Chapter 6 Surface Water Quality

6.1 Introduction

This chapter describes the environmental setting, methods of analysis, and impact analysis for surface water quality that would potentially be affected by the construction and operation of the Project. Surface water quality is defined as the chemical and physical condition of water that affects its use by organisms (e.g., fish, people, vegetation).

The study area for surface water quality consists of those areas with the potential to be significantly affected by the Project and associated changes in operations. This area includes drainages in the Sites Reservoir inundation area, Shasta Lake and the Sacramento River, Lake Oroville and the Feather River, Folsom Lake and the American River, Yolo Bypass, and the Delta (Figure 1-1). Conveyance and storage facilities for moving water to and from Sites Reservoir are also considered, including the CBD due to its multiple beneficial uses and discharge to the Yolo Bypass and the Sacramento River (Figure 1-2). In addition, San Luis Reservoir is considered due to potential changes in CVP and SWP export operations at the Jones and Banks Pumping Plants.

A tsunami is a wave or series of waves that rush ashore in coastal areas. Under CEQA, the risk of release of pollutants due to project inundation from a tsunami should be considered. Because the elevation of Project structures is well above the reach of a tsunami generated in the Pacific Ocean and, due to the attenuating effects of tsunamis by the San Francisco Bay and Sacramento River, tsunamis would not affect Project structures and therefore are not discussed further in this chapter.

Tables 6-1a and 6-1b summarize the CEQA determinations and NEPA conclusions for construction and operation impacts, respectively, between alternatives that are described in the impact analysis.

Table 6-1a. Summary of Construction Impacts and Mitigation Measures for Surface Water Quality Resources

Alternative	Level of Significance Before Mitigation	Mitigation Measures	Level of Significance After Mitigation
Impact WQ-1: Violate any water quality standards or waste discharge requirements or otherwise substantially degrade surface water quality during construction			
No Project	NI/NE	-	NI/NE
Alternative 1	S/SA	**Mitigation Measure WQ-1.1**: Methylmercury Management	SU/SA
Alternative 2	S/SA	**Mitigation Measure WQ-1.1**: Methylmercury Management	SU/SA

Alternative	Level of Significance Before Mitigation	Mitigation Measures	Level of Significance After Mitigation
Alternative 3	S/SA	**Mitigation Measure WQ-1.1**: Methylmercury Management	SU/SA
Impact WQ-4: Be placed in a flood hazard or seiche zone, risking release of pollutants due to Project inundation			
No Project	NI/NE	-	NI/NE
Alternative 1	LTS/NE	-	LTS/NE
Alternative 2	LTS/NE	-	LTS/NE
Alternative 3	LTS/NE	-	LTS/NE
Impact WQ-5: Conflict with or obstruct implementation of a water quality control plan			
No Project	NI/NE	-	NI/NE
Alternative 1	LTS/NE	-	LTS/NE
Alternative 2	LTS/NE	-	LTS/NE
Alternative 3	LTS/NE	-	LTS/NE
Impact WQ-6: Create or contribute runoff water which would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff			
No Project	NI/NE	-	NI/NE
Alternative 1	LTS/NE	-	LTS/NE
Alternative 2	LTS/NE	-	LTS/NE
Alternative 3	LTS/NE	-	LTS/NE

Notes:
Impact WQ-2 and Impact WQ-3 are operational impacts and therefore not included in this table.
NI = CEQA no impact
LTS = CEQA less-than-significant impact
S = CEQA significant impact
SU = CEQA significant and unavoidable
NE = NEPA no effect or no adverse effect
AE = NEPA adverse effect
SA = NEPA substantial adverse effect

Table 6-1b. Summary of Operation Impacts and Mitigation Measures for Surface Water Quality Resources

Alternative	Level of Significance Before Mitigation	Mitigation Measures	Level of Significance After Mitigation
Impact WQ-2: Violate any water quality standards or waste discharge requirements or otherwise substantially degrade surface water quality during operation			
No Project	NI/NE	-	NI/NE
Alternative 1	S/SA	**Mitigation Measure WQ-1.1**: Methylmercury Management **Mitigation Measure WQ-2.1**: Prevent Metal Impacts in Stone Corral Creek Associated with Sites Reservoir Discharge **Mitigation Measure WQ-2.2**: Prevent	SU/SA

Alternative	Level of Significance Before Mitigation	Mitigation Measures	Level of Significance After Mitigation
		Net Detrimental Metal and Pesticide Effects Associated with Moving Colusa Basin Drain Water Through the Yolo Bypass	
Alternative 2	S/SA	**Mitigation Measure WQ-1.1**: Methylmercury Management **Mitigation Measure WQ-2.1**: Prevent Metal Impacts in Stone Corral Creek Associated with Sites Reservoir Discharge **Mitigation Measure WQ-2.2**: Prevent Net Detrimental Metal and Pesticide Effects Associated with Moving Colusa Basin Drain Water Through the Yolo Bypass	SU/SA
Alternative 3	S/SA	**Mitigation Measure WQ-1.1**: Methylmercury Management **Mitigation Measure WQ-2.1**: Prevent Metal Impacts in Stone Corral Creek Associated with Sites Reservoir Discharge **Mitigation Measure WQ-2.2**: Prevent Net Detrimental Metal and Pesticide Effects Associated with Moving Colusa Basin Drain Water Through the Yolo Bypass	SU/SA
Impact WQ-3: Violate any water quality standards or waste discharge requirements or otherwise substantially degrade surface water quality during maintenance activities			
No Project	NI/NE	-	NI/NE
Alternative 1	LTS/NE	-	LTS/NE
Alternative 2	LTS/NE	-	LTS/NE
Alternative 3	LTS/NE	-	LTS/NE
Impact WQ-4: Be placed in a flood hazard or seiche zone, risking release of pollutants due to Project inundation			
No Project	NI/NE	-	NI/NE
Alternative 1	LTS/NE	-	LTS/NE
Alternative 2	LTS/NE	-	LTS/NE
Alternative 3	LTS/NE	-	LTS/NE
Impact WQ-5: Conflict with or obstruct implementation of a water quality control plan			
No Project	NI/NE	-	NI/NE
Alternative 1	LTS/NE	-	LTS/NE
Alternative 2	LTS/NE	-	LTS/NE
Alternative 3	LTS/NE	-	LTS/NE

Alternative	Level of Significance Before Mitigation	Mitigation Measures	Level of Significance After Mitigation
Impact WQ-6: Create or contribute runoff water which would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff			
No Project	NI/NE	-	NI/NE
Alternative 1	LTS/NE	-	LTS/NE
Alternative 2	LTS/NE	-	LTS/NE
Alternative 3	LTS/NE	-	LTS/NE

Notes:
NI = CEQA no impact
LTS = CEQA less-than-significant impact
S = CEQA significant impact
SU = CEQA significant and unavoidable
NE = NEPA no effect or no adverse effect
SA = NEPA substantial adverse effect

6.2 Environmental Setting

6.2.1. Overview of Surface Water Quality Objectives

Surface water quality in the study area is dependent upon local geology, discharges from point and non-point sources, and water flow and storage. Several of the federal and state laws and regulations that directly affect water quality include the Federal Water Pollution Control Act Amendments of 1972, also known as the Clean Water Act (CWA), the California Toxics Rule (CTR), and California Safe Drinking Water Act. These laws and regulations are described in Appendix 4A, *Regulatory Requirements*.

The Water Quality Control Plan for the Sacramento and San Joaquin River Basins (Central Valley Basin Plan; Central Valley Regional Water Quality Control Board 2019a) and the Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary (Bay-Delta Plan), which establish water quality control objectives for the reasonable protection of beneficial uses for the protection of water quality, apply to the study area. In addition, the Water Quality Control Plan for Inland Surface Waters, Enclosed Bays, and Estuaries of California (Part 2; State Water Resources Control Board 2017a) provides fish tissue methylmercury objectives applicable to the Project. The beneficial uses together with the water quality objectives that are contained in the basin plans constitute state water quality standards. The beneficial uses for surface waters in the study area are presented in Appendix 6A, *Water Quality Constituents and Beneficial Uses*.

Waterbodies that do not meet water quality standards are listed as “impaired” on the state’s CWA Section 303(d) list. Appendix 6A presents a compiled 303(d) list of impaired waterbodies in the study area. There are 14 impaired waterbodies in the study area, with impairments ranging from elevated concentrations of mercury and other metals to presence of pesticides and elevated salinity. Additional impairments not represented on the 303(d) list include cyanobacterial harmful algal blooms (HABs).

The Central Valley Basin Plan incorporates by reference the California Department of Public Health numeric drinking water maximum contaminant levels (MCLs). This incorporation by reference is intended to ensure, to the extent possible, that adequate source water quality is maintained to support the domestic and municipal water supply beneficial use.

CTR criteria are numeric water quality criteria for priority toxic pollutants for the State of California. CTR criteria are established for the protection of human health and aquatic life. For the protection of human health, the CTR criteria apply to any receiving water where human consumption of water and/or organisms occurs.

The water quality constituents potentially affected by diversion to, storage in, and release of water from Sites Reservoir are water temperature, salinity, mercury and other metals, pesticides, nutrients, HABs, organic carbon, and dissolved oxygen (DO). These water quality constituents exceed established water quality criteria in some existing waterbodies in the study area and could be affected by operations of a surface water reservoir and changes in flow and storage patterns in the study area.

6.2.2. Constituents

This section discusses water quality constituents that potentially could be affected by Sites Reservoir, and additional information is available in Appendix 6A. Regional information for constituents is provided for locations within the study area based on data availability and relevance to potential Project impacts.

6.2.2.1. Water Temperature

During much of the year, many reservoirs are stratified with warm water at the top and colder water at the bottom. When the reservoir is stratified, preservation of the cold-water pool is needed to ensure suitable reservoir release temperatures when critical thermal limits occur downstream. If reservoir release flows are low, water will move slowly and will warm in a shorter distance than higher flow releases. Low release flow can help protect/preserve the cold-water pool but may result in reduced longitudinal extent of cool water along the river downstream of the release point. When meteorological conditions are cool, flow and reservoir storage are less relevant to water temperature. Cool conditions allow the reservoir surface to become cool, allowing the upper and lower portions of the reservoir to mix, removing stratification.

There are multiple regulations in place to maintain cool water, primarily for fish. These include: Federal Energy Regulatory Commission requirements, Biological Opinions for the Endangered Species Act, National Pollutant Discharge Elimination System permits, water right orders, California Department of Fish and Game Code Section 5937 (pertaining to dam fishways), and Basin Plan Requirements. For example, the Central Valley Basin Plan states: "[a]t no time or place shall the temperature of COLD or WARM intrastate waters be increased more than 5°F above natural receiving water temperature" (Central Valley Regional Water Quality Control Board 2019a). In addition, the Sacramento River (Keswick Dam to Red Bluff and Knights Landing to the Delta), the lower American River (Nimbus Dam to the confluence with the Sacramento River), and multiple locations in the Delta are listed on the 303(d) list as having water temperature impairments.

Large reservoirs are often managed to have cold-water releases for cold-water fish. As the water moves downstream, it is warmed by meteorological conditions such as air temperature and solar radiation (including effect of shade) and approaches equilibrium temperature (also known as ambient temperature). Rate of warming is affected by factors such as channel depth and flow (Deas and Lowney 2000). Equilibrium temperature is the temperature maintained by the water under certain meteorological conditions. As meteorological conditions change, subsequently so does the water temperature.

By the time water from the Sacramento and San Joaquin Rivers reaches the Delta it has warmed considerably, approaching equilibrium. Table 6-2 shows monthly average and monthly average of daily maximum temperatures measured in the Yolo Bypass at Lisbon Weir, in the Sacramento River Deep Water Ship Channel, and the Sacramento River at Rio Vista, based on measurements from 2015–2020 (California Data Exchange Center stations LIS, DWS, and RIV). Water generally moves slowly through the Yolo Bypass and is closer to equilibrium temperature than water at the downstream end of the Sacramento River at Rio Vista when flood flows are not moving through the Yolo Bypass. During August–October, the months proposed for the Sites habitat flows through the Yolo Bypass, average temperatures in the Yolo Bypass were up to 5°F higher than temperatures at Rio Vista but were sometime cooler than at Rio Vista. Differences in daily maximum temperatures between these two locations was somewhat larger due to the greater diurnal temperature fluctuations in the Yolo Bypass. Sacramento River temperatures likely dominate in the Cache Slough Complex between Rio Visa and the Yolo Bypass, although temperatures in this area (Cache Slough Complex) may be somewhat affected by the mixing of water from the Yolo Bypass and Deepwater Ship Channel, especially closer to these inflows.

Table 6-2. Monthly Average and Average of the Daily Maximum Water temperatures (°F) in the Yolo Bypass at Lisbon Weir, the Sacramento River Deep Water Ship Channel, and the Sacramento River at Rio Vista during 2015–2020.

Month	Year	Lisbon Weir	Sacramento River Deep Water Ship Channel	Sacramento River at Rio Vista	Lisbon Weir minus Rio Vista
Monthly Average Temperatures					
Aug	2015	73.0	73.3	73.6	-0.6
Aug	2016	73.8	71.2	71.4	2.4
Aug	2017	76.1	72.5	72.1	4.0
Aug	2018	73.8	71.1	71.0	2.8
Aug	2019	77.5	73.1	72.4	5.1
Aug	2020	77.2	74.1	74.2	3.0
Sep	2015	67.1	71.8	72.0	-4.9
Sep	2016	70.2	68.8	68.8	1.4
Sep	2017	72.4	70.3	68.9	3.4
Sep	2018	70.6	68.8	68.5	2.1
Sep	2019	72.3	70.0	68.7	3.6
Sep	2020	72.1	70.8	70.7	1.4
Oct	2015	67.6	68.2	68.5	-1.0
Oct	2016	63.5	63.8	63.7	-0.2

Month	Year	Lisbon Weir	Sacramento River Deep Water Ship Channel	Sacramento River at Rio Vista	Lisbon Weir minus Rio Vista
Oct	2017	63.0	62.4	61.7	1.3
Oct	2018	65.0	64.6	64.3	0.7
Oct	2019	62.3	61.8	61.2	1.2
Oct	2020	66.7	66.8	66.9	-0.2
Monthly Average of Daily Maximum Temperatures					
Aug	2015	75.0	74.5	74.2	0.9
Aug	2016	76.6	73.0	71.8	4.8
Aug	2017	78.6	74.5	72.6	6.0
Aug	2018	76.4	73.0	71.5	5.0
Aug	2019	79.7	75.3	73.0	6.7
Aug	2020	79.9	75.9	74.9	4.9
Sep	2015	68.4	72.7	72.6	-4.2
Sep	2016	72.6	70.0	69.3	3.3
Sep	2017	74.4	72.0	69.4	5.0
Sep	2018	71.5	70.2	69.0	2.6
Sep	2019	73.2	71.6	69.2	3.9
Sep	2020	73.5	72.1	71.3	2.2
Oct	2015	69.2	68.9	68.9	0.2
Oct	2016	64.6	64.6	64.2	0.4
Oct	2017	64.4	63.4	62.0	2.4
Oct	2018	66.3	65.5	64.7	1.6
Oct	2019	63.8	62.8	61.7	2.0
Oct	2020	68.3	67.9	67.6	0.7

Note: The Yolo Bypass experienced flow pulses during September of 2015, 2018, and 2019 associated with the North Delta Flow Actions

Source: 2015–2020 water temperatures from California Data Exchange Center stations LIS (operated by California Department of Water Resources), DWS (operated by U.S. Geological Survey), and RIV (operated by Reclamation)

6.2.2.2. *Salinity*

Salinity is a measure of dissolved mineral salts in the water. Salinity can be measured as total dissolved solids (TDS)[1], electrical conductivity (EC)[2], or as salinity in practical salinity units·In high concentrations, mineral salts can cause adverse impacts to municipal and industrial water users, agriculture, and fish and wildlife.

Delta waterways are identified on the 303(d) list as having a salinity impairment and there are multiple regulations in place to control this impairment. Water quality in the Delta is highly variable and strongly influenced by seawater intrusion into the western and central portions of

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[1] TDS is a measure of the mass of the salt per unit volume, generally expressed as milligram per liter (mg/L).

[2] EC is a measure of water's ability to conduct an electric current based on its dissolved salt content, expressed as micromhos per centimeter (µmhos/cm) or as microsiemens per centimeter (µS/cm). These two units of measure are interchangeable.

the Delta during periods of low Delta outflow, which may at times be attributed to low Delta inflows and/or high volumes of export pumping at the CVP and SWP facilities. “X2” is one indicator of the extent of seawater intrusion; it is defined as the distance from the Golden Gate Bridge up the axis of the Delta in kilometers to the location where near-bottom salinity is 2 ppt. The location of X2 is important to both aquatic life and water supply beneficial uses. In addition to seawater intrusion, Delta salinity is also affected by the salinity and volume of river inflows, tidal flows, agricultural diversions, drainage flows, wastewater discharges, and groundwater accretions.

There are multiple regulations affecting flow through the Delta (Appendix 4A). For example, the Bay-Delta Plan (State Water Resources Control Board 2018) includes flow and water quality regulations to benefit fish and wildlife, municipal and industrial use, and agriculture. These include Delta export constraints and inflow, outflow, and salinity objectives (including February–June X2 requirements). The 2019 USFWS Biological Opinion and 2020 SWP Incidental Take Permit include additional operational regulations that affect salinity including management of reverse flow in Old and Middle Rivers toward the export pumps, modified operation of the Delta Cross Channel gates for fish protection, San Joaquin River inflow to export ratio requirements, fall X2 requirements, and additional Delta outflow.

Salinity in the Sacramento River is very low compared to other areas in the Central Valley. This low salinity can be seen in EC measurements taken from the Sacramento River from 2000 through 2020 near Red Bluff (Water Data Library [WDL] station A0275890), at Hamilton City (WDL station A0263000), and upstream of CBD (WDL station A0223002) (Figure 6-1). These data show that in the Sacramento River between Red Bluff and Knights Landing, average salinity is about 130 microsiemens per centimeter (µS/cm), with only small variation within and between months. This low and relatively constant value is below all water quality objectives for salinity, and it is expected that water diverted from the Sacramento River to Sites Reservoir would have low salinity based on measured data.

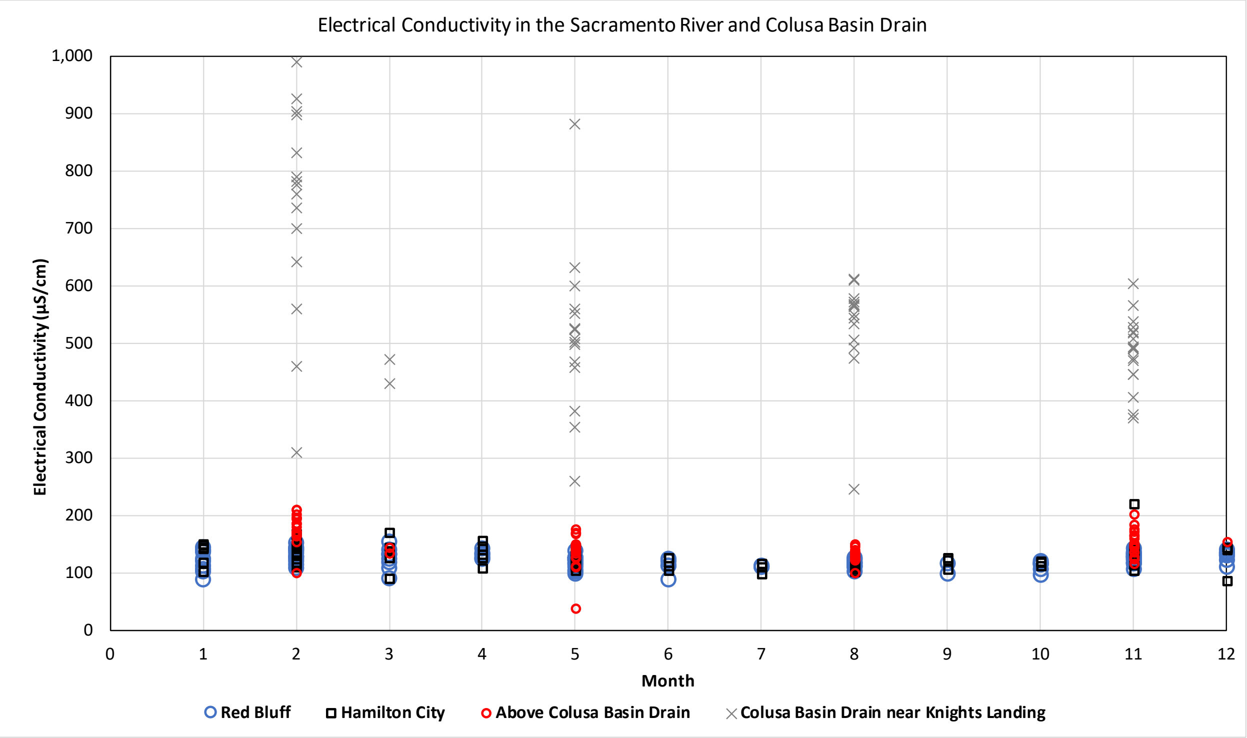

Figure 6-1. Electrical Conductivity Measurements from the Sacramento River and Colusa Basin Drain.

Agricultural drainage areas within the Sacramento Valley have higher salinity than in the Sacramento River. Knights Landing Ridge Cut and the Tule Canal in the Yolo Bypass are listed as having a salinity impairment on the 303(d) list. EC measurements from CBD (WDL station A0294710) are more variable and higher than in the Sacramento River, with an overall average value of 560 µS/cm and a slight tendency towards higher values in the winter (February) than other months with measurements (Figure 6-1). CBD water is higher in salinity than the Sacramento River because much of the CBD inflow is drainage water affected by factors such as evapoconcentration on agricultural lands and input from salts in the soil. These values are higher than in the Sacramento River but are generally still below Delta water quality objectives (State Water Resource Control Board 2018).

Between 1998 and 2011, California Department of Water Resources (DWR) intermittently measured EC in Stone Corral Creek near Sites (WDL station A0043500). The measurements ranged from 205 µS/cm to 5,990 µS/cm with an average of 1,976 µS/cm. EC was measured 14 times in Funks Creek near Maxwell at WDL station A0051000 between 1973 and 1986; values ranged from 192 µS/cm to 935 µS/cm with an average of 520 µS/cm.

