic extent that would result in adverse effects on any beneficial uses of study area waterbodies. Because selenium concentrations are not expected to increase substantially, the project alternatives would not cause long-term degradation of selenium in study area waterbodies that would result in substantially increased risk for adverse effects on any beneficial uses. Furthermore, based on the above described modeling results, the project alternatives would not increase selenium concentrations by frequency, magnitude, and geographic extent to cause measurably higher body burdens of selenium in aquatic organisms that result in substantially increasing the health risks to wildlife (including fish) or humans consuming those organisms. Finally, selenium concentrations under the project alternatives would not further degrade water quality by measurable levels on a long-term basis in any study area waterbody on the State’s CWA Section 303(d) list such that beneficial use impairment would be made discernably worse. Therefore, the impact of the project alternatives on selenium would be less than significant.

Mitigation Impacts

Compensatory Mitigation

The CMP described in Appendix 3F is not intended or needed as mitigation for impacts on water quality due to selenium from project construction or operations. Nevertheless, implementation of the CMP could result in impacts on Delta selenium bioaccumulation.

Implementation of the CMP, namely the creation of tidal habitats that would be hydrodynamically connected to Delta channels, could create new areas with slower water velocities and associated increases in water residence times that, if sufficiently large, promote greater selenium uptake and recycling by plants, algae, and microorganisms. In algae, less-bioaccumulative dissolved forms of selenium, such as selenate, are biotransformed into the more bioaccumulative organoselenium. An increase in more bioavailable forms of particulate selenium could result in increased selenium concentrations in fish and aquatic-dependent birds through dietary uptake.

Location(s) and size(s) of the new tidal habitat are would generally be in the lower Yolo Bypass and Cache Slough Complex and specific locations would be selected in accordance with the tidal habitat mitigation framework in Appendix 3F. Because specific locations and sizes of the CMP tidal habitat are currently undetermined, the extent that water residence times within the created tidal habitats would differ from that of adjacent Delta waters is unknown. However, the tidal habitat is expected to be predominantly sited in the northern Delta, and its area is expected to be less than 1% of the total acres of the Delta's wetted habitat. Therefore, any potential increases in selenium bioaccumulation would occur in a very small geographic area of the Delta even if some tidal habitat resulted in longer residence times that are conducive to greater bioaccumulation of selenium.

Implementation of the CMP tidal habitat is not expected to cause substantial additional bioaccumulation of selenium in Delta aquatic life and aquatic-dependent birds in and near the created habitats that would adversely affect beneficial uses for several reasons. First, the CMP tidal habitats would not involve actions that increase selenium loading, thus would not substantially increase selenium concentrations in the study area waterbodies. Second, modeled water and fish tissue selenium concentrations, with the exception of sturgeon in the western Delta during low flows, are below levels of concern. Third, the CMP tidal habitats would contain a very small fraction of all Delta primary production, thus would have little, likely immeasurable, effects on average selenium levels in phytoplankton or aquatic-dependent wildlife and fish throughout the Delta. Fourth, it is not certain that the magnitude of greater residence time in the restoration tidal habitats would result in measurably higher (i.e., significantly greater) average selenium bioaccumulation into phytoplankton within the tidal habitats as compared to other wetted habitats throughout the Delta. Nor is it certain that changes to selenium forms or concentrations in algae, should they occur in the tidal habitats, would result in statistically significant increases in average selenium concentrations in aquatic-dependent wildlife and fish in those habitats. Even if this were to occur at some of the tidal habitats where tidal water exchange rates were low, their total acreage would not be of sufficient magnitude or geographic extent to affect average selenium levels in phytoplankton or aquatic-dependent wildlife and fish within the northern Delta, or across the Delta. Furthermore, the tidal habitats would have tidal exchange of water and are unlikely to have such substantially increased residence times compared to adjacent habitats such that there would be measurably higher bioaccumulation into phytoplankton within the tidal habitats.

Selenium is CWA Section 303(d)-listed for impairments in Suisun Bay and San Francisco Bay. Nevertheless, as described above, the CMP tidal habitat would not be expected to measurably increase selenium concentrations, including the most bioavailable forms, in Delta outflow due to the comparably limited acreage of tidal habitat to be created. This coupled with the large tidal exchanges in these bays would result in negligible, likely immeasurable, changes in selenium concentrations and forms in Suisun Bay and San Francisco Bay.

Based on the above discussion, the CMP would result in negligible, if any, change in selenium in study area waterbodies relative to existing conditions. As such, the CMP would not cause additional exceedance of applicable selenium water quality criteria/objectives by frequency, magnitude, and geographic extent that would result in adverse effects on any beneficial uses of any study area waterbodies. Because selenium concentrations are not expected to increase substantially, the CMP would not cause long-term degradation of selenium in study area waterbodies that would result in substantially increased risk for adverse effects on any beneficial uses. Furthermore, the CMP would not increase selenium concentrations by frequency, magnitude, and geographic extent to cause measurably higher body burdens of selenium in aquatic organisms that result in substantially increasing the health risks to wildlife (including fish) or humans consuming those organisms. Finally, the CMP would not further degrade selenium concentrations by measurable levels on a long-term basis in any study area waterbody on the State's CWA Section 303(d) list such that beneficial use impairment would be made discernibly worse. Based on these findings, impacts from the CMP on selenium would be less than significant.

Other Mitigation Measures

Most of the other mitigation measures would be static once constructed and as described for Impact WQ-2 would have limited likelihood of producing substantial runoff, including runoff with high concentrations of selenium. A few mitigation measures would have an operational component, such as the mosquito management associated with Mitigation Measure PH-1b: *Develop and Implement a Mosquito Management Plan for Compensatory Mitigation Sites on Bouldin Island and at I-5 Ponds* and tidal wetland inundation projects on Sherman and Twitchell Islands associated with Mitigation Measure AQ-9: *Develop and Implement a GHG Reduction Plan to Reduce GHG Emissions from Construction and Net CVP Operational Pumping to Net Zero*. The tidal inundation projects, which are only one optional component of Mitigation Measure AQ-9, would cause effects on bioaccumulation of selenium similar to what is described above for the CMP.

Because operation of other mitigation measures would have minimal effect on selenium, the other mitigation measures would not cause additional exceedance of applicable selenium water quality criteria/objectives by frequency, magnitude, and geographic extent that would result in adverse effects on any beneficial uses of any study area waterbodies. Because selenium concentrations are not expected to increase substantially, the other mitigation measures would not cause long-term degradation of selenium in study area waterbodies that would result in substantially increased risk for adverse effects on any beneficial uses. Furthermore, the other mitigation measures would not increase selenium concentrations by frequency, magnitude, and geographic extent to cause measurably higher body burdens of selenium in aquatic organisms that result in substantially increasing the health risks to wildlife (including fish) or humans consuming those organisms. Finally, the other mitigation measures would not further degrade selenium concentrations by measurable levels on a long-term basis in any study area waterbody on the State's CWA Section 303(d) list such that beneficial use impairment would be made discernibly worse. As a result, impacts from other mitigation measures on selenium would be less than significant.

Overall, the minimal effect on bioaccumulation of selenium from the CMP and other mitigation measures, combined with project alternatives, would not change the impact conclusion of less than significant.

Impact WQ-11: Effects on Pesticides Resulting from Facility Operations and Maintenance

Maintenance of project alternatives' facilities would not create new sources of pesticides or contribute toward a substantial change in existing sources of pesticides in the Delta. As such, maintenance activities would not cause any substantial change in pesticides in study area waterbodies that would adversely affect beneficial uses anywhere in the Delta.

All project alternatives (i.e., Alternatives 1, 2a, 2b, 2c, 3, 4a, 4b, 4c, and 5) described in Chapter 3 would have similar impact levels and are discussed together.

All Project Alternatives

Delta

The project alternatives would not affect in-Delta sources of pesticides from urban and agricultural runoff and discharges, and would cause negligible, if any, changes in pesticides concentrations within the upstream Delta source waters relative to existing conditions. As such pesticide concentrations in Delta inflows would differ negligibly from existing conditions. Thus, the primary mechanism by which pesticide concentrations in the Delta could be affected by the project alternatives is through the changes in proportions of source waters at specific Delta locations resulting from changes in source water inflow rates.

As shown in Appendix 9B, *Source Water Fingerprinting,* the Sacramento River is the dominant water source throughout all Delta subregions except the south Delta, where various locations can be seasonally dominated by San Joaquin River water. Water quality in the south Delta is also strongly influenced by agricultural drains. At the south Delta assessment locations of Victoria Canal, Old River, Banks Pumping Plant, and Jones Pumping Plant, the modeled percentage of agricultural drainage water is 9% to 17% of the water during some months of the year. In addition to the high fractions of Sacramento River water, the South Fork Mokelumne River at Terminous has substantial influence from the eastside tributaries with modeled percentages ranging from 27% to 36% of the water at this location from January to May. The Sacramento River at Mallard Island, located in the western Delta, is highly influenced by tidal exchange, where the modeled percentage of San Francisco Bay water ranges from 42% to 51% of the river water from July through November.

Under the project alternatives, there would generally be very small changes in source water fractions at the Delta assessment locations relative to existing conditions (Appendix 9B). At all assessment locations, except Banks Pumping Plant and Jones Pumping Plant, implementation of project alternatives would cause long-term average decreases of Sacramento River water and increases in San Joaquin River water and/or other source waters. With the exception of the Banks and Jones Pumping Plants, changes in source water fractions under all project alternatives would be small, with up to about a 2% increase or decrease in major (i.e., Sacramento River, San Joaquin River, San Francisco Bay) source water fractions on a long-term average relative to existing conditions. Changes in flow fractions to the Delta assessment locations for the other source waters (i.e., eastside tributaries, agricultural drainage, and Yolo Bypass) would be even smaller (Appendix 9B). These would be small changes in source water fractions relative to the total fraction of each source water at the assessment locations. As described above in Section 9.1.5.7, *Pesticides*, both the Sacramento and San Joaquin River have pesticide inputs from surrounding land uses. Thus, the small changes in source water fractions that would occur under the alternatives would not substantially alter the relative contribution of pesticide inputs to the Delta assessment locations relative to existing conditions.

At Jones Pumping Plant the greatest changes in source water fractions would occur under Alternatives 2a and 4a in March. The long-term average Sacramento River water fraction was modeled to increase by up to 6.5% in March while San Joaquin River water would decrease up to 4.5% and agricultural drainage waters would decrease by up to 0.7%, as a long-term average. Changes in fractions of source waters in other months would be substantially smaller. The presence of pesticides in all source waters is such that these relatively small increases in Sacramento River water would not cause pesticide concentrations at Jones Pumping Plant to be substantially different from existing conditions.

At Banks Pumping Plant, there would be substantial seasonal increases in the fraction of Sacramento River water. Although Sacramento River water fractions would generally increase in all months, the greatest changes would occur in March, with the increases in long-term average Sacramento River water fraction ranging from 16.5% to 18.8% for the project alternatives relative to existing conditions. All other source waters would decrease, but the greatest decreases would be in San Joaquin River water in March and May (i.e., 7.4% to 10.8% decrease) relative to existing conditions (Appendix 9D). Considering the relative presence of pesticides in Delta source waters, even with relatively large increases in Sacramento River water at Banks Pumping Plant in March, there would not be substantially different pesticide concentrations at this location relative to those that occur under existing conditions.

Current pesticide control programs, including TMDLs and Central Valley RWQCB WQCP amendments for the control of diazinon, chlorpyrifos, and pyrethroids will continue to address past pesticide-related impairments and prevent potential future impairments in surface waters, including inflows to the Delta and Delta waters. These actions, which are separate from the project alternatives, coupled with the relatively small changes in source water fractions at Delta assessment locations from the project alternatives, would result in little to no change in pesticide concentrations occurring within the Delta. Furthermore, considering that legacy pesticides are no longer used and their low frequency of detection (Appendix 9A, *Screening Analysis*), concentrations of legacy pesticides in Delta waters also would not be affected by measurable amounts from the changes in source water fractions under the project alternatives.

Based on the above, the project alternatives would not substantially increase the frequency with which applicable water quality criteria or objectives for pesticides would be exceeded in the Delta or substantially degrade the quality of water in the Delta with regard to pesticides. Any minor changes to pesticide levels that could occur in the Delta for the project alternatives would not be of sufficient magnitude or frequency to cause more frequent or greater toxicity to aquatic life or increase human health risks to those using the Delta as a drinking water source relative to existing conditions or adversely affect any other Delta beneficial uses.

Suisun Marsh, Suisun Bay, San Francisco Bay, and SWP/CVP Export Service Areas

The project alternatives would not result in substantial increases in pesticide concentrations in Delta waters or in Delta outflows. Moreover, project alternatives would not change land use practices or the extent of pesticide use within and around the Suisun Marsh, Suisun Bay, San Francisco Bay, or SWP/CVP export service area waterbodies relative to existing conditions. Consequently, the project alternatives would not substantially affect pesticide runoff from surrounding lands directly into these waterbodies. As such, there would not be a substantial change in pesticide concentrations in Suisun Marsh, Suisun Bay, San Francisco Bay, or within SWP/CVP export service area waterbodies under all project alternatives relative to existing conditions. Therefore, the project alternatives would not substantially increase the frequency with which applicable water quality criteria or objectives for pesticides would be exceeded in Suisun Marsh, Suisun Bay, San Francisco Bay, or within SWP/CVP export service area waterbodies or substantially degrade the quality of these waterbodies with regard to pesticides.

CEQA Conclusion—All Project Alternatives

Based on the analysis above, the project alternatives would not cause a substantial long-term increase in pesticide concentrations in study area waterbodies relative to existing conditions. As such, the project alternatives would not cause additional exceedance of applicable pesticide water quality criteria/objectives by frequency, magnitude, and geographic extent that would result in adverse effects on any beneficial uses of study area waterbodies. Because pesticide concentrations are not expected to increase substantially, the project alternatives would not cause long-term degradation for pesticides in study area waterbodies that would result in substantially increased risk for adverse effects on any beneficial uses. Furthermore, because the project alternatives would not increase pesticide concentrations in study area waterbodies, including bioaccumulative organochlorine legacy pesticides, the project alternatives would not cause increased bioaccumulation of any pesticide by frequency, magnitude, and geographic extent to cause measurably higher body burdens in aquatic organisms that result in increasing the health risks to wildlife (including fish) or humans consuming those organisms. Finally, any negligible changes in long-term pesticide concentrations under the project alternatives would not further degrade water quality by measurable levels on a long-term basis in any study area waterbody on the State's CWA Section 303(d) list such that beneficial use impairment would be made discernably worse. Therefore, the impact of the project alternatives on pesticides would be less than significant.

Mitigation Impacts

Compensatory Mitigation

Although the CMP described in Appendix 3F does not act as mitigation for impacts on water quality from project construction or operations, its implementation could result in impacts on water quality.

Herbicides would be applied for site preparation to remove nonnative vegetation and to support establishment of new plantings. Natural habitats contribute fewer pesticides to receiving waters than agricultural areas where pesticides are applied. Any newly created wetlands or enhanced natural habitat could also filter stormwater to remove solids and either improve or have no effect on pesticide concentrations in discharges to receiving waters relative to existing conditions. As such, restoration areas are expected to somewhat reduce, rather than increase, runoff of pesticides in adjacent waterbodies. Therefore, the CMP would not result in substantially higher pesticide concentrations in study area waterbodies relative to existing conditions. As such, the CMP would not cause additional exceedance of applicable pesticide water quality criteria/objectives by frequency, magnitude, and geographic extent that would result in adverse effects on any beneficial uses of any study area waterbodies. Because pesticide concentrations are not expected to increase substantially, the CMP would not cause long-term degradation of pesticides in study area waterbodies that would result in substantially increased risk for adverse effects on any beneficial uses. Furthermore, because the CMP would not increase pesticide concentrations in study area waterbodies, including bioaccumulative organochlorine legacy pesticides, the CMP would not cause increased bioaccumulation of any pesticide by frequency, magnitude, and geographic extent to cause measurably higher body burdens in aquatic organisms that result in increasing the health risks to wildlife (including fish) or humans consuming those organisms. Finally, any negligible changes in long-term pesticide concentrations under the CMP would not further degrade water quality by measurable levels on a long-term basis in any study area waterbody on the State's CWA Section 303(d) list such that beneficial use impairment would be made discernably worse. Based on these findings, this impact would be less than significant.

Other Mitigation Measures

Implementation of the CMP on Bouldin Island and at three ponds east of the Mokelumne River and west of I-5 would create aquatic habitat potentially suitable for mosquito breeding. To aid in vector management and control, DWR would implement Mitigation Measure PH-1b: *Develop and Implement a Mosquito Management Plan for Compensatory Mitigation Sites on Bouldin Island and I-5 Ponds*.

Mosquito management associated with Mitigation Measure PH-1b could include use of pesticides. Use of larvicides and adulticides could reduce water quality. This would be considered a significant impact should it occur. However, application of these pesticides over or near surface water will require permit coverage under the NPDES. Adherence to the requirements of the NPDES permit and the other precautionary measures would minimize environmental impacts. For example, DWR would consult with the San Joaquin County Mosquito and Vector Control District and take other measures to reduce the need to use pesticides. Larvicides and adulticides would only be used when necessary and would comply with all applicable federal, state and regulations (e.g., CWA, Endangered Species Act). Larvicides and adulticides currently registered by the California Department of Pesticide Regulation would be applied only by trained personnel and according to label directions. If larvicides and/or adulticides are required, DWR would evaluate the effects of these chemicals and, if required, prepare a monitoring program for review by fish and wildlife agencies to evaluate the effects, if any, that application would have on macroinvertebrates and associated covered fish and wildlife species.

Because operation of other mitigation measures would have limited effect on pesticide concentrations, the other mitigation measures would not cause additional exceedance of applicable pesticide water quality criteria/objectives by frequency, magnitude, and geographic extent that would result in adverse effects on any beneficial uses of any study area waterbodies. Because pesticide concentrations are not expected to increase substantially, the other mitigation measures would not cause long-term degradation of pesticides in study area waterbodies that would result in substantially increased risk for adverse effects on any beneficial uses. Furthermore, because the other mitigation measures would not increase pesticide concentrations in study area waterbodies, including bioaccumulative organochlorine legacy pesticides, the other mitigation measures would not cause increased bioaccumulation of any pesticide by frequency, magnitude, and geographic extent to cause measurably higher body burdens in aquatic organisms that result in increasing the health risks to wildlife (including fish) or humans consuming those organisms. Finally, any negligible changes in long-term pesticide concentrations under the other mitigation measures would not further degrade water quality by measurable levels on a long-term basis in any study area waterbody on the State’s CWA Section 303(d) list such that beneficial use impairment would be made discernably worse. As a result, impacts from other mitigation measures on pesticides would be less than significant.

Overall, the minimal effect on pesticide concentrations from the CMP and other mitigation measures, combined with project alternatives, would not change the impact conclusion of less than significant.

Impact WQ-12: Effects on Trace Metals Resulting from Facility Operations and Maintenance

The trace metals assessment addresses aluminum, arsenic, cadmium, chromium, copper, iron, lead, manganese, nickel, silver, and zinc, which are identified in Appendix 9A, *Screening Analysis*, as warranting further assessment.

Maintenance of project alternatives' facilities would not create new sources of trace metals or contribute toward a substantial change in existing sources of trace metals in the Delta. As such, maintenance activities would not cause any substantial change in trace metals in study area waterbodies that would adversely affect beneficial uses anywhere in the Delta.

All project alternatives (Alternatives 1, 2a, 2b, 2c, 3, 4a, 4b, 4c, and 5) described in Chapter 3 would have similar impact levels and thus are discussed together. The analysis and data presented below are based on data presented in Appendix 9K, *Trace Metals*.

All Project Alternatives

Delta

Tables 9-45 and 9-46 present average and 95th percentile trace metals concentrations, along with the lowest applicable water quality criterion or objective for the Delta. Average concentrations are relevant to represent long-term conditions important for protection of municipal and 95th percentile concentrations are relevant for representing upper short-term concentrations that would be of concern to aquatic life beneficial uses.

Trace metal concentrations of the primary source waters to the Delta (i.e., Sacramento River, San Joaquin River, and San Francisco Bay) are similar in order of magnitude. For example, average dissolved copper concentrations for the Sacramento River, San Joaquin River, and San Francisco Bay are 2.0 μg/L, 2.6 μg/L, and 2.1 μg/L, respectively. The 95th percentile dissolved copper concentrations for the Sacramento River, San Joaquin River, and San Francisco Bay are 5.0 μg/L, 5.0 μg/L, and 3.5 μg/L, respectively. Given this similarity, large changes in the proportion of these Delta source waters would be necessary to cause even a relatively small change in trace metal concentration at a particular Delta location. A number of dissolved metals were not detected in source waters (e.g., lead in the San Joaquin River). For trace metals that were detected, average and 95th percentile concentrations for these primary source waters are all below their respective water quality criteria applicable to freshwater (Tables 9-45 and 9-46). Because concentrations are regularly less than water quality criteria, more frequent exceedances of aquatic life water quality criteria or objectives for aluminum, arsenic, cadmium, chromium, copper, iron, lead, manganese, nickel, silver, and zinc in the Delta would not occur under the project alternatives. Because of the similarity of metals concentrations across the source waters, the project alternatives would not substantially degrade the quality of water in the Delta with regard to trace metals.

Table 9-45. Average Concentrations of Trace Metals (in micrograms per liter), Expressed as the Dissolved Fraction, in the Sacramento River, San Joaquin River, and San Francisco Bay

Trace Metal	Sacramento River	San Joaquin River	San Francisco Bay	Lowest Applicable Water Quality Criterion/ Objective for the Delta (and Basis)
Aluminum	39	31	No Data	200 (Central Valley RWQCB WQCP)
Arsenic	1.4	1.7	1.9	10 (Central Valley RWQCB WQCP)
Cadmium	0.020	0.4 [a]	0.05	2.2 (CTR)
Chromium	1.7	1 [a]	0.88	50 (Central Valley RWQCB WQCP)
Copper	2.0	2.6	2.1	9 (CTR)
Iron	57	51	53	300 (Central Valley RWQCB WQCP)
Lead	0.11	5 [a]	0.092	2.5 (CTR)
Manganese	11	45	8.5	50 (Central Valley RWQCB WQCP)

Trace Metal	Sacramento River	San Joaquin River	San Francisco Bay	Lowest Applicable Water Quality Criterion/ Objective for the Delta (and Basis)
Nickel	0.85	5.2	1.7	52 (CTR)
Silver	0.0083	No Data	0.012	3.4 (CTR)
Zinc	2.1	10	1.0	100 (Central Valley RWQCB WQCP)

CTR = California Toxics Rule; RWQCB = Regional Water Quality Control Board; WQCP = Water Quality Control Plan.
[a] Not detected; value shown is average of detection limits.

Table 9-46. 95th Percentile Concentrations of Trace Metals (in micrograms per liter), Expressed as the Dissolved Fraction, in the Sacramento River, San Joaquin River, and San Francisco Bay

Trace Metal	Sacramento River	San Joaquin River	San Francisco Bay	Lowest Applicable Water Quality Criterion/ Objective for the Delta and Source
Aluminum	113	109	No Data	200 (Central Valley RWQCB WQCP)
Arsenic	2.0	4.0	5.8	10 (Central Valley RWQCB WQCP)
Cadmium	0.050	1 [a]	0.096	2.2 (CTR)
Chromium	3.8	1 [a]	4.7	50 (Central Valley RWQCB WQCP)
Copper	5.0	5.0	3.5	9 (CTR)
Iron	145	131	230	300 (Central Valley RWQCB WQCP)
Lead	0.23	5 [a]	0.42	2.5 (CTR)
Manganese	23	105	22	50 (Central Valley RWQCB WQCP)
Nickel	1.8	5	3.4	52 (CTR)
Silver	0.02	No Data	0.03	3.4 (CTR)
Zinc	6.8	28	3.4	100 (Central Valley RWQCB WQCP)

CTR = California Toxics Rule; RWQCB = Regional Water Quality Control Board; WQCP = Water Quality Control Plan.
[a] Not detected; value shown is detection limit.

Suisun Marsh, Suisun Bay, San Francisco Bay, and SWP/CVP Export Service Area

The project alternatives would not result in substantial increases in trace metal concentrations in Delta waters or in Delta outflows. As such, there would not be a substantial change in trace metal concentrations in Suisun Marsh, Suisun Bay, San Francisco Bay, or SWP/CVP export service area waterbodies under all project alternatives relative to existing conditions. As such, the project alternatives would not substantially increase the frequency with which applicable water quality criteria or objectives would be exceeded or substantially degrade the quality of these waterbodies with regard to trace metals.

