Chapter 5

Surface Water Quality

The chapter is presented in its entirety from the Draft Environmental Impact Report (DEIR), with revisions to text presented as a strikethrough or underline. Text shown with a strikethrough has been deleted from the DEIR. Text that has been added is presented as single underlined. Deleted figures are shown with a dashed border. Added figures do not have unique formatting.

This chapter describes the environmental setting, and direct and indirect impacts on surface water quality in the potential environmental impact area. The potential environmental impact area is defined as anywhere the Proposed Project could affect water quality, which includes the Sacramento River from the confluence with the Feather River to the Sacramento–San Joaquin Delta (Delta), the Delta, and Suisun Marsh and Suisun Bay.

5.1 Environmental Setting

This environmental setting identifies the primary factors that affect existing surface water quality, beneficial uses, and water quality impairments for surface waters in the study area.

5.1.1 Primary Factors Affecting Existing Water Quality

Primary factors affecting water quality in the potential environmental impact area include patterns of land use, precipitation, State Water Project (SWP) and Central Valley Project (CVP) operations, and point and nonpoint sources of pollutants. The magnitude of the effect that each factor has on water quality in the potential environmental impact 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 potential environmental impact 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 plants and mosquito control.
- Large dairies and feedlots can contribute nutrients, organic carbon, pesticides, sediment, and pathogens.

- Water-based recreational activities (e.g., 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 potential environmental impact area upstream of the Delta is affected by the factors listed above, as well as watershed hydrology and water management activities, such as reservoir operations and diversions, because 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.

5.1.2 Beneficial Uses

Table 5-1 lists the designated beneficial uses for waterbodies in the potential environmental impact area. Beneficial uses of surface waters are designated by California’s Regional Water Quality Control Boards (RWQCBs) for waters in their jurisdictions within their respective Water Quality Control Plans (WQCPs). In addition, the State Water Resources Control Board (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)* (Central Valley Regional Water Quality Control Board 2019a; San Francisco Bay Regional Water Quality Control Board 2023).

Table 5-1. Designated Beneficial Uses for Waterbodies in the Potential Environmental Impact Area

Name	Sacramento River: Feather River to Confluence	Yolo Bypass	Sacramento–San Joaquin Delta
Municipal and Domestic Supply (MUN)	Existing		Existing
Agricultural Supply (AGR)	Existing	Existing	Existing
Industrial Process Supply (PRO)			Existing
Industrial Service Supply (IND)	Existing		Existing
Hydropower Generation [c] (POW)			
Water Contact Recreation (REC-1)	Existing	Existing	Existing
Non-Contact Water Recreation (REC-2)	Existing	Existing	Existing
Warm Freshwater Habitat (WARM)	Existing	Existing	Existing
Cold Freshwater Habitat (COLD)	Existing	Potential	Existing
Migration of Aquatic Organisms (MIGR)	Existing [a, b]	Existing [a, b]	Existing [c]
Spawning, Reproduction, and/or Early Development (SPWN)	Existing [a, b]	Existing [a]	Existing [d]
Wildlife Habitat (WILD)	Existing	Existing	Existing
Navigation (NAV)	Existing		Existing
Commercial and Sport Fishing (COMM)		Existing	Existing
Groundwater Recharge (GWR)			Existing
Shellfish Harvesting (SHELL)			Existing
Estuarine Habitat (EST)			Existing
Rare, Threatened, or Endangered Species (RARE)			Existing

Sources: Central Valley Regional Water Quality Control Board 2019a:2-1–2-14; San Francisco Bay Regional Water Quality Control Board 2023:Table 2-1; State Water Resources Control Board 2018:7–8.

[a] Striped bass, sturgeon, and shad.

[b] Salmon and steelhead.

[c] Uses of water that support habitats necessary for migration or other temporary activities by aquatic organisms, such as anadromous fish.

[d] Uses of water that support high-quality aquatic habitats suitable for reproduction and early development of fish.

5.1.3 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 5-2 and Table 5-3. The State Water Board's CWA Section 303(d) list also includes numerous other waterbodies or segments of waterbodies in the Delta and Sacramento River and San Joaquin River watersheds due to impairments associated with various constituents.

Table 5-2. Clean Water Act Section 303(d) Listed Pollutants and Sources in the Delta, Suisun Bay, and Suisun Marsh

		Delta Region									Suisun	
Pollutant	**Listed Source**	**Central**	**Eastern**	**Export Area**	**Northern**	**Northwestern**	**Southern**	**Stockton DWSC**	**Western**	**SF Bay Region** [a]	**Suisun Bay**	**Suisun Marsh**
Arsenic	Source unknown								X			
Chlordane	Source unknown				X				X		X	
Chloride	Source unknown									X		X
Chlorpyrifos	Source unknown, agriculture, urban runoff/storm sewers	X	X		X	X	X	X	X			
DDE/DDT	Source unknown	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			
Dieldrin	Source unknown				X				X	X	X	
Dioxin	Source unknown							X		X	X	
Disulfoton	Source unknown											
EC/salinity	Source unknown			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											
Invasive species	Source unknown	X	X	X	X	X	X	X	X	X	X	
Mercury	Resource extraction, industrial-domestic wastewater, atmospheric deposition, nonpoint source	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
PAHs	Source unknown								X			
PCBs	Source unknown				X			X	X	X	X	
Temperature	Source unknown							X				
TDS	Source unknown											X
Toxicity [c]	Source unknown	X	X	X	X	X	X	X	X			
Selenium	Source unknown									X	X	

Source: State Water Resources Control Board 2022.

DWSC = Deep Water Ship Channel; SF = San Francisco; 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 (including lindane), endosulfan, and toxaphene.

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

Table 5-3. 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	X	X	X	X
Dioxin compounds	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
Selenium	Source unknown	X	X	X		X
Trash	Source unknown			X	X	

Source: State Water Resources Control Board 2022.
DDT = dichlorodiphenyltrichloroethane; PCBs = polychlorinated biphenyls.

5.1.4 Existing Surface Water Quality

This section describes the existing surface water quality conditions for constituents analyzed in detail later in this chapter: salinity constituents (electrical conductivity [EC] and chloride), and cyanobacteria and cyanotoxins.

5.1.4.1 Salinity (Electrical Conductivity and Chloride)

Salinity is a measure of dissolved salts in water. Typical salts found in surface waters include major cations (i.e., calcium, magnesium, sodium, and potassium) and anions (i.e., sulfate, chloride, fluoride, bromide, bicarbonate, and carbonate). The relative proportion of 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 saltwater 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 compared to seawater (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, as follows:

- Chloride objectives to protect municipal and industrial water supply beneficial uses, which are shown in Table 5-4
- EC objectives for multiple western, interior, and south Delta compliance locations to protect agricultural supply beneficial uses, which are shown in Table 5-5
- An EC objective for fish and wildlife protection, which is shown in Table 5-6
- EC objectives for brackish tidal marshes of Suisun Bay, which are shown in Table 5-7

In addition, the Bay-Delta WQCP has a Delta outflow standard that regulates the location and number of days of allowable encroachment into the west Delta of salinity exceeding 2 parts per thousand (ppt) isohaline (2.64 milliSiemens per centimeter) referred to as “X2” (State Water Resources Control Board 2018:14–21).

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 5-2). 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.

Table 5-4. Water Quality Objectives for Chloride in the Water Quality Control Plan for the San Francisco Bay/Sacramento–San Joaquin Delta Estuary for Municipal and Industrial Beneficial Uses (in milligrams per liter)

Location	Objective for Municipal and Industrial Beneficial Uses
Contra Costa Canal at Pumping Plant #1 or San Joaquin River at Antioch Water Works Intake	• Wet Year: <150 for 240 days per calendar year (66% of year) • Above Normal Year: <150 for 190 days per calendar year (52% of year) • Below Normal Year: <150 for 175 days per calendar year (48% of year) • Dry Year: <150 for 165 days per calendar year (45% of year) • Critical Year: <150 for 155 days per calendar year (42% of year) Expressed as a maximum mean daily concentration
Contra Costa Canal at Pumping Plant #1, West Canal at Mouth of Clifton Court Forebay, Jones Pumping Plant, Barker Slough at North Bay Aqueduct, and Cache Slough at the City of Vallejo Intake	• 250 (October–September) Expressed as a maximum mean daily concentration

Source: State Water Resources Control Board 2018:11.