Salt Pond

Within the Salt Lake Fault Zone in Antelope Valley and the Sites Reservoir inundation area, a number of salt or brine springs, seeps, and a pond (Salt Pond) have been noted in various state agency reports dating back to 1894 (Watts 1894:6, 7). Saline water has been observed to seep from underground salt springs in the vicinity of the Salt Lake Fault along the slopes above the valley and along the valley floor within the proposed inundation area of Sites Reservoir. These areas are generally located in the Funks Creek watershed. The water from the underground springs accumulates along the trough of the valley and forms the Salt Pond (U.S. Geological Survey 1915:298, 299; Integrated Storage Investigations 2000:2-11). The water from the saline springs flows into Salt Pond, where it typically evaporates. Only during substantial periods of precipitation does the lake water spill over into Funks Creek. The size of Salt Pond and adjacent seasonal brackish wetlands varies with time. The wetted area appears to vary from 0 to 30 acres. The deeper water appears to be approximately 15 acres based on observations in 2017 and Google Earth images. The depth of the water has not been monitored.

Salt Pond was only sampled on a few occasions from 1997 to 1998. In August 1997, the Salt Pond was dry. In September 1997, the springs were bubbling, and the EC was 194,100 µS/cm. In January 1998, there was less than 1 cubic foot per second (cfs) of flow from the springs, and the EC was 7,200 µS/cm. (Sites Project Authority and Bureau of Reclamation 2017:7-26; Integrated Storage Investigations 2000:2-11).

From these samples, it was found that waters from this location are extremely high in minerals. When the EC value of 194,100 µS/cm was recorded, the TDS measurement was 258,000 mg/L. EC, TDS, sodium, and boron exceeded all Central Valley Basin Plan objectives. A few metals also were noted at very high concentrations (aluminum, iron, and manganese) and exceeded all objectives, and a few others exceeded some criteria (arsenic, copper, lead, and nickel). (Sites Project Authority and Bureau of Reclamation 2017:7-27; Integrated Storage Investigations 2000:2-11).

Concentrations present in water from this site likely depend on the season and flow. There is much uncertainty in the EC and concentration of minerals in the water emanating from these springs. The high readings from September 1997 likely represent concentrate from prolonged evaporation of the spring water and the lower EC measured in January 1998 may represent dilution with rainwater.

6.2.2.3. Nutrients, Organic Carbon, and Dissolved Oxygen

For nutrients, organic carbon and DO, Table 6-3 provides summary information for potential natural and anthropogenic sources of, and beneficial uses affected by, these water quality constituents, and includes applicable regulatory numerical and narrative criteria/objectives. More detail on these constituents can be found in Appendix 6A.

The discussion in this section focuses on these constituents and their relevance in a reservoir environment in general and in surface waters within the study area.

Table 6-3. Nutrients, Organic Carbon and Dissolved Oxygen

Constituent	Sources	Beneficial Uses Affected	Applicable Regulatory Water Quality Criteria/Objectives
Nutrients: nitrogen (nitrate and ammonia) and phosphorus	• Natural sources: weathering of rocks, soil, and atmospheric deposition • Anthropogenic sources: agricultural and urban runoff and wastewater discharges	• Drinking water supplies (municipal and domestic supply) • Aquatic organisms (cold freshwater habitat, warm freshwater habitat, and estuarine habitat) • Recreational activities (water contact recreation, noncontact water recreation)	• Nitrate MCL: 45 mg/L (or 10 mg/L as nitrogen) • Nitrite MCL: 1 mg/L (as nitrogen) • Nitrate plus nitrite MCL: 10 mg/L (as nitrogen) • There are no applicable water quality standards for phosphorus. • There are no applicable numerical water quality standards for ammonia in the Central Valley Basin Plan or the Bay-Delta Plans. However, the national recommended acute ambient water quality criteria for protecting freshwater organism is 17 mg/L total ammonia nitrogen (TAN), and the chronic criterion is 1.9 mg/L TAN.[1] • No numerical water quality criteria for nutrients in the Central Valley Basin Plan or the Bay-Delta Plans • Central Valley Basin Plan narrative objective for biostimulatory substances, which restricts biostimulatory substances in waters in concentrations that promote aquatic growths that cause nuisance or adversely affect beneficial uses (Central Valley Regional Water Quality Control Board 2019a). This may be applicable to nutrients.
Organic Carbon	• Natural sources: decomposing animal and plant matter • Anthropogenic sources: domestic wastewater, urban runoff, and agricultural discharge • Reservoirs receive a combination of external sources (i.e., from the watershed),	• Municipal water supplies may be affected because organic carbon contributes to the formation of disinfection byproducts in chlorine-treated drinking water	• No state or federal regulatory numerical water quality objectives or criteria for organic carbon or any USEPA-recommended criteria. • Under USEPA’s Disinfectants and Disinfection Byproducts Rule (63 FR 69390), municipal drinking water treatment facilities must remove specific percentages of total organic carbon in source water through enhanced treatment methods, unless the drinking water treatment system can meet alternative criteria (U.S. Environmental Protection Agency 2010). • The Central Valley Basin Plan outlines a Drinking Water Policy which includes a narrative objective for chemical constituents that includes drinking water chemical constituents of concern,

Constituent	Sources	Beneficial Uses Affected	Applicable Regulatory Water Quality Criteria/Objectives
	and internal sources. Internal supplies of organic carbon in reservoirs include algae (living and decomposing) and dissolved organics released by algae, zooplankton, and fish		including organic carbon. This objective indicates that waters shall not contain chemical constituents in concentrations that adversely affect beneficial uses.
Dissolved Oxygen	• Atmospheric diffusion to surface water; photosynthetic aquatic plants; and groundwater in areas where groundwater inflow contributes significantly to streamflow	• Aquatic life	• The Central Valley Basin Plan contains numerical objectives for dissolved oxygen for locations in the study area as follows: ○ 9.0 mg/L for Sacramento River from Keswick Dam to Hamilton City (June 1 to August 31) ○ 8.0 mg/L for Feather River from Fish Barrier Dam at Oroville to Honcut Creek (September 1 to May 31) ○ 7.0 mg/L for Sacramento River (below I Street Bridge) and in all Delta waters west of the Antioch Bridge (year-round) ○ 5.0 mg/L for all other Delta waters, except for those bodies of water which are constructed for special purposes and from which fish have been excluded or where the fishery is not important as a beneficial use ○ For surface waterbodies outside the legal boundaries of the Delta: ▪ 5.0 mg/L for waters designated WARM ▪ 7.0 mg/L for waters designated COLD ▪ 7.0 mg/L for waters designated SPWN

Notes: mg/L = milligrams per liter; MCL = maximum contaminant level; USEPA = U.S. Environmental Protection Agency

Sources: Walker 1983:39; State Water Resources Control Board 2020a; U.S. Environmental Protection Agency 2010; Central Valley Regional Water Quality Control Board 2019a

[1] At pH 7.0 and 20°C, the acute criterion duration represents a 1-hour average. At pH 7.0 and 20°C, the chronic criterion duration represents a 30-day rolling average with the additional restriction that the highest 4-day average within 30 days be no greater than 2.5 times the chronic criterion magnitude.

Nutrients

Nutrients are of concern in surface water primarily because excess nutrients can result in high production of algae and aquatic plants which can reduce DO and kill fish and other aquatic organisms. Nutrients in surface water, primarily nitrogen and phosphorus, come from natural sources such as weathering of rocks, soil and atmospheric deposition, and from anthropogenic sources including agricultural and urban runoff, and wastewater discharges (National Oceanic and Atmospheric Administration 2020; U.S. Environmental Protection Agency 1998:2). Although nutrients are necessary for a healthy ecosystem, nutrient over-enrichment (or eutrophication) in waterbodies results in the excessive growth of macrophytes, phytoplankton, and potentially toxic algal blooms.

Sediments can be sinks for nutrients when aquatic organisms decompose and thus a source of nutrients when those sediments are released to the water column over time (Hogsett et al. 2018:2-3). Although several factors have been identified that influence nutrient release from sediment, release is often associated with anoxic (no oxygen) conditions at the water-sediment interface, which result in the release of soluble phosphorus; even brief periods of anoxia can result in a substantial release of phosphorus (Friends of Reservoirs 2007; Dzialowski et al. 2007:3). The initial filling of a new reservoir results in the release of nutrients from newly flooded soil and decomposing flooded vegetation. This release declines somewhat as the reservoir ages (Gunnison et al. 1984; Maavara et al. 2020:108).

Agricultural diversions, particularly TC Canal, Corning Canal, and GCID Main Canal, affect nutrient load transport in Sacramento River from Bend Bridge, upstream of RBPP, to Hamilton City in the spring and summer months. In the winter and spring months, flood-control diversions into Sutter and Yolo Bypasses can influence the transport of nutrients in Sacramento River from Hamilton City to Verona. Nutrient levels in the Sacramento River generally follow the seasonal pattern of flows, with maximums occurring in winter/spring and minimums occurring in late summer/fall (Kratzer et al. 2011:56–58).

Nutrient data for the Sacramento River at Red Bluff, Hamilton City, and above the CBD discharge near Knights Landing, and for the CBD near Knights Landing from the DWR WDL are provided in Appendix 6E, *Water Quality Data*. These data include concentrations of dissolved ammonia, nitrate plus nitrite (as nitrogen), and phosphorus and ortho-phosphate (as phosphorus) measured during 2000–2020. Mean nutrient concentrations over the 20-year sampling period at the three Sacramento River locations were 0.10–0.14 mg/L nitrogen [dissolved nitrate plus nitrite as nitrogen]; 0.01–0.02 mg/L nitrogen (ammonia); and 0.04–0.07 mg/L phosphorus. CBD water is dominated by agricultural drainage water and average nitrogen concentrations (nitrate plus nitrite) in the CBD at Knights Landing reflect this and are higher than upstream Sacramento River locations (Domagalski and Dileanis 2000:38). This was confirmed by the 2000–2020 measurements; mean nutrient concentrations for CBD were higher than upstream Sacramento River locations and were: 0.22 mg/L nitrogen [dissolved nitrate plus nitrite as nitrogen]; 0.06 mg/L nitrogen (ammonia); and 0.19 mg/L phosphorus. Measured data for nitrogen for the CBD and Sacramento River locations indicate that concentrations trended lower in summer relative to other times of year, a pattern which is somewhat consistent with monthly average total nitrogen and phosphorus concentrations noted by Tetra Tech (2006a:4-40). There are multiple wastewater treatment plants that discharge to the Sacramento River, which are significant nutrient point-source dischargers, including upstream of the RBPP and Hamilton City Pump Station, and downstream of the proposed points of diversion for Sites Reservoir, in the cities of Chico, Roseville, and Sacramento (Kratzer et al. 2011:37).

Water quality of the Yolo Bypass is dynamic and depends greatly on how much Sacramento River water is flowing over Fremont Weir. When this occurs, water quality in the Yolo Bypass is similar to the Sacramento River except along the western margin of the Yolo Bypass where local stream inflow influences water quality, particularly when flow over Fremont Weir is low. Sacramento Weir contributes additional floodwaters from the Sacramento River only during the highest flows, and discharge is usually much smaller than that over Fremont Weir. Inflows from the local streams that enter the western margin of the Yolo Bypass generally are small in comparison to floodwater discharges over Fremont Weir. However, local streams are often the greatest sources of freshwater to the floodplain in spring and fall and in dry years when Sacramento River water does not spill over the weirs (Schemel et al. 2002:3). Streams providing input from the western foothill watershed also carry nutrient to the Yolo Bypass and include Cache Creek and Knights Landing Ridge Cut, as well as Putah Creek and Willow Slough (Schemel et al. 2002:1, Yolo County 2014:9). Yolo Bypass also receives treated wastewater from the cities of Woodland and Davis; this input is minor during flooding but can be substantial during the dry season (Yolo County 2014:9). Agricultural operations in the Colusa Basin and Yolo Bypass also contribute nutrients to the bypass in summer.

The Sacramento River (along with the San Joaquin River) contributes substantial loads of nutrients to the Delta with municipal and agricultural discharge being the predominant contributors (Dahm et al. 2016:2). It is estimated that the Sacramento Regional Wastewater Treatment Plant, which discharges to the Sacramento River at Freeport, contributes approximately 90% of the annual total ammonia load to the Delta (Dahm et al. 2016:3). However, in April 2021, the wastewater treatment plant’s treatment process was upgraded and the improved treatment removes an estimated 99% of ammonia from the Sacramento region’s wastewater (Sacramento Regional County Sanitation District 2021). Nutrient loading from sources within the Delta is relatively low compared to upstream sources (Dahm et al. 2016:4).

Organic Carbon

Organic carbon sources to surface water include natural sources, such as decomposing animal and plant matter, and anthropogenic sources like domestic wastewater, urban runoff, and agricultural discharge. Organic carbon in water is of primary concern in surface waters because, in addition to bromide (a naturally occurring salt), organic carbon contributes to the formation of disinfection byproducts (DBPs) in treated drinking water. Elevated concentrations of organic carbon in surface waters are associated with increased mercury methylation because organic carbon fuels microbial activity.

Organic carbon in reservoirs comes from a combination of external sources (i.e., from the watershed), and internal sources. Internal supplies of organic carbon in reservoirs include algae (living and decomposing) and dissolved organics released by algae, zooplankton, and fish (Walker 1983:39). Studies have shown a positive correlation between total phosphorus and total organic carbon (TOC) in lakes and reservoirs, which likely reflects the control of algae and aquatic plant growth by this nutrient (Walker 1983:40). In addition, the levels of certain DBPs in treated water are positively correlated with chlorophyll *a* levels (a measure of the concentration of algae in water) in reservoir feed water (Graham et al. 1998:88).

Organic carbon concentrations are substantially higher in the San Joaquin River basin relative to the Sacramento River basin, particularly compared to the upper reaches of the Sacramento River basin. In the Sacramento River, the highest concentrations (and loads) appear in the wet season (October 1 to April 30) (Tetra Tech 2006b:4-8, 4-14, 4-15). Although the average organic carbon concentrations in the Sacramento River are lower than in the San Joaquin River, the organic carbon load to the Delta from the Sacramento River is twice as high as that from the San Joaquin River given that Sacramento River flows are substantially higher than the San Joaquin River (Tetra Tech 2006b:4-60). In the wet season, particularly during storm events, organic carbon loads are greater than in the dry season as organic carbon from the surface layers of various land uses, in addition to stream sediments, are transported downstream. The Yolo Bypass can also be a substantial source of organic material, including phytoplankton, as indicated by chlorophyll *a* measurements (Schemel et al. 2002:15–16).

In-Delta organic carbon sources include primary production in the water column, agriculture on the Delta Islands, and tidal marshes. In-Delta TOC loads are estimated to be substantially smaller than tributary loads to the Delta in wet years. In wet years, in-Delta TOC sources are approximately 15% of the TOC load, and in dry years, in-Delta loads are approximately 33% of the TOC load (Tetra Tech 2006b:ES1-ES2;5-16).

Barker Slough, in the Cache Slough Complex, is a location in the Delta of particular concern with regard to dissolved organic carbon because the Barker Slough Pumping Plant supplies water from the Delta to the North Bay Aqueduct for domestic water use in several northern Bay Area communities. Strongly influenced by inputs from the local watershed, average organic carbon concentrations at the North Bay Aqueduct intake in Barker Slough are the highest of any Delta municipal water supply intake (Delta Stewardship Council 2021).

The CBD contributes substantially to the TOC load of the Sacramento River between Colusa and Verona. Of the four tributaries that enter this segment of the Sacramento River, three agricultural drains (CBD, Butte Slough and Sutter Bypass) have relatively high TOC concentrations. The highest TOC concentrations were found in the CBD near Knights Landing (median concentration of 7.4 mg/L vs. 6.2 mg/L and 4.3 mg/L for Butte Slough and Sutter Bypass, respectively) (Starr Consulting et al. 2020:3-27).

Dissolved Oxygen

DO is a critical water quality constituent for all forms of aquatic life. DO depletion affects primarily aquatic life beneficial uses, which include warm freshwater habitat; cold freshwater habitat; and rare, threatened, or endangered species; migration of aquatic organisms; spawning, reproduction, and/or early development; and estuarine habitat. Low DO also stimulates mercury methylation by bacteria.

DO concentrations vary with several factors, including water temperature, biological oxygen demand, and reaeration. DO concentrations are generally adequate in flowing streams but may be substantially lower in areas of slow-moving water with high biological oxygen demand (a measure of the amount of oxygen consumed by bacteria when decomposing organic matter). In reservoirs, DO concentrations decrease with increasing water depth, particularly in thermally stratified waterbodies where the hypolimnion (i.e., bottom, colder layer of water) is isolated from reaeration due to lack of mixing and potentially a high sediment oxygen demand (Fafard 2018; Beutel 2003:208). In some reservoirs, DO may be depleted in the hypolimnion when sediment oxygen demand is high.

Multiple waterbodies in the study area are listed as impaired due to low DO including the lower Feather River, Sacramento River (Red Bluff to Knights Landing), Stone Corral Creek, CBD, Knights Landing Ridge Cut, and several locations in the Delta, and a total maximum daily load (TMDL) plan has been approved for the Stockton Deep Water Ship Channel in the Delta (Appendix 6A). The causes of low DO in the interior Delta include treated effluent loading, agricultural runoff, and reduced flushing of dead-end channels.

6.2.2.4. Mercury and Methylmercury

Mercury is a constituent of concern throughout California. Human exposure to elevated concentrations of mercury can cause a range of adverse health effects. In California, the most likely pathway for humans to be affected is through consumption of fish that have elevated mercury due to accumulation of methylmercury.

In freshwater environments, sulfate-reducing bacteria convert inorganic mercury to methylmercury primarily under anoxic conditions, such as in sediments, flooded shoreline soils and, to a lesser degree, in the water column (State Water Resources Control Board 2017b:4-3, 4-21; Alpers et al. 2008). This process is affected by multiple environmental variables. In a reservoir, environmental variables that have the greatest effect on mercury methylation are inorganic mercury sources, organic carbon content, water chemistry conditions in the reservoir (e.g., stratification, anoxia, pH, redox potential), and demethylation rates (State Water Resources Control Board 2017b:4-2).

Mercury and methylmercury cycling and biogeochemistry in lakes and reservoirs is a complex process. General information is presented here; however, additional detail on mercury and methylmercury, including applicable water quality criteria/objectives and a discussion of conceptual models for methylmercury production and fish tissue bioaccumulation, is presented in Appendix 6F, *Mercury and Methylmercury*. Mercury in reservoirs can be present in the underlying soils, in water that enters the reservoir through surface or subsurface flow, and from atmospheric deposition. In lakes and reservoirs that thermally stratify, oxygen in the hypolimnion is depleted due to respiration and organic carbon decomposition, and the resulting anoxic conditions stimulate mercury methylation. Due to this stratification, reservoir releases from the warmer, upper layer of water (i.e., the epilimnion) during the summer are less likely to have elevated methylmercury concentrations compared to releases from the deeper hypolimnion. In fall, as ambient temperatures cool, thermal stratification breaks down, and methylmercury that has built up in the hypolimnion will mix throughout the water column and become available for uptake into the food web. For example, seasonal increases in zooplankton and fish methylmercury concentrations have coincided with turnover at Davis Creek Reservoir in California (Slotton et al. 1995). Inflows from rivers into reservoirs can have a substantial influence on circulation, as temperature differences and topography may drive these flows downward in the reservoir, displacing bottom waters and contributing to horizontal advective mixing (Wildman 2016).

Bioaccumulation is the process by which organisms, including humans, can, over time, accumulate certain contaminants (from sources including water, air, and diet) in their tissues more rapidly than can be eliminated through metabolism and excretion. Bioaccumulation of methylmercury in fish is positively correlated with mercury and methylmercury concentrations in water and sediment, and negatively correlated with water pH. In reservoirs, large water level fluctuations may increase methylmercury bioaccumulation in reservoir fish (State Water Resources Control Board 2017b:4-10–4-11 and 4-21). The aqueous methylmercury concentration in a reservoir is a major determinant of the reservoir’s fish tissue methylmercury concentration (State Water Resources Control Board 2017b:4-2).

Methylmercury concentrations in organisms also increase from simpler to more complex organisms (e.g., from lower to higher trophic levels) in a process called biomagnification. Methylmercury uptake into algae occurs passively through diffusion and concentrations can be 100,000 times higher in algae than in surface water. Concentrations again increase by two to five times in the invertebrates that consume algae and another two to five times in fish that consume the invertebrates. There is an inverse relationship between algae abundance and methylmercury concentrations in zooplankton and fish because the available methylmercury is diluted in algae blooms.

In newly constructed reservoirs, the initial inundation of soils and vegetation can cause higher net methylmercury production in early years after filling, when organic carbon is relatively abundant, relative to long-term average production. This initial spike in mercury methylation can increase the concentrations of water column methylmercury to double or triple the long-term average concentrations for up to 10 years (Hall et al. 2005; State Water Resources Control Board 2017b). In addition, Hall et al. (2005) reported concentrations of total mercury exiting three newly inundated reservoirs to be several times higher than inflow concentrations. Mercury accumulated in the soil from atmospheric deposition is a source for total mercury that is released into the water column after a reservoir is inundated, in addition to being a source for methylmercury generation. Total mercury was also reported to be positively correlated with aqueous methylmercury in California reservoirs (State Water Resources Control Board 2017b). Increased methylmercury in surface water is also reflected in fish tissue in newly inundated reservoirs, albeit with a lag-time as mercury is cycled within the food web. Methylmercury concentrations in fish may increase between two- and seven-fold after initial filling (State Water Resources Control Board 2017b:4-14). The literature suggests that fish tissue concentrations of methylmercury may peak 3–8 years after filling, with concentrations slowly declining to a lower steady-state after 10–35 years (Azimuth Consulting Group Partnership 2012; Bodaly et al. 2007; State Water Resources Control Board 2017b:4-14).

Applicable water quality criteria and objectives for mercury and methylmercury are provided in Table 6-4. The lowest applicable water column criterion for mercury is the 50 nanograms per liter (ng/L) total recoverable mercury CTR criterion. This criterion is intended for the protection of aquatic life but may not be sufficiently protective of human health and wildlife consuming large (trophic level 3 [TL3] and trophic level 4 [TL4]) fish (Central Valley Regional Water Quality Control Board 2010a).