CEQA Conclusion—All Project Alternatives

Based on the analysis, the project alternatives would not cause a substantial long-term increase in trace metal concentrations in study area waterbodies relative to existing conditions. As such, the project alternatives would not cause additional exceedance of applicable trace metals water quality criteria/objectives by frequency, magnitude, and geographic extent that would result in adverse effects on any beneficial uses of study area waterbodies. Because trace metal concentrations are not expected to increase substantially, the project alternatives would not cause long-term degradation for trace metals in study area waterbodies that would result in substantially increased risk for adverse effects on any beneficial uses. Furthermore, any negligible changes in trace metal concentrations that may occur under the project alternatives would not further degrade water quality by measurable levels on a long-term basis in any study area waterbody on the State's CWA Section 303(d) list such that the beneficial use impairment would be made discernibly worse. The trace metals discussed in this assessment are not bioaccumulative, thus any trace metal concentration increases under the project alternatives would not directly cause adverse bioaccumulative effects in aquatic organisms. Therefore, the impact of the project alternatives on trace metals would be less than significant.

Mitigation Impacts

Compensatory Mitigation

Although the CMP described in Appendix 3F does not act as mitigation for impacts on water quality from project construction or operations, its implementation could result in impacts on water quality.

Natural habitats contribute fewer trace metals to receiving waters than agricultural or urban areas. Any newly created wetlands or enhanced habitat would also filter stormwater to remove solids and either improve or have no effect on trace metal concentrations relative to existing conditions. Therefore, the CMP would not result in substantially higher trace metal concentrations in study area waterbodies relative to existing conditions. As such, the CMP would not cause additional exceedance of applicable trace metals water quality criteria/objectives by frequency, magnitude, and geographic extent that would result in adverse effects on any beneficial uses of study area waterbodies. Because trace metal concentrations are not expected to increase substantially, the CMP would not cause long-term degradation for trace metals in study area waterbodies that would result in substantially increased risk for adverse effects on any beneficial uses. Furthermore, any negligible changes in trace metal concentrations that may occur under the CMP would not further degrade water quality by measurable levels on a long-term basis in any study area waterbody on the State's CWA Section 303(d) list such that the beneficial use impairment would be made discernibly worse. The trace metals discussed in this assessment are not bioaccumulative, thus any trace metal concentration increases under the CMP would not directly cause adverse bioaccumulative effects in aquatic organisms. Based on these findings, impacts from the CMP on trace metals would be less than significant.

Other Mitigation Measures

Impacts of other mitigation measures would be similar to those described for Impact WQ-2. Operation of other mitigation measures would not generate substantial runoff, including runoff contaminated with elevated concentrations of trace metals. Therefore, the other mitigation measures would not cause additional exceedance of applicable trace metals water quality criteria/objectives by frequency, magnitude, and geographic extent that would result in adverse effects on any beneficial uses of study area waterbodies. Because trace metal concentrations are not expected to increase substantially, the other mitigation measures would not cause long-term degradation for trace metals in study area waterbodies that would result in substantially increased risk for adverse effects on any beneficial uses. Furthermore, any negligible changes in trace metal concentrations that may occur under the other mitigation measures would not further degrade water quality by measurable levels on a long-term basis in any study area waterbody on the State's CWA Section 303(d) list such that the beneficial use impairment would be made discernibly worse. The trace metals discussed in this assessment are not bioaccumulative, thus any trace metal concentration increases under the other mitigation measures would not directly cause adverse bioaccumulative effects in aquatic organisms. As a result, impacts from other mitigation measures would be less than significant.

Overall, the minimal effect on trace metal concentrations from the CMP and other mitigation measures, combined with project alternatives, would not change the impact conclusion of less than significant.

Impact WQ-13: Effects on Turbidity/Total Suspended Solids Resulting from Facility Operations and Maintenance

Maintenance of project alternatives' facilities would not create new sources of TSS concentrations or turbidity or contribute toward a substantial change in existing sources of TSS concentrations or turbidity in the Delta. As such, maintenance activities would not cause any substantial change in TSS concentrations or turbidity in study area waterbodies that would adversely affect beneficial uses anywhere in the Delta.

All project alternatives (i.e., Alternatives 1, 2a, 2b, 2c, 3, 4a, 4b, 4c, and 5) described in Chapter 3 would have similar impact levels and are discussed together.

All Project Alternatives

<u>Delta</u>

Sediment retention in upstream reservoirs has decreased the long-term sediment supply upstream of the Delta (Schoellhamer et al. 2007:7). Turbidity, which has a direct linear relationship with TSS concentrations and is often used as a surrogate for suspended sediment, has decreased along with this reduction in suspended sediment transport. Conversely, the relative sediment supply upstream of the Delta from agriculture and urbanization has increased over time as these land uses have increased downstream of major dams (Schoellhamer et al. 2007:8). However, contributions to TSS and turbidity from urban and agricultural are small in comparison with the sediment retention in reservoirs.

Schoellhamer et al. (2007:6) noted that suspended sediment concentration was more affected by season than flow, with the higher concentrations for a given flow rate occurring during "first flush events" and lower concentrations occurring during spring snowmelt events. These first flush events can comprise up to half of the annual sediment load to the Delta (Morgan-King and Wright 2016:8). The TSS concentrations and turbidity levels of Delta inflows under the project alternatives are not expected to be substantially different from those occurring under existing conditions, including during first flush events. However, the project alternatives would change the quantity of Sacramento River inflows due to diversions at the north Delta intakes, resulting in reduced suspended sediment loading to the Delta.

Under the project alternatives, reductions in annual average Sacramento River sediment load to the Delta are estimated to be 5% for Alternatives 1, 2a, 2c, 3, 4a, 4c, and 5 and 4% for Alternatives 2b and 4b (Chapter 12, Table 12-97). Under existing conditions, the Sacramento River transports five times more sediment to the Delta than the San Joaquin River and accounts for approximately 66% of the annual Delta sediment budget (Wright and Schoellhamer 2005:7). Thus, an annual average 5% reduction in Sacramento River sediment load is equivalent to an annual average 3% reduction in the total external sediment load to the Delta.

Although there could be a reduction in annual average external sediment load to the Delta due to the project alternatives, this reduction is not expected to contribute to a substantial change in TSS concentrations and turbidity levels within the Delta relative to existing conditions. Importantly, the project alternatives would not substantially affect river inflows associated with storm events or the “first flush” events important for sediment transport to the Delta or the TSS concentrations or turbidity levels in those flows. Furthermore, the daily and seasonal sediment resuspension and deposition processes driven by wind and tidal action would continue to occur under the project alternatives. Finally, Environmental Commitment EC-15: *Sediment Monitoring, Modeling, and Reintroduction Adaptive Management* would be implemented to monitor and model Sacramento River sediment entrainment, establish performance criteria, and develop and implement a sediment reintroduction plan, if determined necessary relative to the performance criteria (Appendix 3B). Based on the continued physical processes that generate TSS and turbidity combined with the implementation of Environmental Commitment EC-15, the TSS concentrations and turbidity levels in the Delta under the project alternatives would not be substantially different from those under existing conditions. Consequently, changes in TSS concentrations and turbidity levels that may occur under the project alternatives would not be of sufficient frequency, magnitude and geographic extent that would result in exceedance of applicable water quality criteria or objectives, cause adverse effects on beneficial uses in the Delta region, or substantially degrade the quality of these waterbodies, with regard to TSS and turbidity.

Maintenance for the project alternatives would have very limited effects on study area surface water quality. The cylindrical tee fish screens at each North Delta intake would be lifted out of the water for washing approximately every 6 months (Delta Conveyance Design and Construction Authority 2022:11), with approximately one-half day of associated work (including 1 hour of actual washing) for each screen at each intake (i.e., a total of 15 days of washing for each 3,000 cfs intake and 8 days for each 1,500 cfs intake). This washing process may cause removed sediment and aquatic growth or vegetation to reenter the Sacramento River, resulting in its redistribution by river currents. Because of the limited number of days over which this maintenance would occur and the small amount of material that would be discharged compared to the size of the river, short-term minimal effects on TSS and turbidity are expected. Sediment jetting would only be required at the base of the screen structure to help keep sediment from accumulating beneath the screens; this jetting would be done frequently (hourly to daily, depending on needs), thereby resulting in minimal changes to TSS and turbidity, with sediment jetted from the screen rapidly dispersing within the river channel.

<u>Suisun Marsh, Suisun Bay, San Francisco Bay, and SWP/CVP Export Service Area</u>

The project alternatives would not result in substantial changes in TSS concentrations or turbidity levels in Delta waters or in Delta outflows, nor would the project alternatives affect TSS and turbidity associated with runoff from surrounding lands. As such, there would not be a substantial change in TSS concentrations or turbidity levels in Suisun Marsh, Suisun Bay, San Francisco Bay, or SWP/CVP export service area waterbodies under all project alternatives relative to existing conditions. Therefore, the project alternatives would not substantially increase the frequency with which the applicable water quality criteria or objectives for TSS and turbidity would be exceeded or substantially degrade the quality of these waterbodies with regard to TSS or turbidity.

CEQA Conclusion—All Project Alternatives

Based on the above analysis, the project alternatives would not cause substantial long-term changes in TSS concentrations or turbidity levels in study area waterbodies relative to existing conditions. As such, the project alternatives would not cause additional exceedances of applicable TSS and turbidity water quality criteria/objectives by frequency, magnitude, and geographic extent that would result in adverse effects on any beneficial uses of study area waterbodies. Because TSS concentrations and turbidity levels are not expected to change substantially, the project alternatives would not cause long-term degradation for TSS or turbidity in study area waterbodies that would result in substantially increased risk for adverse effects on any beneficial uses. There are no waterbodies currently on the State's CWA Section 303(d) list because of TSS or turbidity impairments in the study area. Therefore, any negligible changes in long-term TSS concentrations and turbidity levels that may occur in study area waterbodies would not make any existing CWA Section 303(d) impairments discernibly worse. TSS and turbidity are not bioaccumulative, thus any TSS and turbidity changes under the project alternatives would not directly cause adverse bioaccumulative effects in aquatic organisms. Finally, Environmental Commitment EC-15: *Sediment Monitoring, Modeling, and Reintroduction Adaptive Management* would be implemented to monitor and model Sacramento River sediment entrainment, establish performance criteria, and develop and implement a sediment reintroduction plan, if determined necessary relative to the performance criteria. Therefore, the impact of the project alternatives on TSS and turbidity would be less than significant**.**

Mitigation Impacts

Compensatory Mitigation

Although the CMP described in Appendix 3F does not act as mitigation for impacts on water quality from project construction or operations, its implementation could result in impacts on water quality.

Natural habitats containing banks covered with vegetation tend to be a sink (i.e., trap) for TSS and turbidity while runoff from agricultural areas tend to be sources of TSS and turbidity. Any newly created wetlands or enhanced habitat would also filter stormwater to remove solids and either improve or have little to no effect on TSS and turbidity relative to existing conditions. Therefore, the CMP would not result in substantially higher TSS or turbidity in study area waterbodies relative to existing conditions. As such, the CMP would not cause additional exceedances of applicable TSS and turbidity water quality criteria/objectives by frequency, magnitude, and geographic extent that would result in adverse effects on any beneficial uses of study area waterbodies. Because TSS concentrations and turbidity levels are not expected to change substantially, the CMP would not cause long-term degradation for TSS or turbidity in study area waterbodies that would result in substantially increased risk for adverse effects on any beneficial use. There are no waterbodies currently on the State's CWA Section 303(d) list because of TSS or turbidity impairments in the study area. Therefore, any negligible changes in long-term TSS concentrations and turbidity levels that may occur in study area waterbodies would not make any existing CWA Section 303(d) impairments discernibly worse. TSS and turbidity are not bioaccumulative, thus any TSS and turbidity changes under the CMP would not directly cause adverse bioaccumulative effects in aquatic organisms. Based on these findings, impacts from the CMP on TSS and turbidity would be less than significant.

Other Mitigation Measures

As described for Impact WQ-2, operation of other mitigation measures would not create substantial runoff. In addition, as described above for the CMP, the tidal wetland projects that could be part of Mitigation Measure AQ-9: *Develop and Implement a GHG Reduction Plan to Reduce GHG Emissions* *from Construction and Net CVP Operational Pumping to Net Zero* would have little to no effect on TSS and turbidity relative to existing conditions. As a result, operation of other mitigation measures would have minimal effect on turbidity and TSS and would not cause additional exceedances of applicable TSS and turbidity water quality criteria/objectives by frequency, magnitude, and geographic extent that would result in adverse effects on any beneficial uses of study area waterbodies. Because TSS concentrations and turbidity levels are not expected to change substantially, the other mitigation measures would not cause long-term degradation for TSS or turbidity in study area waterbodies that would result in substantially increased risk for adverse effects on any beneficial use. There are no waterbodies currently on the State's CWA Section 303(d) list because of TSS or turbidity impairments in the study area. Therefore, any negligible changes in long-term TSS concentrations and turbidity levels that may occur in study area waterbodies would not make any existing CWA Section 303(d) impairments discernibly worse. TSS and turbidity are not bioaccumulative, thus any TSS and turbidity changes under the other mitigation measures would not directly cause adverse bioaccumulative effects in aquatic organisms. As a result, impacts from other mitigation measures on TSS and turbidity would be less than significant.

Overall, the minimal effect on turbidity and TSS from the CMP and other mitigation measures, combined with project alternatives, would not change the impact conclusion of less than significant.

Impact WQ-14: Effects on Cyanobacteria Harmful Algal Blooms Resulting from Facility Operations and Maintenance

This CHAB assessment builds on the background information presented in Appendix 9E, *Cyanobacteria Harmful Algal Blooms*. The main mechanisms by which the project alternatives could affect CHABs in the study area are by altering the five primary environmental factors that provide favorable conditions for CHABs. These factors are: (1) elevated water temperatures, (2) decreased channel velocities and associated turbulence and mixing, (3) increased hydraulic residence time, (4) increased water column irradiance due to greater water clarity, and (5) changes in nutrient availability. To address potential changes in nutrient availability and water clarity, the CHAB assessment relies on the detailed assessments provided in Impact WQ-8: *Effects on Nutrients Resulting from Facility Operations* and Impact WQ-13: *Effects on Turbidity/TSS Resulting from Facility Operations,* respectively.

This assessment first determined the frequency and magnitude to which the project alternatives would alter each of the five environmental factors relative to existing conditions. Then, the assessment determined whether alternative-driven changes in the environmental factors that influence CHABs would occur with sufficient regularity and magnitude to contribute to increases in the frequency of occurrence or magnitude of CHABs in the waterbodies assessed. After each environmental factor is assessed individually below, findings from all five environmental factor assessments are considered together to determine the relative potential for the project alternatives to result in increased frequency or magnitude of CHABs in any of the waterbodies assessed.

This assessment focuses on the June through November time period when CHABs have been present within the Delta. However, July through September is considered the peak period for CHABs to occur as this is the time when water temperatures are the warmest (Lehman et al. 2017:98, 106).

This CHAB assessment focuses on cyanobacteria harmful algal blooms because these are the phytoplankton most likely to cause harmful algal blooms in the study area (see Appendix 9E for details). The project alternatives would have a less-than-significant effect on other phytoplankton species that can form harmful algal blooms. As such, only cyanobacteria are considered in the analysis below.

All Project Alternatives

All project alternatives (Alternatives 1, 2a, 2b, 2c, 3, 4a, 4b, 4c, and 5) described in Chapter 3 would have similar impact levels and, therefore, are discussed together. Any substantial distinctions among the project alternatives are noted.

Maintenance of project alternatives' facilities would not create conditions that are more conducive to CHABs or contribute toward a substantial change in existing CHABs in the Delta because maintenance would not change conditions for the factors that influence CHAB formation. As such, maintenance activities would not cause any substantial change in CHABs in study area waterbodies that would adversely affect beneficial uses anywhere in the Delta.

Delta

The frequency and severity of CHABs varies by subregions and individual habitats within the Delta. Thus, this Delta assessment focuses on potential impacts to the five environmental factors (i.e., water temperature, channel velocities and associated turbulence/mixing, residence time, nutrients, and water clarity and its effects on irradiance) where favorable conditions for CHAB development currently exist at each of nine Delta assessment locations. These assessment locations were selected because they are included in published studies that address CHABs within the Delta (Lehman et al. 2017:95; Lehman et al. 2020:3) (refer to Appendix 9E for additional information on these factors and locations assessed). In addition to the nine Delta assessment locations, residence time was assessed at several other locations to understand how project alternatives could potentially effect water retention times across the Delta. Potential effects of the project alternatives on each of these five environmental factors are assessed separately below. Then, the interaction of these five environmental factors is assessed to determine the potential overall effects of the project alternatives on Delta CHABs. As described in Appendix 9E, *Microcystis* is the most common and well-studied cyanobacteria in the Delta. As such, much of the Delta assessment is focused on *Microcystis*. Nevertheless, because the factors favoring *Microcystis* also favor other cyanobacteria, and because other cyanobacteria are also considered in the following assessments, the assessment addresses Delta CHABs.

Temperature

Atmospheric exchange processes primarily drive Delta water temperature on both short and long timescales (Kimmerer 2004:19; Wagner et al. 2011:12; Vroom et al. 2017:9919–9920). Thus, by the time water released from upstream reservoirs reaches the Delta, it is typically at or close to equilibrium with ambient air temperatures. As described in Appendix 9E, *Microcystis* bloom formation typically does not occur until water temperature warms to 19°C (66.2°F; Lehman et al. 2013). Peak bloom abundance in the Delta occurs near 23°C (73.4°F) and persists to at least 25.6°C (78.1°F; Lehman et al. 2013:147). Optimal growth rates for *Microcystis* in the laboratory occur at 27.5°C (81.5°F) (You et al. 2018:26), and some *Microcystis* strains can continue to grow in temperatures of 37°C or higher (Bui et al. 2018:10).

DSM2 temperature modeling was used to evaluate how the project alternatives could affect temperatures at the nine Delta assessment locations. This analysis focused on the potential for the project alternatives to increase the frequency at which temperatures greater than 19°C (66.2°F) would occur in the Delta, relative to existing conditions.

Under the project alternatives, monthly average temperatures for all assessment locations would be negligibly different than those under existing conditions (Appendix 9E, Figures 9E-1-1-1 through 9E-1-11-6). Modeling shows that the frequency with which any given temperature above 19°C (66.2°F) would occur for project alternatives would be nearly identical to that of existing conditions (Appendix 9E, Figure 9E-1-12-1 through Figure 9E-1-12-6). From a thermal perspective, any minor differences in water temperatures at the Delta assessment location under the project alternatives, relative to existing conditions, would not affect the frequency or magnitude of cyanobacteria blooms at the Delta assessment locations, relative to that which could occur under existing conditions. This result is to be expected based on the fact that atmospheric exchange processes primarily drive Delta water temperatures on both short and long timescales (Kimmerer 2004:19; Wagner et al. 2011:12; Vroom et al. 2017:9919–9920).

Based on the above findings, the project alternatives would not result in increases in water temperatures that would increase the frequency or magnitude of CHABs in the Delta, relative to existing conditions.

Channel Velocities and Associated Turbulence and Mixing

Flow (measured in cubic feet per second [cfs]) is a measure of the volume of water passing a specified location within a channel, whereas velocity (measured in feet per second [ft/s]) is the measure of how rapidly the water is moving within a channel. Channel velocity is the primary driver of channel turbulence and mixing, in-channel generated turbidity, and hydraulic residence time—all of which can affect CHABs. If a channel is large and has substantial cross-sectional area, the channel may have a relatively high flow (cfs) despite having a relatively low velocity (ft/s). Conversely, if a channel has a small cross-sectional area, it may have a relatively low flow (cfs), but a relatively high velocity (ft/s). The distinction between flow and velocity is important when evaluating cyanobacteria because it is not the volume of water moving through a channel, but rather the velocity (and associated turbulence and mixing within the channel) with which the water moves that most affects the ability of cyanobacteria to outcompete other algae, as discussed further below.

DSM2 was used to model channel velocities at various Delta locations (Appendix 9E). This analysis focused on how the project alternatives would affect 15-minute absolute velocity (regardless of direction) in channels of the Delta. Mathematical daily average velocity may approach zero when flows on the tidal cycle move in opposite directions, and thus is not very useful for determining how channel velocity affects cyanobacteria. In such tidally influenced channels, 15-minute absolute velocity (regardless of direction) is the parameter that best characterize the degree of channel mixing that occurs daily. Hence, this analysis determines how the project alternatives would affect 15-minute absolute velocity, relative to velocities for existing conditions at the assessment locations.

The project alternatives would have negligible, if any, effect on the probability with which any given 15-minute absolute velocity would occur at the assessment locations during the June through November period, relative to existing conditions (Appendix 9E, Figures 9E-2-1-1 through 9E-2-11-6). Therefore, the project alternatives would not cause lower velocities, or reduce the frequency with which any given velocity would occur when velocities are low during the months of June through November, relative to the existing conditions. Consequently, the project alternatives would not alter turbulence and mixing within Delta channels sufficiently to substantially affect, or even measurably affect, the frequency or size of *Microcystis* or other cyanobacteria blooms at any Delta assessment location, relative to existing conditions.

Water Column Irradiance and Clarity

The Delta is a highly turbid ecosystem, yet more and more of the sediment load is being caught behind dams and the Delta is becoming less turbid (Schoellhamer et al. 2012:9). As stated in Impact WQ-13: *Effects on Turbidity/TSS Resulting from Facility Operations*, operations of the project alternatives are expected to have a minimal effect on TSS and turbidity levels in the Delta, relative to the existing conditions. This is because the factors that affect TSS and turbidity within the Delta would remain the same or be negligibly affected by the project alternatives. Turbidity and TSS levels in Delta waters are affected by TSS concentrations and turbidity levels of inflows (and associated sediment load), as well as fluctuation in flows within the channels due to the tides, with sediments depositing when flow velocities and turbulence are low at periods of slack tide and sediments becoming suspended when flow velocities and turbulence increase when tides are near the maximum. Turbidity and TSS variations can also be attributed to phytoplankton, zooplankton, and other biological material in the water. Higher water clarity is at least partially caused by high densities of aquatic vegetation that likely reduce bed shear stress (Hestir et al. 2016:304). These factors are not substantially affected, if affected at all, by the project alternatives.

The Sacramento River transports five times more sediment to the Delta than the San Joaquin River and accounts for 66% of the annual Delta sediment budget (Schoellhamer et al. 2007:9). Thus, a 6% reduction in Sacramento River load is equivalent to a 4% reduction in the total external sediment load to the Delta. Currently, suspended sediment entering the Delta, primarily from the Sacramento River, can be transported throughout the system, settle, and be resuspended during increased flow events (Morgan-King and Wright 2016:6).

TSS concentrations and turbidity levels in the Sacramento River entering the Delta would not differ from existing conditions under the alternatives because the concentrations in the river would not change when a portion of the water is entrained. Any minor settling of sediment that may occur downstream of the north Delta diversions under lower flows would be resuspended on the tidal cycle or when overall river flows are increased. Furthermore, the diversions would not substantially affect flows associated with storm events or the “first flush” events that can comprise approximately half of the annual sediment load to the Delta or the TSS concentrations or turbidity levels in those flows. Finally, erosion and deposition processes that are driven by tidal flow velocity changes would continue under the project alternatives and would be similar to existing conditions.

For the reasons described above, project alternatives are expected to have negligible effects on Delta channel turbidity and TSS levels (see Impact WQ-13 for additional details). Consequently, the project alternatives would have negligible, if any, effects on water column clarity and associated irradiance in Delta channels, relative to existing conditions. Any minor changes to water column clarity and irradiance that could potentially occur in Delta channels as a result of the project alternatives would not occur with sufficient regularity or magnitude to increase the frequency or magnitude of CHABs in Delta waters, relative to existing conditions.

Nutrients

The initiation and maintenance of CHABs require availability of nitrogen and phosphorus. As described in Impact WQ-7, *Effects on Nutrients Resulting from Facility Operations,* phosphorus and nitrogen are available in excess year-round throughout the Delta under existing conditions (Jassby

2008:14; Lehman et al. 2017:106). In other words, there are sufficient nutrients available to initiate and sustain CHABs under existing conditions throughout the June through November CHAB season.