Table 5-5. Water Quality Objectives for Electrical Conductivity in the Water Quality Control Plan for the San Francisco Bay/Sacramento–San Joaquin Delta Estuary for Agricultural Beneficial Uses (in micromhos per centimeter)

Location	Objective for Agricultural Beneficial Uses
Sacramento River at Emmaton	• Wet Year: 450 (April 1–August 15) • Above Normal Year: 450 (April 1–June 30); 630 (July 1–August 15) • Below Normal Year: 450 (April 1–June 19); 1,140 (June 20–August 15) • Dry Year: 450 (April 1–June 14); 1,670 (June 15–August 15) • Critical Year: 2,780 (April 1–August 15) Expressed as a 14-day running average of mean daily EC
San Joaquin River at Jersey Point	• Wet Year: 450 (April 1–August 15) • Above Normal Year: 450 (April 1–August 15) • Below Normal Year: 450 (April 1–June 19); 740 (June 20–August 15) • Dry Year: 450 (April 1–June 14); 1,350 (June 15–August 15) • Critical Year: 2,200 (April 1–August 15) Expressed as a 14-day running average of mean daily EC
South Fork Mokelumne River at Terminous	• Wet Year: 450 (April 1–August 15) • Above Normal Year: 450 (April 1–August 15) • Below Normal Year: 450 (April 1–August 15) • Dry Year: 450 (April 1–August 15) • Critical Year: 540 (April 1–August 15) Expressed as a 14-day running average of mean daily EC

Location	Objective for Agricultural Beneficial Uses
San Joaquin River at San Andreas Landing	• Wet Year: 450 (April 1–August 15) • Above Normal Year: 450 (April 1–August 15) • Below Normal Year: 450 (April 1–August 15) • Dry Year: 450 (April 1–June 24); 580 (June 25–August 15) • Critical Year: 870 (April 1–August 15) Expressed as a 14-day running average of mean daily EC
San Joaquin River at Airport Way Bridge, Vernalis -and- San Joaquin River from Vernalis to Brandt Bridge -and- Middle River from Old River to Victoria Canal - and- Old River/Grant Line Canal from Head of Old River to West Canal	• 700 (April 1–August 31) • 1,000 (September 1–March 31) Expressed as a maximum 30-day running average of mean daily EC
West Canal at mouth of Clifton Court Forebay -and- Delta-Mendota Canal at Jones Pumping Plant	• 1,000 (October 1–September 30) Expressed as monthly average of mean daily EC

Source: State Water Resources Control Board 2018:12.
EC = electrical conductivity.

Table 5-6. Water Quality Objectives for Electrical Conductivity in the Water Quality Control Plan for the San Francisco Bay/Sacramento–San Joaquin Delta Estuary for Fish and Wildlife Beneficial Uses (in micromhos per centimeter)

Location	Objective for Fish and Wildlife Beneficial Uses
San Joaquin River at and between Prisoners Point and Jersey Point	• 440 (April 1–May 31) Expressed as a maximum 14-day running average of mean daily EC

Source: State Water Resources Control Board 2018:14.
EC = electrical conductivity.

Table 5-7. Water Quality Objectives for Electrical Conductivity in the Water Quality Control Plan for the San Francisco Bay/Sacramento–San Joaquin Delta Estuary for Fish and Wildlife Beneficial Uses for Suisun Marsh (in millimhos per centimeter)

Location	Objective for Fish and Wildlife Beneficial Uses
Eastern Suisun Marsh: Sacramento River at Collinsville; Montezuma Slough at National Steel; Montezuma Slough near Beldon Landing	• 19.0 (October) • 15.5 (November–December) • 12.5 (January) • 8.0 (February–March) • 11.0 (April–May) Expressed as a maximum monthly average of both daily high tide EC values, or demonstrate that equivalent or better protection will be provided at the location
Western Suisun Marsh: Chadbourne Slough at Sunrise Duck Club, Suisun Slough 300 feet south of Volanti Slough, Cordelia Slough at Ibis Club, Goodyear Slough at Morrow Island Clubhouse, and water supply	All But Deficiency Period • 19.0 (October) • 16.5 (November) • 15.5 (December) • 12.5 (January) • 8.0 (February–March)

Location	Objective for Fish and Wildlife Beneficial Uses
intakes for waterfowl management areas on Van Sickle and Chipps Island	• 11.0 (April–May) Deficiency Period • 19.0 (October) • 16.5 (November) • 15.6 (December–March) • 14.0 (April) • 12.5 (May) Expressed as a maximum monthly average of both daily high tide EC values, or demonstrate that equivalent or better protection will be provided at the location

Source: State Water Resources Control Board 2018:14.
EC = electrical conductivity.

5.1.4.2 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). 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 2023:1-4).

CHABs in fresh and brackish water environments typically contain *Microcystis*, *Dolichospermum*, and *Aphanizomenon*. *Microcystis* is the most common and well-studied cyanobacteria in the Delta and typically comprises a large percentage of the Delta cyanobacteria community. 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, where 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.
- Sufficient nutrient availability of nitrogen and phosphorus.

Furthermore, in waterbodies influenced by saltwater, salinity below 10 ppt is more likely to support *Microcystis* growth than salinity above 10 ppt.

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). However, 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. 2022:2). 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. 2022:2). 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. 2022:1).

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. 2022:8). 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. 2022:1; 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). Several 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; 2021:14; Spier et al. 2013:8). In addition to producing cyanotoxins, CHABs can create surface scums that interfere with recreation and cause aesthetic problems, produce 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 RWQCB 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's 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 microgram per liter (µg/L), the U.S. Environmental Protection Agency (EPA) 10-day Health Advisories drinking water guidelines of 0.3 µg/L for children under the age of 6, and the California Caution Action Trigger of 0.8 µg/L (Lehman et al. 2017:105). 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 2019b: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.

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 becomes almost undetectable by Chipps Island (Berg and Sutula 2015:47). However, low levels of microcystins have been detected throughout the San Francisco and Suisun Bays (Peacock et al. 2018:138). The origin of these microcystins is unknown, but the toxin may have come from the Delta, urban runoff, 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 do 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.

5.2 Regulatory Setting

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

- ***Clean Water Act.*** The CWA (33 United States Code, Section 1251 et seq.) establishes the basic structure for regulating discharges of pollutants into the waters of the United States (including wetlands) and quality standards for surface waters, and gives 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.
- ***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 Proposed Project is 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 Decision 1641 (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 the U.S. Department of the Interior, Bureau of 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.

5.3 Impacts of the Proposed Project

This section describes the changes to Delta and Suisun Marsh surface water quality associated with the Proposed Project compared to the Baseline Conditions scenario.

The Proposed Project would modify existing operations, Delta surface water flows, and diversions at selected SWP facilities and related waterways. Changes to hydrology may affect surface water quality in the SWP system in the Delta. The changes to surface water flows are discussed in detail in Chapter 4, "Surface Water Hydrology."

5.3.1 Thresholds of Significance

The thresholds of significance used for this impact analysis represent a refinement of the criteria in State California Environmental Quality Act (CEQA) Guidelines Appendix G, Section X, "Hydrology and Water Quality," to make them more effective at evaluating the mechanisms that could lead to potentially significant environmental impacts based on the details of the Proposed Project. The Proposed Project could cause changes in Delta inflows, outflows, and exports, which could affect whether Delta water quality is in compliance with applicable state water quality objectives adopted to protect beneficial uses or could otherwise degrade water quality.

Based on Appendix G of the State CEQA Guidelines, the Proposed Project would result in a potentially significant impact related to surface water quality if it would:

- Violate any water quality standards or waste discharge requirements or otherwise substantially degrade surface or ground water quality, defined as:
    - Causing exceedance of applicable state or federal numeric or narrative water quality objectives/criteria, or other relevant water quality effects thresholds by frequency, magnitude, and geographic extent that would result in adverse effects to one or more beneficial uses within affected water bodies; or
    - Degrading water quality by a sufficient magnitude, duration, and geographic extent that would cause a substantial risk of adverse effects to one or more beneficial uses.

Changes to surface water quality may result in secondary impacts on other beneficial water uses or environmental resources. Such secondary impacts are discussed in their respective sections. For instance, potential changes in Delta salinity are discussed in this section as part of the analysis of surface water quality, and the potential impacts of the changes in Delta salinity on aquatic resources and associated habitat are presented in Chapter 6, "Aquatic Biological Resources."

5.3.2 Methods of Analysis

5.3.2.1 Electrical Conductivity

EC was modeled using Delta Simulation Model II (DSM2). Details of the DSM2 modeling, including model development and input, are provided in Appendix 4A, "Model Assumptions," Attachment 1, "Model Assumptions." Table 5-8 lists the EC assessment locations for which DSM2 modeling output was post-processed and evaluated.

Table 5-8. Delta and Suisun Marsh Assessment Locations for Electrical Conductivity

Assessment Location	**Region**
Sacramento River at Emmaton	Western Delta
South Fork Mokelumne River at Terminous	Interior Delta
Banks Pumping Plant	Export area Delta
Jones Pumping Plant	Export area Delta
San Joaquin River at Jersey Point	Western Delta
San Joaquin River at Prisoners Point	Interior Delta
San Joaquin River at San Andreas Landing	Interior Delta

Assessment Location	Region
San Joaquin River at Vernalis	Southern Delta
San Joaquin River at Brandt Bridge	Southern Delta
Old River near Middle River	Southern Delta
Old River at Tracy Bridge	Southern Delta
Steamboat Slough at Sutter Slough	Northern Delta
Sacramento River at Rio Vista	Northern Delta
Sacramento River at Threemile Slough	Northern Delta
Sacramento River at Collinsville	Suisun Marsh
Montezuma Slough at National Steel	Suisun Marsh
Montezuma Slough near Beldon Landing	Suisun Marsh
Chadbourne Slough near Sunrise Duck Club	Suisun Marsh
Suisun Slough 300 feet south of Volanti Slough	Suisun Marsh

5.3.2.2 Chloride

Chloride concentrations were modeled for the Delta assessment locations. The method for calculating chloride concentrations varied by assessment location. For Delta locations where the predominant source of chloride is seawater, chloride concentrations were determined by applying known relationships between EC and chloride to DSM2-modeled EC. For Delta locations where chloride concentrations are more influenced by Delta inflows from the Sacramento River and San Joaquin River, a mass-balance approach was applied. Table 5-9 summarizes the calculation method used for each Delta assessment location.