Table 6-4. Water Quality Criteria and Numeric Objectives for Mercury and Methylmercury Applicable to the Study Area

Source of Numeric Criterion/Objective	Goal	Application of the Criterion/Objective	Numeric Criterion/Objective
Sacramento–San Joaquin River Delta Estuary TMDL for Methylmercury[1]	To protect human health and wildlife	Trophic level 4 fish Trophic level 3 fish	0.24 mg/kg[2] 0.08 mg/kg[2]
	To protect wildlife	Whole fish <50 mm in length	0.03 mg/kg[3]
California Toxics Rule	To protect human health (as total mercury)	Consumption of water + organism	50 ng/L
		Consumption of organism only	51 ng/L
Water Quality Control Plan for Inland Surface Waters, Enclosed Bays, and Estuaries of California—Tribal and Subsistence Fishing Beneficial Uses and Mercury Provisions	To protect human health and wildlife	Sport fish	0.2 mg/kg[2,4]
	To protect non-commercial fishing by Tribal communities[5]	Sport fish	0.04 mg/kg[6]
	To protect wildlife	Prey fish	0.05 mg/kg[7]

Sources: Central Valley Regional Water Quality Control Board 2010b; State Water Resources Control Board 2017a; U.S. Environmental Protection Agency 2000

Notes: mm = millimeters; mg/kg = milligrams per kilogram; ng/L = nanograms per liter

[1] This TMDL addresses fish mercury impairment in all waterways within the legal Delta except the westernmost portion of the Delta near Chipps Island.

[2] Methylmercury in edible muscle tissue of fish (wet weight).

[3] Methylmercury in whole fish (wet weight).

[4] 12-month average concentration, measured in trophic level 3 (150–500 millimeters total length) or trophic level 4 (200–500 millimeters total length) skinless fish fillet and is applicable to the highest trophic level in the waterbody.

[5] The Tribal Subsistence Fishing objective applies to waters with the Tribal Subsistence Fishing (T-SUB) beneficial use designation, of which there are currently none in the study area.

[6] Objective applies to the wet weight concentration in skinless fish fillet from a mixture of 70% trophic level 3 fish and 30% trophic level 4 fish.

[7] Objective applies to whole fish (wet weight) of any species 50–150 millimeters total length (applicable if there are no trophic level 4 fish to evaluate the sport fish objective).

Mercury present in the Delta, Delta tributaries, Suisun Marsh, and San Francisco Bay is due to historical and ongoing deposition from upstream tributaries and discharge of methylmercury from wetlands adjacent to these waterbodies. Most of the mercury in these locations is the result of historical mining of mercury ore in the Coast Ranges (via Putah and Cache Creeks to the Yolo Bypass) and the extensive use of elemental mercury to aid gold extraction processes in the Sierra Nevada (via Sacramento, San Joaquin, Cosumnes, and Mokelumne Rivers) (Alpers et al. 2008:6; Wiener et al. 2003:1, 2). Elemental mercury from historical gold mining processes appears to be more bioavailable than that from mercury ore tailings because mercury used in gold mining processes was purified before use (Central Valley Regional Water Quality Control Board 2010b). Additional sources of mercury include natural geologic sources and atmospheric deposition from both local and distant sources (State Water Resources Control Board 2017b:S-7). Sediment transport to the Delta affects mercury cycling there. The transport of sediment and associated mercury and methylmercury to the Delta is directly influenced by flows to the Delta (Open Water Mercury Modeling Workgroup 2020:5-33).

Mean mercury concentrations in Shasta Lake and in the Sacramento River at Red Bluff and Hamilton City are substantially lower than the CTR criterion for mercury in freshwater (50 nanograms per liter [ng/L]). Samples taken at Shasta Lake (1998–2003) indicate that the mean mercury concentration is approximately 0.91 ng/L (Table 6-5). The Sacramento River at Red Bluff and Hamilton City has mean total mercury concentrations of 1.2 and 1.8 ng/L (Table 6-5), respectively, and the 75th percentile concentrations are 1.6 and 2.5 ng/L, respectively (Appendix 6F, Table 6F-4). Mean methylmercury concentrations in the Sacramento River at Red Bluff and Hamilton City are 0.037 ng/L and 0.061 ng/L (Table 6-6), respectively, and the 75th percentile concentrations are 0.053 and 0.078 ng/L, respectively (Table 6F-6); there currently is no water column methylmercury criterion against which to compare these concentrations. Total mean and maximum mercury and methylmercury concentrations in other surface waterbodies in the study area are identified in Tables 6-5 and 6-6, respectively.

Table 6-5. Total Mercury Concentrations in Surface Waters in the Study Area.

Location	Station	N	Mean[2] (ng/L)	Maximum (ng/L)	Data Range (years)	Source
Shasta Lake[1]	Shasta Lake	28	0.91	3.04	1998–2003	State Water Resources Control Board 2020b
Lake Oroville[1]	Lake Oroville	2	0.37	0.52	2004–2020	State Water Resources Control Board 2020b
Lake Oroville[1]	Lake Oroville	243	0.54	23.2	2002–2009	State Water Resources Control Board 2017b
Funks Creek	Golden Gate	2	0.35	1.2	2006–2007	California Department of Water Resources 2020
Stone Corral Creek	-	3	0.85	2.3	2007	California Department of Water Resources 2020
Colusa Basin Drain	Knights Landing	26	8.6	19.3	1996–1998	U.S. Geological Survey 2000
Colusa Basin Drain	Knights Landing	66	4.5	75[3]	1999–2007	State Water Resources Control Board 2020b

Location	Station	N	Mean[2] (ng/L)	Maximum (ng/L)	Data Range (years)	Source
Sacramento River	Red Bluff	77	1.2	14.4	1999–2016	State Water Resources Control Board 2020b
Sacramento River	Hamilton City	73	1.8	54	1999–2016	State Water Resources Control Board 2020b
Sacramento River	Freeport	217	4.5	89[4]	1994–2015	State Water Resources Control Board 2020b
Yolo Bypass	Prospect Slough[5]	28	73.2	696	1995–2003	Central Valley Regional Water Quality Control Board 2010b

ng/L = nanograms per liter; non-detects included in summary statistics at half the detection limit.

[1] Concentrations presented in nanograms per liter of unfiltered mercury. Water samples were taken at the surface of the reservoir.

[2] Geometric mean.

[3] Maximum reported concentration of 75 ng/L total mercury represents a stormwater sample collected in January 2003 and was the only one of 92 samples collected between 1996–2007 that exceeded the lowest CTR criterion of 50 ng/L.

[4] This maximum total mercury concentration in the dataset that exceeded the lowest CTR criterion (50 ng/L) in the available data between 1994 and 2015. Sacramento River concentrations of total mercury returned to typical conditions by the time another sample was collected less than 2 weeks later.

[5] Sampling at Prospect Slough (export location of the Yolo Bypass) occurred when there were net outflows from tributaries to the Yolo Bypass and no net outflow (i.e., the slough's water was dominated by tidal waters from the south). Average concentration presented.

Table 6-6. Total Methylmercury Concentrations in Surface Waters in the Study Area.

Location	Station	N	Mean[1] (ng/L)	Maximum (ng/L)	Data Range (years)	Source
Sacramento River	Red Bluff	35	0.037	0.22	2000–2007	State Water Resources Control Board 2020b
Sacramento River	Hamilton City	35	0.061	0.333	2000–2007	State Water Resources Control Board 2020b
Sacramento River	Freeport	105	0.069	0.318	2000–2015	State Water Resources Control Board 2020b
Colusa Basin Drain	Knights Landing	25	0.17	0.89	1996–1998	U.S. Geological Survey 2000
Colusa Basin Drain	Knights Landing	55	0.13	0.55	2000–2007	State Water Resources Control Board 2020b

Location	Station	N	Mean[1] (ng/L)	Maximum (ng/L)	Data Range (years)	Source
Yolo Bypass	Prospect Slough[2]	-	0.35	-	2000, 2003	Central Valley Regional Water Quality Control Board 2010b

ng/L = nanograms per liter

[1] Geometric mean

[2] Sampling at Prospect Slough (export location of the Yolo Bypass) occurred when there were net outflows from tributaries to the Yolo Bypass and no net outflow (i.e., the slough's water was dominated by tidal waters from the south). Average concentration presented.

Over 80% of total mercury loading to the Delta can be attributed to the Sacramento Basin (Sacramento River and Yolo Bypass tributary watersheds) (Central Valley Regional Water Quality Control Board 2010b:132). Of the watersheds in the Sacramento Basin, Cache Creek and the upper Sacramento River (above Colusa) watersheds contribute the most mercury to the Delta (Central Valley Regional Water Quality Control Board 2010b:iv). The Yolo Bypass contributes a significant amount of methylmercury and total mercury to the Delta (Central Valley Regional Water Quality Control Board 2010b). During high-flow events, water from the Sacramento River that enters the Yolo Bypass through Fremont Weir and the Sacramento Weir inundates the bypass. The CBD, Cache Creek, and three other westside tributaries (i.e., Putah Creek, Willow Slough Bypass and Knights Landing Ridge Cut) also contribute to flows in the bypass. Inundation results in the transport of mercury into the bypass. Inundation is followed by periods during which the water drains toward the Sacramento River. The subsequent periods result in the drying of soils. Much of the mercury remains in the soils in the Bypass. As the soil dries, the mercury oxidizes and forms methylated mercury compounds (methylmercury) (Schemel et al. 2002). The Yolo Bypass receives high levels of mercury from the Cache Creek watershed and via the Sacramento River from legacy mercury mines in the Coast Ranges, as well as from gold mines in the Sierra Nevada where mercury was used as part of the gold mining process (Alpers et al. 2014:277). Total mean mercury concentrations in the Yolo Bypass (at Prospect Slough) exceed the CTR mercury criterion of 50 ng/L (Table 6-5). The mean methylmercury concentration in Yolo Bypass is identified in Table 6-6.

Multiple waterbodies in the study area are on the 303(d) list for mercury, including Shasta Lake and the Sacramento River (from Cottonwood Creek to the Delta); Lake Oroville and the lower Feather River; Folsom Lake, Lake Natoma and the lower American River;); San Luis Reservoir; and CBD; and there is a TMDL for mercury in the Delta, which also includes Yolo Bypass (Appendix 6A). The associated mercury and methylmercury control program for the Delta recommends reducing mercury loads entering the Cache Creek Settling Basin (CCSB), and regularly excavating the sediment accumulating in the CCSB in order to increase the mercury trapping abilities of the basin. Additional reductions in mercury loading to Cache Creek will be achieved through the existing mercury TMDL in the watershed, which includes measures for mine remediation, erosion control in mercury-enriched areas, and the removal of floodplain sediments containing mercury (Central Valley Regional Water Quality Control Board 2010b). In addition to efforts targeting mercury loading reductions in Cache Creek, the TMDL includes methylmercury and total mercury load and waste load allocations for agricultural drainage, tributary inputs, and wastewater facilities in the Yolo Bypass to enable reductions in mercury.

Health advisories have been issued by the Office of Environmental Health Hazard Assessment, which recommends limiting consumption of several fish species from several waterbodies in the study area including Lake Oroville, and Shasta and Folsom Lakes, Sacramento River, northern, central and southern Delta, and San Luis Reservoir. Additional locations are identified in Table 4A.23-1 in Appendix 4A. Fish tissue methylmercury concentrations reported from waterbodies in the study area are presented in Table 6F-9 in Appendix 6F. CBD fish tissue methylmercury concentrations approached the California sport fish objective for inland surface waters (0.2 milligrams per kilogram [mg/kg] wet weight [ww] for the highest trophic level in the waterbody) but did not exceed that objective. However, fish tissue methylmercury concentrations in TL3 fish species from Yolo Bypass and in the Delta (Sacramento River river mile [RM] 44) exceeded the 0.08 mg/kg ww methylmercury TMDL objective for the Delta. In addition, the TL4 methylmercury TMDL objective (0.24 mg/kg ww) was also exceeded at the Sacramento River RM 44 location.

6.2.2.5. Metals Other Than Mercury

In addition to mercury, other metals that can impair beneficial uses of waterbodies, including aluminum, arsenic, cadmium, chromium, copper, iron, lead, manganese, nickel, selenium, and zinc, are considered in this chapter. Two of the elements in this list, arsenic and selenium, are actually metalloids, but are evaluated with metals. Metalloids have some properties similar to metals and are adjacent to metals on the periodic table. Heavy metals are dense, with a high atomic weight. There is no single agreed upon list of heavy metals, but cadmium, chromium, copper, iron, lead, manganese, nickel, and zinc are all examples of metals that may be considered heavy metals.

Metals, including those of concern in the Sacramento River region such as cadmium, copper, and zinc, enter the waterbodies with the sediment from eroded soils and discharges from abandoned mines, and in stormwater runoff from municipal areas. Metals can cause health concerns in aquatic life and in humans who consume the fish from affected waterbodies. In addition, metals can cause human health concerns if not adequately controlled in drinking water supply.

Metals in the environment, like other chemicals (e.g., pesticides), exist in mixtures. The effects of mixtures of metals on organisms in the Sacramento River are poorly understood. Toxicity studies have been conducted to attempt to determine whether various metals (primarily heavy metals) together may have additive, antagonistic, or synergistic (greater than additive) physiological effects. In lethality tests on the nematode, *Caenorhabditis elegans*, results indicated that copper had a synergistic effect with cadmium, lead, mercury, zinc and nickel, whereas zinc had a neutralizing effect on the toxicity of other metals (e.g., aluminum, cadmium) (Chu and Chow 2002:58). Copper and cadmium appear to have a synergistic effect in inhibiting cell division in the freshwater alga *Chlorella* sp., while combinations of copper and zinc, cadmium and zinc, and the three metals were less than additive or antagonistic (Franklin et al. 2002:2412).

Shasta Lake, where West Squaw Creek enters the lake, and Keswick Reservoir downstream of Spring Creek were placed on the Section 303(d) list because of impairment by cadmium, copper, and zinc (Appendix 6A). Cadmium, copper, and zinc contamination in the Sacramento River between Keswick Dam and Cottonwood Creek were addressed by the 2002 Upper Sacramento River TMDL and by water quality objectives in the Central Valley Basin Plan (Central Valley Regional Water Quality Control Board 2002).

Metal concentration measurements are available from DWR's WDL. Metal concentrations measured in the Sacramento River from 2000 through 2020 near Red Bluff (WDL stations A0275890 and A0275500), at Hamilton City (WDL station A0263000), and upstream of the CBD (WDL station A0223002) are shown in Appendix 6E along with measurements from the CBD near Knights Landing (WDL station A0294710). These are the best data sources for the most relevant locations. Data from earlier than 2000 were not utilized because metal concentrations in the Sacramento River have changed with time and cleanup efforts. These data show patterns of metal concentrations at the Sites Reservoir intake locations (near Red Bluff and Hamilton City), in the CBD, and upstream of one of the potential release locations (upstream of the CBD).

Water quality objectives for metals can be highly variable depending on the beneficial use being considered. For example, the California Division of Drinking Water primary MCL for aluminum is 1,000 micrograms per liter (µg/L) (California Division of Drinking Water 2020), whereas the objective for the 4-day average for freshwater aquatic life depends on pH, hardness, and dissolved organic carbon and based on measurements in the Sacramento River (Domagalski and Dileanis 2000) and U.S. Environmental Protection Agency (USEPA) lookup tables (U.S. Environmental Protection Agency 2018) is approximately 620 µg/L. Many objectives for metals are applied to total recoverable metal concentration (i.e., unfiltered), as opposed to dissolved metals (i.e., filtered). This means that metals attached to sediment or particulates may contribute to exceedance of the objective even though the metals attached to sediment may be less biologically available and may settle when velocity is decreased (as in a reservoir).

Comparisons of total metal concentrations to the lowest, most stringent water quality standards indicate that metal concentrations in the Sacramento River sometimes exceed objectives, including, for example, objectives for aluminum, copper, iron, and lead (Appendix 6E). In general, metal concentrations in the CBD tend to be higher than in the Sacramento River. For most metals there is little difference in concentration along the Sacramento River between Red Bluff and the CBD discharge site. Arsenic patterns are notably different from the other metals and concentrations appear to increase along the length of the Sacramento River.

For many metals there is a slight tendency for fewer exceedances to occur in the summer and fall. Incorporating flow measurements in the Sacramento River at Keswick and Bend Bridge into the evaluation indicates a very loose tendency for higher concentrations when flow is higher and also when Shasta Lake releases constitute less of the flow and local runoff contributes more (as indicated by the ratio of flow at Keswick to flow at Bend Bridge). Relationships with flow are complex because these two flow conditions are not correlated with each other; Shasta Lake releases tend to constitute more of the flow when flow is higher.

At Salt Pond, a few metals were noted to have high concentrations (aluminum, iron, and manganese, arsenic, copper, lead, and nickel). These concentrations may have been high partly due to evapoconcentration of the spring water in the pond and because little discharge leaves the pond.

Between 2003 and 2011, DWR intermittently measured metals concentration in Stone Corral Creek near Sites (WDL station A0043500). The measured concentrations were not greatly different from the values measured in the Sacramento River except for selenium, which averaged 6.74 µg/L for total selenium in Stone Corral Creek but remained less than 0.95 µg/L in the Sacramento River (Appendix 6E).

6.2.2.6. Harmful Algal Blooms

Cyanobacteria are aquatic, photosynthetic bacteria that occur in fresh, marine, and brackish surface waterbodies (National Oceanic and Atmospheric Administration n.d.). Some species of cyanobacteria produce toxins (cyanotoxins), which can adversely affect humans, domestic animals, fish and other wildlife (Central Valley Regional Water Quality Control Board 2019b:6-7). When toxic cyanobacteria grow out of control, these masses of overgrowth are referred to as HABs.

HABs, depending on the cyanobacteria species, can occur suspended in the water column (planktonic HABs) or attached to substrates (e.g., rocks, cobble, aquatic plants) as a mat in the benthic habitats of rivers or lakes (benthic HABs) (Central Valley Regional Water Quality Control Board 2019b:5). Planktonic HABs can form surface scums and mats and discolor the water column. Most cyanobacteria are planktonic and the toxic bloom-forming cyanobacteria are largely freshwater planktonic species (Berg and Sutula 2015:6). In California, some of the most commonly occurring planktonic genera of cyanobacteria are *Microcystis*, *Dolichospermum*, *Planktothrix*, and *Cylindrospermum* (U.S. Environmental Protection Agency 2020a; Central Valley Regional Water Quality Control Board 2019b:5). Benthic HABs are comprised of algal and cyanobacterial species in an assemblage; however, the mats are typically dominated by one species. Benthic HAB mats can detach and float to the surface of the water column where they can be transported to the shore (California Cyanobacteria and Harmful Algal Bloom Subcommittee 2020). Benthic HABs do not discolor water (Central Valley Regional Water Quality Control Board 2019b:5). *Anabaena*, *Phormidium*, *Nostoc*, and *Cylindrospermum* are common genera of benthic cyanobacteria in California (Central Valley Regional Water Quality Control Board 2019b:5).

There are multiple environmental factors that contribute to the formation and maintenance (i.e., persistence) of HABs. Generally, HABs are dependent on relatively warm water temperatures (at least approximately 66°F), water column sunlight (known as irradiance), low turbidity, a calm, stratified water column coupled with long water residence times, and the availability of dissolved nutrients (specifically nitrogen and phosphorus) in non-limiting concentrations (Lehman et al. 2013:152; Berg and Sutula 2015:ii). Whereas an approximate minimum water temperature of 66°F and irradiance are generally considered the primary drivers of bloom initiation, low flow and long water residence time may be the primary factors in maintaining *Microcystis* blooms in the Delta, for example (Berg and Sutula 2015:iii; Lehman et al. 2013:154). Cyanobacteria are photosynthetic and thus require light for growth. Most cyanobacteria grow relatively poorly at low and mixed light levels, such as deeper in the water column. They grow well when exposed to high light (Berg and Sutula 2015:27, 28). However, some species of cyanobacteria can tolerate lower light intensities than those found at the surface of the water. For example, *Cylindrospermopsis raciborskii* and *Planktothrix* sp. compete well with other phytoplankton at low light and therefore can grow relatively well deeper in the water column (Berg and Sutula 2015:28). The most common and widespread cyanobacterial species in freshwater environments is *Microcystis aeruginosa,* and *Microcystis* is the genus of cyanobacteria most often responsible for HABs (U.S. Environmental Protection Agency 2020a; Harke et al. 2015:4). *Microcystis* produce the cyanotoxin microcystin. *Microcystis* cyanobacteria require relatively high light intensity and thus can regulate their buoyancy and move to the surface to take advantage of higher light levels. Stratified conditions in lakes and reservoirs indirectly promote HABs through increased temperatures, irradiance, and reduced loss of cyanobacteria. Generally, in stratified lakes or reservoirs, planktonic cyanobacteria accumulate near the surface and also distribute throughout the photic zone (the upper water layer where light is sufficient for photosynthesis) (Graham et al. 2008:CYB-11). In shallow reservoirs or lakes where light penetrates to the bottom, cyanobacteria may be found on the surface of lake bottom sediment for part of the day (Graham et al. 2008:CYB-11). Growing close to the water’s surface also aids cyanobacteria in avoiding light limitation due to high turbidity (Berg and Sutula 2015:28).

Although planktonic cyanobacteria and cyanotoxins are generally concentrated closer to the water’s surface in blooms, studies have shown that planktonic cyanobacteria and cyanotoxins may also be detected 5 to 10 meters (approximately 16 to 33 feet; depending on conditions such as stratification and thermocline depth) below the surface in the water column, albeit at lower concentrations relative to shallower depths (Wilkinson et al. 2020:11; Grabowska and Mazur-Marzec 2014:46). The vertical distribution of planktonic cyanobacteria in the epilimnion is also influenced by wind speed, and *Microcystis* is especially sensitive to wind conditions (i.e., wind-induced turbulent vertical mixing) (Wilkinson et al. 2020:10, 13). Studies have shown that some species of cyanobacteria “overwinter” in or on sediment in lakes and rivers by sinking to the lake bottom or stream bed. Overwintering cells may then serve as inoculum to seed the cyanobacterial population the following growing season (Chorus and Welker 2021:225, 516).