As described in detail in the nutrients assessment, the project alternatives could result in changes in source water fractions at various Delta locations being constituted by less Sacramento River water and more San Joaquin River water. Modeling shows the largest potential differences occur at Victoria Canal under Alternatives 2a and 4a and Banks Pumping Plant under Alternatives 1 and 3. At Victoria Canal under Alternatives 2a and 4a, total nitrogen increases up to approximately 0.03 mg/L and total phosphorus could increase by up to approximately 2.7 µg/L in some months of the year. While at Banks Pumping Plant under Alternatives 1 and 3, total phosphorus could decrease by 28.7 µg/L and total nitrogen could decrease by 0.26 mg/L in March. These changes in nutrient concentrations would not cause increases in the frequency or magnitude of CHABs in Delta waters, relative to existing conditions. This is because (1) any increases in nutrient concentrations that would occur at some Delta locations would be small in magnitude, and (2) nutrients would continue to be in excess under the project alternatives as they are under existing conditions, even with some seasonal decreases in nutrients at Banks and Jones Pumping Plants. Consequently, the small increases in nutrients at some locations in some months would not alleviate nutrients as a limiting factor to CHAB growth because nutrients are not a limiting factor under existing conditions. Hence, any potential small increases in nutrients that may occur for the project alternatives, would not cause an increase in the frequency or magnitude of CHABs in Delta waters, relative to existing conditions.

Hydraulic Residence Time

As described above, project alternatives would have little, if any, effect on water temperatures, nutrients, velocities and associated turbulence and mixing, and water clarity and associated irradiance. This section evaluates how project alternatives could affect CHABs within the Delta through changes in Delta hydrodynamics and associated effects on residence time (i.e., the amount of time water remains within a given area of the Delta). Delta residence time can affect the degree to which CHABs accumulate and aggregate in different Delta regions. Aggregation refers to cells or small cell colonies coalescing to form larger colonies while accumulation refers to the collection of colonies that can sometimes form surface scums or mats.

Since water temperatures would be negligibly, if any, different than existing conditions, the project alternatives would also not affect *Microcystis* and other cyanobacteria growth rates. If project alternatives increase residence time in the Delta, bloom size would not increase in an area due to increased growth rates (controlled by water temperature and other environmental variables unaffected by the project alternatives). Rather, bloom size in a particular area could increase through continued growth (at the same growth rate as under existing conditions) for the longer period of time, aggregation of what is produced, and colony accumulation prior to cells ultimately being flushed from the area.

Based on laboratory studies in the literature, cell doubling time for *Microcystis* range from 0.6 to 5.2 days (Wilson et al. 2006:7386; Lürling et al. 2013:555; You et al. 2018:22), depending on a number of factors including species of *Microcystis* and water temperature. Water temperatures from 20°C to 32°C (68°F to 89.6°F) promote the fastest growth rates with doubling times ranging from 0.6 to 2.8 days (Wilson et al. 2006:7386; Lürling et al. 2013:555; You et al. 2018:22). Under most conditions in the Delta, where environmental conditions for growth are not at ideal levels and competition with other algae, grazing losses, and net downstream movement of water are all co-occurring, *Microcystis* would be expected to typically require one or more days to substantially increase bloom size through cell growth.

For *Microcystis* blooms to form, there must be sufficient growth rates to produce the biomass and relatively weak hydrodynamics that allow cyanobacteria cells to remain at a site (versus being flushed out of the area) and aggregate. Coalescence of small colonies (i.e., groups of cyanobacteria cells) into larger aggregates allows cell biomass to accumulate in the water column (Wu et al. 2019:5). Several factors affect cell aggregation, and unlike growth rates, the length of time it takes for cells to accumulate and aggregate to form a substantial bloom in the Delta remains unknown. Factors such as windspeed and small-scale turbulence likely play an important role in the aggregation aspect of bloom development, yet these factors generally remain unexplored (Wu et al. 2019:8). Accumulation of cells in an area where they are not produced is dependent upon the concentration of cells coming into the area compared to the concentration of cells leaving the area, both of which are highly variable both spatially and temporally in the Delta.

Instead of the paint-like scum usually associated with *Microcystis* blooms, in the Delta *Microcystis* is often characterized by large (up to 1 cm) flakes that are distributed throughout the photic zone of the water column. The cells are patchy both horizontally and vertically. Substantial accumulation of cells can form a “scum layer” or “mat” at the surface in slower moving edge-water habitats of channels, backwater areas, and sloughs within the Delta. Scums typically have higher toxin concentrations; however, on average only 20% of *Microcystis* cells within the Delta contain microcystins—the toxin most commonly produced by this cyanobacteria (Lehman et al. 2017:95).

Hydraulic residence time at various locations within the Delta was assessed directly using the QUAL module of the DSM2 model. As described above, the nine Delta assessment locations and several other locations were assessed to understand how project alternatives could potentially affect water residence time in approximately 3- to 9-mile channel reaches across the Delta. Based on the hydrology an approximately 1-mile reach of the channels surrounding Mildred Island was modeled and a 12-mile channel reach in the vicinity of Venice island was modeled. Hydraulic residence time was also modeled for the open waterbodies of Discovery Bay, Franks Tract, and Mildred Island. To assess the incremental increases in residence times modeled for various locations in the Delta for the project alternatives relative to existing conditions, both the residence time of the site itself (defined as the modeled number of hours required to flush 90% of the water from the modeled reach) and the incremental increase in residence time due to the project alternatives were considered.

DSM2 modeling has inherent limitations in simulating the hydrodynamics in the open water areas, including the flooded islands, of the Delta. For open waterbodies, DSM2 assumes uniform and instantaneous mixing over the entire open water area. Thus, it does not account for any variations in localized hydrodynamic conditions (e.g., circulation patterns) that likely exist within the open waterbodies. Residence time within portions of an open waterbody can vary based on such site-specific conditions, which DSM2 cannot model. Hence, the output from DSM2 for the open water areas can only provide a rough estimate of residence time for the entire waterbody and a general indication of whether the project alternatives would be expected to increase or decrease residence times for the entire open waterbody and does not provide any information about site-specific conditions in the open waterbodies that may be important for CHABs. Hence, DSM2 cannot provide definitive residence time estimates for open waterbodies or definitive estimates for changes in residence time due to the project alternatives for open waterbodies. These limitations of the model were considered when interpreting modeled residence times for the open waterbodies.

Additionally, reported effects of residence time increases in closed bodies of waters such as lakes and reservoirs on *Microcystis* growth cannot be used to identify potential effects of the project alternatives on CHABs in the Delta. Residence time-associated temperature increases in the upper portion of the water column in lakes and reservoirs are associated with reduced vertical mixing and prolonged stratification, which favor increased *Microcystis* growth (You et al. 2018:17 [and references within]). The relatively shallow and tidal nature of the Delta prevents much of the area from experiencing thermal stratification.

Table 9-47. Modeled Median Residence Time in Hours Using DSM2 for Existing Conditions and Project Alternatives for Locations with Short Residence Time (i.e., ≤ 72 hours [3 days])

	Alternative					
Location/Month	Existing Conditions	1 & 3 (6,000 cfs)	2a & 4a (7,500 cfs)	2b & 4b (3,000 cfs)	2c & 4c (4,500 cfs)	5 (6,000 cfs Bethany)
Brannan Island						
June	3	3 (0)	3 (0)	3 (0)	3 (0)	3 (0)
July	3	3 (0)	3 (0)	3 (0)	3 (0)	3 (0)
August	2	2 (0)	2 (0)	2 (0)	2 (0)	2 (0)
September	2	2 (0)	2 (0)	2 (0)	2 (0)	2 (0)
October	2	2 (0)	2 (0)	2 (0)	2 (0)	2 (0)
November	2	2 (0)	2 (0)	2 (0)	2 (0)	2 (0)
Discovery Bay Channels						
June	51	52 (1)	52 (1)	52 (1)	52 (1)	52 (1)
July	27	28 (1)	28 (1)	28 (1)	28 (1)	28 (1)
August	25	25 (0)	25 (0)	25 (0)	25 (0)	25 (0)
September	30	32 (2)	32 (2)	32 (2)	33 (3)	32 (2)
October	41	41 (0)	41 (0)	39 (-2)	39 (-2)	41 (0)
November	32	34 (2)	33 (1)	34 (2)	34 (2)	34 (2)
Franks Tract Channels						
June	4	4 (0)	4 (0)	4 (0)	4 (0)	4 (0)
July	3	3 (0)	3 (0)	3 (0)	3 (0)	3 (0)
August	3	3 (0)	3 (0)	3 (0)	3 (0)	3 (0)
September	3	3 (0)	3 (0)	3 (0)	3 (0)	3 (0)
October	3	3 (0)	3 (0)	3 (0)	3 (0)	3 (0)
November	4	4 (0)	4 (0)	4 (0)	4 (0)	4 (0)
Middle River from Woodward Island to Mildred Island						
June	31	32 (1)	32 (1)	31 (0)	32 (1)	32 (1)
July	18	19 (1)	20 (2)	19 (1)	19 (1)	19 (1)
August	21	21 (0)	21 (0)	20 (-1)	21 (0)	21 (0)
September	22	23 (1)	23 (1)	23 (1)	24 (2)	23 (1)
October	24	25 (1)	25 (1)	25 (1)	25 (1)	25 (1)
November	18	19 (1)	19 (1)	18 (0)	18 (0)	19 (1)

	Alternative					
Location/Month	Existing Conditions	1 & 3 (6,000 cfs)	2a & 4a (7,500 cfs)	2b & 4b (3,000 cfs)	2c & 4c (4,500 cfs)	5 (6,000 cfs Bethany)
Mildred Island Channels						
June	5	5 (0)	5 (0)	5 (0)	5 (0)	5 (0)
July	5	5 (0)	5 (0)	5 (0)	5 (0)	5 (0)
August	5	5 (0)	5 (0)	5 (0)	5 (0)	5 (0)
September	4	4 (0)	4 (0)	4 (0)	4 (0)	4 (0)
October	4	4 (0)	4 (0)	4 (0)	4 (0)	4 (0)
November	5	5 (0)	5 (0)	5 (0)	5 (0)	5 (0)
Mokelumne River						
June	6	6 (0)	6 (0)	6 (0)	6 (0)	6 (0)
July	6	6 (0)	6 (0)	6 (0)	6 (0)	6 (0)
August	6	6 (0)	6 (0)	6 (0)	6 (0)	6 (0)
September	6	6 (0)	6 (0)	6 (0)	6 (0)	6 (0)
October	8	7 (-1)	7 (-1)	8 (0)	8 (0)	7 (-1)
November	8	**9 (1)**	8 (0)	**9 (1)**	**9 (1)**	**9 (1)**
Old River at Rock Slough						
June	25	24 (-1)	25 (0)	24 (-1)	25 (0)	24 (-1)
July	15	16 (1)	16 (1)	16 (1)	16 (1)	16 (1)
August	17	18 (1)	18 (1)	18 (1)	18 (1)	18 (1)
September	17	18 (1)	18 (1)	18 (1)	18 (1)	18 (1)
October	17	17 (0)	17 (0)	17 (0)	17 (0)	17 (0)
November	13	13 (0)	14 (1)	13 (0)	13 (0)	13 (0)
San Joaquin River at Jersey Point						
June	4	4 (0)	4 (0)	4 (0)	4 (0)	4 (0)
July	3	3 (0)	3 (0)	3 (0)	3 (0)	3 (0)
August	3	3 (0)	3 (0)	3 (0)	3 (0)	3 (0)
September	3	3 (0)	3 (0)	3 (0)	3 (0)	3 (0)
October	3	3 (0)	3 (0)	3 (0)	3 (0)	3 (0)
November	3	3 (0)	3 (0)	3 (0)	3 (0)	3 (0)
Victoria Canal						
June	16	16 (0)	16 (0)	16 (0)	16 (0)	16 (0)
July	8	**9 (1)**	**9 (1)**	**9 (1)**	**9 (1)**	**9 (1)**
August	10	10 (0)	10 (0)	10 (0)	10 (0)	10 (0)
September	12	13 (1)	13 (1)	13 (1)	13 (1)	13 (1)
October	14	15 (1)	15 (1)	15 (1)	14 (0)	15 (1)
November	11	11 (0)	11 (0)	11 (0)	11 (0)	11 (0)

Note: Change in residence time in hours for project alternatives, relative to existing conditions, are in parentheses. Negative values indicate a shorter residence time under the project alternative. Increases longer than 24 hours or greater than 10% are bolded.

The following assessment focuses on median modeled residence time. However, residence time at the 25th, 75th, 90th, and other percentiles also were considered (Appendix 9E, Tables 9E-3-1-1 through 9E-3-15-6). For the purposes of this assessment, increases in modeled median residence time under project alternatives that were 24 hours (1 day) or greater, or 10% greater, relative to existing conditions, received additional analysis as described in detail below. As described above there are inherent limitations in modeling residence time within open waterbodies. As such, Franks Tract and Mildred Island also received additional analysis even though increases in residence time were modeled to be below the 24-hour/10% increase identified above. These same parameters also were used in assessing changes in residence time at other percentiles of occurrence. As discussed above, based on the growth studies cited, increased residence time of 24 hours (i.e., 1 day) or more could potentially provide sufficient additional time to allow additional growth (i.e., cell production), accumulation, and aggregation of cells at a site. However, there is a great deal of uncertainty that exists regarding interpretation of this residence time modeling because no scientific studies have been performed or published that specifically correlate area-specific residence times within the Delta (as modeled) to cyanobacteria bloom size, or changes in bloom size over time, in specific areas of the Delta.

Depending on location and month, the project alternatives would result in increases, decreases, or no change in modeled median residence time at specific locations for the full simulation period, relative to existing conditions. The project alternatives would have little to no effect on median residence time for all locations with short residence time (Table 9-47). At each of these locations, the median residence time was shown to increase by 3 hours or less. Residence times corresponding to the 25th, 75th, and 90th percentiles also show that the project alternatives would have little, if any, effect on residence time at these Delta locations, relative to existing conditions (Table 9-47). In areas where median residence time are relatively short (i.e., 72 hours or less), an increase of up to 3 hours would not provide enough additional time to allow substantial additional growth and accumulation and aggregation of cells, relative to existing conditions. Any negligible changes in growth and accumulation and aggregation of cells at these locations that may occur from such small increases in residence times would not be sufficiently large to cause effects on beneficial uses that would differ from those that would occur for existing conditions. This is true even if there is a 10% increase in residence time (e.g., an increase in median residence time from 8 to 9 hours at Victoria Canal in July) because the absolute magnitude of increase in residence time would not result in conditions substantially more conducive to CHABs, relative to existing conditions.

Modeling showed larger changes in median residence time under the project alternatives (both positive and negative) at locations with median residence times greater than 72 hours (3 days) (Table 9-48). These locations and changes in residence time under the project alternatives, relative to existing conditions, are discussed in detail below.

Stockton Waterfront

Modeled residence time for the 25th percentile, median, 75th percentile, and 90th percentile at the Stockton Waterfront for the full simulation period for the project alternatives, relative to existing conditions, generally show a decrease, or no change in the months June through November (Table 9-48; refer to Appendix 9E, Tables 9E-3-7-1 to 9E-3-7-6 and Figure 9E-3-7). Occasionally there is a small increase (i.e., up to 7 hours) in residence time, but never an increase of 10% or greater.

Table 9-48. Residence Time in Hours Modeled Using DSM2 for Existing Conditions and Project Alternatives, Stockton Deep Water Ship Channel

	Alternative					
Month	Existing Conditions	1, 3 (6,000 cfs)	2a, 4a (7,500 cfs)	2b, 4b (3,000 cfs)	2c, 4c (4,500 cfs)	5 (6,000 cfs Bethany)
25th Percentile						
June	370	370 (0)	369 (-1)	369 (-1)	369 (-1)	370 (0)
July	407	405 (-2)	405 (-2)	407 (0)	402 (-5)	405 (-2)
August	455	455 (0)	455 (0)	458 (3)	455 (0)	455 (0)
September	436	435 (-1)	436 (0)	435 (-1)	435 (-1)	435 (-1)
October	393	394 (1)	394 (1)	394 (1)	394 (1)	394 (1)
November	452	448 (-4)	447 (-5)	452 (0)	451 (-1)	448 (-4)
50th (Median) Percentile						
June	414	412 (-2)	412 (-2)	412 (-2)	412 (-2)	412 (-2)
July	496	480 (-16)	480 (-16)	484 (-12)	484 (-12)	480 (-16)
August	541	530 (-11)	526 (-15)	534 (-7)	534 (-7)	530 (-11)
September	477	471 (-6)	470 (-7)	471 (-6)	471 (-6)	471 (-6)
October	419	420 (1)	420 (1)	418 (-1)	420 (1)	420 (1)
November	487	479 (-8)	479 (-8)	484 (-3)	479 (-8)	479 (-8)
75th Percentile						
June	465	465 (0)	465 (0)	468 (3)	467 (2)	465 (0)
July	624	595 (-29)	587 (-37)	595 (-29)	595 (-29)	610 (-14)
August	616	613 (-3)	616 (0)	616 (0)	614 (-2)	613 (-3)
September	530	512 (-18)	508 (-22)	517 (-13)	512 (-18)	512 (-18)
October	441	441 (0)	441 (0)	441 (0)	441 (0)	441 (0)
November	555	528 (-27)	538 (-17)	536 (-19)	536 (-19)	528 (-27)
90th Percentile						
June	544	524 (-20)	520 (-24)	530 (-14)	524 (-20)	524 (-20)
July	844	805 (-39)	801 (-43)	831 (-13)	833 (-11)	805 (-39)
August	731	729 (-2)	721 (-10)	738 (7)	731 (0)	731 (0)
September	568	554 (-14)	554 (-14)	555 (-13)	555 (-13)	554 (-14)
October	463	458 (-5)	458 (-5)	458 (-5)	456 (-7)	458 (-5)
November	604	583 (-21)	581 (-23)	583 (-21)	583 (-21)	583 (-21)

Note: Change in residence time in hours for project alternatives, relative to existing conditions, are in parentheses. Negative values indicate a shorter residence time under the project alternative.

The largest decreases in median residence time were modeled to occur from July to September (i.e., during the peak bloom season). The maximum modeled decrease in median residence time at the Stockton Waterfront (i.e., 16-hour decrease) occurs in July. Thus, when the greatest decreases in median residence time occur, the median residence times decrease from 496 hours (20.6 days) to 480 hours (20 days). Similarly, when the greatest modeled decrease occurs (i.e., decrease of 43 hours in July for the 90th percentile), residence time decreases from 844 hours (35.2 days) to 801 hours (33.4 days)

Although decreases in residence time were modeled to occur at the Stockton Waterfront, there is unlikely to be any change in the density or extent of *Microcystis* and other cyanobacteria at this location relative to existing conditions. Any such decreases in residence time under the project alternatives would not be of sufficient magnitude to change *Microcystis* dynamics (i.e., growth rates, accumulation, or aggregation) as residence times would continue to be long and conditions would remain favorable to support *Microcystis* growth, accumulation, and aggregation similar to existing conditions.

Old River at Clifton Court Forebay

In Old River at Clifton Court Forebay median modeled residence time is generally shorter for the project alternatives, relative to existing conditions, from June through September (Table 9-49; refer to Appendix 9E, Tables 9E-3-7-1 to 9E-3-7-6 and Figure 9E-3-7). Median residence time in October and November under project alternatives are nearly identical to median residence time under existing conditions. Changes in residence time at the other percentiles are variable with decreases in some months and increases in other months. Changes in residence time at the 25th percentile range from a decrease of 51 hours in September to an increase of 7 hours in July. Changes in residence time in the 75th percentile range from a decrease of 42 hours in July to an increase of 24 hours in November. Changes in residence time for the 90th percentile range from a decrease of 48 hours in November to an increase of 11 hours in June.

Table 9-49. Residence Time in Hours Modeled Using DSM2 for Existing Conditions and Project Alternatives, Old River South of Clifton Court Forebay

	Alternative					
Month	Existing Conditions	1, 3 (6,000 cfs)	2a, 4a (7,500 cfs)	2b, 4b (3,000 cfs)	2c, 4c (4,500 cfs)	5 (6,000 cfs Bethany)
25th Percentile						
June	71	68 (-3)	69 (-2)	68 (-3)	68 (-3)	68 (-3)
July	108	115 (7)	115 (7)	114 (6)	115 (7)	115 (7)
August	136	135 (-1)	134 (-2)	135 (-1)	135 (-1)	135 (-1)
September	227	189 (-38)	201 (-26)	176 (-51)	176 (-51)	189 (-38)
October	50	50 (0)	50 (0)	50 (0)	50 (0)	50 (0)
November	65	65 (0)	64 (-1)	64 (-1)	65 (0)	65 (0)
50th (Median) Percentile						
June	184	182 (-2)	174 (-10)	180 (-4)	182 (-2)	180 (-4)
July	368	333 (-35)	325 (-43)	339 (-29)	333 (-35)	333 (-35)
August	342	340 (-2)	324 (-18)	335 (-7)	333 (-9)	340 (-2)
September	318	310 (-8)	311 (-7)	314 (-4)	309 (-9)	310 (-8)
October	74	74 (0)	73 (-1)	72 (-2)	73 (-1)	74 (0)
November	83	84 (1)	83 (0)	82 (-1)	84 (1)	84 (1)
75th Percentile						
June	417	392 (-25)	411 (-6)	413 (-4)	413 (-4)	392 (-25)

	Alternative					
Month	Existing Conditions	1, 3 (6,000 cfs)	2a, 4a (7,500 cfs)	2b, 4b (3,000 cfs)	2c, 4c (4,500 cfs)	5 (6,000 cfs Bethany)
July	593	553 (-40)	562 (-31)	581 (-12)	551 (-42)	553 (-40)
August	654	641 (-13)	631 (-23)	642 (-12)	646 (-8)	641 (-13)
September	332	337 (5)	334 (2)	337 (5)	336 (4)	337 (5)
October	88	88 (0)	89 (1)	84 (-4)	84 (-4)	88 (0)
November	170	**194 (24)**	187 (17)	**193 (23)**	**193 (23)**	**193 (23)**
90th Percentile						
June	643	654 (11)	649 (6)	651 (8)	652 (9)	654 (11)
July	693	676 (-17)	680 (-13)	668 (-25)	663 (-30)	676 (-17)
August	718	716 (-2)	723 (5)	716 (-2)	716 (-2)	716 (-2)
September	344	349 (5)	348 (4)	351 (7)	349 (5)	349 (5)
October	118	112 (-6)	112 (-6)	113 (-5)	112 (-6)	112 (-6)
November	368	320 (-48)	301 (-67)	353 (-15)	331 (-37)	319 (-49)

Note: Change in residence time in hours for project alternatives, relative to existing conditions, are in parentheses. Negative values indicate a shorter residence time under the project alternative. Increases longer than 24 hours or greater than 10% are bolded.

Modeled median residence time under existing conditions during the July through September period ranges from 318 to 368 hours (13.3 to 15.3 days). The maximum modeled decrease in median residence time at Old River at Clifton Court Forebay (i.e., up to 43-hour decrease) occurs in July. It is possible that these decreases in median residence time under the project alternatives in July and a 51 hour (22.5%) decrease in 25th percentile residence time in September could result in some decreases in the density and extent of *Microcystis* or other cyanobacteria in Old River at Clifton Court Forebay, relative to existing conditions. This is because cyanobacteria cells would have substantially less time to grow, aggregate, and accumulate at this location than under existing conditions. However, increases or decreases in residence time of this magnitude would not be sufficient to cause substantial changes in *Microcystis* growth, accumulation, and aggregation. Although decreases in residence time also occur in other months, these smaller decreases in residence time are not sufficient to change *Microcystis* dynamics (i.e., growth rates, accumulation, or aggregation) as residence time would continue to be long and conditions would remain favorable to support *Microcystis* growth, accumulation, and aggregation similar to existing conditions.

The largest modeled increase in residence time occurs in November at the 75th percentile when residence time increases by up to 24 hours (i.e., increase by approximately 14%). Residence time corresponding to the other percentiles in November either decrease or remain identical to those that occur under existing conditions. It is possible for cyanobacteria to be present and continue to grow in November; however, after the peak growing season (i.e., July through September) there are rarely, if ever, any substantial blooms. This is due largely to the decrease in water temperatures and slower corresponding growth rates. Based on relatively cool water temperatures, the tidal nature of the waterbody, water column mixing, other environmental factors, and absolute residence time, the project alternatives' effects on residence time would not be sufficient to allow for substantial increases in cell density or the formation of surface scums, relative to existing conditions. As such, increases in residence time in November that could occur under the project alternatives would not cause CHAB frequency or magnitude to change enough to negatively affect any beneficial use in Old River at Clifton Court Forebay, relative to existing conditions.

San Joaquin River near Venice Island

In the San Joaquin River near Venice Island, model results show median residence time generally increases under all alternatives for the full simulation period for the months of July through November (Table 9-50; refer to Appendix 9E, Tables 9E-3-10-1 to 9E-3-10-6 and Figure 9E-3-10). Median residence time in June under project alternatives is nearly identical to median residence time under existing conditions. The largest increases in modeled median residence time occur in September when median residence time increases by 13 to 14 hours under project alternatives, relative to existing conditions (Table 9-50). Residence time for the 25th and 90th percentiles show similar changes as those for the median. Residence time in the 75th percentile increases by 7 hours or less in June, August, September, and October. However, in July and November residence time in the 75th percentile increases by 13 to 18 hours and by 16 to 32 hours, respectively.