Table 5-9. Delta Assessment Locations and Concentration Calculation Method for Chloride

Assessment Location	Delta Region	Concentration Calculation Method
Barker Slough at North Bay Aqueduct	Northern	Mass-balance
San Joaquin River at Empire Tract	Interior	Mass-balance
Banks Pumping Plant	Export area	Mass-balance
Jones Pumping Plant	Export area	Mass-balance
San Joaquin River at Antioch	Western	Regression
Contra Costa Water District Pumping Plant #1	Interior	Regression
Old River at State Route 4	Southern	Regression
Victoria Canal	Southern	Regression

The mass-balance methodology used to calculate chloride concentrations used the DSM2-modeled average monthly source water flow fractions for each Delta assessment location. The source water flow fraction output is the percentage of water at each assessment location constituted by the six primary source waters—Sacramento River (SAC), San Joaquin River (SJR), Yolo Bypass (YOL), eastside tributaries (EST), San Francisco Bay (BAY), and Delta agriculture returns (AGR). These flow fractions were used together with source water constituent concentrations to calculate a given constituent concentration at the assessment locations according to the following equation.

$$C_i = f_{SAC,i}(C_{SAC}) + f_{SJR,i}(C_{SJR}) + f_{YOL,i}(C_{YOL}) + f_{EST,i}(C_{EST}) + f_{BAY,i}(C_{BAY}) + f_{AGR,i}(C_{AGR})$$

In the above equation, Ci is the concentration at Delta assessment location i, $f_{X,i}$ is the average monthly flow fraction from source water X at assessment location i, and C_X is the source water X concentration. Source water concentrations input into the above equation are discussed in Appendix 5A, "Chloride."

The regression methodology used known relationships between EC and chloride to calculate chloride concentrations at Delta assessment locations. These relationships were applied to the EC output from DSM2.

The EC-chloride relationship was developed based on data at Mallard Island, Jersey Island, and Old River at Rock Slough (Contra Costa Water District 1997:1). The relationship is defined by the following equation, in which Cl is the chloride concentration in milligrams per liter (mg/L) and EC is in micromhos per centimeter (µmhos/cm).

$$Cl = max\begin{pmatrix}0.15 * EC - 12\\0.285 * EC - 50\end{pmatrix}$$

5.3.2.3 CHABs

Effects of the Proposed Project on CHABs were determined by evaluating the direction and relative magnitude to which the five environmental conditions that most affect CHABs during the period of the year when CHABs typically occur, which is June through November, would be affected by the Proposed Project relative to Baseline Conditions. The environmental conditions that most affect CHABs are: (1) water temperatures, (2) residence times, (3) channel velocities and associated turbulence and mixing, (4) nutrient levels, and (5) water column irradiance and thus light penetration through the water column, as affected by turbidity. CHABs favor warmer water temperatures; longer residence times; low channel velocities, turbulence, and mixing; high nutrient levels; and low turbidity resulting in high irradiance.

The potential for the Proposed Project to affect the five factors that drive CHABs was determined using CalSim 3 modeling output. Sacramento River and San Joaquin River flows, and Delta inflow and outflow modeling output from CalSim 3 for Baseline Conditions and the Proposed Project were compared to identify Proposed Project effects. Relatively small magnitude changes in these conditions would not be expected to cause substantial, if any, increases in the frequency or magnitude of CHABs. Conversely, substantial changes in one or more of these environmental conditions in the direction favored by CHABs could potentially affect the frequency and/or magnitude of CHABs. Proposed Project–driven changes in water temperatures were assessed qualitatively. Reductions in Delta inflows and outflows may increase residence times at some Delta locations, whereas increases in Delta inflows and/or outflows would tend to reduce residence times (i.e., result in greater flushing rates). Reductions in rates would tend to increase channel velocities, mixing, and turbidity. Changes in river flow rates and expected effects on turbidity levels were evaluated to address changes in irradiance. Changes in river flow rates also could affect nutrient concentrations, if the proportion of Sacramento River water to other Delta source water is significantly affected by the Proposed Project.

5.3.3 Evaluation of the Proposed Project

The discussion below presents the effects of the Proposed Project on the water quality of the Sacramento River from the Feather River to the confluence with the Delta, the Delta, Suisun Marsh, and Suisun Bay.

5.3.3.1 Sacramento River From Feather River to Confluence

Potential changes in water quality in the Sacramento River from the Feather River to the confluence with the Delta is assessed by considering how the Proposed Project could affect: (1) upstream reservoir conditions; and (2) river conditions downstream of the reservoirs. Figure 2-1 shows the project area, including the Sacramento River from the confluence with the Feather River to the Delta.

The Proposed Project would not affect land uses in the upper watersheds that drain into the upstream reservoirs and rivers, or the inflow volume or quality into the reservoirs. Consequently, the Proposed Project would not change the seasonal quality (including water temperatures) or volume of water entering the reservoirs relative to Baseline Conditions. Furthermore, CalSim 3 modeling results for the Proposed Project, presented in Appendix 4B, “Model Results,” Attachment 1, “CalSim Storage,” show very small average end-of-month storage changes for the full simulation period for Lake Oroville, relative to Baseline Conditions. Therefore, there would not be substantial, if any, changes to reservoir seasonal thermal profiles, biochemical and nutrient cycling processes, or dilution capacity within the reservoirs, and water quality under the Proposed Project is expected to be similar to Baseline Conditions.

The Proposed Project does not include reoperation of any SWP reservoirs, including Oroville Reservoir. Therefore, the Proposed Project would have small effects on flows in the Sacramento River, relative to Baseline Conditions, as demonstrated by CalSim 3 modeling results presented in Appendix 4B, Attachment 2, “CalSim3 Flow Results,” and discussed in Chapter 4, “Surface Water Hydrology.” Because little to no changes in reservoir operations would occur, little to no changes in water quality would occur in the Sacramento River under the Proposed Project relative to Baseline Conditions.

Based on these findings, the Proposed Project would result in less-than-significant effects on water quality upstream of the Delta, including the Sacramento River from the Feather River confluence to the Delta.

5.3.3.2 Delta

The Proposed Project has the potential to affect Delta water quality through changes in Delta inflow rates and associated effects on constituent loading and Delta hydrodynamics. As described in the previous section evaluating effects of the Proposed Project on the Sacramento River water quality, the Proposed Project would have little to no effect on the quality of the Sacramento River or other tributary inflows to the Delta. Furthermore, as demonstrated by CalSim 3 modeling results presented in Appendix 4B, “Model Results” Attachment 2, “CalSim Flows,” and discussed in Chapter 4, “Surface Water Hydrology,” there would be little change in the Delta inflow rates under the Proposed Project relative to Baseline Conditions. The small modeled changes in Delta inflow would not cause Delta water quality under the Proposed Project to differ from Baseline Conditions for most constituents and constituent groups of concern, in a way that would contribute to water quality degradation or adverse effects on beneficial uses. Therefore, the discussion below is focused on effects of the Proposed Project on Delta water quality, specifically EC, chloride, and CHABs. EC and chloride are discussed because the Proposed Project is operated to meet Delta water quality objectives for these constituents. CHABs are addressed because of potential for changes in inflows to affect the primary factors that affect their presence in the Delta, particularly residence time, channel velocity, and water temperature.

Electrical Conductivity

Appendix 5B, “Electrical Conductivity,” provides tables and figures presenting modeled EC levels at the Delta assessment locations for Baseline Conditions and the Proposed Project. Table 5-10 presents the modeled monthly average EC levels at the Delta assessment locations under the Proposed Project for the full simulation period and the differences from Baseline Conditions. Detailed discussions of the differences in EC levels at these locations under the Proposed Project relative to Baseline Conditions follow.

Table 5-10. Monthly Average Electrical Conductivity (in micromhos per centimeter) at Delta Assessment Locations for the Full Simulation Period under the Proposed Project, and Difference from Baseline Conditions