Cyanotoxins typically remain within cyanobacteria until the cyanobacteria die or rupture, at which point the toxins are released; however, toxins can be actively released from living cyanobacteria as well (Graham et al. 2008:15), although this may vary by species. The most commonly detected cyanotoxin in the United States are microcystins. In the Central Valley, microcystin and anatoxin-a are the most commonly detected cyanotoxins; cylindrospermopsin and saxitoxin have also been reported, but with less frequency (Central Valley Regional Water Quality Control Board 2019b:21). Once released, cyanotoxins can eventually undergo biodegradation and, to some degree, photodegradation (Gagala and Mankiewicz-Boczek 2012:1128–1129). Biodegradation rates vary depending on cyanotoxin type and are often influenced by temperature and pH. Laboratory studies have shown that microcystins, for example, can be relatively rapidly degraded (4–15 days) by certain bacterial families following a lag period (Berg and Sutula 2015:30; Gagala and Mankiewicz-Boczek 2012:1132). In a study using bacteria isolated from two eutrophic lakes with previous cyanobacteria/cyanotoxin history, cylindrospermopsin removal was 47% and 49% after 14 days at approximately 68°F and 86°F, respectively (Dziga et al. 2016:4). The prevalence of bacteria that degrade microcystin may affect the length of the lag period. Some types of cyanotoxins are more susceptible to photodegradation than others. Anatoxin, for example, has been reported to undergo rapid photodegradation under conditions of the light intensity and pH ranges associated with blooms, whereas microcystins are more stable in sunlight (Chorus and Welker 2021:85, 37–38). Adsorption to sediment may play an important role in the environmental fate and transport of cyanotoxins. For example, following release from cyanobacterial cells, a fraction of dissolved microcystins can adsorb to suspended and settled sediment. This process is inversely proportional to pH and dependent on the organic content of the sediment (Wu et al. 2011:2641). In the Delta, microcystins have been detected in sediment even when concentrations of these toxins in water collected from the same location are below the limit of detection (Bolotaolo et al. 2020:13). Cyanotoxins present in irrigation water can bioaccumulate in certain food crops (Miller et al. 2017:3-4). Zooplankton and zoobenthos have been shown to accumulate microcystins (Larson et al. 2017:96). Fish and shellfish mainly accumulate the cyanotoxins microcystin and cylindrospermopsin through their diet and can break down much of the ingested cyanotoxins (Office of Environmental Health Hazard Assessment 2012:24).

Currently, there are no federal or state regulatory standards for cyanotoxins in recreational waters or drinking water. Participating state agencies have developed voluntary guidance for responding to HABs in recreational waters, and the Office of Environmental Health Hazard Assessment has developed notification-level recommendations for four cyanotoxins in drinking water: anatoxin-a, saxitoxins, microcystins, and cylindrospermopsin (Office of Environmental Health Hazard Assessment 2022; see Appendix 4A, Section 4A.2.2.6, *Harmful Algal Blooms*). USEPA has published 10-day drinking water health advisories for microcystins and cylindrospermopsin, which the State Water Resources Control Board (State Water Board) recommends that California water utilities refer to in managing cyanotoxins in their water systems (Central Valley Regional Water Quality Control Board 2019b:20). See Appendix 4A, Section 4A.2.1.6, *Human Health Recreational Criteria and Drinking Water Health Advisories for Microcystins and Cylindrospermopsin*, for an additional description of USEPA's drinking water health advisory and recommended recreational water quality criteria for cyanotoxins. This section also describes joint efforts to monitor, manage, and respond to HABs across multiple organizations.

In recent years, the range, frequency, duration, and magnitude of HABs have increased globally as well as locally in California (Central Valley Regional Water Quality Control Board 2019b:2). Between 2016–2018, the reported number of HABs in California approximately doubled (Central Valley Regional Water Quality Control Board 2019b:4). Climate change, nutrient loading, and water residence time are the most significant anthropogenic factors to which these increases have been attributed (State Water Resources Control Board 2016:1). In the Central Valley, most HABs occur in the late spring through early fall, when water temperatures are warm and water flow is lower (Central Valley Regional Water Quality Control Board 2019b:20). However, blooms can also begin earlier or continue year-round in some locations (Interagency Working Group on Harmful Algal Bloom Related Illnesses 2019:3).

The majority of the confirmed cases of HABs in the Central Valley have been in reservoirs and lakes used for drinking water and water-contact recreation (Central Valley Regional Water Quality Control Board 2019b:20). HABs have been reported in multiple Central Valley locations, such as Clear Lake, and nearby Black Butte Reservoir (north of the study area), as well as several study area locations including Lake Oroville, and Shasta and Folsom Lakes, the confluence of the Sacramento and American Rivers, San Luis Reservoir, and the Delta (State Water Resources Control Board 2021a).

Microcystis was first observed in the Delta in 1999, and since then blooms have occurred annually at varying magnitudes throughout the Delta. Blooms commonly start in the central Delta and spread seaward into brackish water with streamflow and tide. The abundance of *Microcystis* and the toxin, microcystin, have been greatest in August and September of dry years, which were characterized by low streamflow and total suspended solids, and elevated water temperature and nutrient concentrations (Lehman et al. 2013:142, 152).

6.2.2.7. Invasive Aquatic Vegetation

Freshwater aquatic vegetation or macrophytes grow in the littoral or nearshore zone of rivers, lakes, reservoirs, and wetlands. Generally, submersed macrophytes are found in deeper water, emergent (above the water's surface) macrophytes are found in shallow areas, and free-floating plants can be found throughout the water surface (Ta et al. 2017:1). Common aquatic macrophytes include Brazilian waterweed (*Egeria densa*), water hyacinth (*Eichhornia crassipes*), water thyme (*Hydrilla* sp.), water primrose (*Ludwigia* sp.), curly leaf pondweed (*Potamogeton* sp.), parrot feather (*Myriophyllum aquaticum*), and Eurasian watermilfoil (*Myriophyllum spicatum*). These species are all considered invasive and can displace native aquatic plant species, shade out crucial shallow-water fish habitat, alter turbidity, increase diurnal fluctuations of pH and DO, obstruct waterways and create hazardous conditions for boating and recreation, and clog agricultural and municipal water intakes (Division of Boating and Waterways 2021a, 2021b; Boyer and Sutula 2015:ii). Generally, conditions conducive to the formation and maintenance of HABs are also conducive to overgrowth of invasive aquatic vegetation. Invasive aquatic macrophytes thrive under conditions of low flow, elevated water temperature, low turbidity, and sufficient nutrient concentrations. Brazilian waterweed, water hyacinth, and water primrose are problematic in the Delta (Boyer and Sutula 2015:ii).

In reservoirs and lakes, invasive aquatic vegetation can be introduced inadvertently through recreational boating (e.g., Brazilian waterweed fragments can attach to boat hulls, propellers or trailers and be transported) and sometimes intentionally when people dispose of aquarium contents into lakes.

The Delta is listed as impaired due to invasive species (Appendix 6A). Invasive aquatic plants disperse into the Delta via the Sacramento River and San Joaquin River watersheds, recreational boating, and commercial shipping (Conrad et al. 2020:4). The California State Parks Division of Boating and Waterways (DBW) currently conducts chemical (predominantly) as well as mechanical and biological control of nine species of aquatic invasive weeds across 418 sites in the primary Delta under the Aquatic Invasive Plant Control Program (AIPCP) (Conrad et al. 2020:8).

6.2.2.8. Pesticides

Pesticides are any chemical used to kill or deter pests. Insecticides, herbicides, fungicides, and insect repellents are all considered pesticides. Depending on concentration and type of pesticide, pesticides in surface water can cause a wide range of effects on humans and aquatic organisms including cancer, birth defects, and immune system disorders. Humans may be affected directly through drinking water or by eating contaminated fish or shellfish. Aquatic organisms may accumulate pesticides from the surrounding water or through the food chain (Food and Agriculture Organization of the United Nations 1996:4-4, 4-5). The occurrence of pesticides in surface waters of the Sacramento Valley is dependent on the volume of pesticide applied, the physicochemical properties of the pesticide, the amount of surface runoff, and persistence of the pesticide. Timing of contamination may depend on when pesticides are applied. For example, chlorpyrifos and diazinon are typically applied to dormant orchards during January and February and thiobencarb is typically applied in the spring as a pre-emergent for rice (Starr Consulting et al. 2020:3-29, 4-5). Various pesticides have been detected intermittently in the Sacramento Valley, with more detections in agricultural drain water and small tributaries than in the Sacramento River and few detections at drinking water intake facilities along the lower Sacramento River near Sacramento (Starr Consulting et al. 2020).

TMDLs have been established for pyrethroids and diazinon/chlorpyrifos in the Central Valley (Appendix 6A). Additional older and more regionally specific TMDLs have been established for diazinon and chlorpyrifos in the Sacramento River, Feather River, and the Delta. The CBD has been placed on the Section 303(d) list due to impairment by azinphos-methyl (Guthion), Group A pesticides[3], dichlorodiphenyltrichloroethane (DDT), and dieldrin.

The Sacramento River tends to have low levels of pesticides. Collection of pesticide measurements has occurred in the Sacramento River near Hamilton City, Sacramento River at Colusa, and CBD above Knights Landing. Data presented in Appendix 6E are from the California Department of Pesticide Regulation’s Surface Water Database (SURF) that combines data from multiple sources. Pesticides selected for graphing are those that have been detected in the Central Valley and that have a moderate number of measurements (on average 28 samples per pesticide per site over the entire period of record). These data confirm that pesticides are detected more frequently in agricultural drain water than in the Sacramento River. The measurements show that pesticides are often detectable in the CBD and are mostly non-detectable in the Sacramento River. Although method detection limits for some pesticides are not low enough to detect concentrations that can affect aquatic organisms, the scarcity of detections in the Sacramento River indicates that pesticide concentrations in the river are very low. Of the pesticides with sufficient data for graphing (azinphos-methyl, bifenthrin, carbofuran, chlorpyrifos, diazinon, malathion, proponil, and thiobencarb), only diazinon was detected in the Sacramento River. At Sacramento River at Colusa and near Hamilton City, diazinon was detected in 46 of 268 samples, while the other pesticides were detected zero times. Diazinon, which is subject to degradation by microbes, hydrolysis, and photolysis (U.S. Environmental Protection Agency 2008:12), was measured occasionally in the Sacramento River near Hamilton City and Colusa during January and February. Additional pesticides considered in the evaluation included chlordane, DDT, dichlorvos, dieldrin, and pyrethroids other than bifenthrin. The SURF database either had no data for these pesticides in the Sacramento River between Knights

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[3] Group A pesticides consist of a total concentration from the following organochlorine pesticides: aldrin, dieldrin, endrin, heptachlor, heptachlor epoxide, chlordane (total), hexachlorocyclohexane (total) including lindane, endosulfan (total), and toxaphene.

Landing and Red Bluff (stations at Colusa and near Hamilton City) or all values at these stations were less than detection limits.

6.3 Methods of Analysis

The water quality analysis focuses on those constituents that are likely to be affected by Project construction or operation. For construction effects, constituents of concern include hazardous materials that could be spilled into waterways and sediment that may erode into waterways due to ground disturbance. Effects associated with initial filling of Sites Reservoir, including the first years of operation after filling, are covered under construction. For operation effects, constituents of concern include metals, HABs, invasive aquatic vegetation, mercury, nutrients, organic carbon, DO, pesticides, water temperature, and salinity. Multiple mechanisms for operational effects were considered and the primary mechanisms evaluated are summarized in Table 6-7. Nutrients, organic carbon, and DO are considered together due to the close linkage between these constituents. Similarly, HABs and invasive aquatic vegetation are considered together.

The primary evaluation of flooding effects is in Chapter 5, *Surface Water Resources*, although potential water quality effects associated with flooding are discussed in this chapter under Impact WQ-4, as they relate to the risks of pollutants being released and affecting water quality as the result of be placed in a flood hazard or seiche zone.

Potential impacts on public health due to bioaccumulation of methylmercury in fish tissue or exposure to cyanotoxins are discussed in Chapter 27, *Public Health and Environmental Hazards*.

Table 6-7. Potential Mechanisms of Operational Effects on Water Quality

Mechanism	Main Constituents Considered	Main Region of Concern	Model Results Considered
Temporal Shift (when concentrations in water used to fill Sites Reservoir are higher than concentrations in the Sacramento River at time of release)	Metals Pesticides Salinity	Sacramento River downstream of discharge locations	CALSIM (provided timing of diversions, input to metals calculations, and comparison of Sites discharge to Sacramento River flow)
Evapoconcentration in Sites Reservoir	Metals Salinity	Sites Reservoir and Sacramento River downstream of discharge locations	CALSIM (reservoir water balance)
In-Reservoir Processes	Mercury Metals HABs Nutrients/organic carbon/DO Temperature Salinity	Sites Reservoir and receiving waters	CALSIM (comparison of Sites discharge to Sacramento River flow) Sites Reservoir temperature model (CE-QUAL-W2) Central Valley Regional

Mechanism	Main Constituents Considered	Main Region of Concern	Model Results Considered
			Water Quality Control Board model of fish tissue methylmercury concentrations in Yolo Bypass and Delta
Change in System Reservoir Operations	Temperature HABs Mercury	Shasta Lake and Sacramento River Lake Oroville and Feather River Folsom Lake and American River San Luis Reservoir	CALSIM HEC5Q Reclamation temperature model
Change in Delta Operations	Salinity/Chloride	Delta	DSM2 QUAL – with input from CALSIM and DSM2 HYDRO
Redirection of Some CBD Flow through Yolo Bypass	Pesticides Nutrients/organic carbon/DO HABs Mercury Temperature	North Delta/Cache Slough Complex/Yolo Bypass	CALSIM (provided timing and flow of Sites releases to Yolo Bypass)

CBD = Colusa Basin Drain; DO = dissolved oxygen; HAB = harmful algal bloom
Note: These mechanisms are discussed under Impact WQ-1 (initial filing) and Impact WQ-2 (operational effects)

6.3.1. Construction

Potential surface water quality effects associated with construction are assessed qualitatively and take into consideration the nature of the construction activity; the types of materials that may be used and stored within the construction footprint; the magnitude, timing, and duration of potential contaminant discharges resulting from construction; and the proximity of the activity to surface waters. The impact analysis associated with construction activities is combined for Alternatives 1, 2, and 3 because the impact mechanisms are similar or the same between these alternatives. Construction activities that may affect surface water quality include ground-disturbing activities (e.g., excavation, tunneling, and quarrying); grouting; dewatering; concrete and asphalt batching; demolition; and the accidental release of hazardous materials (e.g., fuel, solvents, lubricants, paint). The BMPs described in Appendix 2D, *Best Management Practices, Management Plans, and Technical Studies*, are incorporated into the analysis of potential construction impacts on water quality. The following BMPs would be incorporated and implemented prior to and during construction:

- BMP-14, Obtainment of Permit Coverage and Compliance with Requirements of Central Valley Regional Water Quality Control Board (Central Valley RWQCB) Order R5-2022-0006 (National Pollutant Discharge Elimination System No. CAG995002 for Limited Threat Discharges to Surface Water) and State Water Resources Control Board Order 2003-0003-003-DWQ (Statewide General Waste Discharge Requirements For Discharges To Land With A Low Threat To Water Quality), requires coverage under and compliance with waste discharge requirements to protect surface water quality from discharges of pollutants.

- BMP-12, Development and Implementation of Stormwater Pollution Prevention Plan(s) (SWPPP) and Obtainment of Coverage under Stormwater Construction General Permit (Stormwater and Non-stormwater) (Water Quality Order No. 2022-0057-DWQ and NPDES No. CAS000002, and any amendments thereto), requires implementation of erosion and sediment control measures, waste management measures, non-stormwater management measures, and postconstruction stormwater management measures to prevent the discharge of sediment, wastes, and other potential pollutants from construction sites to stormwater and surface water.
- BMP-13, Development and Implementation of Spill Prevention and Hazardous Materials Management/Accidental Spill Prevention, Containment, and Countermeasure Plans (SPCCPs) and Response Measures, requires implementation of site-specific plans with measures to minimize or avoid hazardous materials spills during construction and operation/maintenance, procedures for the cleanup and disposal of hazardous materials spills, emergency response and spill containment training, and other related best management practices.
- BMP-11, Management of Dredged Material, requires chemical characterization of Funks Reservoir sediment prior to dredging, and design and operation of settling/dewatering basins and dredged material storage areas to avoid adverse effects on surface water and groundwater quality from pollutants potentially contained in Funks Reservoir sediment, and runoff and subsequent sedimentation and turbidity.
- BMP-15, Performance of Site-Specific Drainage Evaluations, Design, and Implementation, requires evaluation of local drainage features during final Project design and incorporation of necessary design features (e.g., low-impact development practices, bioswales, infiltration basins) to result in equivalent functioning of existing drainage system.

The water quality constituents of concern during initial filling are distinct from those considered for typical construction impacts. They are constituents that may be at elevated levels in the short term during initial filling of Sites Reservoir and for the first few years of reservoir operations. These constituents are a subset of those considered under operational effects and include constituents that may be at higher levels after initial filling due to low storage and elevated levels of nutrients and organic material associated with inundation of vegetation and organic material in the soil. The water quality constituents of concern during initial filling include HABs/invasive aquatic vegetation, mercury and methylmercury, and nutrients/organic carbon/DO. The period of elevated concentrations of these constituents could extend beyond the period during which the reservoir is filled. The full period of potentially elevated concentrations is included in the impact evaluation of initial filling and includes the time to fill the reservoir and the 10-year period after the reservoir has filled. CALSIM results indicate that it may take roughly 2–10 years for Sites Reservoir to fill, depending on hydrologic conditions within the Sacramento River watershed. Aqueous methylmercury levels in newly flooded reservoirs may remain elevated for about 10 years after reservoir filling (State Water Resources Control Board 2017b).

6.3.2. Operation

The water quality analysis evaluating operational effects is both qualitative and quantitative. For the quantitative analysis, the evaluation is either directly or indirectly dependent on the CALSIM II hydrologic modeling results. The CALSIM II model and a summary of model results related to operation of Sites Reservoir and the CVP and SWP system is described in Chapter 5 and more information is provided in Appendices 5A, *Surface Water Resources Modeling of Alternatives*, and 5B, *Water Resources Modeling System*. Chapter 5 includes information about diversions to, storage in, and releases from Sites Reservoir; information about storage in relevant CVP and SWP reservoirs; flow downstream of the CVP and SWP reservoirs; flow in the Yolo Bypass; and flow through the Delta.

As previously indicated, the study area includes those areas with the potential to be significantly affected by the Project and associated changes in operations. CALSIM results indicate that the Project would result in only small hydrologic changes for some waterbodies in the study area. Changes in reservoir storage in Shasta Lake and the upper Sacramento River upstream of Red Bluff, Lake Oroville and the Feather River, Folsom Lake and the American River, and San Luis Reservoir resulting from Project operation are unlikely to affect most water quality constituents because the modeled changes are small and within the normal operating parameters of these locations. Nonetheless, constituents more likely to be affected by changes caused by the Project at these locations are considered below, including nutrients/organic carbon/DO, mercury, and HAB/invasive aquatic vegetation effects related to changes in storage. Water temperature effects associated with changes in storage and flow at these locations were modeled.

6.3.2.1. Selection of Water Quality Constituents to Evaluate

Water quality constituents were chosen for evaluation based on whether elevated levels of the constituents are present in the study area and whether there is a mechanism by which Project operation could affect those levels. Existing water quality impairments in the study area, as indicated by presence on the 303(d) list or existence of TMDLs in the study area, are presented in Appendix 6A. Additional water quality issues known to be a concern, but not included in the 303(d) listings for study area waterbodies were also considered in the analysis (e.g., water temperature and HABs). Constituents evaluated in detail in the impact section consist of HABs/invasive aquatic vegetation, mercury and methylmercury, nutrients/organic carbon/DO, metals, water temperature, salinity, and pesticides.

The Delta is impaired by elevated selenium, but selenium is not included in the evaluation because the Project would not affect the major sources of Delta selenium: natural sources, San Joaquin River flow, and industries in the San Francisco Bay Area. Selenium concentrations in the Sacramento River are low, with most measurements below detection limits and measured values for total selenium all being less than 1 µg/L (WDL values for Sacramento River below Red Bluff, Sacramento River at Hamilton City, and Sacramento River above CBD measured from 2000 through 2020). Selenium concentrations in Stone Corral Creek are somewhat higher (average measured total selenium of 6.74 µg/L; Appendix 6E), but the Project would not affect the selenium load from Stone Corral Creek, and Stone Corral Creek is expected to contribute only a small percent of the water in Sites Reservoir. The volume of inflow from Stone Corral and Funks Creeks is small, estimated to be a combined average of 14 TAF per year (TAF/yr).

Wastewater treatment plant and industrial discharges were not considered in the analysis because the contaminant load from these discharges would not be affected by the Project, nor would dilution of the discharges be compromised. Reduction in Sacramento River flow due to the Project would occur when flow is high and increases in Sacramento River flow would occur when flow is low, potentially improving dilution.

Contaminants associated with sediments were also dismissed from detailed evaluation. Contaminants closely associated with sediment are not expected to be any more concentrated in Sites Reservoir than in the Sacramento River or CBD and would mostly remain adsorbed to sediment. Contaminants associated with sediments include polychlorinated biphenyls and legacy pesticides such as DDT, chlordane, and dieldrin, which are either no longer in use or are used in a restricted manner (Connor et al. 2007:89; San Francisco Bay Regional Water Quality Control Board 2008:13, 15).

Wind, rain, and wave action commonly erode bare soil adjacent to reservoirs and could cause erosion along the edge of Sites Reservoir when it is not full. These phenomena may temporarily increase turbidity along the reservoir's edge prior to settling of the sediment, but this increase would not markedly affect beneficial uses of the reservoir (i.e., recreation, water supply, fisheries and wildlife). The movement of water and sediment from watersheds into waterbodies is a common occurrence during storms, and aquatic communities in reservoirs generally tolerate the associated temporary increases in turbidity.