Table 9-50. Residence Time in Hours Modeled Using DSM2 for Existing Conditions and Project Alternatives, San Joaquin River near Venice Island

	Alternative					
Month	Existing Conditions	1, 3 (6,000 cfs)	2a, 4a (7,500 cfs)	2b, 4b (3,000 cfs)	2c, 4c (4,500 cfs)	5 (6,000 cfs Bethany)
25th Percentile						
June	90	88 (-2)	88 (-2)	88 (-2)	88 (-2)	88 (-2)
July	71	**79 (8)**	**79 (8)**	**79 (8)**	**79 (8)**	**79 (8)**
August	81	81 (0)	81 (0)	81 (0)	81 (0)	81 (0)
September	92	96 (4)	94 (2)	96 (4)	96 (4)	96 (4)
October	104	106 (2)	106 (2)	106 (2)	105 (1)	106 (2)
November	82	82 (0)	82 (0)	82 (0)	82 (0)	82 (0)
50th (Median) Percentile						
June	130	129 (-1)	129 (-1)	130 (0)	128 (-2)	129 (-1)
July	87	**98 (11)**	**98 (11)**	**98 (11)**	**98 (11)**	**98 (11)**
August	94	99 (5)	98 (4)	98 (4)	98 (4)	99 (5)
September	115	**129 (14)**	**128 (13)**	**128 (13)**	**128 (13)**	**129 (14)**
October	143	147 (4)	147 (4)	147 (4)	146 (3)	147 (4)
November	105	104 (-1)	105 (0)	106 (1)	105 (0)	104 (-1)
75th Percentile						
June	154	157 (3)	157 (3)	156 (2)	154 (0)	157 (3)
July	104	**121 (17)**	**122 (18)**	**117 (13)**	**122 (18)**	**121 (17)**
August	131	131 (0)	133 (2)	133 (2)	131 (0)	131 (0)
September	159	160 (1)	160 (1)	159 (0)	160 (1)	160 (1)
October	188	195 (7)	191 (3)	194 (6)	191 (3)	194 (6)
November	165	181 (16)	**197 (32)**	**182 (17)**	181 (16)	181 (16)
90th Percentile						
June	187	187 (0)	188 (1)	185 (-2)	186 (-1)	187 (0)

	Alternative					
Month	Existing Conditions	1, 3 (6,000 cfs)	2a, 4a (7,500 cfs)	2b, 4b (3,000 cfs)	2c, 4c (4,500 cfs)	5 (6,000 cfs Bethany)
July	170	166 (-4)	164 (-6)	164 (-6)	169 (-1)	166 (-4)
August	197	205 (8)	206 (9)	202 (5)	204 (7)	205 (8)
September	181	187 (6)	189 (8)	187 (6)	187 (6)	187 (6)
October	234	227 (-7)	226 (-8)	228 (-6)	226 (-8)	226 (-8)
November	225	229 (4)	231 (6)	228 (3)	230 (5)	229 (4)

Note: Change in residence time in hours for project alternatives, relative to existing conditions, are in parentheses. Negative values indicate a shorter residence time under the project alternative. Increases longer than 24 hours or greater than 10% are bolded.

In July and September there is a 10% or greater increase in median modeled residence time and in July a 15% increase in residence time in the 75th percentile, relative to existing conditions. Although modeled residence time in the 75th percentile increases by up to approximately 18 hours at this location in July and median residence time increases up to approximately 14 hours in September, these increases are not sufficient time to increase the magnitude or severity of CHABs, for several reasons. First, the other four drivers (i.e., temperature, velocity, nutrients, and irradiance) would not change under the project alternatives, relative to existing conditions. Second, although it is possible for some additional growth, accumulation, and aggregation to occur in July and September, there would continue to be competition with other algae, grazing losses, virus losses, and net downstream movement of water that are co-occurring during periods of increased residence time. Third, this area would continue to be tidally influenced and experience both tidal and wind-induced velocity that would interfere with *Microcystis* life history strategy. Finally, although *Microcystis* and other cyanobacteria have been observed at this location, it is not recognized as a primary cyanobacteria producer in the Delta like backwater slough areas and channel margins where residence time is on the order of 2 weeks or more.

The greatest increase in residence time in the San Joaquin River near Venice Island was modeled to occur in November at the 75th percentile. Residence time in the 75th percentile increases by 16 to 17 hours under Alternatives 1, 2b, 2c, 3, 4b, 4c, and 5 and by 32 hours under Alternatives 2a and 4a. Thus, in November residence time in the 75th percentile increases from 165 hours (6.9 days) under existing conditions to 197 hours (8.2 days) under Alternatives 2a and 4a. Although it is possible for cyanobacteria to be present, and continue to grow in November, after the peak growing season (i.e., July through September) there are rarely, if ever, any substantial blooms in November. Importantly, no substantial cyanobacteria presence has ever been observed in the San Joaquin River near Venice Island in November. This is because water temperatures are substantially cooler in November than earlier in the season, causing growth rates to substantially decline and cells to settle out of the water column into the benthos. Due to the cooler water temperatures and lower overall cyanobacteria biomass in November, the modeled increase in residence time of up to 32 hours would not substantially increase growth or presence of *Microcystis* or other cyanobacteria relative to existing conditions. Further, as described above, there would continue to be competition with other algae, grazing losses, virus losses, and net downstream movement of water that co-occur during periods of increased residence time. Although it is possible for some additional growth and cell aggregation to occur, this would not be expected to result in substantially larger blooms than would occur under existing conditions. As such, modeled increases in the 75th percentile residence time of up to 32 hours would not lead to conditions that would negatively affect beneficial uses, relative to existing conditions in the San Joaquin River near Venice Island.

Mildred Island

At Mildred Island, the modeled median residence time for the full simulation period under the project alternatives, relative to existing conditions, show little to no change in residence time for June and November (Table 9-51; refer to Appendix 9E, Tables 9E-3-8-1 to 9E-3-8-6 and Figure 9E-3-8). Under all project alternatives there are increases in median residence time in July, August, September, and October. The largest increase in median residence time of 20 hours occurs in October for Alternatives 2b and 4b. Under the other alternatives, median residence time in October increases by 14 to 17 hours, relative to existing conditions. Modeled residence time corresponding to the 25th, 75th, and 90th percentiles show that the project alternatives would have varying levels of effect on residence time with similar ranges to those reported for the median residence time. Changes in residence time at the 25th percentile range from a decrease of 2 hours in June to an increase of 13 hours in July. Changes in residence time in the 75th percentile range from a decrease of 17 hours in October to an increase of 21 hours in November. Finally, changes in residence time in the 90th percentile range from a decrease of 22 hours in August to an increase of 13 hours in June. All modeled increases in residence time under the project alternatives are less than 24 hours and less than 10%, relative existing conditions.

Table 9-51. Residence Time in Hours Modeled Using DSM2 for Existing Conditions and Project Alternatives, Mildred Island

	Alternative					
Month	Existing Conditions	1, 3 (6,000 cfs)	2a, 4a (7,500 cfs)	2b, 4b (3,000 cfs)	2c, 4c (4,500 cfs)	5 (6,000 cfs Bethany)
25th Percentile						
June	283	281 (-2)	282 (-1)	283 (0)	282 (-1)	281 (-2)
July	196	209 (13)	208 (12)	208 (12)	208 (12)	209 (13)
August	204	207 (3)	206 (2)	206 (2)	206 (2)	207 (3)
September	219	230 (11)	227 (8)	225 (6)	230 (11)	230 (11)
October	240	243 (3)	243 (3)	243 (3)	241 (1)	245 (5)
November	202	203 (1)	203 (1)	203 (1)	203 (1)	203 (1)
50th (Median) Percentile						
June	289	287 (-2)	288 (-1)	288 (-1)	287 (-2)	287 (-2)
July	210	218 (8)	218 (8)	217 (7)	219 (9)	218 (8)
August	210	219 (9)	217 (7)	217 (7)	218 (8)	219 (9)
September	245	256 (11)	257 (12)	255 (10)	256 (11)	256 (11)
October	279	296 (17)	296 (17)	299 (20)	293 (14)	296 (17)
November	226	228 (2)	227 (1)	229 (3)	228 (2)	228 (2)
75th Percentile						
June	320	322 (2)	322 (2)	315 (-5)	321 (1)	322 (2)
July	232	241 (9)	241 (9)	241 (9)	238 (6)	241 (9)
August	278	264 (-14)	264 (-14)	265 (-13)	264 (-14)	264 (-14)

	Alternative					
Month	Existing Conditions	1, 3 (6,000 cfs)	2a, 4a (7,500 cfs)	2b, 4b (3,000 cfs)	2c, 4c (4,500 cfs)	5 (6,000 cfs Bethany)
September	296	303 (7)	308 (12)	297 (1)	300 (4)	303 (7)
October	349	339 (-10)	342 (-7)	339 (-10)	332 (-17)	339 (-10)
November	312	327 (15)	333 (21)	329 (17)	329 (17)	327 (15)
90th Percentile						
June	408	421 (13)	421 (13)	416 (8)	416 (8)	421 (13)
July	361	370 (9)	373 (12)	378 (17)	367 (6)	370 (9)
August	420	398 (-22)	407 (-13)	411 (-9)	413 (-7)	398 (-22)
September	335	340 (5)	338 (3)	336 (1)	342 (7)	339 (4)
October	427	421 (-6)	421 (-6)	421 (-6)	421 (-6)	421 (-6)
November	421	420 (-1)	427 (6)	427 (6)	419 (-2)	420 (-1)

Note: Change in residence time in hours for project alternatives, relative to existing conditions, are in parentheses. Negative values indicate a shorter residence time under the project alternative. Increases longer than 24 hours or greater than 10% are bolded.

Under Alternatives 2b and 4b, Mildred Island median October residence time was modeled to increase by 20 hours, from 279 hours (11.6 days) to 299 hours (12.5 days). During October, water temperatures are substantially cooler than during the peak CHAB season of July through early September (Appendix 9E, Figures 9E-1-1-1 through 9E-1-11-6). As such, the growth rates of cyanobacteria are lower and there is substantially less biomass in the water column relative to the peak growth period. Further, modeling showed that both the 75th and 90th percentiles residence time decrease in October rather than increase for the project alternatives. Considering these factors, along with continued competition with other algae, grazing losses, virus losses, and net downstream movement of water, an increase of up to about 20 hours in residence time at Mildred Island in October, when residence time is on the order of 11 to 12 days, would not be expected to substantially increase growth, accumulation, and aggregation of cyanobacteria, relative to that which would occur for existing conditions. Although it is possible for some additional growth and cell aggregation to occur, this would not be expected to result in substantially larger blooms for the project alternatives than would occur at this location under existing conditions. The same findings are also applicable to the increased residence time for the 75th percentile of 21 hours under Alternatives 2a and 4a in November. In November water temperatures are even cooler than October and *Microcystis* growth rates slow considerably. As such, increases of 21 hours in residence time in November would not result in substantially larger blooms than those that would occur under existing conditions.

Based on the discussion above, it can be concluded that for the project alternatives during the July through September period there may be a small increase in the number of *Microcystis* flakes (from an aggregation of cells) floating within the water column. However, based on growth rates, the tidal nature of the waterbody, water column mixing, other environmental factors, and absolute residence time, the project alternatives' effects on residence time would not be sufficient to allow for substantial increases in cell density or the formation of surface scums, relative to existing conditions. As such, the relatively small increases in residence time that could occur for the project alternatives would not cause CHAB frequency or magnitude to change enough to negatively affect any beneficial use at Mildred Island, relative to existing conditions.

Franks Tract

Changes in modeled median residence time for the project alternatives, relative to existing conditions, are variable with no change in some months to a small increase in other months (Table 9-52; refer to Appendix 9E, Tables 9E-3-5-1 to 9E-3-5-6 and Figure 9E-5-8). The maximum increase in median residence time is up to 6 hours in August under Alternatives 2c and 4c and in October under Alternatives 2a and 4a. Modeled 25th percentile and 90th percentile changes in residence time are similar to those reported for the median. The greatest change in residence time occurs in the 75th percentile when residence time increases by 10 to 14 hours in September and by 16 to 21 hours in November. All modeled increases in residence time under the project alternatives would be less than 24 hours and less than 10%, relative to existing conditions.

Table 9-52. Residence Time in Hours Modeled Using DSM2 for Existing Conditions and Project Alternatives, Franks Tract

	Alternative					
Month	Existing Conditions	1, 3 (6,000 cfs)	2a, 4a (7,500 cfs)	2b, 4b (3,000 cfs)	2c, 4c (4,500 cfs)	5 (6,000 cfs Bethany)
25th Percentile						
June	289	288 (-1)	288 (-1)	288 (-1)	288 (-1)	288 (-1)
July	273	280 (7)	280 (7)	278 (5)	280 (7)	280 (7)
August	278	281 (3)	280 (2)	280 (2)	280 (2)	281 (3)
September	283	289 (6)	289 (6)	289 (6)	289 (6)	289 (6)
October	296	297 (1)	297 (1)	298 (2)	296 (0)	297 (1)
November	268	268 (0)	268 (0)	269 (1)	268 (0)	268 (0)
50th (Median) Percentile						
June	311	311 (0)	311 (0)	311 (0)	311 (0)	311 (0)
July	283	287 (4)	287 (4)	286 (3)	286 (3)	287 (4)
August	292	297 (5)	297 (5)	294 (2)	298 (6)	297 (5)
September	303	305 (2)	305 (2)	305 (2)	305 (2)	305 (2)
October	315	317 (2)	321 (6)	316 (1)	317 (2)	317 (2)
November	290	293 (3)	293 (3)	293 (3)	293 (3)	293 (3)
75th Percentile						
June	322	320 (-2)	320 (-2)	319 (-3)	319 (-3)	320 (-2)
July	297	303 (6)	302 (5)	305 (8)	303 (6)	303 (6)
August	332	338 (6)	337 (5)	337 (5)	337 (5)	338 (6)
September	335	348 (13)	345 (10)	348 (13)	349 (14)	348 (13)
October	362	362 (0)	361 (-1)	360 (-2)	360 (-2)	362 (0)
November	325	343 (18)	346 (21)	341 (16)	344 (19)	343 (18)
90th Percentile						
June	352	352 (0)	348 (-4)	353 (1)	348 (-4)	352 (0)
July	351	351 (0)	353 (2)	353 (2)	350 (-1)	355 (4)
August	381	378 (-3)	378 (-3)	377 (-4)	378 (-3)	378 (-3)
September	377	382 (5)	384 (7)	381 (4)	381 (4)	382 (5)

	Alternative					
Month	Existing Conditions	1, 3 (6,000 cfs)	2a, 4a (7,500 cfs)	2b, 4b (3,000 cfs)	2c, 4c (4,500 cfs)	5 (6,000 cfs Bethany)
October	409	410 (1)	409 (0)	409 (0)	415 (6)	410 (1)
November	391	391 (0)	393 (2)	386 (-5)	391 (0)	391 (0)

Note: Change in residence time in hours for project alternatives, relative to existing conditions, are in parentheses. Negative values indicate a shorter residence time under the project alternative. Increases longer than 24 hours or greater than 10% are bolded.

Modeled median and 75th percentile residence times in Franks Tract under existing conditions are relatively long (i.e., from 283 to 315 hours [11.8–13.1 days] and 297 to 362 hours [12.4–15.0 days], respectively). These long residence times are conducive to cyanobacteria aggregation, and *Microcystis* flakes are routinely observed at this location (ESA 2022:5). Modeled increases in residence time for the 75th percentile in September and November could allow for some additional growth, cell accumulation, and aggregation of cells at the site. However, in November, when the largest increase in modeled residence time occurs (i.e., up to 21 hours), water temperatures are cool and growth rates are slow compared to the peak growing season of July through September.

Although it is possible for cyanobacteria to be present and continue to grow in November, after the peak growing season there are rarely, if ever, any substantial blooms in November. Importantly, no substantial cyanobacteria bloom has been observed in Franks Tract in November. Thus, modeled increases in residence time would not be sufficient to substantially increase *Microcystis* growth, accumulation, or aggregation at this location. This is particularly true when the other four drivers of *Microcystis* and other cyanobacteria blooms (including water temperature) are changing negligibly. Based on growth rates, the tidal nature of the waterbody, water column mixing, other environmental factors, and absolute residence time, the project alternatives' effects on residence time would not be sufficient to allow for substantial increases in cell density or the formation of surface scums, relative to existing conditions. As such, the relatively small increases in residence time that could occur for the project alternatives would not cause CHAB frequency or magnitude to change sufficiently that it would negatively affect any beneficial use at Franks Tract, relative to existing conditions.

Discovery Bay

In Discovery Bay, model results show median residence time generally increase under all alternatives for the full simulation period for the months July through November (Table 9-53; refer to Appendix 9E, Tables 9E-3-5-1 to 9E-3-5-6 and Figure 9E-5-8). There is little to no change in median residence time in June. The greatest increase in median residence time occurs in July, September, and October when median modeled residence time increases by 20 to 34 hours. Modeled residence time corresponding to the 25th, 75th, and 90th percentiles show that the project alternatives have varying levels of effect on residence time, with decreases in some months and increases in other months. Modeled residence time in the 25th percentile for the project alternatives range from a decrease of up to 5 hours in June to an increase of 25 to 26 hours in July and September. Changes in residence time in the 75th percentile range from a decrease of up to 19 hours in October to an increase of 44 to 47 hours in July and November, respectively. Residence time in the 90th percentile generally decrease, except in September when residence time increases by up to 11 hours. While some modeled increases in residence time under the project alternatives are longer than 24 hours, all modeled increases are less than 10%, relative existing conditions.

Table 9-53. Residence Time in Hours Modeled Using DSM2 for Existing Conditions and Project Alternatives, Discovery Bay

	Alternative					
Month	Existing Conditions	1, 3 (6,000 cfs)	2a, 4a (7,500 cfs)	2b, 4b (3,000 cfs)	2c, 4c (4,500 cfs)	5 (6,000 cfs Bethany)
25th Percentile						
June	619	615 (-4)	620 (1)	614 (-5)	615 (-4)	615 (-4)
July	456	**482 (26)**	479 (23)	478 (22)	**482 (26)**	**482 (26)**
August	472	478 (6)	478 (6)	477 (5)	478 (6)	478 (6)
September	520	**544 (24)**	**545 (25)**	541 (21)	**544 (24)**	**544 (24)**
October	568	570 (2)	570 (2)	574 (6)	570 (2)	574 (6)
November	470	474 (4)	475 (5)	471 (1)	471 (1)	474 (4)
50th (Median) Percentile						
June	629	628 (-1)	628 (-1)	628 (-1)	627 (-2)	628 (-1)
July	482	**507 (25)**	**508 (26)**	502 (20)	**515 (33)**	**513 (31)**
August	498	510 (12)	509 (11)	508 (10)	508 (10)	510 (12)
September	575	**608 (33)**	597 (22)	**605 (30)**	**609 (34)**	**605 (30)**
October	662	**687 (25)**	**687 (25)**	**686 (24)**	**686 (24)**	**687 (25)**
November	539	551 (12)	551 (12)	540 (1)	551 (12)	551 (12)
75th Percentile						
June	685	687 (2)	691 (6)	687 (2)	687 (2)	687 (2)
July	533	**570 (37)**	**573 (40)**	**577 (44)**	555 (22)	**570 (37)**
August	639	620 (-19)	623 (-16)	624 (-15)	620 (-19)	620 (-19)
September	687	690 (3)	701 (14)	688 (1)	688 (1)	696 (9)
October	759	760 (1)	758 (-1)	759 (0)	759 (0)	760 (1)
November	689	**733 (44)**	**736 (47)**	**732 (43)**	**733 (44)**	**733 (44)**
90th Percentile						
June	779	773 (-6)	783 (4)	773 (-6)	774 (-5)	773 (-6)
July	763	761 (-2)	764 (1)	765 (2)	761 (-2)	761 (-2)
August	832	815 (-17)	824 (-8)	806 (-26)	807 (-25)	815 (-17)
September	764	775 (11)	772 (8)	772 (8)	775 (11)	775 (11)
October	857	850 (-7)	849 (-8)	850 (-7)	833 (-24)	850 (-7)
November	847	850 (3)	849 (2)	850 (3)	850 (3)	850 (3)

Note: Change in residence time in hours for project alternatives, relative to existing conditions, are in parentheses. Negative values indicate a shorter residence time under the project alternative. Increases longer than 24 hours or greater than 10% are bolded.

Under existing conditions, residence time in Discovery Bay is long with residence time ranging from a minimum of 456 hours (19 days) in June at the 25th percentile to a maximum of 857 hours (35.7 days) in October for the 90th percentile. This long residence time is conducive to *Microcystis* growth, accumulation, and aggregation and is one of the reasons CHABs develop in Discovery Bay. Under the project alternatives, the largest increase in residence time occurs in July and November at the 75th percentile when residence time increases by 44 to 47 hours. Large increases in residence time also occur at the median in July and September when residence time increases by 33 to 34 hours. In November, at the 75th percentile, when the largest increase in residence time occurs (i.e., up to 47 hours), water temperatures are cool and growth rates are slow compared to the peak growing season of July through September. As such, there is unlikely to be much additional growth, aggregation, or accumulation in November, relative to existing conditions.

In July when optimal temperature conditions occur, there could be some additional growth, aggregation, and accumulation under project alternatives relative to existing conditions. However, there would also continue to be competition with other algae, grazing losses, and virus losses that are co-occurring during periods of increased residence time. In a location like Discovery Bay that has very long residence time (i.e., on the order of 2 to 5 weeks) a day or two of additional residence time under the project alternatives is not enough time to cause significantly more cyanobacteria biomass or to cause a substantially larger bloom, relative to existing conditions.

As described above, there are inherent limitations in simulating the hydrodynamics in the open water areas of the Delta, and DSM2 can only provide a rough estimate of residence time for the entire waterbody. The modeling does not account for any variations in localized hydrodynamic conditions (e.g., circulation patterns) that likely exist within the open waterbodies, and the modeling cannot account for residence time in portions of the open waterbody that vary based on site-specific conditions. Although it is reasonably certain that project alternatives would increase residence time under a few circumstances for Discovery Bay, insufficient information is available to definitively determine the relative magnitude of change in residence time that would occur annually. Nevertheless, due to the long residence time that occur under existing conditions, even if residence time were to increase slightly more than those modeled, the project alternatives would not alter cyanobacteria dynamics such that they would negatively affect any beneficial use at Discovery Bay, relative to existing conditions.

Integration of Findings for the Delta

As discussed above, the key factors thought to affect CHAB bloom development in the Delta are (1) water temperature, (2) channel velocities and associated turbulence/mixing, (3) residence time, (4) nutrients, and (5) water clarity. Based on the analysis findings, the project alternatives would not affect Delta water temperatures, nutrients, or water clarity (and thus irradiance) at levels that would substantially affect, or affect at all, CHAB frequency or magnitude in the Delta. Moreover, the project alternatives would have little effect on velocities and associated turbulence/mixing in the channels assessed. However, the project alternatives may result in small increases in residence time in some of the open water areas of the central portion of the Delta, in areas that already experience relatively long residence times. This is mainly because the use of the proposed north Delta diversions would result in reduced south Delta pumping under a few circumstances. This would not be the case in the northern, southern, western, or eastern portions of the Delta, where residence times would be minimally affected by the project alternatives, relative to existing conditions.

Based on these findings, two initial conclusions can be reached. First, none of the five factors assessed would be substantially affected by the project alternatives in the northern, southern, western, or eastern Delta. Consequently, the project alternatives would not be expected to cause substantial, or even measurable, differences in the frequency or magnitude of CHABs in the northern, southern, western, or eastern Delta. Second, in the central portion of the Delta, only residence time would change for the project alternatives, relative to existing conditions, with the other four parameters assessed changing little, if at all. Because these other four parameters of water temperature, turbulence and mixing, nutrient levels, and water clarity and associated irradiance are key to the initiation of blooms and subsequent growth, the project alternatives would not be expected to cause more frequent CHABs anywhere in the Delta, relative to existing conditions.

The remainder of this integration assessment evaluates whether the magnitude of project alternative effects on residence time in the central Delta would be sufficient to make blooms in certain Delta locations substantially larger in size, by allowing accumulation/aggregation of cells and colonies for longer periods of time, relative to existing conditions.