Location/Parameter	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Sacramento River at Emmaton												
Full Simulation Period Average	~~1652~~ 1793	~~1640~~ 1669	~~968~~ 978	~~517~~ 503	~~278~~ 266	~~231~~ 237	~~258~~ 269	~~325~~ 362	~~540~~ 585	~~682~~ 735	~~1156~~ 1246	~~1465~~ 1631
Difference from Baseline Conditions	~~30~~ 40	~~11~~ 4	~~-10~~ -6	~~-18~~ -1	~~-16~~ -2	~~-10~~ -3	~~-3~~ -4	3	~~5~~ -2	0	~~29~~ 20	~~29~~ 41
Sacramento River at Rio Vista												
Full Simulation Period Average	~~296~~ 311	~~303~~ 302	~~248~~ 250	~~211~~ 208	~~192~~ 190	188	~~188~~ 189	~~189~~ 192	~~204~~ 209	~~210~~ 215	~~248~~ 258	~~271~~ 286
Difference from Baseline Conditions	~~2~~ 3	~~1~~ 0	-1	~~-2~~ 0	~~-1~~ 0	~~-1~~ 0	0	0	~~1~~ 0	0	3	~~2~~ 3
Sacramento River at Threemile Slough												
Full Simulation Period Average	~~816~~ 889	~~805~~ 812	~~509~~ 517	~~322~~ 311	~~222~~ 216	~~202~~ 204	~~211~~ 214	~~233~~ 249	~~317~~ 339	~~363~~ 389	~~570~~ 619	~~715~~ 796
Difference from Baseline Conditions	~~13~~ 17	~~6~~ 1	~~-5~~ -3	~~-8~~ 0	~~-7~~ -1	~~-4~~ -1	-1	~~0~~ 1	~~3~~ 0	1	~~14~~ 11	~~12~~ 19
South Fork Mokelumne River at Terminous												
Full Simulation Period Average	187	195	209	~~215~~ 214	~~223~~ 222	~~213~~ 211	~~199~~ 200	189	186	183	~~184~~ 185	182
Difference from Baseline Conditions	0	~~-1~~ 0	0	0	0	0	0	0	0	0	0	0
San Joaquin River at Jersey Point												
Full Simulation Period Average	~~1155~~ 1156	~~1359~~ 1332	~~1297~~ 1170	~~678~~ 623	~~361~~ 344	~~263~~ 260	~~255~~ 253	~~273~~ 280	~~335~~ 354	~~631~~ 611	~~993~~ 951	~~1226~~ 1227
Difference from Baseline Conditions	~~15~~ 21	~~1~~ 7	~~-7~~ 0	~~-28~~ -2	~~-20~~ -5	~~-7~~ -2	~~-3~~ -1	~~-1~~ 1	~~-4~~ -5	~~-2~~ -5	~~39~~ 44	~~40~~ 38
San Joaquin River at Prisoners Point												
Full Simulation Period Average	~~334~~ 328	~~378~~ 366	~~506~~ 455	~~391~~ 360	~~313~~ 298	~~284~~ 269	~~301~~ 277	~~265~~ 250	~~227~~ 220	~~239~~ 234	~~286~~ 278	~~321~~ 319
Difference from Baseline Conditions	0	~~-3~~ 1	~~-3~~ 1	~~-7~~ 0	~~-3~~ 2	~~2~~ 3	~~-1~~ 1	~~-8~~ -5	0	~~0~~ -1	6	5
San Joaquin River at San Andreas Landing												
Full Simulation Period Average	~~366~~ 361	~~417~~ 403	~~514~~ 461	~~350~~ 323	~~251~~ 243	~~223~~ 219	~~229~~ 223	~~223~~ 220	~~209~~ 210	~~233~~ 232	~~290~~ 287	~~331~~ 337
Difference from Baseline Conditions	~~-1~~ 1	~~-4~~ 1	~~-3~~ 1	~~-8~~ 0	~~-6~~ -1	~~-1~~ 0	~~-1~~ 0	~~-3~~ -2	~~-1~~ 0	0	7	~~5~~ 6

Location/Parameter	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
San Joaquin River at Vernalis												
Full Simulation Period Average	~~601~~ 519	~~707~~ 675	~~689~~ 644	~~643~~ 661	~~590~~ 575	~~601~~ 564	~~448~~ 370	~~400~~ 325	~~469~~ 415	~~532~~ 474	~~548~~ 508	~~566~~ 493
Difference from Baseline Conditions	0	0	0	0	0	0	0	0	0	0	0 ~~1~~	0
San Joaquin River at Brandt Bridge												
Full Simulation Period Average	~~599~~ 518	~~702~~ 667	~~692~~ 650	~~648~~ 661	~~593~~ 582	~~601~~ 565	~~457~~ 382	~~405~~ 329	~~468~~ 413	~~531~~ 475	~~550~~ 507	~~567~~ 499
Difference from Baseline Conditions	0	0	0	0	0	0	0	0	0	0	- 1	0
Old River near Middle River												
Full Simulation Period Average	~~601~~ 520	~~704~~ 671	~~693~~ 650	~~651~~ 666	~~597~~ 585	~~605~~ 569	~~457~~ 381	~~405~~ 330	~~470~~ 417	~~533~~ 479	~~552~~ 509	~~569~~ 501
Difference from Baseline Conditions	0	0	0	0	0	0	0	0	0	0	~~1~~ 0	0
Old River at Tracy Bridge												
Full Simulation Period Average	~~599~~ 522	~~699~~ 657	~~705~~ 666	~~674~~ 685	~~628~~ 619	~~623~~ 590	~~477~~ 405	~~418~~ 344	~~451~~ 382	~~480~~ 412	~~485~~ 417	~~524~~ 465
Difference from Baseline Conditions	0	0	0	0	0	0	0	0	~~-3~~ -2	~~-1~~ 1	~~1~~ 3	~~2~~ 5
Banks Pumping Plant												
Full Simulation Period Average	~~462~~ 453	~~494~~ 480	~~650~~ 611	~~614~~ 579	~~522~~ 497	~~494~~ 458	~~454~~ 391	~~401~~ 342	~~333~~ 310	~~308~~ 299	~~363~~ 349	~~427~~ 418
Difference from Baseline Conditions	~~1~~ 4	~~0~~ 2	~~-2~~ 0	~~-1~~ 4	~~2~~ 10	~~5~~ 8	~~-1~~ 3	~~-5~~ -1	~~1~~ 3	~~0~~ -1	4	9
Jones Pumping Plant												
Full Simulation Period Average	~~498~~ 473	~~543~~ 521	~~660~~ 620	~~625~~ 594	~~540~~ 516	~~514~~ 477	~~469~~ 402	~~408~~ 342	~~355~~ 323	~~345~~ 324	~~394~~ 369	~~455~~ 434
Difference from Baseline Conditions	~~1~~ 3	~~0~~ 2	~~-1~~ 0	~~-1~~ 3	~~1~~ 8	4 6	~~0~~ 1	~~-4~~ -1	~~0~~ 2	~~0~~ -1	4	8

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

Sacramento River at Emmaton

In the Sacramento River at Emmaton for the months of ~~December~~ November through July, modeled monthly average EC levels for the full simulation period under the Proposed Project are no more than ~~5~~ 4 µmhos/cm higher than EC levels under Baseline Conditions, and for many months the average EC is lower under the Proposed Project (Table 5-10; Appendix 5B, Tables 5B-1a through 5B-2d, Figures 5B-1a through 5B-1r). Differences in modeled monthly average EC under the Proposed Project range from up to 3 percent higher in ~~August~~ September to ~~5~~ 1 percent lower in ~~February~~ December, February, March, and April (Appendix 5B, Tables 5B-1a through 5B-2d).

In the Sacramento River at Emmaton for August through ~~November~~ October, modeled monthly average EC levels for the full simulation period are up to ~~30~~ 41 µmhos/cm higher under the Proposed Project compared to Baseline Conditions (Table 5-10). The modeled monthly average EC from August through ~~November~~ October under Baseline Conditions ranges from ~~1,127~~ 1,227 µmhos/cm in August to ~~1,628~~ 1,753 µmhos/cm in ~~November~~ October for the full simulation period (Appendix 5B, Table 5B-1b). Under the Proposed Project, the modeled monthly average EC ranges from ~~1,156~~ 1,246 µmhos/cm in August to ~~1,652~~ 1,793 µmhos/cm in ~~November~~ October for the full simulation period (Table 5-10). On a long-term average basis, modeled monthly average EC levels are from ~~1~~ 2–3 percent higher under the Proposed Project relative to Baseline Conditions in August through ~~November~~ October.

Based on these modeled differences in EC, which consists of up to ~~5~~ 1 percent lower and up to 3 percent higher average EC levels relative to Baseline Conditions, depending on the month, and several months with little to no difference, the Proposed Project would not substantially degrade water quality with regard to EC on a long-term average basis in the Sacramento River at Emmaton.

Sacramento River at Threemile Slough and Rio Vista

In the Sacramento River at Threemile Slough for ~~December~~ November through July, modeled monthly average EC levels for the full simulation period under the Proposed Project are no more than ~~3~~ 1 µmhos/cm higher than EC levels under Baseline Conditions, and for many months the average EC is lower under the Proposed Project (Table 5-10; Appendix 5B, Tables 5B-25a through 5B-26d, Figures 5B-13a through 5B-13r). Differences in modeled monthly average EC under the Proposed Project range from up to ~~3~~ 2 percent higher in August, September, and October to ~~3~~ 1 percent lower in ~~February~~ December (Appendix 5B, Tables 5B-25a through 5B-26d).

In the Sacramento River at Threemile Slough for August through ~~November~~ October, modeled monthly average EC levels for the full simulation period are up to ~~14~~ 19 µmhos/cm higher under the Proposed Project compared to Baseline Conditions (Table 5-10). The modeled monthly average EC from August through ~~November~~ October under Baseline Conditions ranges from ~~556~~ 608 µmhos/cm in August to ~~804~~ 871 µmhos/cm in October for the full simulation period (Appendix 5B, Table 5B-25b). Under the Proposed Project, the modeled monthly average EC ranges from ~~570~~ 619 µmhos/cm in August to ~~816~~ 889 µmhos/cm in October for the full simulation period (Table 5-10). On a long-term average basis, modeled monthly average EC levels are ~~from 1–3~~ 2 percent higher under the Proposed Project relative to Baseline Conditions in the months of August through ~~November~~ October.