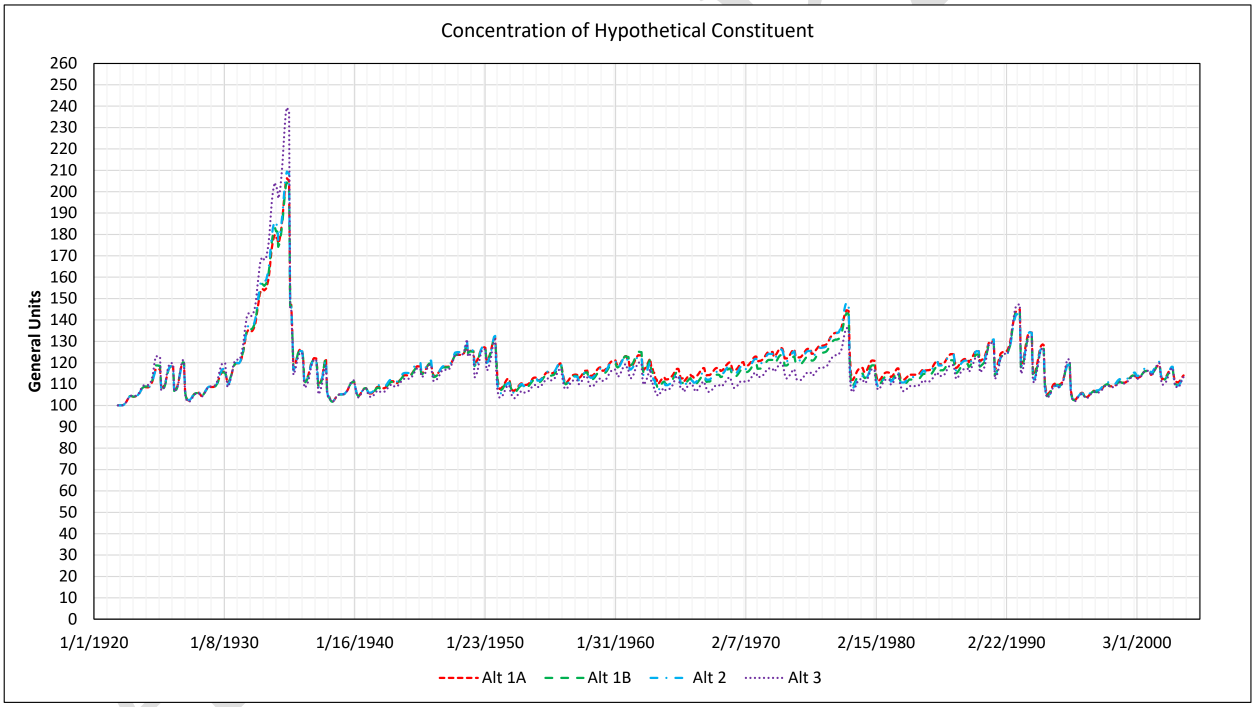
6.3.2.2. Temporal Shift

Seasonal differences in constituent concentrations in the Sacramento River potentially could cause constituent concentrations in the water used to fill Sites Reservoir to be higher than the concentrations in the Sacramento River at the time of release from Sites Reservoir. Measured concentrations of EC, pesticides, nutrients, and metals in the Sacramento River between Red Bluff and Knights Landing above the CBD discharge were evaluated to determine if there was a tendency for concentrations to be higher at the time of diversion to storage (primarily January–March) than at the time of release from storage to the Sacramento River (primarily May–September). Seasonal differences were most apparent in the metals data (Appendix 6E).

6.3.2.3. Evapoconcentration

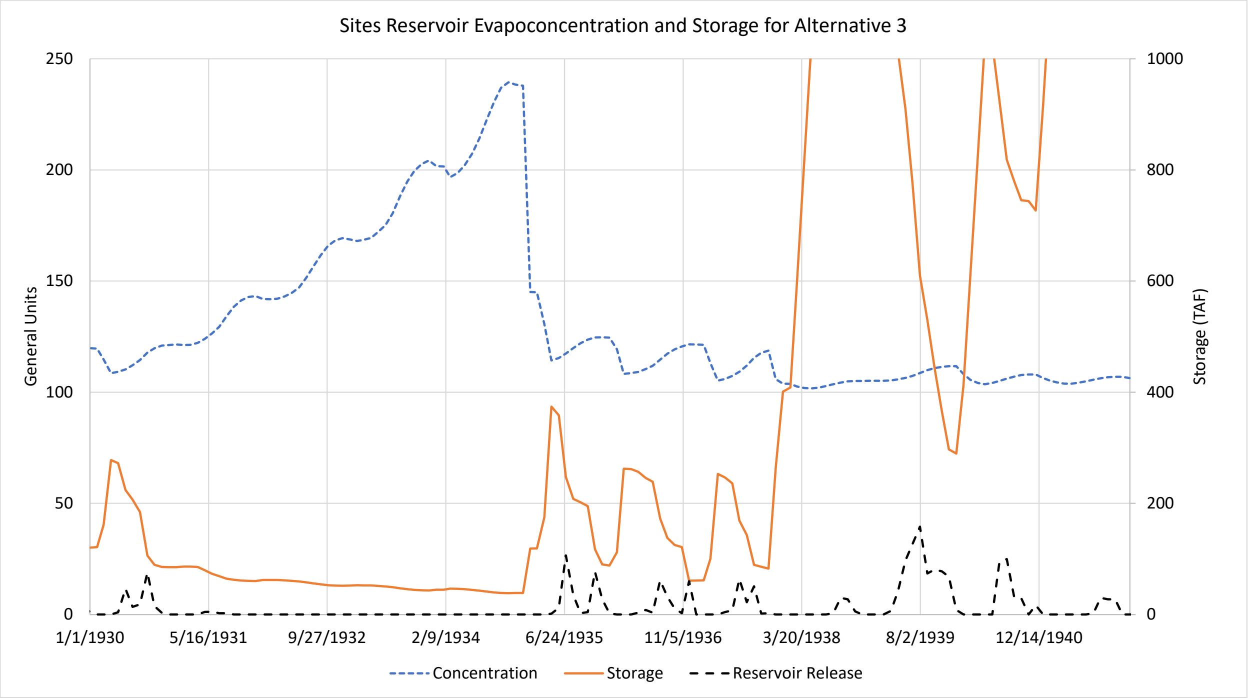
Evapoconcentration occurs when water evaporates from a reservoir and leaves behind the same amount of solute in a smaller volume of water. Evaluation of evapoconcentration is applicable to all water quality constituents evaluated for Sites Reservoir operations except water temperature. The results are more directly pertinent to conservative constituents (constituents that do not degrade or react), such as metals and EC, than constituents that may be affected by in-reservoir processes, such as methylmercury, nutrients, and HABs. To evaluate the potential for water quality constituents to become more concentrated due to evaporation, monthly water balance information from the CALSIM II modeling was used to estimate the concentration of a hypothetical constituent through time. Initial concentration of the constituent in Sites Reservoir was assumed to be a value of 100, regardless of the actual unit of measurement (e.g., whether 100 ng/L, 100 µg/L, or some other measure). In addition, inflow concentration was assumed to be 100 and concentration of precipitation that exceeded evaporation in the winter was assumed to be 100. This constituent was assumed to mix thoroughly through the reservoir. Concentrations increase when net evaporation (evaporation minus precipitation) reduces reservoir volume while leaving behind constituent molecules. The results of these calculations (Figure 6-2a) show that when the reservoir went through multiple years of depletion without refilling, constituent concentrations increased by up to 139% depending on the alternative evaluated. Close analysis of the period of peak evapoconcentration (Figure 6-2b) shows that the peak calculated evapoconcentration for Alternative 3 occurred when the reservoir continued to dry after operational dead pool was reached. After approximately 4 years with essentially no refilling (1931–1934), Alternative 3 storage dropped to 38 TAF and evapoconcentration peaked at 139%. Water supply releases, however, were not made until the reservoir partially refilled in 1935 resulting in evapoconcentration of less than 25%.

Overall, average concentration ranged from 16%–18% higher than the inflow concentration depending on the alternative. There was little difference in the evapoconcentration results between Alternatives 1, 2, and 3; however, the slight increase in magnitude of emptying and refilling for the reservoir under Alternative 3 resulted in a greater maximum spike in evapoconcentration, but slightly reduced average concentrations overall (1%–2% lower on average).



Note: dates correspond to hydrologic period simulated by CALSIM

Figure 6-2a. Estimated Effect of Evaporation from Sites Reservoir on a Hypothetical Constituent through Time as Derived from CALSIM Results



Note: Dates correspond to hydrologic period simulated by CALSIM.

Figure 6-2b. Sites Reservoir Storage and Releases for Water Supply during Period of Peak Evapoconcentration for Alternative 3 as derived from CALSIM Results

6.3.2.4. Dilution of Sites Discharges in the Sacramento River

Water quality in Sites Reservoir would have limited effect on the water quality in the Sacramento River because the river flow would dilute the Sites Reservoir discharge, with dilution effect dependent of the ratio of Sites water to Sacramento River water. The full set of monthly CALSIM results for Sites Reservoir discharges to the Sacramento River via the Dunnigan Pipeline (Alternative 2) or via CBD (Alternatives 1 and 3) were compared to CALSIM results for flow in the Sacramento River at Wilkins Slough (upstream of the discharge locations). This comparison allows the evaluation of dilution of Sites Reservoir discharges in the Sacramento River. When Sites Reservoir would release water to the Sacramento River, it would constitute 6%–7% of the Sacramento River flow on average and 14%–15% when discharges are relatively high compared to river flow (i.e., 90th percentile values), depending on whether Alternative 1, 2, or 3 was implemented. Alternative 3 would discharge slightly less water to the Sacramento River when flow in the Sacramento River is low and constitutes the smaller percentages (6% and 14%); Alternative 1A constitutes the larger percentages (7% and 15%). The differences in these numbers do not reflect average differences in Sites Reservoir releases between Alternatives 1, 2, and 3. They indicate differences in the dilution effect in the Sacramento River when flow in the river is relatively low. Sites Reservoir water would be even further diluted downstream where the Feather River joins the Sacramento River.

6.3.2.5. Water Temperature

The HEC5Q water temperature model was used to simulate daily reservoir and riverine temperature effects in Shasta Lake, the Sacramento River, Folsom Lake, and the American River based on the results of the CALSIM II model. The Reclamation Temperature Model was used to simulate monthly temperatures in Lake Oroville and the Feather River. These models (HEC5Q and Reclamation Temperature Model) have been jointly developed by Reclamation and DWR over many years. These models are useful for planning purposes to compare different alternatives. The flow and reservoir storage inputs to these models are monthly values from CALSIM and the Reclamation Temperature Model is a monthly model. The HEC5Q model has a smaller time step. Meteorological inputs for the HEC5Q model are on a 6-hour time step. The 6-hour time step for meteorological conditions helps the model capture the daily and sub-daily variations in water temperature. These models and model results are described in detail in Appendix 6C, *River Temperature Modeling Results*.

Water temperature in Sites Reservoir was modeled using CE-QUAL-W2. Model flow and storage inputs came from the Upper Sacramento River Daily Operations Model (USRDOM). Some flexibility in reservoir release temperatures is provided by selective use of the multiple tiers in the I/O tower (centerlines at 340, 370, 390, 410, 430, and 450 feet elevation, with an additional outlet at 470 feet for Alternatives 1 and 3) and at the low-level intake with centerline at 311 feet. The selection of release ports for water temperature modeling followed the protocols described in the RMP (Appendix 2D, Section 2D.3, *Reservoir Management Plan*), with tier selection based on meeting a reservoir release temperature objective of 65°F during the rice growing season. A description of the Sites Reservoir temperature modeling and its results are provided in Appendix 6D, *Sites Reservoir Discharge Temperature Modeling*.

Temperature effects downstream of Sites Reservoir in the TC Canal, CBD, TRR East or TRR West, and the Sacramento River were estimated with a monthly spreadsheet model. The model blended upstream flows and temperatures with those from Sites Reservoir and estimated warming along the lengths of the canals. The estimations used assumptions for warming as a function of canal length that were based on HEC5Q results for the Sacramento River. First, temperatures in Funks Reservoir and TRR were estimated based on warming along the TC Canal and GCID Main Canal between the intake locations and these small reservoirs. Then, the Funks Reservoir and TRR East or West temperatures were blended with the temperatures from Sites Reservoir releases. The resulting Funks Reservoir temperatures were then warmed along the length of the lower section of the TC Canal. Temperatures estimated for the downstream end of the TC Canal near the Dunnigan Pipeline were used to estimate temperature effects in the Sacramento River. For Alternative 2, the TC Canal temperatures were directly blended with Sacramento River temperatures. For Alternatives 1 and 3, the TC Canal temperatures were blended with CBD temperatures and then blended with Sacramento River temperatures.

The spreadsheet model uses flow and temperature output from CALSIM, HEC5Q, and the Sites Reservoir CE-QUAL-W2 models. It also uses a repeating time-series of long-term monthly average temperatures measured at two locations: the CBD and the Sacramento River above the CBD. The temperatures used to represent CBD temperatures were measured slightly downstream of the CBD in Knights Landing Ridge Cut at Highway 113. Values for January through May were estimated due to lack of data. The flows and temperatures in the canals were blended with flows and temperatures in the Sacramento River upstream of the discharge location (Alternative 2). The Sacramento River flow at this location was based on the CALSIM flows at Wilkins Slough for Alternatives 1, 2, and 3 and the temperatures were based on measured data that were the same for all alternatives. The use of a single set of temperatures for the Sacramento River allows an evaluation of the effects due to Sites Reservoir releases not confounded by changes in temperature due to changes in Shasta Lake operations. More details regarding the monthly blending model are provided in Appendix 6D.

Fisheries resources are the primary designated beneficial use potentially affected by water temperature. As such, most of the potential effects associated with changes in water temperature are discussed in Chapter 11, *Aquatic Biological Resources*. Water temperature is also discussed in Chapter 15, *Agriculture and Forestry Resources*, because it is important for growing rice. The analysis in this chapter focuses on the Central Valley Basin Plan objective for waterbodies designated with the WARM or COLD beneficial use that at no time or place shall the temperature of intrastate waters be increased more than 5°F above natural receiving water temperature. For the Project, receiving waters are identified as locations where potentially warmer water may be discharged into a natural waterbody that typically provides cold-water habitat (i.e., not the CBD and Yolo Bypass during periods of Sites Reservoir discharge). This analysis focuses on temperature effects at the Sites Reservoir discharge locations: (1) the Sacramento River at the terminus of the Dunnigan Pipeline (Alternative 2); (2) the Sacramento River at the CBD discharge (Alternatives 1 and 3); and (3) the Yolo Bypass discharge to the north Delta (Alternatives 1, 2, and 3). Effects of discharge on temperatures in the Sacramento River at the Dunnigan Pipeline and the CBD were based on water temperature modeling as described above. Effects of discharge from Yolo Bypass were evaluated qualitatively and were informed by a combination of measured temperatures and CALSIM flows.

6.3.2.6. Salinity

The salinity evaluation considers whether there would be any significant adverse effects on Delta salinity due to seawater intrusion and movement of saline water towards the export pumps. It also considers whether there would be substantial degradation of water quality in the Sacramento River due to increases in salinity. Compliance with Delta salinity objectives and changes in Delta salinity were evaluated with Delta Simulation Model II (DSM2) using CALSIM results for Delta inflows and exports. Effects of Sites Reservoir operations on Sacramento River salinity were evaluated by quantitative and qualitative consideration of salt inputs to Sites Reservoir, evapoconcentration in Sites Reservoir, Sacramento River salinity, and salinity objectives.

Salt Pond Salinity

Salinity in Sites Reservoir may be affected by the salt springs that feed Salt Pond. The weight of reservoir water above the salt springs near Funks Creek would likely reduce the flow of saline mineral water from these springs, thereby reducing the overall discharge of Salt Pond into the reservoir. However, because of uncertainty in the geologic forces pushing the spring water to the ground surface, it is possible this spring water may continue to seep from the ground when Sites Reservoir is filled. Therefore, the water quality impact analysis for Sites Reservoir includes the following conservative evaluation and assumes that saltwater would continue to enter the reservoir in a similar manner as historical seepage.

The potential rate of spring seepage into the pond is based on estimated pond size and evaporation rate. The surface area of Salt Pond may vary between zero and 30 acres, but based on observations of Salt Pond in 2017, the deeper and likely typical size is estimated to be 15 acres. Net evaporation from Salt Pond was assumed to be equal to the reference evapotranspiration (ETo) for the region, which is 57 inches per year (California Irrigation Management Information System 1999). Although evaporation from a small body of open water may be somewhat higher than ETo, ETo is a conservative overestimate because it does not account for the higher salinity in Salt Pond or for contributions from precipitation. An annual evaporation of 57 inches from a 15-acre waterbody results in total evaporation of approximately 71 AF/year. The long-term average seepage rate from the springs would need to be approximately 0.1 cfs to supply the Salt Pond with enough water for 71 AF/year of evaporation. Because Salt Pond is sometimes dry, it is assumed that seepage from the springs is very low in Dry and Critically Dry Water Years.

Delta Water Quality

EC in the Delta was simulated using DSM2. DSM2 is a one-dimensional model that simulates hydrodynamics (with the HYDRO module), water quality (with the QUAL module), and particle tracking (with the PTM module) in the Delta or other networks of estuary or river channels (California Department of Water Resources 2021). DSM2 represents the best available planning model for simulating multiple years of Delta tidal hydraulics and salinity. It is appropriate for describing the existing Delta, as well as performing simulations for the assessment of incremental environmental impacts caused by changes in facilities and operations. The results from the DSM2 modeling provide a way to ascertain the salinity effects from the changes in the operations from each alternative.

DSM2 was used to simulate Delta hydrodynamics and water quality at a 15-minute time step over an 82-year period (Water Years 1922–2003), using the hydrological inputs and exports determined by the CALSIM II model under the operations for Alternatives 1, 2, and 3. A summary of this model and the model results are provided in Appendix 6B, *Sacramento–San Joaquin Delta Modeling*. For long-term planning simulations, the inputs needed for DSM2 (inflows, exports, and Delta Cross Channel gate operations) were derived from 82-year CALSIM II model simulations. The monthly CALSIM results for the Sacramento River and San Joaquin River inflows to the Delta were converted into daily values to smooth the transition between months prior to use as input to DSM2.

The CALSIM simulations used to generate input for the DSM2 model include algorithms to meet key salinity objectives, especially those associated with seawater intrusion. To verify that Delta EC objectives are expected to continue to be met for Alternatives 1, 2, and 3, the CALSIM flows were used as inputs to DSM2, which is a more accurate model for Delta water quality. DSM2 results were used to evaluate attainment of 17 Delta EC objectives. In addition, EC values at five drinking water intake locations were used to estimate the associated chloride concentrations, which were compared to chloride objectives.

There are inherent limitations in simulating hydrodynamic and transport processes in a complex estuarine environment, such as the Delta. DSM2 assumes that flow in a channel can be represented by a single average velocity over the channel cross-section, meaning that variations both across the width of the channel and through the water column are negligible. The flow boundary conditions that drive DSM2 are generally monthly values that are typically from CALSIM. Even though CALSIM simulations may model sufficient flow to meet the standards on a monthly average basis, the resulting daily time step EC results from DSM2 may appear to exceed the standard (be above) for part of a month and under the standard (be below) for part of the month, depending on the spring/neap tide and other factors (e.g., simplification of operations). Therefore, DSM2 simulation results are presented and analyzed on a monthly basis. The DSM2 model is well-calibrated for the Delta and provides a reasonable estimate of the changes and trend in salinity conditions between the No Project Alternative and Alternatives 1, 2, and 3.

6.3.2.7. Nutrients, Organic Carbon, and Dissolved Oxygen

Potential nutrient, organic carbon, and DO effects were evaluated qualitatively. The evaluation considers existing concentrations of nutrients and organic carbon in surface waters downstream of Sites Reservoir (i.e., CBD, Sacramento River, Yolo Bypass, and the Delta) and the likelihood that Sites Reservoir releases would increase these concentrations to such a degree as to substantially degrade water quality in both the near term after reservoir filling and the long term. Chapter 11 evaluates potential effects of these constituents (i.e., DO) on fish species. For example, potential fish effects associated with possible temporary reductions in DO in the Yolo Bypass as a result of habitat flow releases are discussed in Chapter 11 under Impact FISH-8, *Operations Effects on Delta Smelt.* Nutrient, organic carbon and DO levels in Sites Reservoir were considered qualitatively in the context of how initial inundation of the reservoir footprint may result in changes in the levels of these constituents in Sacramento River diversions to the reservoir in the short term and how operational changes in reservoir storage, thermal stratification, and HABs may affect levels of these constituents in the long term.

Potential changes in the nutrient, organic carbon and DO levels relative to the No Project Alternative in Shasta Lake, Lake Oroville, Folsom Lake, and San Luis Reservoir were also qualitatively assessed based on modeled changes in their storage due to operation of the Project.

6.3.2.8. Harmful Algal Blooms

The assessment of HABs entails consideration of operations and associated potential effects on environmental variables generally considered to be the primary drivers of HABs formation and maintenance including nutrient levels, water temperature, and water column stability or residence time. Results from the Sites Reservoir water temperature model were also considered.

Changes in CALSIM-modeled reservoir storage for all water year types relative to the No Project Alternative for Shasta Lake, Lake Oroville, Folsom Lake, and San Luis Reservoir were assessed to determine the magnitude of the changes. Because there was no substantial change in end-of-month storage at these reservoirs it is reasonable to conclude that conditions conducive to HABs formation and maintenance are not expected to be affected by the Project. Accordingly, these reservoirs are not discussed in the HABs impact analysis.

For the purposes of generally assessing the potential for high concentrations of cyanobacteria and cyanotoxins to be released from Sites Reservoir if HABs were to occur in the vicinity of the I/O tower, comparisons were made between the elevation of the lowest I/O tower tier (centerline at 340 feet) and the low-level intake (centerline at 311 feet) and the modeled (CALSIM II) average end-of-month reservoir water surface elevations (WSEs) for Alternatives 1, 2, and 3 in

Dry and Critically Dry Water Years (Tables 6-8a and 6-8b), when the reservoir would be at its lowest levels.

Table 6-8a. Sites Reservoir Average End-of-Month Water Surface Elevation (ft) as Simulated by CALSIM for Dry Water Years

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Alternative 1A	409	406	413	439	444	450	449	448	442	433	423	416
Alternative 1B	398	395	403	432	438	444	442	438	432	423	412	405
Alternative 2	393	390	397	424	429	436	435	433	428	418	407	400
Alternative 3	377	375	383	416	423	430	428	423	413	401	391	383

Notes: ft = feet above mean sea level

Table 6-8b. Sites Reservoir Average End-of-Month Water Surface Elevation (ft) as Simulated by CALSIM for Critically Dry Water Years

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Alternative 1A	356	354	354	394	397	399	395	391	383	374	365	359
Alternative 1B	349	348	349	388	391	394	391	386	377	368	359	352
Alternative 2	346	345	345	385	388	391	387	383	375	365	356	349
Alternative 3	338	337	337	375	379	382	378	371	363	352	344	341

Notes: ft = feet above mean sea level

6.3.2.9. Mercury and Methylmercury

The information provided below is a summary of information contained in Appendix 6F. Appendix 6F details the methods of analysis for mercury and methylmercury, including the conceptual model as it applies to each of the four geographies evaluated and the RWCB model used.