Numerous other factors would affect the amount of *Microcystis* biomass that can accumulate over time for any given residence time, or increase in residence time for a site. For example, turbulence and mixing, water temperatures, and competition with other algae and macrophytes exert effects on growth rates. Also, grazing losses to zooplankton, fish, and clams and mortality from viruses exert influences on the size and severity of a given *Microcystis* bloom. Furthermore, residence time in the Delta is highly variable with natural and manmade changes such as fluvial and tidal hydrology, engineered floodplains, trapezoidal channels, and other ongoing factors that affect residence time in unpredictable ways (Kimmerer et al. 2019:13). Hence, greater residence time may provide the opportunity for cyanobacteria to accumulate and aggregate in areas of the Delta, without getting flushed from the area. However, because of the other factors identified above that also affect the ability of cyanobacteria to grow, accumulate, and aggregate in areas, a given percent increase in residence time does not necessarily equate to a similar percent increase in bloom size or an increase in bloom size or scum development at all.

This was exemplified by past studies in the Stockton Deep Water Ship Channel, where there is a long summer residence time. There, a three-year study documented a large persistent *Microcystis* bloom in 2012 but not in 2009 or 2011 (Spier et al. 2013:10). Environmental conditions were similar in 2012 and 2009 and *Microcystis* cells were present in 2009, yet no bloom formed in 2009. No specific environmental factor could be attributed to the 2012 bloom (Spier et al. 2013:10). In another study, researchers investigated how the rock barrier installed across False River during the 2015 drought would affect water quality in Franks Tract (Kimmerer et al. 2019:1). The researchers hypothesized that the rock barrier would increase residence time in Franks Tract and form conditions that would allow *Microcystis* cells to accumulate. Instead, the authors found the barrier could not be attributed to variability in water age and it did not cause *Microcystis* to become more abundant in Franks Tract during 2015 than it was in other dry years (Kimmerer et al. 2019:1). However, submerged aquatic vegetation was found in areas of Franks Tract that had previously been clear of vegetation (Kimmerer et al. 2019:1). Due to extreme drought conditions, the west false river rock barrier was installed again in 2021 as part of the Temporary Urgency Change Order. The Temporary Urgency Change Order required a special study to determine if the management actions caused changes in the presence of CHABs or submerged aquatic vegetation. Using the Constituent-oriented Age and Residence Time theory, or CART, the special study found greater spatial organization of residence time within Franks Tract, with a clear gradient developing from northeast to southwest when the barrier is in place (California Department of Water Resources 2022:2-65–2-66). In July and August 2021, a large cyanobacteria bloom was observed in the eastern portion of Franks Tract while there was an increase in submerged aquatic vegetation in the western portion of Franks Tract, where there was the greatest increase in residence time (California Department of Water Resources 2022: 2-1). The special study report suggests that changes in flow through the system may have exacerbated the bloom through increases in residence time, but that was not the only factor that caused the larger bloom (California Department of Water Resources:2-75). It is possible that flow from Old River “seeded” the eastern potion Franks Tract with *Microcystis* cells and the barrier prevented the cells from being flushed seaward or that changes to tidal flow reduced mixing in the area (California Department of Water Resources:2-75). Together, findings from these studies suggest *Microcystis* ecology and competition with other algae and macrophytes is complex, and longer residence time at small or intermediate scales does not indicate that a substantial bloom will form. Instead, the relationship between residence time (or increases in residence time at a specific location) and the size of *Microcystis* blooms (should a bloom occur at the site) would be expected to vary substantially by location within the Delta and by year due to how the factors listed above and other environmental factors vary temporally and spatially.

Because no scientific studies in the Delta that specifically correlate area-specific residence time to cyanobacteria bloom size in those areas have been published, substantial uncertainty exists for the above assessment findings. In an effort to reduce that uncertainty, studies by Lehman et al. (2018, 2020) that describe residence time as a key factor affecting *Microcystis* blooms in the Delta were reviewed. Lehman et al. (2018, 2020) used other hydraulic parameters such as Delta outflow and the position of X2 as a *proxy* of residence time for the entire Delta. These indirect parameters were correlated (along with temperature using multiple-regression) to bloom size across two years with extreme hydrologic differences (i.e., a severe drought year in 2014 and an extreme wet year in 2017).

First, there is no known study that relates residence time at specific Delta locations to X2 position. Increases in residence time will vary widely among Delta channels, sloughs, and flooded islands for a given change in Delta outflow or X2 position. Second, both outflow and X2 position are hydrodynamic measurements that are geographically removed from specific areas of greatest CHABs (e.g., Discovery Bay, Stockton Deep Water Ship Channel). Third, in their comparison of an extreme drought year (2014) to an extreme wet year (2017), Lehman et al. (2020) found that the position of X2 (i.e., the 2 parts per thousand (ppt) salinity isohaline) and water temperature were the parameters that accounted for most of the variation in *Microcystis* bloom size (i.e., surface biovolume and subsurface cell abundance) between the two years. Lehman et al. (2020:7) reported that *Microcystis* subsurface abundance was statistically correlated with the X2 index ($r=0.79$, $P<0.01$) when data for both years were combined, and where average X2 position differed between years by 12.4 km, but the same correlation was not significant when data for 2014 and 2017 were analyzed separately.

Despite Delta outflow varying by 37% across the July through November period of 2014 and by 97% across these same months in 2017, outflow did not explain the changes in *Microcystis* bloom size across these months in either year. Similarly, in 2014, the X2 index itself averaged 86 km in July, increased to 88 km in August (2 km increase), and increased further to 89 km in September (3 km increase from July level). This 3 km increase in the X2 index between July and September was not sufficient to result in the X2 index correlating significantly to bloom size across months in 2014. The same scenario is seen in 2017, where the average X2 index was 71 km in July and increased to 77 km in August and again in November (an increase of 6 km). Nevertheless, this 6 km increase in the X2 index was not sufficient to correlate significantly to changes in bloom size across months in 2017. This was true despite cell biovolume and abundance peaking later in the season (i.e., during September) followed by declining abundance in October and November. In fact, in 2017, both surface biovolume and subsurface abundance peaked in September, when the X2 index was 75 km and outflow was at its highest for the July through November period. The September X2 index of 75 km was 2 km lower than the 77 km X2 index level in August and November of 2017, when both surface biovolume and subsurface abundance were markedly lower than in September. Moreover, in September, the range of surface biovolume levels documented for 2014 and 2017 overlapped despite the X2 index being 89 km in 2014 and 75 km in 2017 (a 14 km difference in the index). Likewise, Delta outflow was nearly four times higher in September of 2017 compared to September of 2014.

Hence, factors other than Delta-wide residence time (as indexed by X2 or Delta outflow) were driving the similar September surface biovolume levels documented for 2014 and 2017 and bloom size in general during each year. The key factor that explained much of the variation was temperature. Lehman et al. (2020:5, Table 2) indicated that average temperature in September was higher (23.3°C [73.9°F]) in 2017 (wet year) than in 2014 (22.0°C [71.6°F]) (drought year), which largely explains the overlap in surface biovolume between 2014 and 2017 despite X2 being 14 km different between these two Septembers. These findings also show that ambient air temperatures primarily dictate Delta water temperatures, and air temperatures can completely overshadow any lesser temperature effect on Delta waters that derives from longer residence time, as shown in September of 2014 vs. 2017 as indexed by X2 position.

Water temperature is a key variable that affects *Microcystis* bloom size because it affects growth rates. This can be further seen by the fact that *Microcystis* subsurface abundance was significantly correlated with water temperature for both years combined ($r=0.45$, $p<0.01$) as well as for 2014 ($r=0.80$, $p<0.01$) and 2017 ($r=0.38$, $p<0.01$) separately. This distinction is important because temperature is what allows *Microcystis* to produce more cells per unit time. It is the parameter that directly affects the rate of production, particularly when temperatures reach high levels (e.g., 25°C (77°F) and above), where *Microcystis* can outcompete other algae (Lürling et al. 2013:554). In fact, Lehman et al. (2020:8) stated that the lower bloom size in 2017 was partially because water temperatures did not reach and exceed 25°C (77°F) as often as occurred in 2014.

In their study of *Microcystis* blooms between the two drought years of 2014 and 2015, Lehman et al. (2018:297, 298) similarly determined the percentage of water temperatures above 25°C (77°F) (18%) in 2014 compared to 2015 (8%) in the summer favored the growth of more *Microcystis* in 2014 than in 2015. When data from both years were combined, subsurface abundance was correlated to water temperature and X2, but surface biovolume was correlated to water temperature and outflow and not correlated to X2 position.

Lehman et al. (2020:8), in reference to their 2018 study of 2014 and 2015, state that "relatively small changes in the location of the X2 index may be important. A shift of X2 index by only 3 km was associated with a factor of 3 increase in the percent abundance of subsurface *Microcystis* cells in the cyanobacterial community between the extreme drought years 2014 and 2015." This statement that small increases in X2 position *may* be important in terms of affecting bloom size is not well supported by the data presented in Lehman et al. (2020), as indicated by the above discussion. This is not to say that residence time is not important; rather, it is to say that small changes in the X2 position alone are not likely to explain changes in CHABs at various locations across the Delta.

This is exemplified in the 2018 study where X2 reached 86 km in 2015, yet *Microcystis* blooms and associated microcystins remained low despite 2015 being a drought year. This finding suggests that complex interactions among the factors that affect bloom development and accumulation ultimately dictate bloom magnitude (Berg and Sutula 2015:21). Neither Delta outflow nor X2 position by themselves are good predictors of bloom size between years, or across months within a year. Based on the scientific findings discussed above, it is clear that neither Delta outflow nor X2 position themselves explain a substantial amount of the variability in *Microcystis* bloom size in the Delta. However, when X2 is combined with water temperature, these factors together did explain a substantial amount of the variation in Delta-wide *Microcystis* bloom size between an extreme drought year (2014) vs. an extreme wet year (2017), where differences between years for both water temperatures and X2 are very large and driven by extreme hydrologic conditions. For this impact analysis it was necessary to determine the effects of project alternatives on residence times while considering that the project alternatives would not have any substantial impacts on water temperature (as described above in the temperature portion of this assessment). Thus, this impact analysis focused primarily upon actual location-specific residence time as modeled directly using DSM2. This allows a more precise assessment of the effects of the project alternatives on actual residence time at numerous locations across the Delta. Residence time, as modeled using DSM2, was the amount of time required for 90% of water within a defined multi-mile channel reach to flush out of the reach. The magnitudes of increased residence time modeled was then assessed to determine expected effects on CHABs, based upon how increased residence time affects bloom development.

In conclusion, DSM2 residence time modeling indicates that residence time would decrease in the Stockton Deep Water Ship Channel and have little to no change in the southern, eastern, western, and northern parts of the Delta. Consequently, the project alternatives would not affect water temperature, nutrients, turbulence and mixing, water clarity, or residence time in the southern, eastern, western, and northern parts of the Delta sufficiently to cause substantially increased frequency or magnitude of CHABs in these areas of the Delta.

Based on DSM2 modeling, the project alternatives are expected to increase residence time in some locations and months within the Central Delta, namely Discovery Bay. The greatest increases in residence time would occur in Discovery Bay where there is already very long residence time (i.e., 2 to 5 weeks under existing conditions). Increases in residence time for the project alternatives may contribute to more *Microcystis* cell and colony production and accumulation/aggregation in Discovery Bay due to a 1- to 2-day increase in residence time in July at this location. Furthermore, as described above, there is uncertainty regarding how modeled increases in residence time would translate to *Microcystis* bloom size through additional growth, accumulative, and aggregation provided by longer residence time. Nevertheless, based on known *Microcystis* dynamics in the Delta an additional day or two of residence time at Discovery Bay would not cause *Microcystis* blooms to substantially increase in size or last substantially longer, relative to existing conditions. As such, the project alternatives would not affect water temperature, nutrients, turbulence and mixing, water clarity, or residence time in the central Delta sufficiently to cause substantially increased frequency or magnitude of CHABs in the central Delta, including Discovery Bay.

Finally, the production of the toxin microcystin by *Microcystis* is highly variable and not well understood. Even in intensively studied waterbodies it is not possible to accurately predict microcystin concentrations or correlate toxin to biomass ratios (Ibelings et al. 2021:270). Nevertheless, *Microcystis* blooms usually produce microcystin, and studies often see greater toxin levels when large blooms occur, as was the case in the Delta between the 2014 and 2017 water years (Ibelings et al. 2021:261; Lehman et al. 2020). *Microcystis* blooms are usually comprised of toxic and nontoxic strains (Ibelings et al. 2021:261). As such, a larger bloom does not always correlate to greater toxin concentrations as a bloom could potentially contain more nontoxic than toxic strains of *Microcystis*. In fact, because blooms continuously evolve and can contain any mixture/ratio of toxic and nontoxic strains, bloom presence does not guarantee toxin production (Turner et al. 2018:3). Hence, small to moderate increases in bloom size would not always be expected to be accompanied by small to moderate increases in toxin concentration in the water. Factors other than bloom size alone affect the amount of toxin that a given bloom will produce in an area, and these factors are not well understood at this time.

Because the project alternatives, through their effects on the five factors potentially associated with CHABs in the Delta, are not expected to cause Delta CHABs to be substantially larger in size, and because bloom size does not necessarily dictate toxin concentration in the water, the project alternatives are not expected to substantially increase microcystin or any other cyanotoxins in the Delta, relative to existing conditions at the Delta assessment locations.

Suisun Marsh, Suisun Bay, and San Francisco Bay

The following assessment focuses on the potential impacts of the project alternatives to the environmental factors that provide favorable conditions for CHAB development in Suisun Marsh, Suisun Bay, and San Francisco Bay. These factors are the same factors addressed above for the Delta, which are (1) water temperature, (2) channel velocities and associated turbulence/mixing (3) residence time, (4) nutrients, and (5) water clarity and its effects on irradiance. This assessment also addresses salinity, which at levels typical for San Francisco and Suisun Bay do not provide favorable habitat for *Microcystis* growth or accumulation. Although average salinities in Suisun Marsh are below the 10 ppt salinity threshold generally accepted as the salt tolerance for *Microcystis* (San Francisco Bay Regional Water Quality Control Board 2012:7), CHABs are not common in Suisun Marsh (Sommer et al. 2020:18; Hammock et al. 2015:319). An additional factor discussed in this assessment that could affect presence of CHABs and associated cyanotoxins in these waterbodies is potential project alternative driven changes in CHABs and associated toxin concentrations in Delta waters and Delta outflows.

As described above for the Delta, modeling shows that the project alternatives would result in a relatively minor, if any, increase in Delta water temperatures, relative to existing conditions. Since there would be little to no change to Delta water temperatures, the project alternatives also would have little to no effect on water temperatures in Suisun Marsh, Suisun Bay, or San Francisco Bay. From a thermal perspective, any minor differences in water temperatures would not affect the frequency or magnitude of CHABs in Suisun Marsh, Suisun Bay, or San Francisco Bay, relative to that which could occur under existing conditions.

Nutrient levels in Suisun Marsh are a function of nutrient levels in Delta outflow, San Francisco Bay water intrusion, and runoff from surrounding lands. As described in Impact WQ-7, *Effects on Nutrients Resulting from Facility Operations*, the project alternatives would not result in substantial increases in nutrient concentrations in Delta waters, including Delta outflows entering the marsh, and would have no effect on inputs from San Francisco Bay water intrusion or runoff from surrounding lands. Furthermore, the project alternatives would not cause any substantial changes in nutrient concentrations in Suisun Marsh, Suisun Bay, or San Francisco Bay, relative to existing conditions. Consequently, the project alternatives would not increase the frequency or magnitude of CHABs in Suisun Marsh, Suisun Bay, or San Francisco Bay, relative to existing conditions, due to changes in nutrients in these waterbodies.

Water clarity and associated sunlight penetration into the water column (i.e., irradiance) also plays a critical role in CHAB formation. As described in Impact WQ-13, *Effects on Turbidity/Total Suspended Solids Resulting from Facility Operations*, the project alternatives would not result in substantial changes in turbidity levels or TSS concentrations in Suisun Marsh, Suisun Bay, or San Francisco Bay, relative to existing conditions. Consequently, the project alternatives would not increase the frequency or magnitude of CHABs in Suisun Marsh, Suisun Bay, or San Francisco Bay, relative to existing conditions, due to changes in water clarity in these waterbodies.

The project alternatives would have small effects on Delta outflow volume (Appendix 5A). As such, the hydrodynamics within Suisun Marsh, Suisun Bay, or San Francisco Bay, which are driven primarily by Delta outflow, tidal excursions, and winds would change little, if at all, for the project alternatives, relative to existing conditions. Consequently, associated residence time, turbulence, and mixing in Suisun Marsh, Suisun Bay, and San Francisco Bay would differ negligibly from existing conditions. Therefore, the project alternatives would not affect hydrodynamic factors sufficiently to encourage more frequent or larger cyanobacteria blooms in Suisun Marsh, Suisun Bay, or San Francisco Bay, relative to hydrodynamics in these waterbodies under existing conditions.

As described in Impact WQ-5, *Effects on Electrical Conductivity Resulting from Facility Operations*, the project alternatives would result in small increases or decreases in EC in Suisun Marsh and negligible changes in EC in Suisun Bay and San Francisco Bay. These small changes in EC would not cause waters to decrease in salinity so that they would be more conducive to supporting CHAB growth, accumulation, or aggregation, relative to existing conditions. Consequently, the project alternatives would not increase the frequency or magnitude of CHABs in Suisun Marsh, Suisun Bay, or San Francisco Bay, relative to existing conditions, due to changes in EC that would enable *Microcystis* and other cyanobacteria to grow where they do not grow under existing conditions.

As discussed above, the frequency of CHABs in the Delta would not be expected to change substantially, if at all, relative to existing conditions. Regarding bloom magnitude, project alternatives are not expected to substantially affect CHAB magnitude anywhere in the Delta but could potentially contribute to smaller (less than substantial) increases in bloom size in some areas of the Delta in some years due to increased residence time.

Even if the project alternatives were to cause some periodic increase in CHAB magnitude, which is uncertain, such increases would not be expected to change cyanotoxin concentrations in Delta outflows by measurable levels and would not be expected to affect levels in Suisun Marsh, Suisun Bay, or San Francisco Bay sufficiently to be measurable or result in any adverse effect to beneficial uses of these waterbodies.

In summary, the project alternatives would not affect water temperature, channel turbulence and mixing, residence time, nutrients, water clarity, or salinity that would create conditions more conducive to CHAB formation in Suisun Marsh, Suisun Bay, or San Francisco Bay, relative to existing conditions. Any small changes in these conditions that may potentially occur for the project alternatives would not be of sufficient frequency and magnitude to cause CHABs to form more frequently, or grow to larger levels, than would occur for existing conditions. Furthermore, if there were to be any increases in the magnitude of *Microcystis* or other cyanobacteria bloom production in the Delta, tidal dilution and other factors would prevent substantial additional toxin concentration relative, to existing conditions. Hence, CHABs and their associated cyanotoxins levels in Suisun Marsh, Suisun Bay, and San Francisco Bay under the project alternatives would not adversely affect any beneficial uses or degrade water quality substantially, if even measurably, relative to existing conditions.

SWP/CVP Export Service Areas

The assessment of effects from CHABs in the SWP/CVP export service areas is based on the assessment of CHABs and associated toxins in source waters to Banks and Jones Pumping Plants and potential for changes in the environmental factors needed for CHABs to form within the export service area waterbodies.

Conditions in SWP/CVP export service area waterbodies under the project alternatives would not become more conducive to CHABs, relative to existing conditions. This is because there would be negligible changes in source water channel turbulence and mixing, temperature, and water clarity. As described above in Impact WQ-7, nutrients in the export areas of the Delta are in excess and any small changes in nutrient concentrations at these locations would not increase the potential for CHABs, relative to existing conditions. Furthermore, residence time modeling in south Delta channels showed incremental increases in residence time was not sufficiently large under all project alternatives (Appendix 9E, Figure 9E-3-6-1 and Figure 9E-3-14) to substantially affect CHABs. As such, conditions in SWP/CVP export service area waterbodies under all project alternatives would not become more conducive to CHAB formation, relative to existing conditions.

In summary, the project alternatives would not result in changes to temperature, channel turbulence and mixing, residence time, nutrients, or water clarity that would create conditions more conducive to CHAB formation in the export service area, relative to existing conditions. Any small changes in these conditions that may potentially occur for the project alternatives would not be of sufficient frequency and magnitude to cause CHABs to form more frequently, or grow to larger levels, than would occur for existing conditions. Hence, CHABs and their associated cyanotoxins levels in the SWP/CVP export service areas under the project alternatives would not adversely affect any beneficial uses or degrade water quality substantially, if even measurably, relative to existing conditions.

CEQA Conclusion—All Alternatives

Based on the discussion and findings above, the project alternatives would not cause additional exceedance of applicable water quality criteria or objectives associated with CHABs or their toxins because none currently exist. Because the frequency and magnitude of CHABs for project alternatives are not expected to increase substantially, if at all, in the study area waterbodies, no long-term water quality degradation that would result in substantially increased risks of negative effects to beneficial uses associated with CHABs would occur in these regions. Similarly, project alternatives would not cause the key factors potentially associated with CHABs (i.e., temperature, residence time, nutrients, water velocities and associated turbulence and mixing, and water clarity and associated irradiance) to change in the Delta in a manner that would increase the frequency or magnitude of CHABs in the Delta region. CHABs are not directly associated with any 303(d) listings within the study area and thus these project alternatives would not make any 303(d) listings discernably worse. Microcystin, the toxin produced by *Microcystis*, bioaccumulates in aquatic life. However, because of their less-than-substantial effects on CHAB frequency and magnitude, project alternatives are not expected to increase levels of microcystins or other cyanotoxins within the study area, including the Delta, by frequency, magnitude, and geographic extent that would cause measurably higher body burdens of microcystins or other CHAB toxins in aquatic organisms, thereby increasing the health risks to wildlife (including fish) or humans consuming those organisms. Thus, the impact of project alternatives on CHABs would be less than significant.

Mitigation Impacts

Compensatory Mitigation

The CMP described in Appendix 3F is not intended or needed as mitigation for impacts to water quality due to formation of CHABs from project construction or operations. Nevertheless, implementation of the CMP could potentially affect Delta CHABs in and near tidal habitats created as part of the plan, as analyzed in this chapter. CEQA requires analysis of the impacts of mitigation; therefore, this discussion is included here.

Implementation of the CMP, namely, the creation of tidal habitats in the North Delta Habitat Arc (i.e., especially the areas within the lower Yolo Bypass and Cache Slough Complex) that would be hydrodynamically connected to Delta channels, could create new areas that are conducive to CHABs. The other types of CMP habitat (i.e., valley/foothill riparian, freshwater emergent perennial wetland, seasonal wetland, lake/pond) would not be hydrodynamically connected with Delta channels. As such, these other types of CMP habitat would not affect CHAB formation within the Delta, relative to existing conditions. Thus, the following discussion is focused solely on the potential for CHAB formation in tidal habitats in the North Delta Habitat Arc.

It should be noted that cyanobacteria are ubiquitous within the Delta as part of the overall phytoplankton community. As such, cyanobacteria would be present within any newly created tidal habitat. The issue is not one of presence/absence of cyanobacteria at these new tidal habitats but rather whether the new tidal habitat sites provide highly suitable conditions for CHABs. This is important because high amounts of cyanobacteria biomass (i.e., blooms) are often accompanied by sufficiently high cyanotoxin levels to pose risks of adverse effects, and even mortality, to aquatic life and wildlife using/feeding in these habitats or immediately adjacent Delta waters that receive flushing from these habitats. As described above, there are five environmental factors (i.e., water temperature, channel velocities and associated turbulence/mixing, residence time, nutrients, and water clarity and its effects on irradiance) that provide favorable conditions for CHAB development. These environmental factors are considered in the discussion below to assess if the new tidal habitat sites would provide highly suitable conditions for CHABs, relative to existing conditions.

The new tidal habitats would be located within the North Delta Habitat Arc, especially those areas within the lower Yolo Bypass and Cache Slough Complex, which was chosen, in part, because it is a region that is less likely to support CHABs (ESA 2022:5).

CHABs are also not problematic in the Cache Slough or Yolo Bypass regions even though the areas are characterized as fresh water habitat (i.e., ~0 ppt). Depending on the specific location within Cache Slough, residence time ranges from 0 to 20 days (Downing et al. 2016:13,387) while median summer temperatures are above 20°C (ESA 2022:7). Similarly, just upstream of Cache Slough in the Sacramento Deep Water Ship Channel, median water temperatures exceed 23°C and residence time ranges from 20 to 50 days (Downing et al. 2016:13387; ESA 2022:7). Although both locations have water temperature and residence time that are sufficient to support CHABs, neither location has a history of CHABs. In fact, visual observations of *Microcystis* occurrence collected by DWR and California Department of Fish and Wildlife during their fish and water quality surveys at discrete stations throughout the Delta from 2007 to 2019 show little to no *Microcystis* in the water column of the Deep Water Ship Channel (ESA 2022:5). Similarly, just downstream in Cache Slough, visual observations of *Microcystis* are generally low (ESA 2022:5). The only times visual observations (i.e., ranked 4 on a scale of 0 to 5 with 5 being the highest) of *Microcystis* were high in Cache Slough was in the drought years of 2015 and 2016. Further analysis of the visual observation data in the Cache Slough region show that the frequency of *Microcystis* occurrence is low (ESA 2022:5). Although the exact reasons why CHABs are not problematic in the Cache Slough Region remain unknown, water residence time and gradients in mixing likely control the phytoplankton community within Cache Slough (Stumpner et al. 2020:1, 13).