Differences in modeled EC levels for the Sacramento River at Rio Vista under the Proposed Project relative to Baseline Conditions exhibit a similar pattern to that described above for Threemile Slough (Table 5-10). However, the magnitude of the EC increases is smaller (Table 5-10; Appendix 5B, Tables 5B-23a through 5B-24d, Figures 5B-12a through 5B-12r).

Based on these modeled differences in EC, the Proposed Project would not substantially degrade water quality with regard to EC on a long-term average basis in the Sacramento River at Threemile Slough and Rio Vista.

San Joaquin River at Jersey Point

In the San Joaquin River at Jersey Point for ~~December~~ November through July, modeled monthly average EC levels for the full simulation period under the Proposed Project are ~~1 to 28~~ no more than 7 µmhos/cm ~~lower~~ higher than EC levels under Baseline Conditions, and for many months the average EC is lower under the Proposed Project (Table 5-10; Appendix 5B, Tables 5B-9a through 5B-10d, Figures 5B-5a through 5B-5r). Differences in modeled monthly average EC under the Proposed Project range from ~~0 percent change in July~~ up to 5 percent higher in August to ~~5~~ 1 percent lower in February, March, June, and July (Appendix 5B, Tables 5B-9a through 5B-10d).

In the San Joaquin River at Jersey Point for August through ~~November~~ October, modeled monthly average EC levels for the full simulation period are up to ~~40~~ 44 µmhos/cm higher under the Proposed Project compared to Baseline Conditions (Table 5-10). The modeled monthly average EC from August through ~~November~~ October under Baseline Conditions ranges from ~~953~~ 908 µmhos/cm in August to ~~1,358~~ 1,189 µmhos/cm in ~~November~~ September for the full simulation period (Appendix 5B, Table 5B-9b). Under the Proposed Project, the modeled monthly average EC ranges from ~~993~~ 951 µmhos/cm in August to ~~1,359~~ 1,227 µmhos/cm in ~~November~~ September for the full simulation period (Table 5-10). On a long-term average basis, modeled monthly average EC levels are ~~up~~ from ~~1–4~~ 2–5 percent higher under the Proposed Project relative to Baseline Conditions in August through ~~November~~ October.

Based on these modeled differences in EC, which consists of up to ~~5~~ 1 percent lower and up to ~~4~~ 5 percent higher average EC levels relative to Baseline Conditions, depending on the month, the Proposed Project would not substantially degrade water quality with regard to EC on a long-term average basis in the San Joaquin River at Jersey Point.

San Joaquin River at Prisoners Point and San Andreas Landing

In the San Joaquin River at Prisoners Point and San Andreas Landing, modeled monthly average EC levels for the full simulation period are up to 7 µmhos/cm higher under the Proposed Project compared to Baseline Conditions, and a difference of 0–1 µmhos/cm in several months (Table 5-10; Appendix 5B, Tables 5B-11a through 5B-14d, Figures 5B-6a through 5B-7r). Based on these modeled differences in EC, the Proposed Project would not substantially degrade water quality with regard to EC on a long-term average basis in the San Joaquin River at Prisoners Point and San Andreas Landing.

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

In the San Joaquin River at Vernalis and Brandt Bridge, Old River at Middle River ~~and Tracy Bridge~~, and South Fork Mokelumne at Terminous, little to no change in monthly average EC levels would occur under the Proposed Project relative to Baseline Conditions (Appendix 5B, Figures 5B-2a through 5B-2r, and 5B-8a through 5B-11r). ~~The~~ In Old River at Tracy Bridge, the increase in modeled monthly average EC is ~~2~~ 1–5 µmhos/cm ~~or less at these locations~~ in July through September, a reduction of 2 µmhos/cm in June, and no change for the remaining months for the full simulation period (Table 5-10). Based on these modeled differences in EC, the Proposed Project would not substantially degrade water quality with regard to EC on a long-term average basis in the San Joaquin River at Vernalis and Brandt Bridge, Old River near Middle River and Tracy Bridge, and South Fork Mokelumne at Terminous.

Banks and Jones Pumping Plants

At Banks and Jones Pumping Plants, modeled EC levels under the Proposed Project are overall similar to Baseline Conditions, with decreases in some months and increases in other months (Appendix 5B, Tables 5B-5a through 5B-8d, Figures 5B-3a through 5B-4r). Modeled monthly average EC levels for the full simulation period are up to ~~9~~ 10 µmhos/cm higher under the Proposed Project (Table 5-10). On a long-term average basis, modeled monthly average EC levels are from 0–2 percent higher under the Proposed Project relative to Baseline Conditions for the full simulation period. Based on these modeled differences in EC, the Proposed Project would not substantially degrade water quality with regard to EC on a long-term average basis at Bank and Jones Pumping Plants.

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 (Table 5-5). The Bay-Delta WQCP also includes water quality objectives for EC for protection of fish and wildlife (Table 5-6). The modeling results show a slight (0.01 percent) increase in the frequency of exceeding the EC objective for Old River at Tracy Bridge and San Joaquin River at Vernalis for agricultural beneficial use protection under the Proposed Project relative to Baseline Conditions and no change or a decrease at all other EC compliance locations (Table 5-11). The modeling results ~~also~~ show a ~~slight (0.04 percent) increase~~ decrease in frequency of exceeding the fish and wildlife objectives under the Proposed Project (Table 5-12).

The modeled increase in the frequency of exceeding the Bay-Delta WQCP objective for Old River at Tracy Bridge and San Joaquin River at Vernalis would not actually occur. The modeled increases are attributable to the monthly timestep of the hydrologic modeling conducted by CalSim 3 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. The small (0.01 percent) modeled increased frequency of exceedance of the EC objective relative to the period of record modeled indicates that the Proposed Project would not be expected to increase the frequency of exceeding Bay-Delta WQCP objectives with actual real-time operations. Thus, the increase is a modeling artifact and does not indicate that operation of the Proposed Project would increase the frequency of exceeding Bay-Delta WQCP EC objectives.

Table 5-11. Percent of Days in Water Years 1922–2021 that Modeled Electrical Conductivity Exceeded the Agricultural Beneficial Uses Water Quality Objective, Baseline Conditions and the Proposed Project

Assessment Location	Baseline Conditions	Proposed Project
Sacramento River at Emmaton	~~2.72~~ 2.53 %	~~2.72~~ 2.25 %
South Fork Mokelumne River at Terminous	0.00%	0.00%
Banks Pumping Plant	0.00%	0.00%
Jones Pumping Plant	0.00%	0.00%
San Joaquin River at Jersey Point	~~5.55~~ 4.12 %	~~5.35~~ 4.01 %
San Joaquin River at San Andreas Landing	0.00%	0.00%
San Joaquin River at Vernalis	~~0.02~~ 0.00 %	~~0.00~~ 0.01 %
San Joaquin River at Brandt Bridge	~~0.02~~ 0.01 %	~~0.02~~ 0.01 %
Old River near Middle River	~~0.02~~ 0.01 %	~~0.02~~ 0.01 %
Old River at Tracy Bridge	~~0.09~~ 0.01 %	~~0.10~~ 0.02 %

Table 5-12. Percent of Days in Water Years 1922–2021 that Modeled Electrical Conductivity Exceeded the Fish and Wildlife Beneficial Uses Water Quality Objective, Baseline Conditions and the Proposed Project

Assessment Location	Baseline Conditions	Proposed Project
San Joaquin River at Jersey Point	~~0.33~~ 0.22 %	~~0.00~~ 0.12 %
San Joaquin River at Prisoners Point	~~0.41~~ 0.06 %	~~0.45~~ 0.00 %

One-Time Water Commitment for Delta Outflow

As described in Section 2.3.6.3, "One Time Water Commitment for Delta Outflow," during 2025, DWR would release a block of water from Oroville Reservoir during summer–fall ~~if it is not deployed in 2024 and~~ if 2025 is not a Critical water year. Sacramento River flow at Freeport and Delta outflow may be slightly higher during these months than the CalSim 3 modeling indicates for the Proposed Project. As a result, EC levels in the Delta, particularly in the Sacramento River at Emmaton, Threemile Slough, and Rio Vista, could also be lower than the modeling indicates. Because EC levels could be lower with the release of this water than modeling indicates, this action would not substantially degrade water quality with regard to EC in the Delta.

CEQA Conclusion

Based on the modeling results discussed above, which showed that average EC levels would be 1– ~~5~~ 2 percent lower in several months and from 0– ~~4~~ 5 percent higher in a few months, depending on location, the Proposed Project would not cause substantial increases in EC levels in the Delta relative to Baseline Conditions. Furthermore, the Proposed Project would not cause additional exceedance of applicable EC 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 EC levels are not expected to increase substantially, the Proposed Project 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. Therefore, the impact of the Proposed Project on EC would be less than significant.

Mitigation

None required.

Chloride

Appendix 5A, "Chloride," provides tables and figures presenting modeled chloride concentrations at the Delta assessment locations for Baseline Conditions and the Proposed Project. Table 5-13 presents the modeled monthly average chloride concentrations at the Delta assessment locations under the Proposed Project for the full simulation period and the differences from Baseline Conditions. Detailed discussions of the differences in chloride concentrations under the Proposed Project relative to Baseline Conditions follow.