The mercury and methylmercury assessment estimates the potential for increases in mercury and methylmercury concentrations in water and methylmercury concentrations in fish tissue in four geographies per the analysis in Appendix 6F: Sites Reservoir, CBD, Yolo Bypass and Delta. Mercury and methylmercury concentrations in water and methylmercury concentrations in fish tissue under Alternatives 1, 2, and 3 are compared to concentrations for each geography under the No Project Alternative, as well as to applicable water quality criteria and objectives for mercury and methylmercury (Table 6-4).

Current fish tissue methylmercury concentrations in the CBD (see Appendix 6F, Table 6F-9) and estimated potential fish tissue methylmercury concentrations in Sites Reservoir were compared to the State Water Board's sport fish objective of 0.2 mg/kg ww or the 0.05 mg/kg prey fish objective (Table 6-4) if tissue mercury concentration data were not available from TL4 fish to evaluate the sport fish objective. These objectives are applicable to waterbodies outside of the Delta and Yolo Bypass where the Delta methylmercury TMDL site-specific objectives apply.

Tissue concentrations in fish in the Delta and Yolo Bypass were compared to the Central Valley RWQCB methylmercury TMDL tissue concentration goal of 0.24 mg/kg ww for TL4 fish (Table 6-4). The fish tissue objective is based on fillets normalized to 350-mm (total length) largemouth bass and is protective of health effects in wildlife and human health when the TL4 objective is met. Mercury tissue concentrations normalized to 350-mm largemouth bass corresponds with the 0.08 mg/kg objective in TL3 fish. Therefore, meeting the TL4 objective is protective of all listed beneficial uses in the Delta (Central Valley Regional Water Quality Control Board 2010a). The objective for small TL2 and TL3 fish is protective of wildlife species that consume small fish less than 50 mm in length and can be evaluated if no TL3 or TL4 species data are available. It is appropriate to standardize concentrations by fish length at each of the four geographies to facilitate comparisons and because of the well-established positive relationship between fish length and age and tissue mercury concentrations (Alpers et al. 2008).

Qualitative Assessment for Mercury and Methylmercury

The qualitative assessment considers the primary factors that could increase or decrease mercury and methylmercury concentrations at each of the four geographies that could be affected by Project implementation. The assessment relies on a conceptual model describing mercury fate and transport to describe how predicted or modeled flows within the receiving waters, and Sites Reservoir, could affect mercury concentrations in water and fish tissue. See Appendix 6F, Section 6F.1.2.2, *Conceptual Models for Methylmercury Production and Fish Tissue Bioaccumulation*, for descriptions of the conceptual models for the four geographies.

CALSIM II modeling results were reviewed to determine the magnitude and timing of reservoir end-of-month storage and releases and flow conditions throughout the year. The conceptual model describes the mechanisms by which these factors can affect mercury and methylmercury and the qualitative assessment determines whether they are expected to cause a relative increase in mercury or methylmercury in surface waters or fish tissue at each of the geographies. The qualitative assessments for each geography are detailed below.

In addition, although not included in the Appendix 6F analysis, a qualitative assessment of the potential for mercury and methylmercury to increase in Funks and Stone Corral Creeks is also presented in this chapter.

Sites Reservoir

The assessment of Sites Reservoir focused on aqueous total mercury concentration and annual reservoir water level fluctuation as the primary factors driving fish methylmercury concentrations in reservoirs identified by the State Water Board in the *Draft Staff Report for the Mercury TMDL and Implementation Program for Reservoirs* (State Water Resources Control Board 2017b). The anticipated levels of mercury and methylmercury in Sites Reservoir were estimated based on those for similar reservoirs in California and using known or suspected sources of mercury to the Sites Reservoir.

Because Sites Reservoir would be an offstream storage reservoir, most of the water stored would not be from the local watershed, but rather from the Sacramento River watershed. Accordingly, the extent of influence of local watershed/soils via runoff and infiltration processes on the Sites Reservoir may be limited given the much higher volume of water that would be imported to the reservoir from the Sacramento River. As described in Chapter 12, *Geology and Soils*, geologic units in the study area and watershed are not known to contain mercury and there are no legacy mercury mines in the vicinity that would contribute to mercury-laden runoff into Sites Reservoir. Local inputs from Stone Corral Creek and Funks Creek are intermittent and thus any contribution of mercury from these waterbodies to the reservoir would be minimal. Therefore, the analysis assumes that primary mercury inputs to Sites Reservoir would be from atmospheric deposition onto the reservoir surface and from Sacramento River water. The relative influence of atmospheric mercury is incorporated into this assessment by making comparisons with nearby reservoirs and lakes of similar size, which are not affected by legacy mercury mines, and where the primary anthropogenic source of mercury is from atmospheric deposition. These other waterbodies are expected to have similar geologic and atmospheric mercury sources to the Project.

The qualitative assessment cataloged mercury data and other information from reservoirs in California to compare with the Sites Reservoir in terms of location, size (e.g., surface area and volume), expected reservoir surface elevation fluctuations, mercury sources, and fish species present. Though there is no perfect analog that can be used to model expected Project conditions, some inferences can be reasonably drawn based on nearby reservoirs with similar physical characteristics. Expected mercury concentrations were determined for the Project based on this analysis but cannot be compared to current conditions within the reservoir footprint because the Sites Reservoir does not currently exist.

Funks Creek, Stone Corral Creek, and Colusa Basin Drain

The primary ways in which mercury concentrations could become elevated in Funks and Stone Corral Creeks and the CBD due to the Project are: (1) increased flows at certain times, and (2) potentially increased mercury or methylmercury concentrations from the Sites Reservoir deliveries. These factors are qualitatively assessed, along with potential mercury and methylmercury inputs from Sites Reservoir deliveries, to determine the potential for changes to mercury and methylmercury concentrations from the Project relative to the No Project Alternative.

Yolo Bypass

The primary ways in which mercury and methylmercury concentrations could become elevated in the Yolo Bypass due to the Project are: (1) changes in the timing and magnitude of flows through the Yolo Bypass, and (2) concentrations of mercury and methylmercury in the Sacramento River when it enters Yolo Bypass that would be available for methylation and/or bioaccumulation.

Delta

Primary factors affecting mercury and methylmercury concentrations in the Delta that could change due to the Project are: (1) changes in the timing and magnitude of flows in the Sacramento River and through the Yolo Bypass, and (2) concentrations of mercury and methylmercury in Sacramento River and Yolo Bypass flows as they enter the Delta. Modeled flows were considered with historical and/or projected mercury and methylmercury concentrations in the Sacramento River and Yolo Bypass to determine how loading of mercury and methylmercury to the Delta would be expected to change.

To assess potential changes in mercury and methylmercury concentrations due to the Project, results of assessments in the other upstream geographies were reviewed for their potential to elevate mercury and methylmercury concentrations entering the Delta. For example, if increased methylmercury production was expected in an upstream domain, the potential for increased concentrations to persist downstream to the Delta (considering dilution, degradation, etc.) was assessed. Additional quantitative analyses that modeled surface water and fish tissue methylmercury concentrations which could occur in the Delta from Project operation are described in the following section.

Quantitative Assessment for Methylmercury in the Delta

Changes in water column methylmercury concentrations that could contribute to fish tissue concentrations above tissue-based criteria were assessed quantitatively for the Delta using the Central Valley RWQCB TMDL model (RWQCB model) (Central Valley Regional Water Quality Control Board 2010a:73). This is an empirical non-linear tissue concentration model that predicts mercury (assumed to be primarily methylmercury) concentration in 350-mm normalized largemouth bass fillet tissue from unfiltered methylmercury concentrations in water. The Central Valley RWQCB model is not applicable to Sites Reservoir or the CBD because mercury uptake is governed by site-specific conditions and this model has not been validated for spatial domains outside the Delta.

Sources of uncertainty in the quantitative analysis approach include: (1) analytical variability in the original measurements; (2) temporal and/or seasonal variability in Delta source water concentrations of methylmercury; (3) interconversion of mercury species (i.e., the non-conservative nature of methylmercury as a modeled constituent); and (4) limited sampling in terms of the number of fish and the time span over which the measurements were made. The Central Valley RWQCB model did not attempt to estimate the errors and propagate them from correlation to correlation in the application of the model for deriving the aqueous methylmercury goal (Central Valley Regional Water Quality Control Board 2010a).

Considering this uncertainty, relatively small increases or decreases in modeled or expected fish tissue methylmercury concentrations should be interpreted to be within the uncertainty of the overall approach, and not predictive of actual effects. Appendix 6F and Appendix 5B provide details regarding appropriate use of modeling results. Larger magnitude increases can be interpreted as more reliable indicators of potential adverse effects of operations under Alternatives 1, 2, and 3.

A sensitivity analysis was also performed to identify the concentrations of aqueous methylmercury that would need to be discharged from the Project to cause a given change (e.g., a 5% increase in methylmercury concentrations in the water column in the Sacramento River at Freeport). Calculations were based on the proportional flows from the Project in the Sacramento River at Freeport and are applicable to the Delta and Yolo Bypass, as determined by CALSIM II. Source water concentrations (i.e., inputs from all sources affecting concentrations at Freeport except for Sites Reservoir) were held constant. The geometric mean of measured historical aqueous methylmercury concentrations in the Sacramento River at Freeport (Table 6-6) was used to represent concentrations entering the Delta and Yolo Bypass for the No Project Alternative.

This analysis approach represents a simplified model that assumes that fate and transport of methylmercury from Sites Reservoir is conservative (i.e., that there is no loss or generation of methylmercury between the reservoir and the Sacramento River at Freeport). This does not fully reflect real-world conditions given that prior to reaching Freeport the methylmercury can adsorb to suspended particulates and settle to bed sediment; it can be incorporated into the food web; and it may be degraded by light or microbes. Further, mercury present in Sites Reservoir releases may undergo methylation in transit. It is unknown whether these processes would result in more or less aqueous methylmercury at Freeport, but the assumptions allow a reasonable estimate. Therefore, the modeling is not meant to be taken as predictive but to provide insight as to the relative magnitude and direction of changes that may be expected in the Delta under worst-case conditions. Freeport was used as an assessment location because the Central Valley RWQCB model is applicable in the Delta. In addition, Freeport is located at the northern end of the Delta and would therefore exhibit the net Sacramento River change in methylmercury concentrations due to Project operation. Therefore, Freeport represents a conservative (i.e., worst-case) assessment location for the rest of the Delta. At locations further downstream in the Delta, source waters other than the Sacramento River mix and serve to lessen any incremental effect that increased concentrations of methylmercury due to the Project may have.

6.3.2.10. Pesticides and Metals Other Than Mercury

Pesticides and metals other than mercury were evaluated with measured pesticide and metal concentrations for the Sacramento River. The metals analysis relies on best available data provided by DWR’s WDL. The pesticide analysis relies on best available data provided by the California Department of Pesticide Regulation’s SURF database. These data were collected intermittently over multiple years, with measurements representing a wide range of flow conditions. These data provide a general understanding of how metal and pesticide concentrations may vary with flow and location, allow the identification of trends, and support the impact analysis and conclusion. Metal measurements, collected through monitoring, are described in Section 2D.3. This monitoring, required as part of the Project, would refine the understanding of metals as more data would likely improve the accuracy of equations used in this analysis for estimating metal concentrations.

These data were used to consider:

- Whether concentrations would be higher during the Sites Reservoir diversion season than during the discharge season (i.e., a temporal shift), and
- Whether measurements would be close to or above water quality standards.

These conditions indicate potential for Project-related effects. Based on this evaluation, further quantitative assessment was performed for total concentrations of four metals: aluminum, copper, iron, and lead. These four metals are of greatest concern based on what the measured data show for seasonal changes in concentration and concentrations above standards (Table 6-9).

Table 6-9. Metals Water Quality Standards

Metal	California MCL (µg/L)	California Secondary MCL (µg/L)[1]	Freshwater Chronic Standard for Aquatic Life Protection (µg/L)[2]	Agriculture (µg/L)
Aluminum	1,000	200	620 T[3]	5000
Arsenic	10		150 D	100
Cadmium	5		0.45 T[4], 0.43 D[4]	10
Chromium (III)	50		49 T[4], 42 D[4]	100
Copper	1,300	1,000	5.2 T[4], 5.0 D[4]	200
Iron		300	1,000 T[5]	5,000
Lead	15		1.3 T[4], 1.2 D[4]	5,000
Manganese		50		200
Nickel	100		29 T and D[4]	200
Selenium	50		1.5 D for standing water, 3.1 D for flowing – 30-day average, not more than 1X per 3 years	20
Silver		100	0.12 T[6]	
Zinc		5,000	67 T[4], 66 D[4]	2,000

Sources for table data: California Division of Drinking Water 2018, 2020; State Water Resources Control Board 2021b; U.S. Environmental Protection Agency 1980:B-13; 1986:40, 2016:xv; 2018:K-7; and 2020b; Ayers and Westcot 1985:96.

MCL = maximum contaminant level

[1] Secondary MCLs are for taste or aesthetics. Because drinking water generally does not contain high concentrations of suspended sediment, these standards are most applicable to measurements of dissolved concentrations. Because dissolved concentrations are lower, the lack of health-related effects, and the long distance and inflows between Sites Reservoir and drinking water intakes, the standard for aquatic life protection was used in the metals evaluation instead of the lower secondary MCLs for iron and aluminum.

[2] T=total concentration, D=dissolved concentration. U.S. Environmental Protection Agency guidance (2020b) indicates that all standards except aluminum and iron are for concentrations of dissolved metals. However, in many cases, standards are also provided for total concentrations based on conversion factors. The values for total concentrations are shown in this table because they are more conservative. In the Sacramento River, the standards for total concentrations are harder to meet than the standards for dissolved concentrations because the standards are based on conversion factors that do not accurately represent differences between dissolved and total concentrations in the river.

[3] Assumes hardness = 50 mg/L, pH = 7.5, and dissolved organic carbon = 1 mg/L. The pH and dissolved organic carbon values are conservative values (resulting in lower standard) and are based on the low end of values measured in the Sacramento River (Domagalski and Dileanis 2000: 34, 39, 50).

[4] Assumes hardness = 50 mg/L

[5] Total (T) because for iron U.S. Environmental Protection Agency (2020b) refers to the Gold Book (U.S. Environmental Protection Agency 1986:40), which suggests use of total concentration for evaluation of water quality.

[6] Total (T) because there is no recent guidance on chronic standards for silver for aquatic life. Recent guidance on instantaneous maximum criteria is given as both dissolved (1.0 µg/L) and total (1.23 µg/L) (State Water Resources Control Board 2022a).

Because the Project would not change the amount of metals entering CBD from existing land use, the effect of the metals load in discharges from Sites Reservoir on the Sacramento River water quality was evaluated independently of existing CBD effects.

The metals analysis provides a general description of potential operational effects. The analysis has some uncertainty associated with variability in metal concentrations, the conservative interpretation of water quality standards for aquatic life, and the effects of settling of suspended sediment. The first part of the analysis assumed no reduction in concentration due to settling of suspended sediment in the canals, regulating reservoirs (Funks and TRR East or West), or in Sites Reservoir. An additional assessment was performed to demonstrate the effect of partial settling of suspended sediment.

Evaluation of Concentration Assuming No Settling of Suspended Sediment

For this assessment, the following steps were taken to evaluate total metal concentrations assuming no settling of suspended sediment in the canals, the re-regulating reservoirs (Funks Reservoir and TRR East or West), and Sites Reservoir:

- Total concentrations measured in the Sacramento River at Red Bluff and Hamilton City were used to develop equations for estimating total metal concentration entering Sites Reservoir assuming no settling of suspended sediment. These data were paired with the daily average flow measured in the Sacramento River at Keswick and Bend Bridge. The data used in the evaluation were restricted to the November–May period of higher flows and concentrations to better focus on the range of flows that may occur when Sacramento River water would be diverted to Sites Reservoir.
- Measured flows in the Sacramento River at Bend Bridge and Keswick were used to evaluate whether metal concentrations are high when flows are high (assessed using flow at Keswick) or when runoff from local tributaries contributes a higher percent of water to the Sacramento River (assessed using the ratio of Keswick flow to Bend Bridge flow). This evaluation showed that both conditions can contribute to elevated concentrations of metals.
- A metric of the following form was developed to combine the indicators of flow and local runoff:
    - Metric = A*max(0,1-KWK/BND-B) + KWK
    - Where:
    - KWK = Sacramento River flow at Keswick in cfs
    - BND = Sacramento River flow at Bend Bridge in cfs
    - A and B are constants selected to balance the ratio metric (KWK/BND) with the flow metric and to optimize ability to estimate concentration.
- An exponential trendline was fitted to the metric data to estimate concentration as a function of the metric. In some cases, the fitted equation was modified to estimate the higher concentrations more conservatively by slightly increasing the estimated values. Figure 6-3 shows an example for total aluminum.
- The equation for this curve was used in combination with CALSIM results for Sacramento River flow at Keswick Dam and Bend Bridge to calculate estimated concentration of metals entering Sites Reservoir for each month of the CALSIM simulation.
- Evapoconcentration calculations described above in Section 6.3.2.3, *Evapoconcentration*, were applied to the metals in Sites Reservoir for each month of the CALSIM simulation.

- Dilution of metal concentrations in the Sites Reservoir discharge by flow in the Sacramento River was estimated by calculating the blended concentration using the CALSIM results for the Sites Reservoir release to the Sacramento River and flow in Sacramento River at Wilkins Slough. A range of concentrations were assumed for the Sacramento River upstream of the discharge locations. These concentrations were based on measurements representing the Sacramento River at the approximate time and location of discharge (i.e., Sacramento River concentrations measured at Hamilton City and upstream of the CBD during May through September). The description of results focuses on the calculations that used the median and 95th percentiles of these measurements.

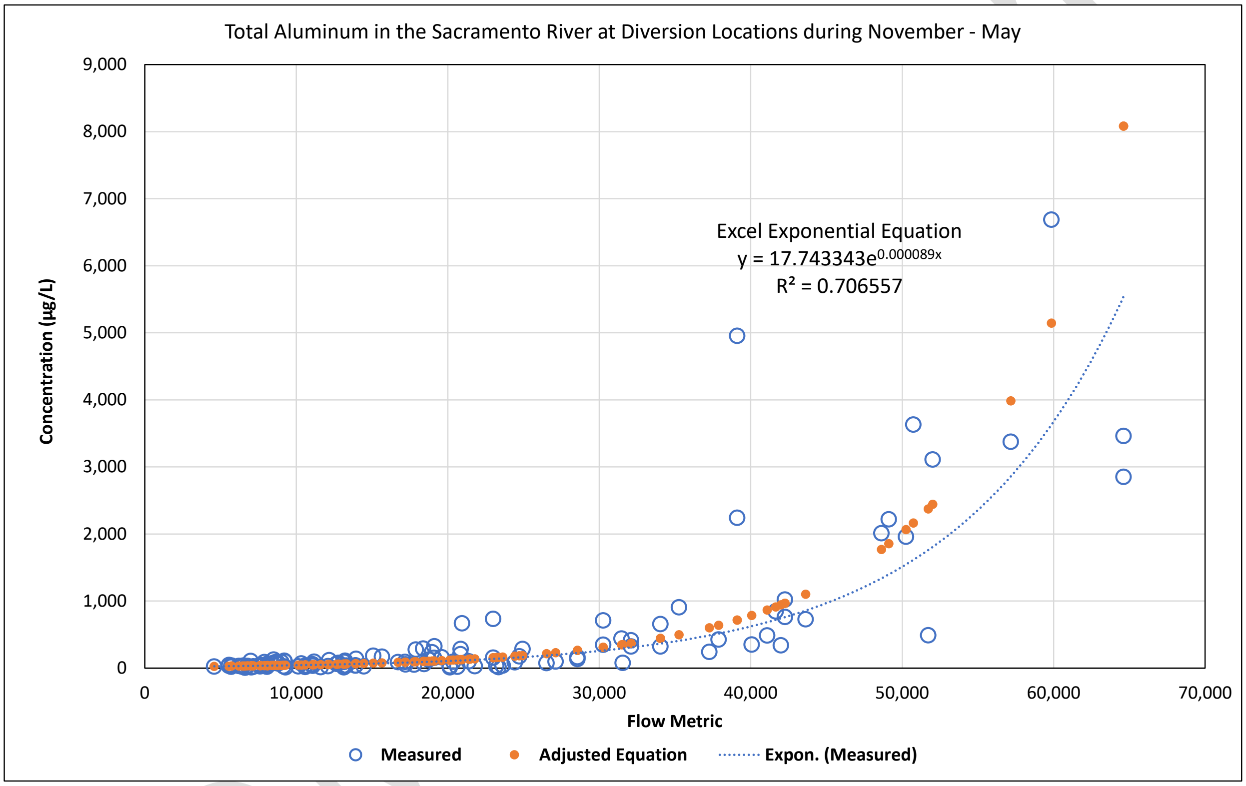


Figure 6-3. Relationships between Flow Metric and Total Aluminum Concentrations

Evaluation of Concentration Assuming Partial Settling of Suspended Sediment

To approximate potential concentration of total metal in Sites Reservoir after settling of sediment, additional calculations were made based on the assumption that once total concentrations are high (above the 80th percentile of measured values), most of the difference between the measured total and dissolved concentrations is due to sediment that would settle in the canals, regulating reservoirs, or Sites Reservoir. This approximated value could be an underestimate of the amount of settling, and thus is conservative, but serves to illustrate the substantial effect that sediment settling can have on metal concentrations. A second set of inflow concentrations to estimate inflow concentration after settling was created to estimate the effect of this partial settling. If the estimated total concentration was less than the 80th percentile value, it was unmodified; if it was greater, the new inflow concentration was estimated as:

(total concentration – 80th percentile value) * ratio + 80th percentile value

80th percentile value equals 80th percentile of measurements collected from the Sacramento River at Red Bluff and Hamilton City during November–May (i.e., the same measured values used to create the equations for estimating Sites Reservoir inflow concentrations).

ratio equals 80th percentile of dissolved concentrations / 80th percentile of total concentrations.

Figure 6-4 shows how this estimation process affects estimated metals concentrations using aluminum as an example. All of the concentrations below the 80th percentile are unaffected. Concentrations above the 80th percentile increase as a fraction of the total concentration. Most of the concentrations are below the 80th percentile, but the spread of the higher concentrations, some of which are outside of the graph, dominates what is seen on the graph.