There is some uncertainty related to the design of the wetlands (e.g., depth, amount of aquatic vegetation, and exact location). However, design of the tidal habitat would consider hydrologic regime and channel morphology (backwater areas with low velocities and high residence time can create conditions that foster CHABs) to help ensure potential effects related to CHABS are minimized. As such, newly created tidal habitats would have daily tidal flushing to ensure no substantial increase in residence time, relative to existing conditions. Although tidal habitats would be designed to reduce potential for CHAB formation, it is possible that along the edges of the new tidal habitat there could be small areas of increased residence time, elevated water temperatures, decreased water column turbulence and mixing, and turbidity (which affects irradiance). Depending on the vegetation in the tidal habitat, there could be some increased nutrient concentrations (from decomposing vegetation). However, the presence of vegetation would generally decrease the potential for CHAB formation as plants would likely outcompete cyanobacteria for nutrients and sunlight.

Although there are some characteristics of the newly created tidal habitats that could increase residence time and water temperatures along the margins, implementation of the CMP is not expected to cause substantial additional *Microcystis* or other cyanobacteria production for the following reasons. First, tidal restoration sites would be sited in areas of the Northern Delta Habitat Arc where conditions are not conducive to CHAB formation. Second, the design of the tidal habitats is such that there would be daily hydrologic exchange that would ensure that there would not be substantially increased residence time compared to adjacent habitats. Third, if the tidal habitats were to be located in Cache Slough, the mixing gradients and residence time would continue to prevent substantial cyanobacteria production. Based on the above findings, the impact of the new tidal habitats created in accordance with the CMP on CHABs in the Delta is considered to be less than significant

Other Mitigation Measures

Most of the other mitigation measures would be implemented on land with limited ability to affect formation of CHABs. The two mitigation measures that would be implemented in water are assessed in more detail below.

Mitigation Measure PH-1b, *Develop and Implement a Mosquito Management Plan for Compensatory Mitigation Sites on Bouldin Island and I-5 Ponds*, could have some effect on conditions for CHAB formation. Some actions may cause conditions to be more favorable for CHAB formation (e.g., vegetation removal could increase water clarity) or less favorable for CHAB formation (e.g., constant circulation of water and periodic draining). Overall, the net effect of the mosquito management actions on CHAB formation would be negligible. Further, mitigation sites on Bouldin Island and the I-5 ponds would not be connected to other Delta channels.

The tidal inundation projects that are one optional component of MM AQ-9: *Develop and Implement a GHG Reduction Plan to Reduce GHG Emissions from Construction and Net CVP Operational Pumping to Net Zero*, could potentially cause increased formation of CHABs. Tidal wetland inundation projects on Sherman and Twitchell Islands associated with MM AQ-9 could increase CHAB formation through the same mechanisms described for the tidal restoration projects discussed for compensatory mitigation. Although there are some characteristics of newly created tidal habitats that could increase residence time and water temperatures along the margins, implementation of MM AQ-9 is not expected to cause substantial additional *Microcystis* or other cyanobacteria production for the following reasons. First, tidal restoration sites would be sited in areas of Sherman and Twitchell

Islands where conditions are not conducive to CHAB formation. Second, the design of the tidal habitats is such that there would be daily hydrologic exchange that would ensure that there would not be substantially increased residence time compared to adjacent habitats. Third, mixing gradients and residence time would continue to prevent substantial cyanobacteria production.

Based on the above findings, the impacts of potential new tidal habitats created as part of Mitigation Measure AQ-9 and the mosquito management plan for MM PH-1b are considered to be less than significant.

Impact WQ-15: Risk of Release of Pollutants from Inundation of Project Facilities

All project alternatives (i.e., Alternatives 1, 2a, 2b, 2c, 3, 4a, 4b, 4c, and 5) described in Chapter 3 would have similar impact levels and thus are discussed together.

All Project Alternatives

The project alternatives consist of various water conveyance facility components that would be placed in and adjacent to the Sacramento River and the Delta where water levels fluctuate. As described in Chapter 25, *Hazards, Hazardous Materials, and Wildlife*, Impact HAZ-1: *Create a Substantial Hazard to the Public or the Environment through the Routine Transport, Use, or Disposal of Hazardous Materials* and Impact HAZ-2: *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*, project operations would involve the handling and use of different quantities of commonly used hazardous materials, such as fuels, lubricants, and oils, to operate vehicles and equipment at the north Delta intakes and pumping plants. The transport, handling, use, and disposal of these materials would comply with regulations enforced by regulatory agencies such as the local Certified Unified Program Agency and California Department of Industrial Relations Division of Occupational Safety and Health. In addition, Environmental Commitments EC-2: *Develop and Implement Hazardous Materials Management Plans* and EC-3: *Develop and Implement Spill Prevention, Containment, and Countermeasure Plans* would further reduce the potential for accidental release or exposure during project operations. Per Environmental Commitment EC-2, accumulation and storage of hazardous materials would not exceed 90 days, thus substantial accumulation of hazardous materials would not occur, reducing the risk of release the environment. Per Environmental Commitment EC-3, petroleum products would be stored in non-leaking containers, thus reducing the risk of release to the environment. Storage of materials in a manner that protects the public and environment would reduce the potential for pollutants to be released to the environment should the project facilities become inundated. Furthermore, the intakes, pumping plants, and control structures would be designed to accommodate the 200-year flood event, including projected future hydrology due to climate change and up to 10.2 feet of sea level rise at Golden Gate Bridge, which is the Ocean Protection Council's extreme high scenario at the year 2100 (Chapter 3, Section 3.3.1, *Design for Climate Change and Sea Level Rise*). Thus, there would be low risk of facility inundation and associated release of pollutants from project facilities.

CEQA Conclusion—All Project Alternatives

Potential sources of pollutants at the water conveyance facilities would be used and stored in a manner consistent with applicable laws and regulations and the project's environmental commitments established to protect the public and environment from the release of pollutants. Furthermore, the water conveyance facilities would be designed to accommodate the 200-year flood event, including projected future hydrology and an extreme high sea level rise scenario due to climate change, resulting in a low risk of releasing facility-related pollutants upon project facility inundation. Thus, the project alternatives would not result in a substantial risk for release of pollutants upon project facility inundation that would cause degradation of water quality in affected waterbodies at levels and duration that would result in substantially increased risk for significant impacts on one or more beneficial uses. This impact would be less than significant for all project alternatives.

Mitigation Impacts

Compensatory Mitigation

Although the CMP described in Appendix 3F does not act as mitigation for impacts on water quality from project construction or operations, its implementation could result in impacts on water quality.

The CMP sites may be situated in areas where flooding could occur; however, these areas would not be a substantial source of pollutants to adjacent waterways. Any pollutants such as mercury or herbicides that could be released from the CMP sites into adjacent waterways due to flood inundation would be at sufficiently low levels and loads that no adverse effects on beneficial uses would occur, as described previously in Impacts WQ-2 through WQ-13. Based on these findings, impacts from the CMP on water quality would be less than significant.

Other Mitigation Measures

Some other mitigation measures may be constructed in areas where flooding could occur; however, these areas would not be a substantial source of pollutants to adjacent waterways. Any pollutants that could be released from the mitigation sites into adjacent waterways would be at sufficiently low levels and loads that they would not cause any exceedance of water quality objectives or criteria, and no impacts on beneficial uses would occur. As a result, impacts from other mitigation measures on water quality would not be substantial.

Overall, the CMP and other mitigation measures, combined with the project alternatives, would have a minimal risk of releasing pollutants due to inundation and would not change the impact conclusion of less than significant.

Impact WQ-16: Effects on Drainage Patterns as a Result of Project Facilities

All project alternatives (i.e., Alternatives 1, 2a, 2b, 2c, 3, 4a, 4b, 4c, and 5) described in Chapter 3 would have similar impact levels and thus are discussed together.

All Project Alternatives

The project alternatives would result in alteration of approximately 2,600 to 4,600 acres of land, some temporary and some permanent, to support construction activities and for placement of water conveyance facility components, which would alter the existing drainage patterns of the affected areas (refer to Chapter 3 for a detailed description of these alterations). As described in Chapter 3, Section 3.4.15.5, *Local Water Supply, Drainage, and Utilities*, all project alternatives would be designed to not increase peak runoff flows into adjacent storm drains, drainage ditches, or rivers and sloughs. Furthermore, as described in Chapter 3, Section 3.4.14, *Land Reclamation*, the project alternatives would implement several actions to lands used during construction to prepare the land for future use. Areas to be restored to grassland would be seeded with native grasses and areas to be restored to agricultural use could be seeded with an erosion control seed mix. Thus, while the project alternatives would result in substantial alteration of drainage patterns on lands used for construction and project facilities, the drainage modifications would not result in substantial on-site or off-site erosion. Moreover, project construction and operations would not contribute substantial additional sources of polluted runoff or cause siltation or pollution to enter one or more affected waterbodies at levels and frequency that would adversely affect one or more beneficial use.

CEQA Conclusion—All Project Alternatives

The project alternatives would result in substantial changes in drainage patterns on lands used for construction and new water conveyance facility components. However, the project alternatives would implement site design and restoration actions so that the drainage pattern alterations would not result in substantial erosion or siltation on-site or off-site, or create or contribute runoff water that would provide substantial additional sources of polluted runoff causing siltation or pollution to enter one or more affected waterbodies at levels and frequency that would adversely affect one or more beneficial use. Furthermore, several environmental commitments described in Appendix 3B and discussed in Impact WQ-1: *Impacts on Water Quality Resulting from Construction of the Water Conveyance Facilities* (Table 9-7) would further reduce any additional sources of polluted runoff. This impact would be less than significant for all project alternatives.

Mitigation Impacts

Compensatory Mitigation

Although the CMP described in Appendix 3F does not act as mitigation for impacts on water quality from project construction or operations, its implementation could result in impacts on water quality.

There would be reconfiguration of land to implement the CMP, including creation of wetland, riparian, and tidal habitats, which would thereby change site drainage patterns. Temporary staging areas would be created to support construction activities, but there would be no new permanent impervious areas created that would contribute sources of polluted runoff. As discussed in Impact WQ-13, natural habitats containing banks covered with vegetation tend to be a sink (i.e., trap) for TSS and turbidity while runoff from agricultural areas tend to be sources of TSS and turbidity. Any newly created wetlands or enhanced habitat would also filter stormwater to remove solids and either improve or have little to no effect on TSS and turbidity relative to existing conditions. Thus, the CMP would not result in substantial on-site or off-site erosion, contribute substantial additional sources of polluted runoff, or cause siltation or pollution to enter one or more affected waterbodies at levels and frequency that would adversely affect one or more beneficial use. Based on these findings, this impact would be less than significant.

Other Mitigation Measures

Many of the other mitigation measures could result in recontouring of land surface that would alter drainage patterns. However, as described for Impact WQ-2, the recontouring would not cause substantial increases in runoff.

New tidal wetlands potentially created as part of Mitigation Measure AQ-9: *Develop and Implement a GHG Reduction Plan to Reduce GHG Emissions from Construction and Net CVP Operational Pumping to Net Zero* would have effects similar to those described for the CMP and would not be substantial.

Overall, the CMP and other mitigation measures, combined with the project alternatives, would have a minimal effect on drainage patterns and would not change the impact conclusion of less than significant.

Impact WQ-17: Consistency with Water Quality Control Plans

All project alternatives (i.e., Alternatives 1, 2a, 2b, 2c, 3, 4a, 4b, 4c, and 5) described in Chapter 3 would have similar impact levels and thus are discussed together.

All Project Alternatives

WQCPs with jurisdiction in the study area include the State Water Board's Bay-Delta WQCP (State Water Resources Control Board 2018), the Central Valley Regional Water Quality Control Board's *Water Quality Control Plan (Basin Plan) for the Sacramento and San Joaquin River Basins* (Central Valley Regional Water Quality Control Board 2018), and the San Francisco Bay Regional Water Quality Control Board's *San Francisco Bay Basin Water Quality Control Plan (Basin Plan)* (San Francisco Bay Regional Water Quality Control Board 2019). Construction, operation, and maintenance of the project alternatives would be subject to meeting applicable water quality objectives in these WQCPs, as implemented through water rights decisions for operation and NPDES permits for construction and maintenance. DWR commits to performing all construction activities in compliance with WQCP requirements and will be confirmed through various permits for construction, including the State Water Board's NPDES General Permit for Storm Water Discharges Associated with Construction and Land Disturbance Activities (Order 2009-0009-DWQ/NPDES Permit CAS000002) and CWA Section 401 Water Quality Certifications issued for CWA Section 404 permits. DWR commits to operating the new diversion facilities in compliance with WQCP requirements and would be confirmed through a State Water Board-issued water rights decision for the change in point of diversion for the SWP for the selected project alternative.

CEQA Conclusion—All Project Alternatives

Based on the above analysis, the construction and operation of the project alternatives would have no impact on the implementation of a WQCP, nor would the project alternatives conflict with a WQCP.

Mitigation Impacts

Compensatory Mitigation

Although the CMP described in Appendix 3F does not act as mitigation for impacts on water quality from project construction or operations, its implementation could result in impacts on water quality.

As described above for the project alternatives, construction of the CMP would be subject to meeting applicable water quality objectives in applicable WQCPs, with implementation achieved through various permits that would be required. Implementation of the CMP also would be consistent with WQCPs. In particular, the mitigation to be implemented for mercury (Mitigation Measure WQ-6: *Develop and Implement a Mercury Management and Monitoring Plan*) would be developed and implemented in coordination with the Delta Methylmercury TMDL (Central Valley Regional Water Quality Control Board 2010a:iv, 73, 80, 88, 134, 197) and *Amendments to the Water Quality Control Plan for the Sacramento River and San Joaquin River Basins for the Control of Methylmercury and Total Mercury in the Sacramento-San Joaquin Delta Estuary* (Central Valley Regional Water Quality

Control Board 2010a:iv, 73, 80, 88, 134, 197, 2010b). Therefore, the construction and operation of the CMP would have no impact on the implementation of a WQCP, nor would the CMP conflict with a WQCP.

Other Mitigation Measures

As described for the CMP, other mitigation measures would be subject to meeting applicable water quality objectives in applicable WQCPs, with implementation achieved through various permits that would be required. Therefore, the other mitigation measures would have no impact on the implementation of a WQCP plan, nor would they conflict with a WQCP.

Overall, the CMP and other mitigation measures, combined with the project alternatives, would have no impact on the implementation of a WQCP or conflict with a WQCP.

9.3.4 Cumulative Analysis

The cumulative effects analysis for water quality in the study area (Section 9.1.1, *Study Area*) considers past, present, and reasonably foreseeable future projects and programs being completed in combination with the effects of any one of the project alternatives or the No Project Alternative. Future water quality conditions in the study area are expected to be different from existing conditions as a result of the cumulative effects of past, present, and reasonably foreseeable future projects, population growth, climate change, and changes in water quality regulations. Programs, projects, and policies that are either ongoing or proposed for future implementation that could affect cumulative water quality conditions are listed in Table 9-54.

Table 9-54. Cumulative Impacts on Water Quality from Programs, Projects, and Policies

Program/Project	Agency	Status	Description of Program/Project	Impacts on Water Quality
Regulatory-, Discharge-, and Source Control-Related Actions				
Expanded Urban Development within the watersheds	Multiple	Ongoing and future	The Cities and Counties within the study area will have urban development projects implemented in the future	Additional municipal wastewater and stormwater discharges into the watershed rivers that are tributary to the Delta
Regional Facility Upgrade Project (EchoWater Project)	Sacramento Regional County Sanitation District	Final EIR certified September 2014; construction has been initiated	Upgrade existing secondary treatment facilities to advanced unit processes including improved nitrification/ denitrification and filtration.	Reduced discharge concentration and mass of many constituents in wastewater to Sacramento River.
Regional Wastewater Control Facility Modifications Project	City of Stockton	Final certified March 2019; construction has been initiated	Modifications to various unit processes including improved nitrification/ denitrification.	Reduced discharge concentration of nitrate plus nitrite in wastewater to San Joaquin River.

Program/Project	Agency	Status	Description of Program/Project	Impacts on Water Quality
Sacramento Stormwater Quality Partnership	Sacramento County, Sacramento, Citrus Heights, Elk Grove, Folsom, Galt, and Rancho Cordova	Ongoing and future actions	Development and implementation of federal stormwater compliance programs	Reduced discharge concentration and mass of many constituents in stormwater to Sacramento River.
San Joaquin County, Stockton, and Tracy Stormwater Management Programs	San Joaquin County, Stockton, Tracy, and the State Water Resources Control Board	Ongoing and future actions	Development and implementation of federal stormwater compliance programs	Reduced discharge concentration and mass of many constituents in stormwater to San Joaquin River.
Yolo County Stormwater Management Program	Yolo County, Public Works Division	Ongoing and future actions	Development and implementation of federal stormwater compliance programs	Reduced discharge concentration and mass of many constituents in stormwater to Yolo Bypass.
Irrigated Lands Regulatory Program	Central Valley Water Board	Ongoing and future actions	Prevent agricultural discharges from impairing the waters that receive runoff.	Reduced discharge concentration and mass of many constituents in agricultural drainage to the Delta and tributaries.
Grassland Bypass Project, 2010–2019	Bureau of Reclamation and San Luis & Delta Mendota Water Authority	Ongoing and future actions	Agricultural drainage management actions to reduce selenium discharges.	Goal is regulatory compliance for reduced selenium discharges to San Joaquin River.
Agricultural Drainage Selenium Management Program Plan	Bureau of Reclamation and San Luis & Delta Mendota Water Authority	Ongoing and future actions	Agricultural drainage management actions to reduce selenium discharges.	Goal is regulatory compliance for reduced selenium discharges to San Joaquin River.
American River Methylmercury TMDL	Central Valley Water Board	Ongoing and future actions	Regulatory and implementation actions to achieve compliance with water quality objectives.	Goal is reduced source loading of mercury and methylmercury formation.
Cache Creek, Bear Creek, Sulphur Creek, and Harley Gulch Mercury TMDL	Central Valley Water Board	Ongoing and future actions	Regulatory and implementation actions to achieve compliance with water quality objectives.	Goal is reduced source loading of mercury and methylmercury formation.
Central Valley Diuron TMDL	Central Valley Water Board	Ongoing and future actions	Regulatory and implementation actions to achieve compliance with water quality objectives.	Goal is reduced source loading of diuron pesticide.
Central Valley Diazinon and Chlorpyrifos TMDL	Central Valley Water Board	Ongoing and future actions	Regulatory and implementation actions to achieve compliance with water quality objectives.	Goal is reduced source loading of diazinon and chlorpyrifos pesticide.

Program/Project	Agency	Status	Description of Program/Project	Impacts on Water Quality
Central Valley Salt and Nitrate Control Program	Central Valley Water Board	Ongoing and future actions	Regulatory and implementation actions to achieve compliance with water quality objectives.	Goal is reduced source loading of salt to surface water and groundwater, and loading of nitrate to groundwater.
Clear Lake Mercury TMDL	Central Valley Water Board	Ongoing and future actions	Regulatory and implementation actions to achieve compliance with water quality objectives.	Goal is reduced source loading of mercury and methylmercury formation.
Clear Lake Nutrients TMDL	Central Valley Water Board	Ongoing and future actions	Regulatory and implementation actions to achieve compliance with water quality objectives.	Goal is reduced source loading of nutrients.
Sacramento and Feather Rivers Diazinon TMDL	Central Valley Water Board	Ongoing and future actions	Regulatory and implementation actions to achieve compliance with water quality objectives.	Goal is reduced source loading of diazinon pesticide.
Sacramento County Urban Creeks Diazinon and Chlorpyrifos TMDL	Central Valley Water Board	Ongoing and future actions	Regulatory and implementation actions to achieve compliance with water quality objectives.	Goal is reduced source loading of diazinon and chlorpyrifos pesticide.
Sacramento River (Upper) Cadmium, Copper, and Zinc TMDL	Central Valley Water Board	Ongoing and future actions	Regulatory and implementation actions to achieve compliance with water quality objectives.	Goal is reduced source loading of cadmium, copper, and zinc.
Sacramento-San Joaquin Delta Methylmercury TMDL	Central Valley Water Board	Ongoing and future actions	Regulatory and implementation actions to achieve compliance with water quality objectives.	Goal is reduced source loading of mercury and methylmercury formation.
Sacramento-San Joaquin Delta Diazinon and Chlorpyrifos TMDL	Central Valley Water Board	Ongoing and future actions	Regulatory and implementation actions to achieve compliance with water quality objectives.	Goal is reduced source loading of diazinon and chlorpyrifos pesticide.
Salt Slough Selenium TMDL	Central Valley Water Board	Ongoing and future actions	Regulatory and implementation actions to achieve compliance with water quality objectives.	Goal is reduced source loading of selenium.
San Joaquin River Dissolved Oxygen TMDL	Central Valley Water Board	Ongoing and future actions	Regulatory and implementation actions to achieve compliance with water quality objectives.	Goal is reduced source loading of oxygen-demanding substances.
San Joaquin River Diazinon and Chlorpyrifos TMDL	Central Valley Water Board	Ongoing and future actions	Regulatory and implementation actions to achieve compliance with water quality objectives.	Goal is reduced source loading of diazinon and chlorpyrifos pesticide.
San Joaquin River Salt and Boron TMDL	Central Valley Water Board	Ongoing and future actions	Regulatory and implementation actions to achieve compliance with water quality objectives.	Goal is reduced source loading of salts and boron.

Program/Project	Agency	Status	Description of Program/Project	Impacts on Water Quality
San Joaquin River Selenium TMDL	Central Valley Water Board	Ongoing and future actions	Regulatory and implementation actions to achieve compliance with water quality objectives.	Goal is reduced source loading of selenium.
Central Valley Pyrethroid Pesticide TMDL	Central Valley Water Board	Ongoing and future actions	Regulatory and implementation actions to achieve compliance with water quality objectives.	Goal is reduced source loading of pesticides.
Central Valley Organochlorine Pesticide TMDL	Central Valley Water Board	Ongoing and future actions	Regulatory and implementation actions to achieve compliance with water quality objectives.	Goal is reduced source loading of legacy organochlorine pesticides.
Stockton Urban Waterbodies Pathogen TMDL	Central Valley Water Board	Ongoing and future actions	Regulatory and implementation actions to achieve compliance with water quality objectives.	Goal is reduced source loading of pathogens in urban stormwater runoff.
Sulphur Creek Mercury TMDL	Central Valley Water Board	Ongoing and future actions	Regulatory and implementation actions to achieve compliance with water quality objectives.	Goal is reduced source loading of mercury and methylmercury formation.
Biological Opinion for the Reinitiation of Consultation on the Coordinated Operations of the Central Valley Project and State Water Project	U.S Fish and Wildlife Service, Bureau of Reclamation	Ongoing and future actions	Actions and operations to protect endangered fish, including coldwater pool management, real-time operations adaptive management, and hatcheries investments.	Actions may affect seasonal and long-term Delta water quality conditions.
Biological Opinion for the Reinitiation of Consultation on the Coordinated Operations of the Central Valley Project and State Water Project	U.S. Department of Commerce, National Marine Fisheries Service, Bureau of Reclamation	Ongoing and future actions	Actions and operations to protect endangered fish, including coldwater pool management, real-time operations adaptive management, and hatcheries investments.	Actions may affect seasonal and long-term Delta water quality conditions.
Restoration Actions				
Franks Tract Restoration (“Futures”)	California Department of Fish and Wildlife	Proposed	Habitat enhancement plan for Franks Tract in the Delta	Goal is for plan to achieve Delta water quality objectives.
Ecosystem Restoration Program Conservation Strategy	California Department of Fish and Wildlife	Ongoing	Actions to address the critical environmental conditions in the Delta and Suisun Marsh/Bay including Delta flows and habitat restoration.	Changes in tidal prism and salinity patterns; potential incremental increase methylmercury formation and contribution to Delta load.