Table 5-13. Monthly Average Chloride (in milligrams per liter) at Delta Assessment Locations for the Full Simulation Period under the Proposed Project and Difference from Baseline 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	21	23	~~23~~ 22	28	31	27	28	19	16	14	15	21
Difference from Baseline Conditions	0	0	0	0	0	0	0	0	0	0	0	0
San Joaquin River at Empire Tract												
Full Simulation Period Average	~~45~~ 44	~~53~~ 50	~~76~~ 65	~~60~~ 53	~~48~~ 43	~~41~~ 35	~~41~~ 34	~~32~~ 27	~~29~~ 27	~~26~~ 24	~~34~~ 33	~~41~~ 42
Difference from Baseline Conditions	0	~~-1~~ 0	~~-1~~ 0	~~-1~~ 0	~~0~~ 1	1	0	-1	0	0	1	~~0~~ 1

Location/Parameter	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Contra Costa Pumping Plant #1												
Full Simulation Period Average	~~107~~ 108	~~120~~ 116	~~165~~ 148	~~110~~ 95	~~59~~ 55	~~40~~ 37	~~46~~ 42	~~40~~ 36	30	~~43~~ 42	~~73~~ 69	~~102~~ 101
Difference from Baseline Conditions	1	~~0~~ 1	~~-1~~ 0	~~-3~~ 0	~~-2~~ 1	~~0~~ 1	~~-1~~ 1	~~-5~~ -3	0	0	3	4
Old River at State Route 4												
Full Simulation Period Average	91	~~103~~ 99	~~147~~ 133	~~118~~ 103	~~77~~ 72	~~61~~ 56	~~69~~ 61	~~61~~ 53	~~39~~ 37	~~41~~ 40	~~62~~ 59	~~86~~ 84
Difference from Baseline Conditions	1	~~0~~ 1	~~-1~~ 0	~~-1~~ 0	~~-1~~ 2	~~1~~ 3	~~-1~~ 2	~~-4~~ 0	~~-1~~ 0	0	2	3
Victoria Canal												
Full Simulation Period Average	~~62~~ 60	~~71~~ 67	~~103~~ 95	~~111~~ 97	~~97~~ 88	~~85~~ 77	~~83~~ 73	~~69~~ 59	~~46~~ 40	~~34~~ 32	~~39~~ 37	~~49~~ 47
Difference from Baseline Conditions	0	0	~~-1~~ 0	~~0~~ 1	~~1~~ 2	~~2~~ 3	~~1~~ 3	~~-3~~ 0	~~-1~~ 0	0	0	1
San Joaquin River at Antioch												
Full Simulation Period Average	~~984~~ 1021	~~1074~~ 1087	~~757~~ 723	~~344~~ 331	~~123~~ 117	~~63~~ 67	~~74~~ 82	~~125~~ 145	~~263~~ 283	~~487~~ 491	~~804~~ 808	~~980~~ 1027
Difference from Baseline Conditions	~~19~~ 23	~~2~~ 5	~~-5~~ -2	~~-16~~ -1	~~-15~~ -4	~~-8~~ -4	~~-2~~ -3	~~5~~ 4	~~-1~~ -5	-6	~~18~~ 17	33
Banks Pumping Plant												
Full Simulation Period Average	~~92~~ 91	~~96~~ 93	~~122~~ 109	~~99~~ 92	~~74~~ 69	~~66~~ 59	~~58~~ 46	~~48~~ 37	~~41~~ 39	~~46~~ 44	~~72~~ 68	~~96~~ 95
Difference from Baseline Conditions	~~0~~ 1	0	~~-1~~ 0	~~-1~~ 1	~~0~~ 2	1	0	~~-1~~ 0	0	~~0~~ -1	~~2~~ 3	3
Jones Pumping Plant												
Full Simulation Period Average	~~94~~ 89	~~101~~ 98	~~119~~ 107	~~99~~ 94	~~77~~ 73	~~70~~ 62	~~60~~ 47	~~50~~ 38	~~45~~ 41	~~52~~ 48	~~75~~ 70	~~97~~ 94
Difference from Baseline Conditions	~~0~~ 1	0	0	~~-1~~ 1	~~0~~ 1	1	0	~~-1~~ 0	0	0	2	3

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

Barker Slough at 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 the Proposed Project relative to Baseline Conditions (Table 5-13). Modeled monthly average chloride concentrations are ~~69~~ 68 mg/L or less 99.9 percent of the time under both Baseline Conditions and the Proposed Project (Appendix 5A, Tables 5A-5a through 5A-6d, Figures 5A-1a through 5A-1r). Based on these modeled chloride concentrations, the Proposed Project would not cause any exceedances of the 250 mg/L chloride objective and would not substantially degrade water quality with regard to chloride on a long-term average basis in Barker Slough.

San Joaquin River at Empire Tract

In the San Joaquin River at Empire Tract, monthly average chloride concentrations under the Proposed Project would differ negligibly from Baseline Conditions. Modeled monthly average chloride concentrations are up to 1 mg/L higher under the Proposed Project for the full simulation period (Table 5-13). Furthermore, modeling results show no increased frequency of exceeding the secondary maximum contaminant level recommended level of 250 mg/L under the Proposed Project (Appendix 5A, Figures 5A-2a through 5A-2r). Modeled monthly average concentrations at Empire Tract are ~~153~~ 134 mg/L or less 99.9 percent of the time under the Proposed Project, compared to ~~156~~ 136 mg/L or less under Baseline Conditions (Appendix 5A, Tables 5A-7a through 5A-8d). Based on these modeled chloride concentrations, the Proposed Project would not cause any increases in chloride concentrations above 250 mg/L and would not substantially degrade water quality with regard to chloride on a long-term average basis in the San Joaquin River.

Contra Costa Water District Pumping Plant #1

At Contra Cost Water District Pumping Plant #1, monthly average chloride concentrations under the Proposed Project for the full simulation period would differ negligibly from Baseline Conditions. Modeled monthly average chloride concentrations are 3 mg/L higher in August, 4 mg/L higher in September, and 1 mg/L higher in October, November, February, March, and April under the Proposed Project for the full simulation period (Table 5-13). In all other months, modeled monthly average concentrations under the Proposed Project are similar to or less than concentrations under Baseline Conditions (Table ~~5.3-6~~ 5.13; Appendix 5A, Tables 5A-16a through 5A-17d, Figures 5A-6a through 5A-6r). Based on these modeled chloride concentrations, the Proposed Project would not substantially degrade water quality with regard to chloride on a long-term average basis at this location.

Furthermore, there would be no increased frequency of exceeding Bay-Delta WQCP chloride objectives applicable to Contra Costa Pumping Plant #1. The modeled frequency of exceedance of the 250 mg/L objective was ~~3.34~~ 1.01 percent under Baseline Conditions and ~~3.07 percent under~~ the Proposed Project (Table 5-14). Compliance with the 150 mg/L objective was modeled to be the same under both Baseline Conditions and the Proposed Project; ~~zero~~ one out of 99 years exceeded the objective (Table 5-15). The modeled ~~exceedance~~ exceedances of the Bay-Delta WQCP ~~250 mg/L~~ chloride ~~objective is~~ objectives are attributable to the monthly timestep of the hydrologic modeling conducted by CalSim 3 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~~ these and other Bay-Delta WQCP objectives. Thus, the modeled exceedances of the ~~250 mg/L objective~~ chloride objectives are modeling artifacts and do not indicate that Proposed Project operations would result in exceeding ~~Bay-Delta WQCP chloride~~ these objectives at the Contra Costa Pumping Plant #1 compliance location.

Table 5-14. Percent of Days in Water Years 1922–2021 that Modeled Chloride Concentrations Exceeded the 250 Milligrams per Liter Municipal and Industrial Uses Water Quality Objective, Baseline Conditions and the Proposed Project

Assessment Location	Baseline Conditions	Proposed Project
Contra Costa Pumping Plant #1	~~3.34~~ 1.01 %	~~3.07~~ 1.01 %
West Canal at Mouth of Clifton Court Forebay (Banks Pumping Plant)	~~0.06~~ 0.00 %	~~0.05~~ 0.00 %
Jones Pumping Plant	~~0.02~~ 0.00 %	~~0.01~~ 0.00 %
Barker Slough at North Bay Aqueduct	0.00%	0.00%
Cache Slough at the City of Vallejo Intake	0.00%	0.00%

Table 5-15. Number of Years in Calendar Years 1922–2020 that Modeled Chloride Concentrations Exceeded the 150 Milligrams per Liter Chloride Objective for Contra Costa Pumping Plant #1, Baseline Conditions and the Proposed Project

Assessment Location	Baseline Conditions	Proposed Project
Contra Costa Pumping Plant #1	~~0~~ 1 out of 99	~~0~~ 1 out of 99

Old River at State Route 4

In Old River at State Route 4, monthly average chloride concentrations under the Proposed Project for the full simulation period also would differ negligibly from Baseline Conditions. Modeled monthly average chloride concentrations are 2 mg/L higher in February, April, and August, and 3 mg/L higher in March and September, and 1 mg/L higher in October and November under the Proposed Project for the full simulation period (Table 5-13). In all other months, modeled monthly average concentrations under the Proposed Project are similar to ~~or less than~~ concentrations under Baseline Conditions (Appendix 5A, Tables 5A-18a through 5A-19d, Figures 5A-7a through 5A-7r). Based on these modeled differences in chloride, the Proposed Project would not substantially degrade water quality with regard to chloride on a long-term average basis in Old River.