It is difficult to know the exact effect of sediment settling on total metals concentrations, but this approach for demonstrating the effect of partial settling may underestimate the actual effect of settling. Based on studies of other reservoirs, sediment trapping efficiency for Sites Reservoir may be estimated as a function of the ratio of reservoir storage capacity to annual inflow volume. Based on Brune (1953), Sites Reservoir storage capacity of 1.3 or 1.5 MAF combined with the average annual inflow volume of 230 TAF to 280 TAF, depending on the alternative, likely would result in settling in the reservoir of 95% or more of the sediment that enters the reservoir.

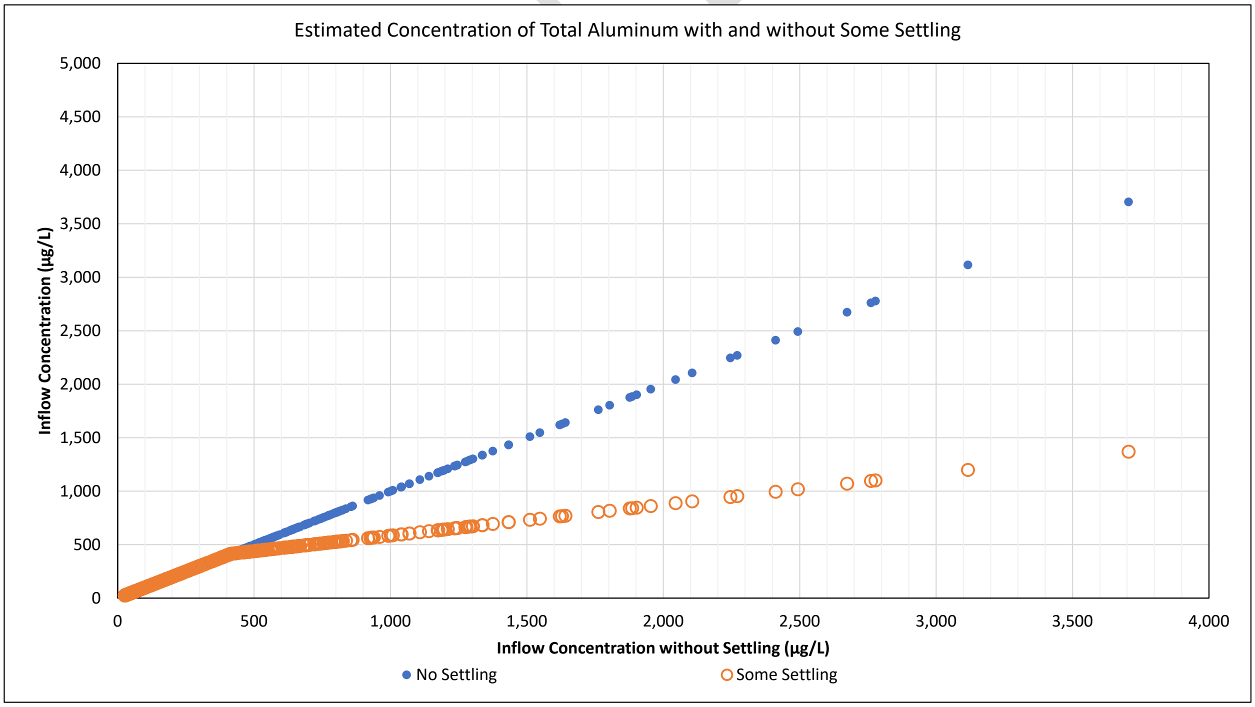


Figure 6-4. Estimated Total Concentration of Aluminum Before and After Settling of Suspended Sediment.

6.3.2.11. Reservoir Management Plan

The RMP (Section 2D.3) is part of the Project and is therefore incorporated into the analysis of impacts to water quality. The purpose of the plan is to describe the management of water resources in Sites Reservoir, including monitoring water quality. The RMP will include metrics, standards, testing and monitoring protocols, guidelines for water quality measurements, and the frequency and location of measurements in the reservoir, the source water, and the reservoir discharge. The requirements are described in Section 2D.3 and the constituents addressed include: HABs, methylmercury, metals, water temperature, and salt and minerals (Salt Pond). The regulating agencies such as the State Water Board and Central Valley RWQCB would review and provide input on the requirements in the plan.

6.3.2.12. Antidegradation Policy

As described in Appendix 4A, the purpose of the California Antidegradation Policy (State Water Board Resolution No. 68-16) is to protect high quality waters from degradation even if no water quality objectives would be violated. The policy allows for the consideration of beneficial uses even if water quality objectives are not fully met. Any actions that can adversely affect existing high water quality in surface water and groundwater must be consistent with maximum benefit to the people of the state, must not unreasonably affect present and anticipated beneficial use of such water, and must not result in water quality less than that prescribed in water quality plans and policies. The Antidegradation Policy may allow for some degradation of water quality (i.e., increases in constituent concentration) if beneficial use increases. Evapoconcentration in reservoirs, for example, is generally accepted due the benefits of water storage.

6.3.3. Thresholds of Significance

The impact analysis focuses on changes in water quality that might: conflict with water quality plans; cause exceedances of water quality standards, requirements, or objectives that are in place to protect beneficial uses; or otherwise have a substantial effect on beneficial uses. Most of the impacts on water quality are evaluated qualitatively, with a determination of significance or substantial adverse effect depending on likelihood of the mechanism occurring, the magnitude of likely effect, and the ability to avoid or reduce effects through implementation of BMPs and/or the RMP. An impact on surface water quality would be considered significant if the Project would:

- Violate any water quality standards or waste discharge requirements or otherwise substantially degrade surface water quality
- Be placed in a flood hazard or seiche zone, risking release of pollutants due to Project inundation
- Conflict with or obstruct implementation of a water quality control plan
- Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river or through the addition of impervious surfaces, in a manner that would create or contribute runoff water which would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff

For evaluation of operational effects under Impact WQ-2, the effect varies by constituent group. Table 6-10 summarizes the approach for evaluating significance.

Table 6-10. Approach for Evaluating Significance of Operations Effects on Water Quality (Impact WQ-2)

Constituent	Thresholds	Primary Waterbodies Evaluated
Temperature	From Central Valley Basin Plan: increase of more than 5°F in receiving water	Sacramento River downstream of discharge locations North Delta / Cache Slough Complex
Salinity	Increase in Sacramento River or Delta salinity that would cause increased violations of Delta water quality objectives or substantially degrade water quality	Sacramento River downstream of discharge locations Delta
Nutrients, Organic Carbon, and DO	Increase in concentrations or reduction in DO that would substantially degrade water quality	Sites Reservoir North Delta / Cache Slough Complex
Mercury	Increase in aqueous mercury exceeding the CTR mercury criterion of 50 ng/L or increases in aqueous or fish tissue methylmercury exceeding the California sport fish objective of 0.2 mg/kg, wet weight, for water bodies outside of the Delta and Yolo Bypass, or 0.24 mg/kg, wet weight (trophic level 4 fish), and 0.08 mg/kg, wet weight (trophic level 3 fish) for the Yolo Bypass and Delta [1].	Sites Reservoir Funks Creek Stone Corral Creek Colusa Basin Drain Yolo Bypass Delta (Sacramento River at Freeport)
Metals	Substantial increases in concentration, especially those that could cause or exacerbate exceedances of the most sensitive existing water quality standards (Freshwater Chronic Standard for Aquatic Life Protection)	Sites Reservoir Stone Corral Creek Sacramento River downstream of Sites Reservoir discharge locations Yolo Bypass and Cache Slough Complex
HABS and Invasive Aquatic Vegetation	Substantial degradation of water quality that could affect beneficial uses	Sites Reservoir and receiving waters
Pesticides	Substantial increases in concentration, especially those that could cause or exacerbate exceedances of existing water quality standards	Sites Reservoir Yolo Bypass and Cache Slough Complex

Notes: DO=dissolved oxygen; HABs=harmful algal blooms; CTR=California Toxics Rule; mg/kg=milligrams per kilogram.

[1] The Tribal Subsistence Fishing water quality objective for methylmercury (0.04 mg/kg, ww of skinless fish fillet) is more stringent than the California sport fish water quality objective. However, because the Tribal Subsistence Fishing objective applies only to waters with the Tribal Subsistence Fishing (T-SUB) beneficial use designation, of which there are currently none in the study area, this water quality objective was not used in the impact analysis as a threshold for evaluating significance.

6.4 Impact Analysis and Mitigation Measures

Impact WQ-1: Violate any water quality standards or waste discharge requirements or otherwise substantially degrade surface water quality during construction

No Project

Under the No Project Alternative, the operations of the existing TC Canal, RBPP, and GCID Main Canal would continue, and Sites Reservoir would not be constructed. Existing surface water quality conditions in the study area would not be expected to change substantially.

Significance Determination

The No Project Alternative would not violate any water quality standards or waste discharge requirements or otherwise substantially degrade surface water quality during construction because no new facilities would be built. There would be no impact/no effect.

Alternatives 1, 2, and 3

Impact mechanisms during construction of Alternative 1, 2, or 3 would be similar. For example, all alternatives would involve soil disturbance and require similar equipment. In addition, the same initial filling of the reservoir would occur under each alternative, although Alternative 2 would be 200,000 AF less than Alternatives 1 and 3. Therefore, the alternatives are evaluated together in this section with differences in construction impacts noted where appropriate.

Ground Disturbance

Construction activities for Alternatives 1, 2, and 3 involving ground disturbance such as vegetation removal, excavation, trenching, grading, filling, and soil stockpiling (including from tunneling) could result in erosion and runoff to nearby surface waters (e.g., Funks and Stone Corral Creeks). Erosion and runoff tend to occur more in areas with steeper slopes and are of less concern in areas that are flat. Suspended sediment, turbidity, and sedimentation could cause temporary, adverse effects on water quality. Eroded soil can also transport other pollutants such as nutrients, metals, oils, and greases, which could also result in temporary, adverse effects on water quality. Alternative 2 would include construction of the approximately 20-mile-long South Road, which would entail substantial ground disturbance and require work on relatively steep slopes. In addition, the proposed Dunnigan Pipeline, the construction of which would also entail substantial excavation, would be longer under Alternative 2 relative to the other alternatives.

Areas of bare soil, both during and after construction, would be subject to erosion during rainfall events, which could introduce sediment and turbidity to nearby surface waters. Construction associated with the TRR East or West pipelines, TC Canal intake tie-in, and the GCID Main Canal improvements would likely occur during the winter when irrigation is typically not occurring and existing Project facilities are not being regularly used (i.e., wet season). The terrain in the areas where this construction would occur is relatively flat, which would reduce the potential for erosion and runoff. However, the timing of construction activities associated with these facilities would likely result in some erosion and runoff from these areas that could cause turbidity and sedimentation, depending on the frequency and magnitude of precipitation in the wet season.

BMP-12 would address the potential for increased erosion that could occur as a result of ground-disturbing construction activities or areas of bare soil and would ensure that erosion rates would not be excessive. This BMP would include implementation of erosion and sediment control measures and during-construction and postconstruction runoff management measures. The erosion control measures would be implemented to protect soils that have been exposed during excavation, filling, and stockpiling operations from eroding at rates greater than preconstruction conditions. Erosion control measures may include the placement of coconut coir matting or tackified hydroseeding compounds over areas of bare soil to prevent it from becoming dislodged during rain events. The sediment control measures, such as placement of silt fencing around areas of ground disturbance, would capture sediment that is generated from exposed soils. The runoff management measures would be implemented to reduce runoff rates and prevent concentrated runoff from causing scour, such as at culvert outfall points. Implementation of this BMP would ensure that ground disturbance during construction would not result in sedimentation or turbidity that would violate water quality standards or waste discharge requirements or otherwise substantially degrade water quality.

In-Channel Construction

In-channel construction activities could cause temporary sediment disturbance and resuspension, which may cause increased turbidity and siltation through either the actual construction activity or the release of diverted water back into a receiving water. In-channel construction would be required under Alternatives 1, 2, and 3 and would include construction of Golden Gate and Sites Dams; upgrades to the GCID system and canal head gate structure; TRR East and West pipelines where they cross Funks Reservoir; construction of saddle dams; and installation of the outlet and energy dissipating structure in the CBD. In addition, under Alternative 2 there would be in-channel construction activities for the installation of the Sacramento River discharge. With BMP-14, all discharge of water diverted from streams and canals and removed during dewatering activities would be done in compliance with the requirements of the Central Valley RWQCB Order R5-2022-0006 (Waste Discharge Requirements for Limited Threat Discharges to Surface Water) to avoid or minimize potential adverse effects on water quality. As necessary, water would be pumped into Baker tanks, or approved equivalent, with either a filter or gel coagulant system or other containment to remove sediment as required. Sediment could be disposed of offsite at a permitted facility. Remaining water would be discharged to a designated receiving waterbody or via land application, in accordance with the requirements of Central Valley RWQCB Order R5-2022-0006.

In-channel or in-water construction would require the temporary installation of coffer dams and subsequent temporary dewatering of the isolated in-channel work area. Coffer dams would be installed during construction at multiple locations including the GCID Main Canal, Funks Reservoir, and TC Canal. The coffer dam installed for the construction of Golden Gate Dam would be permanent and would become part of the dam. Potential water quality effects due to coffer dam installation and removal (if required) would include a temporary increase in turbidity due to sediment disturbance. Construction of Golden Gate Dam would occur in Funks Creek, and construction of Sites Dam would be in Stone Corral Creek. Although flow in these creeks is intermittent, stream flow would be rerouted during construction. For the Funks Creek construction diversion, water would pond behind the coffer dam, flow through the temporary pipe underneath the Golden Gate Dam construction site to the east side of the dam, and then reenter the Funks Creek channel. The coffer dam would provide enough residence for settling to occur for typical flows in Funks Creek. If needed, silt curtains would be used when installing coffer dam sheet piles for construction of the Sacramento River discharge to minimize turbidity effects in the river. Water pumped from behind the Sacramento River coffer dam (i.e., on the landward side) would be discharged through a silt sock to the area between the coffer dam and the silt curtains to minimize turbidity effects in the river channel.

In-channel construction activities may also result in the inadvertent introduction of chemical contaminants (e.g., fuel, oil, lubricants) from construction equipment to a stream, which would adversely affect water quality. BMP-13 entails developing and implementing site-specific SPCCPs that would include measures to ensure that equipment used in direct contact with water would be inspected daily for oil, grease, and other petroleum products, and cleaned of external petroleum products prior to beginning work where contact with water may occur. Such measures would prevent the release of these pollutants to surface waters to avoid violating water quality standards or waste discharge requirements or otherwise degrading water quality during in-channel work.

Groundwater Dewatering

Groundwater dewatering would be necessary during construction at several locations. Dewatering would be required for quarrying, road construction and improvement, and construction of the Dunnigan Pipeline, TRR East and West pipelines, and the I/O Works. Groundwater pumped as part of dewatering would not be released into nearby surface water and would not cause temporary, adverse effects on surface water quality (e.g., localized increases in TDS, changes in pH). An onsite water treatment facility, including a settling basin, would be located near the I/O Works. The facility would treat the pumped groundwater for oil/grease, settable solids, pH, and turbidity. This treated water would then be used for dust suppression or discharged into Funks Creek (Appendix 2C, *Construction Means, Methods, and Assumptions*, Section 2.14, *Inlet/Outlet Works*). Groundwater encountered in other areas during dewatering would be stored onsite in bermed areas or tanks, as needed, and then utilized for dust suppression or applied to suitable land where it would infiltrate back into the water table. BMP-14, which, includes the storage and treatment described above, would be implemented as part of compliance with Central Valley RWQCB Order R5-2022-0006. Central Valley RWQCB Order R5-2022-0006 identifies water quality- and technology-based effluent limitations, receiving water limitations, standard and special provisions (e.g., monitoring and reporting requirements, and a pollution prevention and monitoring and reporting plan, respectively), and other requirements for those dischargers seeking coverage under the order. Groundwater discharged to land would comply with State Water Board Order No. 2003-0003-003. If groundwater contamination is suspected, water testing would be implemented prior to disposal as part of a SWPPP. Implementation of BMP-14 would ensure that groundwater dewatering would not violate water quality standards or waste discharge requirements or otherwise substantially degrade water quality.

Dredging and Tunneling

Hydraulic dredging and excavation of Funks Reservoir would occur generally during the non-operational period (December through February) when the reservoir pool is lowered (Sites

Project Authority 2021:10, 15). Dredging would result in the short-term resuspension of sediment in the water column, which would temporarily increase turbidity. If the sediment is comprised predominately of silt and clay (i.e., fine sediment particles), as opposed to sand (i.e., coarse sediment particles) turbid conditions would be expected to last longer because fine sediments remain suspended longer than coarse sediments. In addition, dredging would potentially result in the indirect, temporary, and short-term reduction of DO in the water column. The resuspension of anoxic organic matter in sediment results in a temporary increase in chemical and biological oxygen demand in the water column. If contaminants exist in sediment, they would likely be adsorbed to organic matter and not readily released during short-term resuspension due to low water solubility. Therefore, the potential for a substantial increase in chemical contaminants in the water column relative to the No Project Alternative is unlikely. Furthermore, water generated during dredging and tunneling activities would be discharged into the TC Canal and not directly into the CBD or the Sacramento River; therefore, it would have limited ability to affect downstream receiving waters during construction.

BMP-11 requires that dredged material from Funks Reservoir, tunnel muck from construction of the I/O tunnel, and soil spoils be stored in stockpile areas and eventually reused or disposed of on site or off site. Dredged material from Funks Reservoir would be placed in stockpile areas adjacent to the reservoir for dewatering and potential reuse or disposal. The Authority would follow standard protocols and implement BMP-11 for storage of dredged materials. BMP-11 includes a chemical evaluation of Funks Reservoir water and sediment to identify any chemical contaminants to help inform potential requirements for onsite water treatment (including containment and dewatering) and suitability of dredged sediment for reuse, and design and operation measures for the dewatering facilities to avoid direct discharge of dredged material or effluent to surface waters. In addition, measures implemented as part of BMP-12, including erosion control measures and sediment control measures, would minimize or avoid long-term, potentially adverse effects from sedimentation and turbidity on Funks Reservoir and the TC Canal resulting from ground disturbance during dredging, transport of dredged material to dewatering sites, and construction and operation of dewatering facilities. Erosion control measures may include the placement of coconut coir matting or tackified hydroseeding compounds over areas of bare soil to prevent the soil from becoming dislodged during rain events. The sediment control measures, such as placement of silt fencing around areas of ground disturbance, would capture sediment that is generated from exposed soils. Tunnel muck and soil stockpiles would be stored away from surface waters. As a result, dredging and tunneling would not violate water quality standards or waste discharge requirements or otherwise substantially degrade water quality.

Release of Chemical Pollutants

The potential for the inadvertent release of chemical pollutants (e.g., fuel, paint, cement) to surface waters would be avoided or minimized with the implementation of BMP-13. The SPCCPs in BMP-13 would include safe handling and storage of hazardous materials; monitoring equipment and vehicles for fluid leaks; refueling in designated areas only, which would be located a minimum of 150 feet from surface waters; providing onsite equipment and materials necessary for containment and cleanup of accidental spills; and designing staging areas to contain contaminants should a spill occur. Therefore, the potential for the accidental release of pollutants would be minimized and reduced during construction, and water quality would not be adversely affected by petroleum products (fuel, oils, and grease from vehicles and equipment), paving materials such as concrete and asphalt, and other materials potentially used and/or stored on site during construction (e.g., aboveground fuel tanks, waste oil storage tanks, paint, adhesives, solvents), and construction waste (e.g., trash, construction debris, hazardous waste). Onsite concrete batching plants would be used for construction, including near Funks and Stone Corral Creeks for constructing Golden Gate Dam and Sites Dam, respectively. Wastewater from concrete batching plants may contain potential pollutants such as cement, sand, and aggregates that would adversely affect water quality by increasing turbidity, raising surface water pH, and potentially introducing heavy metals. All materials from demolition of existing structures would be handled and disposed of in accordance with applicable regulations.

Initial Filling

Based on CALSIM results, Sites Reservoir may take 2 to 10 years to fill. During this time, concentrations of nutrients, organic carbon, and mercury and methylmercury are expected to be elevated relative to long-term concentrations under standard operating conditions. Further, mercury and methylmercury concentrations are also expected to remain elevated following the initial filling of the reservoir (i.e., 1–10 years) relative to long-term concentrations, based on the data, assumptions, and uncertainty described in the methods section of this chapter. Additional water quality constituents (e.g., metals) may have effects associated with operations that could occur during the first 10 years of operations, but the effects are not expected to be any different during the first 10 years than they would be during subsequent years (refer to Impact WQ-2 for further discussion of those water quality constituents).

Nutrients, Organic Carbon, and Dissolved Oxygen

The initial filling of Sites Reservoir would result in the release of nutrients and dissolved organic carbon to the water column from newly inundated soil and other organic matter in the inundation area. These releases would decrease over time. Decomposition of freshly submerged organic matter would consume oxygen and the biochemical oxygen demand in the reservoir during this period could be relatively high. Vegetation would be removed in the inundation area prior to the initial filling, which would reduce the available nutrients and organic carbon prior to reservoir filling. As the reservoir fills, the concentration of nutrients and dissolved organic carbon would be progressively diluted and thus these constituents would not adversely affect water quality in the long term. Turbulent mixing during filling, at least in the area near the I/O Works, would also help aerate the water and increase DO. The nature of any downstream water quality effects due to releases of nutrients and dissolved organic carbon during initial filling period would be similar to that discussed for operations (Impact WQ-2), although the concentrations of nutrients and dissolved organic carbon in reservoir releases may be greater in the short term relative to the long term.

Mercury and Methylmercury

Sites Reservoir

New reservoirs increase mercury methylation and bioaccumulation (State Water Resources Control Board 2017b:4-13). Mercury accumulated in the soil from atmospheric deposition and mercury in the water diverted from the Sacramento River would be the primary sources of mercury in the reservoir. The magnitude and duration of mercury methylation after the initial filling of Sites Reservoir would partially depend on the amount of organic carbon in the underlying soils and how much organic material is inundated when the reservoir fills.

Estimated short-term mercury and methylmercury concentrations in Sites Reservoir for Alternatives 1, 2, and 3 are presented in Table 6-11.