Program/Project	Agency	Status	Description of Program/Project	Impacts on Water Quality
Suisun Marsh Habitat Management, Preservation, and Restoration Plan	California Department of Fish and Wildlife, U.S. Fish and Wildlife Service, Bureau of Reclamation, and Suisun Marsh Charter Group	Ongoing	Seasonal wetland and tidal marsh restoration actions in Suisun Marsh.	Changes in tidal prism and salinity patterns; potential incremental increase methylmercury formation and contribution to Delta load.
Dutch Slough Tidal Marsh Restoration Project	California Department of Water Resources	Final EIR certified September 2014	Seasonal wetland and tidal marsh restoration actions in western Delta.	Changes in tidal prism and salinity patterns; potential incremental increase methylmercury formation and contribution to Delta load.
Cache Slough Area Restoration	California Department of Water Resources and Department of Fish and Wildlife	Ongoing and future actions	Enhancement and restoration of existing and potential open water, marsh, floodplain and riparian habitat in northern Delta.	Changes in tidal prism and salinity patterns; potential incremental increase methylmercury formation and contribution to Delta load.
Liberty Island Conservation Bank	Reclamation District 2093	Ongoing	Tidal marsh restoration project in southern Yolo Bypass.	Changes in tidal prism and salinity patterns; potential incremental increase methylmercury formation and contribution to Delta load.
California Water Action Plan and California Water Action Plan Update 2016	California Natural Resources Agency, California Department of Food & Agriculture, California Environmental Protection Agency	Initiated in January 2014	This plan lays out a roadmap for actions that would fulfill 10 key themes. In addition, the plan describes certain specific actions and projects that call for improved water management throughout the state.	Actions implemented may affect seasonal and long-term Delta water quality conditions.
California EcoRestore	California Department of Water Resources	Initiated in 2015	Implements a suite of actions for up to 30,000 acres of fish and wildlife habitat restoration and enhancement in the Delta, Suisun Marsh, and Yolo Bypass.	Potential for effects on water quality at various Delta locations related to changes in hydrodynamics near restoration actions.

EIR = environmental impact report; TMDL = total maximum daily load.

9.3.4.1 Cumulative Impacts of the No Project Alternative

Water quality conditions in the study area under the future cumulative condition are expected to differ from existing conditions as a result of the programs, projects, and policies listed in Table 9-54, future population growth and associated urban development, climate change, and changes in water quality regulations (e.g., completion of TMDLs, adoption of new or more restrictive criteria/objectives). The effects of the programs, projects, and policies listed in Table 9-54 will vary, with some having the potential to contribute to degradation of water quality, whereas others will improve water quality in certain areas. Population growth may produce increased constituent loadings to surface waters through increased development and urban stormwater runoff, and increased municipal wastewater discharges. Climate change is anticipated to cause salinity increases in the western and southern Delta due to sea level rise. Conversely, changes in water quality regulations, such as restrictions on urban stormwater runoff, completion of TMDLs to lessen or eliminate existing beneficial use impairments through improved water quality, more restrictive regulations on municipal wastewater discharges, new or more restrictive water quality objectives in RWQCB WQCPs, generally are in a direction that will result in improvements in water quality.

Some water quality constituents in the study area are at levels under existing conditions that cause occasional adverse effects on beneficial uses. These include chloride, EC, mercury, organic carbon, pesticides, selenium, and CWA Section 303(d)-listed constituents. Under the cumulative condition with the No Project Alternative, with consideration of the factors that will affect water quality listed in Table 9-54, some constituents are expected to remain at levels that will cause some adverse effects on some beneficial uses, whereas others are expected to have improvements relative to existing conditions, and for others it remains speculative regarding the future conditions, as discussed below.

Chloride and EC. Higher chloride and EC are anticipated in the western Delta under the cumulative condition relative to existing conditions such that beneficial uses (e.g., municipal and industrial supply) may be adversely affected. Anticipated climate change effects on sea level rise would be the primary driver of these future increases in chloride and EC.

Mercury. Numerous regulatory efforts have been implemented or are under development to control and reduce mercury loading to the Delta, including TMDLs and associated implementation strategies (e.g., methylmercury control studies), increased restrictions on point source discharges, greater restrictions on suction dredging in Delta tributary watersheds, and continued clean-up actions on mine drainage in the upper watersheds. Although many positive mercury reduction efforts are underway, a key challenge surrounds the pool of mercury deposited in the sediments of the Delta, which cannot be readily or rapidly reduced, despite efforts to reduce future loads in Delta tributaries, and serves as a source for continued methylation and bioaccumulation of methylmercury by Delta biota. Thus, future concentrations of mercury in study area waterbodies could be lower than existing conditions, but are expected to be at levels that would still contribute to beneficial use impairment in some areas of the Delta. The wetland restoration projects listed in Table 9-54 are not expected to contribute considerably to greater mercury methylation at restoration sites and thus are not expected to make future Delta mercury impairments discernably worse. Nevertheless, Delta beneficial use impairments for mercury that exist presently are expected to continue to exist in the future.

Organic carbon. Future nonpoint and point source loadings of organic carbon from growing urbanized areas of the Sacramento River and San Joaquin River watersheds are expected to increase, contributing to higher organic carbon concentrations under the cumulative condition relative to existing conditions.

Pesticides. Pesticide use within and upstream of the Delta is changing continuously. While factors such as TMDLs and future development of more target-specific and less toxic pesticides will ultimately influence the cumulative condition for pesticides, forecasting whether these various efforts will ultimately be successful at resolving current pesticide-related impairments requires considerable speculation. The non-target pesticide toxicity that has been seen historically first with organochlorine insecticides and then with organophosphate and pyrethroid insecticides is expected to continue into the future, at somewhat reduced levels, despite changes in common-use pesticide classes. While concentrations of current use or historically used pesticides in study area waterbodies may be lower under the cumulative condition relative to existing conditions, future new pesticide concentrations may be higher.

Selenium. Implementation of TMDLs has resulted in significant reductions in selenium loadings to the Delta. Current selenium concentrations in the San Joaquin River at Vernalis are below applicable water quality criteria and are anticipated to remain low or improve further such that future selenium concentrations in the lower San Joaquin River and Delta would be no worse, and possibly better than, existing conditions.

CWA Section 303(d)-Listed Constituents. Study area waterbodies that have been listed as impaired for one or more constituents on the state's CWA Section 303(d) list either have adopted TMDLs or will have TMDLs developed in the future to reduce loadings of those constituents. Thus, the trend for these waterbodies will be improved constituent concentrations, which will depend on how much loading can be controlled from point and nonpoint sources.

9.3.4.2 Cumulative Impacts of the Project Alternatives

The potential for cumulative impacts on water quality for the project alternatives is assessed for: (1) construction-related activities; and (2) facility operations. Effects are specifically discussed by study area region and by constituent or constituent groups.

The assessment of cumulative impacts of the project alternatives discusses only water quality constituents which could be affected, in part, from construction and implementation of the project alternatives. Constituents or constituent groups which could not be affected by the project alternatives are identified and addressed in Appendix 9A, *Screening Analysis*. The majority of the constituents assessed in Appendix 9A have not been detected in the major source waters to the Delta, and others that have been detected have generally not exceeded water quality objectives/criteria or would not be affected by construction and implementation of the project alternatives. Consequently, they are not specifically addressed in this cumulative assessment.

In addition, this cumulative analysis evaluates whether the project alternatives would have considerable contributions to significant cumulative water quality conditions for constituents currently on the CWA Section 303(d) list, and thus presently adverse.

If the cumulative water quality condition is determined not to be significant, then no further assessment to determine whether the project alternatives' contribution is cumulatively considerable is needed because the alternative would not have effects that are individually minor but collectively significant. Conversely, if the cumulative water quality condition for a particular constituent is determined to be significant relative to existing conditions, then further assessment is conducted to determine whether the project alternatives' individual contributions to the significant cumulative condition are "cumulatively considerable" and thus significant.

Cumulative Impacts on Water Quality Resulting from Construction-Related Activities

Although the number of intakes to be constructed, tunnel alignments and other construction aspects vary among the project alternatives, all project alternatives involve sufficient construction activities that, if conducted improperly, could adversely affect water quality. Because of this commonality among alternatives regarding potential for construction-related water quality effects, and the common means of avoiding or reducing such effects, all project alternatives are assessed collectively rather than individually. The project alternatives do not include construction activities upstream of the Delta thus the remaining discussion focuses on the Delta, Suisun Marsh, Suisun Bay, San Francisco Bay and the SWP/CVP export service areas.

Delta

Construction of all project alternatives, which could occur over an approximately 14-year period, could result in significant impacts on water quality due to the numerous construction-related activities that would occur adjacent to and within the Delta waterways. Although construction activities could occur over many years, each individual construction component, and its potential effects on water quality, would be temporary in nature. Hence, construction-related effects could cumulate with effects from other projects, but would do so temporarily, during the duration of the effect, and would not do so over longer periods of time like permanent project effects tend to do. Moreover, environmental commitments, discussed further below, would minimize construction-related effects on water quality.

Although construction sites will be capturing, treating, storing, and reusing all runoff and dewatering flows the construction of new water conveyance facilities under all project alternatives could result in periodic and temporary elevated turbidity/TSS levels in surface waters adjacent to construction activities. This would be due to the erosion of disturbed soils and associated sedimentation entering Delta waterways or other construction-related wastes (e.g., concrete, asphalt, cleaning agents, paint, and trash). In addition, the use of heavy earthmoving equipment adjacent to Delta waterways may result in spills and leakage of oils, gasoline, diesel fuel, and related petroleum contaminants used in the fueling and operation of such construction equipment. The extensive construction activities that would be necessary to implement the new conveyance facilities would involve a variety of land disturbances in the Delta including vegetation removal; grading and excavation of soils; establishment of roads, bridges, staging, and storage areas; in-water sediment dredging and dredge material storage; and hauling and placement or disposal of excavated soils and dredge materials.

Construction of individual project alternative components (e.g., north Delta diversion intakes and fish screens) would involve site preparation and earthwork immediately adjacent to a waterbody. As such, their construction would include water quality protection actions in the form of environmental commitments (Appendix 3B). For example, berms and drainage channels would be installed around these construction sites to avoid untested/untreated flows and soil from being discharged from the sites into Delta waterways. Moreover, related water quality protection actions would be issued in agency permits required for construction and operation of facilities. Such actions would include SWPPPs that would minimize erosion of soils into waterbodies and would minimize/eliminate the direct spilling of earthmoving equipment fuels, oils, and other construction materials into waterbodies, thus minimizing any effects on water quality in adjacent waterbodies. Other water quality protection actions issued in agency permits would include those in the State

Water Board's NPDES General Permit for Stormwater Discharges Associated with Construction and Land Disturbance Activities (Order 2009-0009-DWQ/NPDES Permit CAS000002), project-specific waste discharge requirements or CWA Section 401 water quality certification from the appropriate RWQCB, CDFW Streambed Alteration Agreements, and CWA Section 404 dredge and fill permits. The implementation of construction-related environmental commitments (Appendix 3B) and abiding by agency-issued permits needed for construction activities will reduce potential construction-related water quality impacts in the Delta to less-than-significant levels.

Any construction-related effect on water quality at a particular site would be of small magnitude, geographically limited, and temporary in nature (i.e., would not occur on a long-term basis); therefore, the small spatially and temporally limited effect on water quality would not cumulate substantially with past, present, or reasonably foreseeable projects listed in Table 9-54 and thus would not result in a cumulatively significant water quality impact where one would not otherwise exist without construction of a project alternative. Similarly, for any cumulatively significant water quality condition that would occur in the Delta in the future resulting from all past, present, and reasonably foreseeable projects, including those listed in Table 9-54, the construction-related effects on Delta water quality resulting from implementing any of the project alternatives would not have a cumulatively considerable and thus significant contribution to such significant future cumulative water quality conditions in the Delta due to their small magnitude, limited geographical extent, and temporary nature.

Suisun Marsh, Suisun Bay, San Francisco Bay, and SWP/CVP Export Service Areas

The project alternatives do not include construction activities in Suisun Marsh, Suisun Bay, San Francisco Bay or the SWP/CVP export service areas. Because construction-related activities are not expected to contribute considerably to any significant cumulative Delta water quality condition, they also would not have a cumulatively considerable and thus significant contribution to any significant cumulative water quality condition in these areas that receive Delta flows. In addition, construction-related effects on Delta water quality would not make an otherwise non-significant cumulative water quality condition for any constituent/parameter in these areas cumulatively significant.

Cumulative Impacts on Water Quality in the Delta Resulting from Facility Operations

This cumulative water quality analysis of the Delta addresses constituents and constituent groups addressed by the project alternatives analysis: boron, bromide, chloride, dissolved oxygen, EC, mercury, nutrients, organic carbon, pesticides, selenium, trace metals, turbidity and TSS, and cyanobacteria. When the effects of implementing any one of the project alternatives on water quality are considered together with the potential effects of all past, present, and reasonably foreseeable future projects, including those listed in Table 9-54, the cumulative water quality condition in the Delta for the following constituents would be less than significant. Additional discussion for these water quality constituents is provided below.

- Dissolved Oxygen
- Nutrients
- Trace Metals
- Turbidity/TSS

Dissolved Oxygen

Dissolved oxygen throughout the Delta is generally suitable for beneficial use protection presently, and is expected to remain so for the future cumulative condition. This is because organic enrichment of Delta waters has been and continues to be heavily regulated and controlled to prevent projects and actions from substantially reducing or depleting Delta dissolved oxygen levels. None of the projects listed in Table 9-54 would be expected to substantially reduce dissolved oxygen in the Delta, and the San Joaquin River Dissolved Oxygen TMDL listed in Table 9-54 is intended to improve dissolved oxygen levels in this river. Nevertheless, due to various past and present projects and actions, there are impairments related to organic enrichment and/or low dissolved oxygen in specific Delta waterways (State Water Resources Control Board 2021). Many of the impaired waterways are on the Delta periphery and would be unaffected by the project alternatives. The most notable impairment occurred historically in the Stockton Deep Water Ship Channel. Since adoption of the Stockton Deep Water Ship Channel TMDL in 2007, dissolved oxygen conditions in the Deep Water Ship Channel have been improving. The duration and magnitude with which dissolved oxygen levels are lower than water quality objectives are smaller than before the TMDL adoption (U.S. Environmental Protection Agency 2015a:3). The TMDL for dissolved oxygen and TMDL actions for other impaired areas are expected to continue to improve dissolved oxygen levels in the future. The CMP activities are not anticipated to adversely affect dissolved oxygen levels in Delta waters. With regulatory actions being taken to improve dissolved oxygen and further limit the effects that past, present, and reasonably foreseeable future projects have on Delta dissolved oxygen levels, combined with the minimal to no effects of the project alternatives (including CMP activities) on dissolved oxygen in the Delta relative to existing conditions, the cumulative condition for Delta dissolved oxygen would not be significant.

Nutrients

Long-term average total nitrogen concentrations are anticipated to remain similar to existing conditions in the future due to ongoing and future anticipated regulations on nonpoint and point sources of total nitrogen to Delta waters. The State is currently doing research on nutrient levels in the Delta and whether new nutrient objectives need to be adopted in order to ensure that future nutrient levels do not impair Delta beneficial uses. Future urban growth in the watersheds can cause increased nutrient loading from greater wastewater and stormwater discharges. However, much of the future urban growth will be the result of converting existing agricultural lands to urban uses. Many agricultural uses such a grazing and row cropping result in substantial loading of nutrients to adjacent waterways, and these sources would cease and be replaced by urban sources. Both wastewater and stormwater loading of nutrients are regulated presently, and more so than agricultural loading, and are expected to be more strictly regulated in the future. As such, the future conversion of agricultural lands to urban land uses in the watershed is not expected to substantially increase nutrient loading to the Delta relative to existing conditions.

The project alternatives would not present new or substantially changed sources of total nitrogen or total phosphorus in the Delta. Small increases in total nitrogen and total phosphorus could occur in some areas of the Delta for the project alternatives due to a greater proportion of the water being San Joaquin River water, which has higher total nitrogen and total phosphorus concentrations as compared with other Delta primary source waters such as the Sacramento River and eastside tributaries. Nevertheless, such changes would be small in magnitude and would not occur at levels that would adversely affect Delta beneficial uses with regard to nutrients. The restoration activities are not anticipated to contribute substantial additional total nitrogen or total phosphorus load to the Delta, nor are any of the projects listed in Table 9-54.

Conversely, there may be a decrease in total nitrogen (and possibly phosphorus as well) concentrations as lands used for agriculture are converted for restoration as part of the CMP, thus reducing fertilizer application on these lands. In addition, the Sacramento Regional County Sanitation District is nearing completion of its EchoWater Project (Table 9-54) that will substantially reduce the load of total nitrogen compounds discharged from its Sacramento Regional Wastewater Treatment Plant into the lower Sacramento River at Freeport.

Thus, the concurrent implementation of the project alternatives with the CMP would result in total nitrogen and total phosphorous concentrations in Delta waters differing negligibly from existing conditions, or possibly decreasing somewhat in the future due to increased regulation of nutrients and completion of the EchoWater Project. As such, the future cumulative nutrient condition in the Delta would not be significant relative to existing conditions.

Trace Metals

Primary sources of trace metals to Delta waters include acid mine drainage (e.g., zinc, cadmium, copper, lead) from abandoned and inactive mines (i.e., Iron Mountain and Spring Creek mines) in the Shasta watershed area, which enter the Sacramento River system through Shasta Lake and Keswick Reservoir, agriculture (e.g., copper and zinc), POTW discharges (e.g., copper, zinc, and aluminum), and urban runoff (e.g., zinc, copper, lead, cadmium). Continued efforts to control acid mine drainage into the Sacramento River system and increasingly stringent regulations on point and nonpoint source discharges are expected in the future. Monitoring and regulatory controls on agricultural runoff, POTW discharges, and urban runoff are anticipated to prevent trace metal concentration under the cumulative condition from becoming substantially worse than existing conditions. The projects listed in Table 9-54 are not expected to load substantial additional trace metals to Delta waters, with the possible exception of mercury, which is discussed further below. Furthermore, neither implementation of any project alternative operations nor implementation of the CMP would present new or substantially changed sources of trace metals into the Delta. The concurrent implementation of the water conveyance facilities with the CMP would not substantially affect, or affect at all, trace metal levels in the Delta. Hence, the cumulative condition for Delta trace metals would not be significant.

Turbidity/TSS

Future land use changes could have minor effects on TSS concentrations and turbidity levels throughout the study area. Site-specific and temporal exceptions may occur due to localized temporary construction activities, dredging activities, development, or other land use changes. These localized actions would generally require agency permits that would regulate and limit both their short-term and long-term effects on TSS concentrations and turbidity levels to less-than substantial levels. Construction activities are closely regulated under construction NPDES permits, which require the preparation of SWPPPs and the implementation of agency permitted construction BMPs that will minimize sedimentation into adjacent waterbodies which would, in turn, increase turbidity and TSS levels. Moreover, construction projects are temporary in nature with ground disturbances occurring at distinct locations, and thus, their effects on turbidity and TSS levels tend not to be additive among multiple construction activities over time. This is true for the present and future projects listed in Table 9-54 as well.

Moreover, operations of the project alternatives are not expected to increase Delta turbidity and TSS, nor would they substantially reduce turbidity and TSS levels anywhere in the Delta. Likewise, the CMP would not substantially affect, or affect at all, turbidity and TSS levels in the Delta. A recent analysis examining future climate scenarios predicts significant increases in large-flow events and sediment loading to the Delta from the Sacramento River over the next century for two representative greenhouse gas concentration pathways, which may increase turbidity (Stern et al. 2020). The magnitude of the projected increases in sediment loading relative to existing conditions would be +33%–38% by 2040–2069; +39%–69% by 2070–2099. The increase in sediment would have the potential to largely reverse the approximately 50% reduction in sediment loading from the Sacramento River estimated to have occurred during the second half of the twentieth century. The resulting effects on Delta TSS and turbidity levels are uncertain, but it is expected that as a result of the additional sediment loading, TSS and turbidity levels would be at least as high as those occurring under existing conditions. Consequently, Delta turbidity and TSS levels under the cumulative condition are not expected to be significant.

Based on the findings above, the cumulative water quality conditions in the Delta for the constituents discussed above would be not significant relative to existing conditions when considering all past, present, and reasonably foreseeable projects and regulatory actions, including those listed in Table 9-54.

When the effects of implementing any one of the project alternatives on water quality are considered together with the potential effects of all past, present, and reasonably foreseeable future projects, including the projects listed in Table 9-54, the cumulative water quality condition in the Delta for the following constituents could be significant.

- Boron
- Bromide
- Chloride
- EC
- Mercury
- Organic Carbon
- Pesticides
- Selenium
- CHABs

These constituents or constituent groups are discussed further below to determine whether implementation of the project alternatives when combined with past, present, and reasonably foreseeable future projects and programs would result in a significant cumulative water quality impact and if the project alternatives would contribute considerably to a significant cumulative water quality impact.

Boron

The San Joaquin River is listed on the State Water Board's CWA Section 303(d) list of impaired waterbodies for boron (State Water Resources Control Board 2021). The Central Valley RWQCB adopted a control program for the control of boron along with salt from irrigated lands within the

Lower San Joaquin River Basin and the Delta at the Airport Way Bridge near Vernalis. Although progress has been made to reduce boron levels in the lower San Joaquin River and Delta, uncertainty remains as to whether future boron levels will be reduced to below existing condition levels. Hence, the significant condition for boron that exists presently is conservatively assumed to persist in the future. Consequently, the cumulative condition for boron is considered to be significant in the Delta. Modeling performed for the project alternatives (Appendix 9C) showed minor increases in boron concentrations at all Delta assessment locations, except Banks Pumping Plant, where concentrations would typically decrease relative to existing conditions. Any minor increases in boron concentrations that would occur from implementing the project alternatives would not be of sufficient magnitude to adversely affect any beneficial use of Delta waters. The CMP would not substantially affect, or affect at all, boron levels in the Delta. Hence, the project alternatives would not have a cumulatively considerable and thus significant contribution to the significant cumulative boron condition in the Delta.

Bromide

The cumulative condition for bromide is considered significant in the Delta because of anticipated future increases in bromide concentrations in the western Delta. Anticipated climate change effects on sea level rise would be the primary driver of these future increases, and thus the significant cumulative condition for bromide.

Modeling results (Appendix 9D) show that long-term average bromide concentrations with implementation of the project alternatives would be similar to existing conditions at most Delta locations and months. No state objectives or federal criteria have been adopted for bromide. Concentrations at Banks Pumping plant would decrease relative to existing conditions. Bromide increases that would occur due the project alternatives would not be of sufficient frequency, magnitude and geographic extent to directly cause impacts on beneficial uses or contribute substantially to anticipated future bromide levels in the western Delta. Likewise, the CMP would not substantially affect, or affect at all, bromide levels in the Delta. Thus, the project alternatives would not have a cumulatively considerable and thus significant contribution to the significant cumulative condition for bromide in the Delta.

Chloride

The cumulative condition for chloride is considered significant in the Delta because of anticipated increases in chloride concentrations in the western Delta. Anticipated climate change effects on sea level rise would be the primary driver of these future increases and thus the significant cumulative condition for chloride.

Modeling results (Appendix 9F) show that long-term average chloride concentrations with implementation of the project alternatives would be similar to existing conditions at most Delta locations and months. Concentrations at Banks Pumping plant would decrease relative to existing conditions. Chloride increases that would occur due the project alternatives would not be of sufficient frequency, magnitude and geographic extent to directly cause impacts on beneficial uses or contribute substantially to anticipated future chloride levels in the western Delta. Likewise, the CMP would not substantially affect, or affect at all, chloride levels in the Delta. Thus, the project alternatives would not have a cumulatively considerable and thus significant contribution to the significant cumulative condition for chloride in the Delta.

Electrical Conductivity

The cumulative condition for EC is considered significant in the Delta because of anticipated increases in EC levels in the western Delta. Anticipated climate change effects on sea level rise would be the primary driver of the significant cumulative condition.

Modeling results (Appendix 9G) show that long-term average EC levels with implementation of the project alternatives would be similar to existing conditions at most Delta locations and months. Under the project alternatives, the largest EC increases would occur in the Sacramento River at Emmaton and Threemile Slough (September and October), and in the San Joaquin River at Jersey Point (November). Nevertheless, compliance with Bay-Delta WQCP EC objectives would continue to occur with the project alternatives, particularly when the operational flexibility allowed by real-time operations is considered. Hence, EC increases that would occur due the project alternatives would not be of sufficient frequency, magnitude and geographic extent to directly cause impacts on beneficial uses or contribute substantially to anticipated future EC levels in the western Delta. Likewise, the CMP would not substantially affect, or affect at all, EC levels in the Delta. Thus, the project alternatives would not have a cumulatively considerable and thus significant contribution to the significant cumulative condition for EC in the Delta.