Victoria Canal

In Victoria Canal, monthly average chloride concentrations under the Proposed Project for the full simulation period would differ negligibly from Baseline Conditions. Modeled monthly average chloride concentrations are up to 2 mg/L higher in February, 3 mg/L higher in March and April, and 1 mg/L higher in January and September under the Proposed Project for the full simulation period (Table 5-13). In all other months, modeled monthly average concentrations under the Proposed Project are similar to ~~or less than~~ concentrations under Baseline Conditions (Appendix 5A, Tables 5A-20a through 5A-21d, Figures 5A-8a through 5A-8r). Based on these modeled differences in chloride, the Proposed Project would not substantially degrade water quality with regard to chloride on a long-term average basis in Victoria Canal.

Banks and Jones Pumping Plants

At Banks and Jones Pumping Plants, monthly average chloride concentrations under the Proposed Project would differ negligibly from Baseline Conditions. Modeled monthly average chloride concentrations are up to 3 mg/L higher under the Proposed Project for the full simulation period (Table 5-13; Appendix 5A, Tables 5A-9a through 5A-12d, Figures 5A-3a through 5A-4r). There would be no increased frequency of exceeding the Bay-Delta WQCP chloride objective of 250 mg/L (Table 5-14). Based on these modeled differences in chloride, the Proposed Project would not cause any exceedances of the 250 mg/L chloride objective and would not substantially degrade water quality with regard to chloride on a long-term average basis at the Banks and Jones Pumping Plants.

San Joaquin River at Antioch

In the San Joaquin River at Antioch, modeled monthly average chloride concentrations for the full simulation period are up to 33 mg/L higher under the Proposed Project relative to Baseline Conditions (Table 5-13; Appendix 5A, Tables 5A-13a through 5A-14d, Figures 5A-5a through 5A-5r). Modeling results show the frequency of monthly average chloride concentrations exceeding the secondary maximum contaminant level of 250 mg/L under the Proposed Project would decrease by ~~1–3~~ 2 percent or be the same as Baseline Conditions in all months except July, September, and

October, when the frequency would increase by 1 percent, 2 percent and ~~4~~ 6 percent, respectively (Appendix 5A, Table 5A-15a). Based on these modeled differences in chloride, the Proposed Project would not substantially degrade water quality with regard to chloride on a long-term average basis in the San Joaquin River at Antioch.

One-Time Water Commitment for Delta Outflow

As described above under "Electrical Conductivity," during 2025, DWR would release a block of water from Oroville Reservoir during the summer–fall ~~if it is not deployed during 2024 and~~ if 2025 is not a Critical water year, which could result in lower EC levels in the Delta than modeling indicates. Chloride concentrations in the Delta are correlated with EC levels. Therefore, chloride concentrations also could be lower in 2025 than modeling indicates, particularly in the northern and western Delta. Because chloride concentrations could be lower with the release of this water, this action would not substantially degrade water quality with regard to chloride in the Delta.

CEQA Conclusion

Based on the analysis above, the Proposed Project would not cause substantial increases in chloride concentrations in the Delta relative to Baseline Conditions. Furthermore, the Proposed Project 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 Proposed Project 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. Therefore, the impact of the Proposed Project on chloride would be less than significant.

Mitigation

None required.

Cyanobacteria Harmful Algal Blooms

Although other cyanobacteria species are also frequently detected in the Delta, only *Microcystis* has been clearly shown to produce cyanotoxins (Otten et al. 2017:3632). However, other cyanobacteria species that are routinely detected in the Delta (i.e., *Dolichospermum* spp. and *Aphanizomenon* spp.) were also considered in the assessment. In the cyanobacterial community, *Dolichospermum* and *Aphanizomenon* typically appear in the water column first and are then replaced with *Microcystis* spp. as water temperature increases. Although the specific environmental conditions that favor *Aphanizomenon* and *Dolichospermum* blooms differ somewhat from that of *Microcystis*, hence their separation in bloom times each year, the environmental factors that trigger *Microcystis* are the same factors that trigger the formation of these and other Delta cyanobacteria species that form CHABs. Consequently, this assessment addresses CHABs in general, with a focus on *Microcystis*, which causes the most problematic CHABs in the Delta annually.

The peak Delta cyanobacteria bloom season is typically July through September, when water temperatures reach their seasonal highs. Cyanobacteria experience their maximum growth rates at relatively high water temperatures. Optimal growth rate for *Microcystis* in the laboratory occurs 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 (98.6 °F) or higher (Bui et al. 2018:10). 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) , though Delta inflow quantity can affect the spatial variability of water temperatures (Bashevkin and Mahardja 2022:692) . ~~Thus~~ Furthermore , by the time water released from upstream reservoirs reaches the Delta, it is typically at or close to equilibrium with ambient air temperatures (Wagner et al. 2011:10) . This, coupled with the Proposed Project having relatively minor effects on Delta inflows, outflows, and exports (Chapter 4, "Surface Water Hydrology") indicates that the Proposed Project would have minor, if any, effects on Delta water temperatures. Any minor effects on Delta water temperatures due to the Proposed Project would not be of sufficient magnitude to affect the frequency or magnitude of Delta CHABs relative to Baseline Conditions.

Cyanobacteria, particularly *Microcystis*, prefer a calm, non-turbulent water column versus a flowing, turbulent water column. Turbulence and mixing inhibits the ability of *Microcystis* to control its buoyancy and thus location in the water column. *Microcystis* prefers to be at or near the water surface to outcompete other algae and form large blooms. Based on the changes in Sacramento River inflows modeled for the Proposed Project (Chapter 4, Section 4.3.3.1, "Sacramento River at Freeport"), channel velocities and associated turbulence and mixing in Delta channels would not be expected to change substantially relative to Baseline Conditions. Tidal dynamics within the Delta also would not change substantially. Any minor changes in channel velocities and turbulence and mixing in the Delta for the Proposed Project would have negligible, if any, effects on Delta CHABs relative to that which occurs for Baseline Conditions.

Cyanobacteria tend to be slower growing than diatoms and green algae and thus need long residence times (i.e., water remaining in the same area) to build up their cell numbers at a given location, forming a bloom. Minor changes in Delta inflows, outflows, and exports (Chapter 4) would indicate that residence times of water in the various Delta channels would not change substantially. Minor changes in residence times within Delta channels would have negligible effects on both the frequency and magnitude of Delta CHABs relative to Baseline Conditions.

Cyanobacteria need high nutrient levels to form and sustain blooms. The Delta, under Baseline Conditions, has sufficiently high nutrient levels that nutrients do not limit CHABs in the Delta. The Proposed Project would not result in new or greater nutrient sources to the rivers flowing into the Delta. Because the Proposed Project would not result in new or greater nutrient sources to the rivers flowing into the Delta and nutrients are not a factor that limits CHABs in the Delta, any minor changes in nutrient levels within Delta waters that could occur would have negligible effects on both the frequency and magnitude of CHABs relative to Baseline Conditions.

Cyanobacteria prefer high water clarity and high irradiance because they are outcompeted by diatoms and green algae under lower light conditions. This is also why many species of cyanobacteria, including *Microcystis* spp., can control their buoyancy and thus their location in the water column. *Microcystis* will move to the water surface where it can grow the most rapidly (under high irradiance conditions) and can form a scum layer that shades out other species of algae living lower in the water column. The minor changes in hydrodynamics within the Delta due to the Proposed Project would not be expected to change channel turbidity levels substantially, if at all. Consequently, water clarity and irradiance in Delta channels would not be expected to increase sufficiently to affect the frequency or magnitude of Delta CHABs relative to Baseline Conditions.

CEQA Conclusion

Because the Proposed Project would not substantially change any of the five drivers of CHABs in the Delta, the Proposed Project would have negligible, if any, effects on the frequency and magnitude of CHABs in the Delta relative to Baseline Conditions. Therefore, the impact of the Proposed Project on CHABs in the Delta would be less than significant.

Mitigation

None required.

5.3.3.3 Suisun Marsh and Suisun Bay

For the reasons described in Section 5.3.3.2, “Delta,” the focus of the water quality effects assessment for Suisun Marsh and Suisun Bay is on EC, chloride, and CHABs.

Electrical Conductivity

For Suisun Marsh, October through May is the period when Bay-Delta WQCP EC objectives for protection of fish and wildlife apply (Table 5-7). 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 5B provides tables and figures presenting modeled EC levels at the Suisun Marsh assessment locations for Baseline Conditions and the Proposed Project. Table 5-16 presents the monthly average EC levels at the Suisun Marsh assessment locations under the Proposed Project for the full simulation period and the differences from Baseline Conditions. Modeled monthly average EC for the full simulation period is generally lower in the months of October through May under the Proposed Project relative to Baseline Conditions (Table 5-16; Appendix 5B, Tables 5B-14a through 5B-18r, Figures 5B-27a through 5B-36d).

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 millimhos per centimeter (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). 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 changes in long-term average EC under the Proposed Project relative to Baseline Conditions are not expected to contribute to adverse effects on Suisun Marsh beneficial uses.

Salinity throughout Suisun 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 Proposed Project could affect salinity in Suisun 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 cubic feet per second and average historical tidal flow at Chipps Island is 170,000 cubic feet per second. The historical average tidal flows are two to three orders of magnitude larger than the largest mean monthly change in Delta outflow under the Proposed Project (Chapter 4, “Surface Water Hydrology,” Section 4.3.3.2, “Delta Outflow”). Thus, the changes in Delta outflow due to the Proposed Project 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.

CEQA Conclusion

Based on the analysis above, the Proposed Project would not cause substantial increases in EC levels in Suisun Marsh or Suisun Bay relative to Baseline Conditions. As such, the Proposed Project would not cause additional exceedance of applicable EC water quality objectives/criteria by frequency, magnitude, and geographic extent that would result in adverse effects on any beneficial uses of the Suisun Marsh and Suisun Bay. Because EC levels are not expected to increase substantially, the Proposed Project would not cause long-term degradation of EC in Suisun Marsh and Suisun Bay that would result in substantially increased risk for adverse effects on any beneficial uses. Therefore, the impact of the Proposed Project on EC would be less than significant.

Mitigation

None required.

Table 5-16. Monthly Average Electrical Conductivity (in micromhos per centimeter) at Suisun Marsh Assessment Locations for the Full Simulation Period under the Proposed Project and Difference from Baseline 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	~~6.6~~ 6.8	4.3	2.1	0.9	~~0.6~~ 0.7	~~0.8~~ 0.9	~~1.3~~ 1.4	~~2.3~~ 2.4	~~3.5~~ 3.6	~~5.4~~ 5.5	~~6.2~~ 6.5
Difference from Baseline Conditions	0.1	0.0	0.0	~~-0.1~~ 0.0	~~-0.1~~ 0.0	~~-0.1~~ 0.0	0.0	0.0	0.0	-0.1	0.0	0.2
Montezuma Slough at National Steel												
Full Simulation Period Average	~~6.9~~ 7.1	~~7.1~~ 7.3	~~5.0~~ 5.1	2.6	1.1	0.8	1.2	~~1.9~~ 2.0	~~3.3~~ 3.4	~~4.5~~ 4.6	~~6.5~~ 6.6	~~6.7~~ 7.1
Difference from Baseline Conditions	~~-0.4~~ -0.3	-0.1	0.0	0.0	0.0	~~-0.1~~ 0.0	0.0	0.0	0.0	0.0	~~0.1~~ 0.0	~~-0.3~~ -0.2
Montezuma Slough near Beldon Landing												
Full Simulation Period Average	~~8.0~~ 8.2	~~8.2~~ 8.4	~~6.3~~ 6.5	~~3.5~~ 3.7	1.7	~~1.5~~ 1.4	~~2.1~~ 2.0	3.1	4.8	~~5.9~~ 6.0	~~8.0~~ 8.3	~~8.0~~ 8.3
Difference from Baseline Conditions	~~-1.1~~ -0.8	-0.2	~~0.0~~ 0.1	0.0	0.0	~~-0.1~~ 0.0	-0.1	0.0	~~0.1~~ 0.0	~~0.2~~ 0.1	~~0.2~~ 0.1	~~-1.1~~ -0.8
Chadbourne Slough near Sunrise Duck Club												
Full Simulation Period Average	~~9.5~~ 9.6	~~9.5~~ 9.7	~~8.1~~ 8.3	~~5.5~~ 5.6	~~3.5~~ 3.4	2.9	3.4	4.2	~~5.8~~ 5.9	7.7	9.6	~~9.9~~ 10.0
Difference from Baseline Conditions	~~-0.8~~ -0.6	~~-0.3~~ -0.2	0.0	0.0	0.0	~~-0.1~~ 0.0	-0.1	~~0.1~~ 0.0	~~0.1~~ 0.0	~~0.4~~ 0.3	~~0.8~~ 0.6	~~-0.4~~ -0.3
Suisun Slough 300 feet south of Volanti Slough												
Full Simulation Period Average	~~8.6~~ 8.8	~~8.8~~ 9.0	~~7.5~~ 7.7	~~5.0~~ 5.1	3.0	2.3	2.6	3.4	~~4.9~~ 5.0	~~6.4~~ 6.5	~~8.3~~ 8.4	~~8.8~~ 9.1
Difference from Baseline Conditions	~~-1.1~~ -0.8	~~-0.4~~ -0.3	~~-0.1~~ 0.0	0.0	0.0	~~-0.1~~ 0.0	-0.1	0.0	~~0.1~~ 0.0	~~0.3~~ 0.2	~~0.5~~ 0.4	~~-0.5~~ -0.4

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

Chloride

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, water exported from the Delta to Suisun Marsh can be an additional source of chloride. Chloride concentrations are related to EC levels. As discussed above, modeled monthly average EC for the full simulation period is generally lower in the months of October through May under the Proposed Project relative to Baseline Conditions (Table 5-16; Appendix 5B, Tables 5B-14a through 5B-18r, Figures 5B-27a through 5B-36d). As a result, the Proposed Project would not be expected to measurably degrade water quality with regard to chloride or adversely affect marsh beneficial uses relative to Baseline Conditions.

Because Suisun Bay is 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 are not of concern relative to drinking water supplies or other beneficial uses. Furthermore, as discussed above for EC, the Proposed Project would have no substantial adverse effects on salinity or fish and wildlife beneficial uses that occur in Suisun Bay.

CEQA Conclusion

Based on the analysis above, the Proposed Project would not cause substantial increases in chloride concentrations in Suisun Marsh and Suisun Bay relative to Baseline Conditions. As such, the Proposed Project 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 Suisun Marsh and Suisun Bay. Because chloride concentrations are not expected to increase substantially, the Proposed Project would not cause long-term degradation of chloride in Suisun Marsh and Suisun Bay that would result in substantially increased risk for adverse effects on any beneficial uses. Therefore, the impact of the Proposed Project on chloride in Suisun Marsh and Suisun Bay would be less than significant.

Mitigation

None required.

Cyanobacteria Harmful Algal Blooms

The factors that provide favorable conditions for CHAB development in Suisun Marsh and Suisun Bay are the same factors addressed above for the Delta: (1) water temperature, (2) channel velocities and associated turbulence/mixing (3), residence time, (4) nutrients, and (5) water clarity and its effects on irradiance. Salinity also is a factor. Typical Suisun Bay salinity levels 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*, CHABs are not common in Suisun Marsh (Sommer et al. 2020:18; Hammock et al. 2015:319).

As described above for the Delta, the Proposed Project would result in relatively minor, if any, increase in Delta water temperatures relative to Baseline Conditions. Since there would be little to no change to Delta water temperatures, the Proposed Project also would have little to no effect on water temperatures in Suisun Marsh and Suisun Bay. From a thermal perspective, any minor differences in water temperatures would not affect the frequency or magnitude of CHABs in Suisun Marsh and Suisun Bay relative to that which could occur under Baseline 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 above for the Delta, the Proposed Project 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. Consequently, the Proposed Project would not increase the frequency or magnitude of CHABs in Suisun Marsh and Suisun Bay relative to Baseline 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 above for the Delta, the Proposed Project would not result in substantial changes in turbidity levels or total suspended solids concentrations in Suisun Marsh and Suisun Bay relative to Baseline Conditions. Consequently, the Proposed Project would not increase the frequency or magnitude of CHABs in Suisun Marsh and Suisun Bay relative to Baseline Conditions due to changes in water clarity in these waterbodies.

The Proposed Project would have small effects on Delta outflow volume (Chapter 4, "Surface Water Hydrology," Section 4.3.3.2, "Delta Outflow"). As such, the hydrodynamics in Suisun Marsh and Suisun Bay, which are driven primarily by Delta outflow, tidal excursions, and winds, would change little, if at all, for the Proposed Project relative to Baseline Conditions. Associated residence time, turbulence, and mixing in Suisun Marsh and Suisun Bay would differ negligibly from Baseline Conditions. Therefore, the Proposed Project would not affect hydrodynamic factors sufficiently to encourage more frequent or larger CHABs in Suisun Marsh and Suisun Bay relative to hydrodynamics in these waterbodies under Baseline Conditions.

As described above for the Delta, the Proposed Project would result in small increases or decreases in EC in Suisun Marsh. 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 Baseline Conditions. Consequently, the Proposed Project would not increase the frequency or magnitude of CHABs in Suisun Marsh and Suisun Bay relative to Baseline Conditions due to changes in EC that would enable *Microcystis* and other cyanobacteria to grow where they do not grow under Baseline Conditions.

As discussed above, the frequency of CHABs in the Delta would not be expected to change substantially, if at all, relative to Baseline Conditions. Regarding bloom magnitude, the Proposed Project is not expected to substantially affect CHAB magnitude anywhere in the Delta. Therefore, the Proposed Project 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 and Suisun Bay sufficiently to be measurable or result in any adverse effect on beneficial uses of these waterbodies.

CEQA Conclusion

The Proposed Project 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 and Suisun Bay relative to Baseline Conditions. Any small changes in these conditions that may potentially occur for the Proposed Project would not be of sufficient frequency and magnitude to cause CHABs to form more frequently, or grow to larger levels, than would occur for Baseline 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 Baseline Conditions. Hence, CHABs and their associated cyanotoxins levels in Suisun Marsh and Suisun Bay under the Proposed Project would not adversely affect any beneficial uses or degrade water quality substantially, if even measurably, relative to Baseline Conditions.

Mitigation

None required.