Mercury

Numerous regulatory efforts have been implemented or are under development to control and reduce mercury loading to the Delta, including the Delta mercury TMDL and associated implementation strategies (e.g., methylmercury control studies), increased restrictions on point source discharges such as POTWs, greater restrictions on suction dredging in Delta tributary watersheds, and continued cleanup actions on mine drainage in the upper watersheds. The Sacramento–San Joaquin Delta Estuary TMDL for methylmercury endeavors to reduce agricultural drainage, tributary inputs, and point and nonpoint source discharges of mercury and methylmercury in the Delta to meet fish tissue objectives and is supported by the Central Valley RWQCB Delta Mercury Exposure Reduction Program. The State Water Board is also developing a statewide mercury control program for reservoirs and a Central Valley mercury control program for rivers.

Although many positive mercury reduction efforts are underway and will continue into the future, a key challenge surrounds the pool of mercury deposited in the Delta sediments that cannot be readily or rapidly reduced, despite efforts to reduce future loads in Delta tributaries, and serves as a source for continued methylation and bioaccumulation of methylmercury by Delta biota. Also, atmospheric deposition of mercury into Delta waters and its tributary rivers is expected to continue in the future. In addition, future planned Delta restoration projects, including those listed in Table 9-54, may contribute to additional methylation of mercury within the restored wetland habitats. Consequently, the cumulative condition for mercury is considered significant in the Delta.

Modeling results (Appendix 9H) show that long-term average water column mercury and methylmercury concentrations under the project alternatives would be similar to existing conditions at all Delta locations. Any changes in Delta fish tissues concentrations from facility operations would likely not be measurable or would decrease. Hence, implementation of facility operations under the project alternatives would not substantially alter the cumulative condition for mercury and the mercury impairment in the Delta or contribute considerably to the significant cumulative mercury condition. As such, operations of the project alternatives would not contribute considerably to the significant cumulative condition for Delta mercury.

Conversely, the total acreage of tidal habitat would account for less than 1% of the total acres of the Delta wetted habitat. Wetland habitats have the potential to methylate mercury at higher rates than most other aquatic habitats. Hence, the creation of the CMP wetlands has the potential to contribute to additional mercury methylation and bioaccumulation of mercury in the wetlands themselves and adjacent Delta waters. The extent to which the compensatory actions of increasing tidal wetland habitats within the Delta may contribute to elevated methylmercury concentrations in and adjacent to the restoration sites is dependent upon restoration habitat conditions (e.g., type of sediments, type and amount of organic material within the sediments, mercury concentrations in the sediments) and habitat design elements (e.g., depth, water residence times, amount of aquatic vegetation). As such, the CMP component of the project alternatives could have a cumulatively considerable and thus significant contribution to the significant cumulative mercury condition in the Delta. Consequently, this is considered to be a significant cumulative impact for mercury.

Mitigation Measure WQ-6: *Develop and Implement a Mercury Management and Monitoring Plan* would be implemented with the goal to minimize generation of methylmercury within CMP sites. While there are uncertainties associated with the total acres of CMP tidal wetland to be created and the effectiveness of the siting and design criteria in controlling methylation of mercury within these CMP habitats, there is low potential for significantly greater methylmercury concentrations in surface water and biota of CMP tidal wetlands compared to existing habitats elsewhere in the Delta. As such, there is low potential for CMP habitats to make the existing mercury-related CWA Section 303(d) impairment within the Delta measurably worse, as discussed above. Monitoring would also inform adaptive management actions, if necessary, to minimize any increases. Therefore, the incremental contribution of the CMP to the significant cumulative condition for mercury is not cumulatively considerable and would be less than significant after mitigation.

Organic Carbon

The cumulative condition for organic carbon is considered significant in the Delta because future nonpoint and point source loadings from growing urbanized areas of the watershed (Table 9-54) are expected to increase in the future relative to existing conditions. The project alternatives would not have a cumulatively considerable and thus significant contribution to the significant cumulative condition for organic carbon within Delta waters based on modeling results showing little effect of the project alternatives on long-term average DOC concentrations (Appendix 9I). Likewise, the CMP would not substantially affect organic carbon levels in the Delta based on the planned acreage of tidal habitat restoration being a small percentage of the total Delta acreage, and the fact that organic carbon within the Delta is not a conservative constituent. Thus, the project alternatives would not have a cumulatively considerable and thus significant contribution to the significant cumulative condition for organic carbon in the Delta.

Pesticides

Pesticide use within and upstream of the Delta is changing continuously. While factors such as TMDLs and future development of more target-specific and less toxic pesticides will ultimately influence the cumulative condition for pesticides, forecasting whether these various efforts will ultimately be successful at resolving current pesticide-related impairments requires considerable speculation. As such it is conservatively assumed that the cumulative condition will be significant with respect to pesticides in the Delta. In other words, the non-target pesticide toxicity that has been seen historically first with organochlorine insecticides and then with organophosphate and pyrethroid insecticides is expected to continue into the future, despite changes in common-use pesticide classes.

The project alternatives would not have a cumulatively considerable and thus significant contribution to the significant cumulative pesticide condition. This is because the changes in the source water fractions (i.e., Sacramento River, San Joaquin River, Bay water, eastside tributaries, and Delta agriculture water) to any given Delta location resulting from implementation of any of the project alternatives would not substantially alter the pesticide concentrations at any Delta location consistently over time in a manner that would substantially alter the long-term risk of pesticide-related toxicity to aquatic life or adversely affect other beneficial uses. Likewise, the CMP would not substantially affect, or affect at all, pesticide levels in the Delta. Thus, the project alternatives would not have a cumulatively considerable and thus significant contribution to the significant cumulative condition for pesticides in the Delta.

Selenium

Implementation of the selenium TMDL has resulted in significant reductions in selenium loadings from the San Joaquin River to the Delta, resulting in the selenium water quality objective being met most of the time. Current selenium concentrations in the San Joaquin River at Vernalis are below the chronic CTR criterion of 5 μg/L and are anticipated to remain low or improve further such that future selenium concentrations in the lower San Joaquin River and Delta would be no worse, and possibly better than, existing conditions. However, water quality criteria for selenium applicable to the Delta continue to be refined and may become more restrictive (Appendix 9J). Thus, the cumulative condition for selenium in the lower San Joaquin River and Delta is assumed to be potentially significant.

The project alternatives would not have a cumulatively considerable and thus significant contribution to the potentially significant cumulative condition for selenium within Delta waters based on modeling results showing little effect of the project alternatives on long-term average selenium concentrations (Appendix 9J). Modeling indicates the project alternatives would result in essentially no change in selenium concentrations in water, fish tissue, or bird eggs throughout the Delta, with no exceedances of benchmarks for biological effects. The project alternatives also would result in essentially no change in selenium concentrations in sturgeon, which would exceed only the lower benchmark, indicating a low potential for effects. Overall, the project alternatives would not substantially increase the frequency with which applicable concern level or toxicity benchmarks for selenium would be exceeded in the Delta (there being only a small increase for sturgeon exceedance relative to the low benchmark and no exceedance of the high toxicity benchmark), or substantially degrade the quality of water in the Delta, with regard to selenium. Thus, the project alternatives would not have a cumulatively considerable and thus significant contribution to the significant cumulative condition for selenium in the Delta.

Implementation of the CMP would result in additional Delta tidal habitats. Created tidal habitats could have longer residence times than surrounding Delta channels, and longer residence times are known to increase the bioaccumulation of selenium in fish tissues and fish-eating bird eggs. However, the siting and design of the tidal habitats in the northern Delta and the total acreage of tidal habitat accounting for less than 1% of the total acres of the Delta wetted habitat would result in their cumulative contribution to the significant cumulative selenium condition being less than significant.

Thus, the project alternatives, along with the CMP, would not have a cumulatively considerable and thus significant contribution to the significant cumulative condition for selenium in the Delta.

CHABs

Future climate change will result in reduced Delta inflows annually during the June through November period relative to existing conditions, which may result in longer residence times in some areas of the Delta. Delta inflows are also expected to be warmer in the future as less water enters the Delta from the upper watersheds due to a lower snowpack and precipitation increasingly falling as rain. Climate change and greater drawdowns of the reservoirs over the summer months to support expanded urban areas will reduce reservoir storage levels more often, thereby potentially leading to lower and warmer flows into the Delta. Residence times in some portions of the Delta could increase further due to sea level rise unless SWP/CVP releases are increased to maintain salinity standards. In the latter case, residence times may be reduced in some portions of the Delta.

Climate change combined with warmer Delta inflows is expected to cause an increase in average Delta water temperatures during the summer and early fall months. High water temperatures, particularly those above 25°C (77°F), give cyanobacteria a competitive advantage over other algae. As such, *Microcystis* and other cyanobacteria typically produce more biovolume and cell abundance (i.e., have greater production) at elevated water temperatures. Increased water temperatures could lead to earlier attainment of the water temperature threshold of 19°C required to initiate *Microcystis* bloom in the Delta and thus earlier occurrences of *Microcystis* blooms relative to existing conditions. Warmer water temperatures could also increase bloom duration and magnitude relative to existing conditions.

The other key drivers of CHAB in the Delta—nutrient levels, channel velocities and associated turbulence and mixing, and irradiance—are not expected to change substantially in the future relative to existing conditions. This is the case when considering all past, present, and reasonably foreseeable projects, including those in Table 9-54, and climate change.

Past research within the Delta has shown that increased residence time and higher water temperatures are the two most important drivers of past and present problem-level CHABs in the Delta. Because water temperatures and possibly residence times in some portions of the Delta could be expected to increase in the future due primarily to sea level rise and climate change, which will favor CHABs, the future cumulative condition for *Microcystis* (and thus microcystin concentrations) and other species that form CHABs is considered to be significant in the Delta.

Project alternatives would not substantially alter Delta water temperatures, nutrient levels, channel velocities and associated turbulence and mixing, water clarity and associated irradiance, or residence times relative to existing conditions. Residence times were modeled to increase somewhat (i.e., up to 32 hours) for these project alternatives in the northern, eastern, and southern Delta, but the modeled increases are not sufficiently large to result in greater magnitude of cyanobacteria blooms in the Delta relative to existing conditions. Residence times in the open water areas of Discovery Bay would increase by up to 2 days, where residence times for existing conditions were on the order of several weeks. Multi-week-long residence times occur annually in Discovery Bay under existing conditions, and such long residence times would continue for the future cumulative condition, albeit potentially increasing by several days. Discovery Bay, characterized by long residence times, would support substantial accumulation of cyanobacteria cells under both existing and project conditions. Consequently, these project alternatives' individual contributions to the significant cumulative condition for CHABs in the Delta would not be cumulatively considerable and thus would not be significant.

Finally, the CMP tidal wetlands to be constructed in the North Delta Habitat Arc could cause small areas of increased residence time, slightly elevated water temperatures, decreased water column turbulence and mixing, turbidity (which affects irradiance), and increased nutrient concentrations (from decomposing vegetation). However, tidal wetland design would consider hydrologic regime and channel morphology to ensure backwater areas with low velocities and high residence times do not develop. Cyanobacteria are ubiquitous within the Delta as part of the overall phytoplankton community and will continue to be present, particularly along the channel margins, at the CMP sites. However, even if some additional cyanobacteria forms along the margins of the tidal habitats, the additional cyanobacteria biomass would not be sufficient to have a cumulatively considerable or significant contribution to the significant cumulative condition for CHABs in the Delta.

Cumulative Impacts on Water Quality in Suisun Marsh, Suisun Bay, and San Francisco Bay Resulting from Facility Operations

Based on both existing conditions and all past, present, and reasonably foreseeable projects, including those in Table 9-54, and other factors affecting constituent concentrations (e.g., sea level rise and climate change), the cumulative condition for boron, bromide, dissolved oxygen, organic carbon, pesticides, trace metals, and turbidity/TSS would not be significant relative to existing conditions in Suisun Marsh, Suisun Bay and San Francisco Bay. Hence, no further assessment of these constituents is necessary.

Suisun Marsh

Suisun Marsh is CWA Section 303(d)-listed for chloride, EC, TDS, mercury, nutrients, and organic enrichment/low dissolved oxygen (Table 9-2). Because uncertainty exists regarding whether the levels of these parameters will be reduced in the future, and to what degree, it is conservatively determined that the cumulative condition will remain significant for each of these constituents. The salinity constituents of chloride, EC, and TDS in the marsh are primarily a function of Delta outflow, outflow salinity levels, and the tides. The project alternatives have small effects on chloride, EC, and TDS levels in Delta outflow and on Delta outflow volume. This is particularly true when considering the volume of tidal excursions into the marsh and the salinity levels in the marsh and in Bay water. The CMP would not substantially affect, or affect at all, chloride, EC, and TDS levels in Delta outflow waters entering Suisun Marsh. Hence, the project alternatives would not have a cumulatively considerable and thus significant contribution to the significant cumulative chloride, EC, and TDS, conditions in Suisun Marsh.

The primary source of mercury to Suisun Marsh is resource extraction (i.e., mines) in the upper watersheds, Delta outflow, industrial and domestic wastewater, and atmospheric deposition. The project alternatives would not contribute at all to these sources. Moreover, for the same reasons addressed above for the Delta, facility operations of the project alternatives would not contribute considerably to the significant cumulative mercury condition in Suisun Marsh. Based on the large dilution of Delta outflows in Suisun Marsh by the tidal excursions, any incremental contribution of additional methylmercury produced in the CMP wetlands associated with the project alternatives also would not contribute considerably to the significant cumulative mercury condition in Suisun Marsh. Hence, the project alternatives would not have a cumulatively considerable and thus significant contribution to the significant cumulative mercury condition in Suisun Marsh.

Nutrient levels in Suisun Marsh are a function of nutrient levels in Delta outflow, San Francisco Bay water intrusion, and runoff from surrounding lands. The project alternatives would have negligible effects on nutrient levels in Delta outflows entering the marsh and would have no effect on inputs from San Francisco Bay water intrusion or runoff from surrounding lands. The CMP would not substantially affect, or affect at all, nutrient levels in Delta outflow waters entering Suisun Marsh. Hence, the project alternatives would not contribute considerably to the significant cumulative nutrient condition in Suisun Marsh. Similarly, the listing for organic enrichment/low dissolved oxygen is sourced to municipal point sources, urban runoff/storm sewers, and hydromodifications. The project alternatives and CMP would not contribute considerably, if at all, to these sources of organic enrichment/low dissolved oxygen, and thus would not contribute considerably to the significant cumulative condition for organic enrichment/low dissolved oxygen in Suisun Marsh. Hence, the project alternatives would not have a cumulatively considerable and thus significant contribution to the significant cumulative nutrient and organic enrichment/low dissolved oxygen conditions in Suisun Marsh.

Selenium is not CWA Section 303(d)-listed for Suisun Marsh, and the cumulative condition for selenium in Suisun Marsh would not be significant relative to existing conditions. The project alternatives and CMP would have negligible effects on the cumulative selenium concentrations in Delta waters and thus also would have negligible effects on selenium levels in Suisun Marsh.

CHABs have not historically occurred at problem levels in Suisun Marsh, due to difference in water quality, temperatures, and hydrodynamics of the marsh versus the Delta. Consequently, the cumulative condition for CHABs in Suisun Marsh would not be significant.

Suisun Bay

In addition to the constituents listed above, the cumulative condition for chloride, EC, nutrients, and CHABs would not be significant relative to existing conditions in Suisun Bay. Moreover, the project alternatives and CMP would have negligible effects on the future cumulative condition for these constituents in Suisun Bay. Salinity levels in Suisun Bay generally prevent CHABs from forming large, persistent blooms.

Suisun Bay is CWA Section 303(d)-listed for dioxins and furans, mercury, certain organochlorine pesticides (i.e., chlordane, DDE/DDT, dieldrin), PCBs, and selenium. Because uncertainty exists regarding whether the levels of these parameters will be maintained/reduced in the future to levels at/below existing conditions, it is conservatively determined that the cumulative condition will remain significant for each of these constituents.

The listed organochloride pesticides were banned from use decades ago. Legacy concentrations from their historic uses have led to their CWA Section 303(d) listing. The project alternatives and CMP would have no effect on the concentrations of chlordane, DDE/DDT, or dieldrin in Suisun Bay. Hence, to the degree that these legacy pesticides continue to persist in the environment, thus constituting a significant cumulative water quality condition, the project alternatives would not contribute considerably to this significant cumulative condition. Likewise, the project alternatives would have negligible, if any, effects on dioxin, furan, and PCB concentrations in Delta outflows and thus would not have a considerable contribution to the significant cumulative condition for dioxins, furans and PCBs in Suisun Bay.

Elevated mercury levels in Suisun Bay are sourced from historical resource extraction activities (i.e., mines) in the upper watersheds, industrial and domestic wastewater discharges, atmospheric deposition, nonpoint sources, and Delta outflows containing mercury. Modeling showed that the project alternatives would have negligible effects on mercury levels throughout the Delta (Appendix 9H) and thus on mercury levels in Delta outflows. Moreover, the project alternatives would have no effects on the other sources of mercury to Suisun Bay. The incremental methylmercury produced in the CMP wetlands would be sufficiently diluted by tidal excursions in Suisun Bay as to be inconsequential to concentrations in the bay. Consequently, the project alternatives and CMP would not contribute considerably to the significant cumulative condition for mercury in Suisun Bay.

The selenium impairment for Suisun Bay is attributed to discharge from natural sources, industrial point sources such as oil refineries, and the presence of exotic species, which increase selenium bioaccumulation into the foodweb. Modeling for the project alternatives showed negligible changes in selenium concentrations in Delta waters (Appendix 9J) that ultimately flow through Suisun Marsh and into Suisun Bay. The CMP wetland habitats would not produce higher selenium concentrations in Delta waters. As such, the project alternatives and CMP would not contribute considerably to the significant cumulative condition for selenium in Suisun Bay.

San Francisco Bay

Based on existing conditions and factors affecting constituent concentrations, the cumulative condition for boron, bromide, chloride, dissolved oxygen, EC, organic carbon, current use pesticides, trace metals, and turbidity/TSS, would not be significant relative to existing conditions in San Francisco Bay. Moreover, the project alternatives and CMP would have negligible effects on the cumulative condition for these constituents in San Francisco Bay. Also, salinity levels in San Francisco Bay generally prevent *Microcystis* spp. and other Delta cyanobacteria from forming large, persistent blooms. Hence, future levels of CHABs in the bay would remain low and thus would not be significant relative to existing conditions.

San Francisco Bay is CWA Section 303(d)-listed as impaired for various organochlorine pesticides (i.e., chlordane, DDT, dieldrin), dioxins and furans, mercury, PCBs, selenium and trash. Because uncertainty exists regarding whether the levels of these parameters will be maintained/reduced in the future to levels at/below existing conditions, it is conservatively determined that the cumulative condition will remain significant for each of these constituents.

While there have been improvements to selenium concentrations in San Francisco Bay, due in part to the petroleum refineries implementing controls that have decreased selenium in their discharges, the bay remains CWA Section 303(d) listed as impaired for elevated selenium. TMDLs that will be developed to address the impairment would be expected to contribute to some reduction in selenium in the bay, including the North Bay, which is partially influenced by Delta outflow. Thus, it is anticipated that the cumulative condition for selenium would be no worse, and possibly better than, existing conditions, but will likely remain adverse to beneficial uses through its bioaccumulation in the foodweb.

For the same reasons stated above for Suisun Bay, the project alternatives would have negligible, if any, effect on the future concentrations of chlordane, DDT, or dieldrin in San Francisco Bay. As such, the project alternatives would not contribute considerably to the cumulative condition for these constituents in San Francisco Bay. Similarly, the project alternatives would have negligible effects on dioxin, furan, and PCB concentrations in Delta outflows and thus would not have a considerable contribution to the cumulative condition for dioxins, furans and PCBs in San Francisco Bay.

The State Water Board adopted Part 2 of the Water Quality Control Plan for Inland Surface Waters, Enclosed Bays, and Estuaries of California—Tribal and Subsistence Fishing Beneficial Uses and Mercury Provisions, which includes water-column and fish tissue-based mercury limits to protect the beneficial uses associated with the consumption of fish by both people and wildlife. Similarly, expansion of the San Francisco Bay Mercury TMDL to include Suisun Bay and the Suisun Marsh Dissolved Oxygen and Mercury TMDL will also control the amount of mercury that reaches the bay and implement actions to minimize mercury bioavailability through site-specific water quality objectives and waste load allocations for point sources and nonpoint sources. Implementation actions in the Suisun Marsh TMDL are expected to reduce methylmercury production through BMPs to control conditions leading to low oxygen concentrations. Nevertheless, mercury is expected to remain a significant cumulative condition in San Francisco Bay. For the same reasons discussed above for Suisun Bay, the project alternatives and CMP would not contribute considerably to the significant cumulative condition for mercury in San Francisco Bay.

The project alternatives would not produce substantial amounts of trash, if any, that would be transported to San Francisco Bay. Consequently, the project alternatives would not contribute considerably to the significant cumulative condition for trash in San Francisco Bay.

Cumulative Impacts on Water Quality in the SWP/CVP Export Service Areas Resulting from Facility Operations

Based on existing conditions and factors affecting constituent concentrations, the cumulative condition for boron, bromide, chloride, dissolved oxygen, nutrients, organic carbon, current use pesticides, selenium, trace metals, and turbidity and TSS would not be significant relative to existing conditions in SWP/CVP export service area waterbodies. The project alternatives and CMP would have negligible, if any, effects on the cumulative condition for these constituents in this region. Based on modeling performed for the project alternatives, concentrations of boron (Appendix 9C), bromide (Appendix 9D), chloride (Appendix 9F), organic carbon (Appendix 9I), and selenium (Appendix 9J) would change little at Jones Pumping Plant and would typically decrease at Banks Pumping Plant relative to existing conditions. This is largely a function of the north Delta diversions associated with the project alternatives and thus would be expected to continue in the future.

The export area of the Delta, which is the region with the Banks and Jones Pumping Plants, is CWA Section 303(d)-listed as impaired for chlorpyrifos, diazinon, various organochlorine pesticides, EC, and mercury. Despite their CWA Section 303(d) listing, the cumulative conditions for chlorpyrifos and diazinon are not expected to be significant relative to existing conditions in the export area of the Delta. This is because the Central Valley RWQCB has adopted TMDLs for diazinon and chlorpyrifos for CWA Section 303(d)-listed segments of the Feather River, Sacramento River, and San Joaquin River. In 2019, the California Department of Pesticide Regulation and manufacturers agreed to end the sale of chlorpyrifos by 2020. Agricultural applications of diazinon have continued after it was banned from residential use in 2004 by the EPA. The project alternatives and CMP would have negligible, if any, effects on the future concentrations of these pesticides in SWP/CVP export service area waterbodies.

Whether or not future organochlorine pesticides levels at the export area of the Delta will be reduced below existing conditions is uncertain. Hence, the cumulative condition for organochlorine pesticides in the export area of the Delta are determined to remain significant. As discussed above, the CWA Section 303(d) listings for organochlorine pesticides are because of their widespread historical use and the fact that they are extremely persistent in the aquatic environment.

Organochlorine pesticides have all been banned and thus are no longer used. The project alternatives and CMP would not contribute considerably to the significant cumulative condition for any of the CWA Section 303(d) listed organochlorine pesticides.

Similarly, whether or not future EC and mercury levels at the export area of the Delta will be reduced below existing conditions is uncertain. Hence, the cumulative condition for EC and mercury in the export area of the Delta are determined to remain significant. Regarding EC and mercury, modeling showed (Appendix 9G and Appendix 9H) that the project alternatives would have small effects on EC and negligible, if any, effects on mercury levels at Jones Pumping Plant and would typically result in EC and mercury decreases at Banks Pumping Plant. The CMP has the potential to produce elevated levels of methylmercury within the wetlands themselves, and to a lesser degree in areas immediately adjacent to the wetland outlets. Should methylmercury levels be somewhat elevated in some of the CMP wetlands, such elevated levels (for site-specific areas) would undergo substantial dilution with other Delta waters prior to CMP wetland waters reaching the south Delta pumps. Based on the hydrodynamic mixing of the Delta, methylmercury levels would not be expected to be measurably higher at the south Delta pumps due to implementation of the CMP tidal wetland habitats. Consequently, the project alternatives and CMP would not contribute considerably to the significant cumulative condition for EC or mercury in SWP/CVP export service area waterbodies.

Cyanobacteria populations have historically been lower in the Sacramento River compared to the San Joaquin River. This is due to the different environmental conditions that typically exist in each river, and thus this trend is expected to continue in the future. The amount of *Microcystis* and other cyanobacteria, and their associated cyanotoxins, exported through Jones and Banks Pumping Plants into the SWP/CVP export service areas is expected to either remain about the same or decline based on use of the north Delta diversions under the project alternatives relative to existing conditions. Consequently, the cumulative condition for cyanobacteria and their associated cyanotoxins in the SWP/CVP export service areas would not be significant.