Table 6-11. Estimated Concentrations of Total Mercury and Methylmercury in Sites Reservoir in the Short-Term

Estimated Concentration	Short-Term (1–10 years after filling) (ng/L)
Expected Total Mercury	2.8
Reasonable Worst-case Total Mercury[1]	3.6
Expected Methylmercury	0.16
Reasonable Worst-case Methylmercury[1]	0.24

Notes: ng/L = nanogram per liter

[1] The term "reasonable worst-case" refers to an estimated upper bound of the expected average concentration based on the published literature and site-specific conditions. It is not necessarily the maximum concentration that could occur in Sites Reservoir.

Because mercury methylation in newly inundated reservoirs is greater than in established reservoirs, expected mercury and methylmercury concentrations in the short term after reservoir filling (i.e., within 1–10 years) are estimated to be roughly double the long-term (i.e., more than 10 years) average expected concentrations (see Impact WQ-2 for how long-term concentrations were estimated). However, the estimated short-term mercury concentration in Sites Reservoir would be substantially lower than the CTR mercury criterion of 50 ng/L. Normalized fish tissue methylmercury concentrations at nearby reservoirs (Appendix 6F, Table 6F-10) are relatively consistent despite the variation in the size, depth, and surrounding mercury sources. As discussed for Impact WQ-2, assuming similar fish species and comparable food web structures at these reservoir counterparts, a reasonable worst-case fish tissue concentration in the long term is the 99th percentile value among these reservoirs (0.85 mg/kg ww), which is similar to the mean fish tissue mercury concentrations from nearby Indian Valley Reservoir in 2008. Due to expected higher mercury methylation in the short term after reservoir filling, methylmercury concentrations in fish tissue may be higher than this value and thus would likely exceed the California sport fish objective of 0.2 mg/kg ww, as further discussed for Impact WQ-2. There is currently no reservoir in Antelope Valley. This would be an effect on the Project itself occurring within the Sites Reservoir, rather than an effect from the Project on the surrounding environment. Effects beyond the reservoir itself on the surrounding environment are described below, including potential effects on Funks and Stone Corral Creeks, the CBD, the Yolo Bypass, and the Delta.

Funks and Stone Corral Creeks

Estimated short-term mercury concentrations in Sites Reservoir releases would be higher than existing Funks and Stone Corral Creeks mean and maximum concentrations (Table 6-5). The CTR criterion would not be exceeded because estimated short-term expected and reasonable worst-case total mercury concentrations in Sites Reservoir releases would be substantially lower than the CTR mercury criterion of 50 ng/L, and because most of the flow in these streams would come from Sites Reservoir.

Aqueous methylmercury contributions to Funks and Stone Corral Creeks from Sites Reservoir would be higher in the short term relative to the long term given that methylmercury in the reservoir is estimated to be twice the long-term concentrations. The contribution of mercury and methylmercury from Sites Reservoir would be reflected in fish in these creeks and could cause exceedances of the 0.20 mg/kg ww sport fish objective. Aqueous and fish tissue methylmercury concentrations in Stone Corral Creek due to Sites Reservoir releases may be greater than in Funks Creek, as discussed for Impact WQ-2.

Colusa Basin Drain

The mean total mercury concentration in surface water in CBD at Knights Landing prior to 1998 was 8.6 ng/L and from 1999–2007 was 4.5 ng/L. Total mercury discharges from the Project are not expected to exceed 3.6 ng/L (**Error! Reference source not found.**) and thus Alternatives 1, 2, and 3 would not increase concentrations in the CBD relative to the No Project Alternative or cause exceedances of the 50 ng/L CTR criterion. The mean methylmercury concentration in the CBD at Knights Landing was 0.17 ng/L prior to 1998 and from 2000–2007 was 0.13 ng/L (Table 6-6). The estimated expected short-term and reasonable worst-case short-term methylmercury concentrations (0.16 ng/L and 0.24 ng/L, respectively) that could be released from Sites Reservoir to the CBD up to 10 years following the initial filling period would potentially exceed the average concentration in the CBD based on the 2000–2007 period. The nature of any CBD water quality effects due to methylmercury in Sites Reservoir releases in the short term would be similar to that discussed for operations (Impact WQ-2). The methylmercury concentration in reservoir releases would be greater in the short term relative to the long term and thus the magnitude of temporary mercury bioaccumulation in CBD fish in the short term would be greater, particularly in Dry and Critically Dry Water Years.

Yolo Bypass and the Delta

The nature of short-term impacts in Yolo Bypass and the Delta related to mercury and methylmercury due to elevated concentrations in Sites Reservoir associated with initial filling would be similar to those discussed for operations (Impact WQ-2). Aqueous mercury and aqueous and fish tissue methylmercury concentrations in the Yolo Bypass would not increase substantially in the short term relative to the No Project Alternative due to Sites Reservoir releases. Historical average total mercury concentrations in the Yolo Bypass as measured at Prospect Slough are approximately 73.2 ng/L (Table 6-5), which exceeds the lowest CTR criterion of 50 ng/L. Exports from Sites Reservoir entering the Yolo Bypass with the short-term expected and reasonable worst-case total mercury concentrations (2.8 and 3.6 ng/L, respectively) would be substantially lower than this average concentration in the Yolo Bypass. Similarly, exports from Sites Reservoir the expected and short-term reasonable worst-case aqueous methylmercury concentrations (0.16 and 0.24 ng/L, respectively) would be less than the mean concentration in the Yolo Bypass of 0.35 ng/L (Table 6-6).

The average concentration of total mercury in the Sacramento River at Freeport is 4.5 ng/L (Table 6-5). Estimated short-term mercury concentrations in Sites Reservoir releases would be lower and would be diluted by the Sacramento River prior to reaching the north Delta. The historical average methylmercury concentration in the Sacramento River at Freeport is 0.069 ng/L (Table 6-6), which is greater than the estimated short-term methylmercury concentrations

(Table 6-11). Given estimated methylmercury concentrations in Sites Reservoir releases in the short term, there could be increased aqueous and fish tissue methylmercury concentrations in the north Delta in the short-term in Dry and Critically Dry Water Years during the Sites Reservoir release period (e.g., May through November).

HABs and Invasive Aquatic Vegetation

During initial filling of Sites Reservoir, nutrient (nitrogen and phosphorus) levels would be expected to be relatively high due to flooding of soils in the inundation footprint. This, along with warm water temperatures starting in late spring, could contribute to creating conditions conducive to promoting and maintaining HABs, and supporting the growth of nuisance algae and aquatic vegetation. This condition would be limited to the Project reservoir itself and would not cause adverse impacts beyond the reservoir on the surrounding environment.

The production of HABs depends on a variety of environmental factors, as described in Section 6.2.2.6, *Harmful Algal Blooms*. If HABs were to occur in the reservoir near the I/O tower when releases were made, cyanobacteria and cyanotoxins could be released from the reservoir in varying concentrations. The concentration would generally depend on the magnitude of the bloom(s) and the depth from which water is released. Downstream effects on water quality would not be expected if cyanobacteria and cyanotoxins were present in the releases because concentrations of cyanobacteria and cyanotoxins would be greatly diluted when eventually discharged into the Sacramento River. Furthermore, cyanotoxins undergo biodegradation and, to some degree, photodegradation, depending on the specific cyanotoxin. Laboratory studies have shown that microcystins, for example, can be relatively rapidly degraded (several days) by certain bacterial families following a lag period (Berg and Sutula 2015:30; Gagala and Mankiewicz-Boczek 2012:1128). In addition, releases could be made from lower in the water column (e.g., through the low-level intake) to reduce the potential for higher concentrations of cyanobacteria and cyanotoxins to be released downstream, and this action would be informed by water quality monitoring for cyanobacteria and cyanotoxins (Section 2D.3). The timing and volume of releases from Sites Reservoir to Funks and Stone Corral Creeks will be determined and adaptively managed as part of a comprehensive aquatic study plan and adaptive management plan to ensure that fish are maintained in good condition in compliance with California Fish and Game Code Section 5937 (see Appendix 2D). Water diversions to Sites Reservoir would not be expected to result in an increase in the frequency of HABs in the Delta or further downstream as a result of flow reductions in the Sacramento River because these diversions would occur primarily during storm events in winter when conditions are less conducive to HABs.

Plants or viable fragments may enter the reservoir via Sacramento River diversions. It is unlikely that invasive aquatic vegetation fragments could be released downstream via the I/O tower if invasive aquatic vegetation were present in the reservoir in proximity to the I/O tower while releases were being made. However, were this to occur, it is unlikely this would result in a substantial degradation of water quality downstream given the widespread nature of existing invasive aquatic plant species in the study area.

Water quality management in Sites Reservoir as it relates to HABs requires implementation of a water quality monitoring program and a HABs action plan. Monitoring for the presence of HABs in the reservoir, which would also include water sampling to confirm the presence of cyanobacteria and cyanotoxins, reporting the presence of cyanobacteria and cyanotoxins to the State Water Board and Central Valley RWQCB, and posting warning signs around the reservoir for the public would minimize the potential for public exposure to cyanotoxins. Signage will be placed in multiple locations around the reservoir, including the Peninsula Hills and Stone Corral Creek Recreational Areas and at the boating kiosks, urging boaters to exercise caution or restricting boating altogether, depending on cyanobacterial cell density and cyanotoxin concentrations in the water. These warnings/restrictions would also act to limit the potential for boats and equipment to inadvertently introduce invasive aquatic plant species to Sites Reservoir during the initial filling period. As discussed under Impact WQ-2, the spread of submerged and floating invasive aquatic vegetation would be controlled in Sites Reservoir through implementation of invasive aquatic vegetation control actions (Section 2D.3). These actions would be consistent with the DBW's AIPCP (Division of Boating and Waterways 2021a, 2021b) and may include biological, mechanical or chemical methods for removal and control of invasive aquatic plant species. These actions are noticed and required of the recreating community at other reservoirs in California (e.g., Lake Berryessa) and would serve to further reduce the potential for introduction and spread of invasive aquatic plants.

<u>*CEQA Significance Determination and Mitigation Measures*</u>

Construction of Project facilities would not violate any water quality standards or waste discharge requirements or otherwise substantially degrade surface water quality in the study area. Implementation of BMP-11, BMP-12, BMP-13, and BMP-14 would minimize or avoid the potential discharge of pollutants, including sediment, to study area waterbodies.

The initial filling of Sites Reservoir would result in the release of nutrients and dissolved organic carbon to the water column from newly inundated soil and other organic matter in the inundation area. Decomposition of freshly submerged organic matter would consume oxygen and thus temporarily reduce DO in the reservoir. Conditions within the reservoir itself would be effects on the Project, rather than effects from the Project on the surrounding environment. Releases during the initial filling period would not reduce drinking water quality downstream due to nutrients and organic carbon or cause low DO because nutrients and organic carbon in Sites Reservoir releases would be diluted and water would be aerated upon release. Thus, effects from initial filling of Sites Reservoir on downstream conditions with respect to nutrients, organic carbon and DO would be less than significant.

The initial filling of Sites Reservoir would not result in the substantial introduction or spread of invasive aquatic vegetation because these species already exist in the Sacramento River system. Recreational boating activities could be limited during the initial filling period if HABs were also present (Section 2D.3), which would help reduce the substantial introduction or spread of invasive aquatic vegetation. Furthermore, potential effects of invasive aquatic vegetation on water quality would be managed and minimized (Section 2D.3).

The initial filling of Sites Reservoir would result in temporarily elevated concentrations of nutrients and dissolved organic carbon relative to concentrations in diverted Sacramento River water. Elevated nutrient levels would promote initiation and sustainment of HABs in Sites Reservoir generally in late spring through fall. If cyanobacteria and cyanotoxins were present in reservoir releases, potential downstream effects on water quality would not be expected because concentrations of cyanobacteria and cyanotoxins would be greatly diluted when eventually discharged into the Sacramento River, and cyanotoxins would undergo biodegradation relatively rapidly. Photodegradation would also occur to some degree. Furthermore, measures including monitoring and restricting in-water recreation based on the presence of cyanobacteria and cyanotoxins, and releasing water from lower in the reservoir if cyanobacteria and cyanotoxins are confirmed near the I/O tower at a level at or exceeding the "Caution" action trigger level, would further reduce any potential for adverse water quality effects (Section 2D.3). Thus, effects from initial filling of Sites Reservoir on downstream conditions would be less than significant with respect to HABs.

In the short term, estimated reservoir total mercury and aqueous methylmercury concentrations would be approximately twice as high as estimated long-term average concentrations. Mercury concentrations in the short-term (within 1–10 years of initial filling) would not exceed the CTR criterion, but methylmercury fish tissue concentrations may exceed the California sport fish objective of 0.2 mg/kg ww. Conditions within the reservoir itself would be effects on the Project, rather than effects from the Project on the surrounding environment.

Sites Reservoir releases to Funks and Stone Corral Creeks would likely increase aqueous and fish tissue methylmercury concentrations in these creeks such that the sport fish tissue objective is exceeded but would not cause aqueous mercury concentrations to exceed the CTR criterion. In the short-term, given the greater mercury and methylmercury concentrations in releases relative to long-term concentrations, methylmercury in Sites Reservoir releases may temporarily increase aqueous and fish tissue methylmercury concentrations in the CBD. This temporary increase could cause exceedances of the sport fish objective because methylmercury concentrations in CBD fish approach the California sport fish objective under the No Project Alternative. Because Funks Creek and Stone Corral Creek are small, intermittent streams and their stream banks are located primarily on private land, it is unlikely that anglers would be fishing these creeks; accordingly, any potential exceedances of the sport fish objective at these locations would not be expected to affect the public. Aqueous mercury and methylmercury in the Yolo Bypass would not increase substantially due to Sites Reservoir releases, and these releases would not cause measurable increases in fish tissue methylmercury. Aqueous and fish tissue methylmercury concentrations in the Sacramento River at Freeport may increase measurably in Dry and Critically Dry Water Years during release periods due to methylmercury in Sites Reservoir releases. The potential methylmercury impact on water quality in the CBD, Funks and Stone Corral Creeks, and the north Delta would be significant. To reduce the magnitude of this impact, Mitigation Measure WQ-1.1, *Methylmercury Management,* would be implemented at Sites Reservoir with the goal of reducing the methylation of mercury in Sites Reservoir. Most of the methylmercury reduction actions under this mitigation measure are recommended actions for new reservoirs as part of the Statewide Mercury Control Program for Reservoirs, as identified in the *Draft Staff Report for Scientific Peer Review for the Amendment to the Water Quality Control Plan for Inland Surface Waters, Enclosed Bays, and Estuaries of California, Mercury Reservoir Provisions – Mercury TMDL and Implementation Program for Reservoirs* (State Water Resources Control Board 2017b). The potential to reduce methylmercury concentrations exists based on current research (State Water Resources Control Board 2017b); however, the effectiveness of the methylmercury minimization actions to reduce reservoir methylmercury during the initial fill period such that there would be no substantial measurable increase in aqueous and fish tissue methylmercury concentrations at the downstream locations is not known at this time. Therefore, this impact would be significant and unavoidable.

Mitigation Measure WQ-1.1: Methylmercury Management

The Authority will implement the following actions as part of the RMP (Section 2D.3) to minimize reservoir methylmercury production and bioaccumulation of methylmercury in reservoir fish so that the average methylmercury concentrations in Sites Reservoir fish do not exceed the 0.2 mg/kg sport fish objective[4]. Most of these actions are recommended actions for new reservoirs as part of the Statewide Mercury Control Program for Reservoirs (currently under development), as identified in the *Draft Staff Report for Scientific Peer Review for the Amendment to the Water Quality Control Plan for Inland Surface Waters, Enclosed Bays, and Estuaries of California, Mercury Reservoir Provisions – Mercury TMDL and Implementation Program for Reservoirs* (State Water Resources Control Board 2017b). The potential effectiveness of these recommended methylmercury reduction actions is supported by current research (State Water Resources Control Board 2017b). Methylmercury reduction actions and fish tissue monitoring will be implemented in coordination with the State Water Board and Central Valley RWQCB, as required.

1. Remove vegetation (e.g., brush, trees) in the inundation area prior to initial reservoir filling.
2. Do not stock Sites Reservoir with fish for the first 10 years following its initial filling.
3. Upon completion of the initial filling of Sites Reservoir, implement a fish sampling program to determine whether game fish are present (e.g., due to unauthorized fish stocking) and whether a population has established (i.e., presence of reproductively mature fish and several year classes). This sampling program would include one or two surveys in spring or early summer using a single electrofishing crew. The survey would include several transects along the shoreline, likely in the vicinity of the boat ramps and campgrounds. Once it has been determined that a population of game fish has established in the reservoir, begin monitoring Sites Reservoir fish tissue methylmercury concentrations (as total mercury) via annual tissue sampling.

   Based on results from fish tissue monitoring, and in coordination with the State Water Board, Central Valley RWQCB, and the Office of Environmental Health Hazards Assessment, fish consumption warning signs will be posted in several visible locations around the reservoir if fish tissue concentrations exceed the 0.20 mg/kg ww

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[4] The average methylmercury concentrations shall not exceed 0.2 milligrams per kilogram (mg/kg) fish tissue within a calendar year. The water quality objective must be applied to trophic level 3 (TL3) or trophic level 4 (TL4) fish, whichever is the highest existing trophic level in the water body. The objective applies to the wet weight concentration in skinless fillet. Freshwater TL3 fish are between 150 to 500 millimeters (mm) in total length and TL4 fish are between 200 to 500 mm in total length, or as additionally limited in size in accordance with the “legal size” set for recreational fishing, established by Title 14, California Code of Regulations 14 Sections 1–53.03.

sport fish objective[5]. Sport and prey-sized fish tissue from multiple species will be sampled in accordance with the State Water Board's Surface Water Ambient Monitoring Program, Safe to Eat Workgroup protocol (State Water Resources Control Board 2021c, 2022b). Mercury in fish tissues will be analyzed according USEPA's Standard Method 7473 (U.S. Environmental Protection Agency 2007, or as updated). The annual reservoir mercury monitoring program will continue for a minimum of 10 years following the first year of regulated reservoir stocking.

4. Monitor and manage reservoir water chemistry according to methods proven feasible and effective at reducing mercury methylation by pilot tests undertaken in other mercury-impaired reservoirs, as determined by the State Water Board's program review at the conclusion of the Phase 1 pilot tests for the Statewide Mercury Control Program for Reservoirs. Water chemistry management actions may include the addition of an oxidant (e.g., DO, ozone, nitrate) to the reservoir bottom waters (near the sediment-water interface) to reduce anoxia or adjust redox potential when the reservoir is stratified. If this method is employed, reservoir releases will be made from a higher tier (i.e., higher elevation) in the I/O tower to avoid discharging bottom waters. Methylmercury concentrations in the reservoir would be assessed prior to oxidant addition to establish baseline levels and following reservoir treatment to assess effectiveness of the methylmercury management action at reducing bioaccumulation and fish methylmercury concentrations. Further, if nitrate is added to the reservoir, monitoring of reservoir releases will be implemented to ensure nitrate concentrations in the releases are not substantially increased to avoid potentially affecting downstream surface water quality.
5. Manage reservoir fisheries according to methods proven feasible and effective at reducing methylmercury bioaccumulation by pilot tests undertaken in other mercury-impaired reservoirs. Fisheries management actions could include the following.
    a. Intensive fishing to reduce fish populations to provide more food resources for remaining fish. This would increase the growth rate in the remaining fish and reduce their methylmercury body burdens through somatic growth dilution.
    b. Stocking the reservoir with low-methylmercury prey fish for stocked predator fish to consume.
    c. Stocking more or different sport fish species, including lower trophic level sport fish.
    d. Stocking large, old predator fish from hatcheries that supply fish with low methylmercury concentrations.

    To assess the effectiveness of methylmercury reduction actions after initial implementation, fish tissue methylmercury concentrations (as total mercury) will be monitored. Young fish will be sampled because they have accumulated

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[5] For evaluating compliance with the sport fish objective, monitoring will include representative TL4 fish species, if present, or TL3 fish if no TL4 fish are present in the reservoir. A sample will be considered either an analytical result from individual fish tissue or a composite of tissue from several fish. Sample sets for comparison with the sport fish objective shall include a range of TL3 fish between 150 to 500 mm total length and TL4 fish between 200 to 500 mm total length.

methylmercury for a shorter time period relative to older, larger sport fish and therefore will better reflect recent mercury exposure (State Water Resources Control Board 2017b). Fish tissue methylmercury concentrations in young fish will be assessed prior to implementation of any methylmercury reduction action. The timing and frequency of tissue sampling following implementation of reduction actions will be informed by Phase 1 pilot tests.

To assess the effectiveness of fisheries management actions over the long term, ongoing monitoring of aqueous and fish tissue methylmercury in Sites Reservoir will be implemented per requirements or conditions in a water right order, Section 401 water quality certification issued pursuant to the CWA, or other appropriate order issued by the State Water Board and/or Central Valley RWQCB.

The Authority will coordinate with the Central Valley RWQCB to implement mercury/methylmercury control or reduction measures pursuant to the mercury TMDL and implementation program for reservoirs (State Water Resources Control Board 2017b), once adopted.

NEPA Conclusion

Construction effects on water quality would be the same as described above for CEQA. Construction of Alternatives 1, 2, or 3 would not violate any water quality standards or waste discharge requirements or otherwise substantially degrade surface water quality in the study area as compared to the No Project Alternative. Operation of the Project alternatives could cause a substantially adverse effect on water quality in the CBD, Funks and Stone Corral Creeks and in the north Delta as compared to the No Project Alternative, due to increases in aqueous and fish methylmercury at these locations as a result of Sites Reservoir releases during the initial filling of the reservoir or for up to 10 years after the initial filling. Methylmercury water quality effects would be minimized with implementation of Mitigation Measure WQ-1.1. However, because of the uncertainty of the effectiveness of this measure for reducing methylmercury concentrations in the reservoir such that releases do not cause exceedances of the sport fish methylmercury tissue objective and the methylmercury TMDL fish tissue objectives, this effect would remain substantially adverse.

Impact WQ-2: Violate any water quality standards or waste discharge requirements or otherwise substantially degrade surface water quality during operation

No Project

Under the No Project Alternative, the operations of the existing TC Canal, RBPP, and GCID Main Canal would continue, and no new facilities would be built and operated. Existing surface water quality conditions in the study area would not be expected to change substantially.

Significance Determination

The No Project Alternative would not violate any water quality standards or waste discharge requirements or otherwise substantially degrade surface water quality during operation because no new Project-related facilities would be operated. There would be no impact/no effect.

Alternatives 1, 2, and 3

Impact mechanisms for operating conditions under Alternatives 1, 2, and 3 would be similar. For example, all alternatives would release water into Funks Creek and Stone Corral Creek and into the conveyance system for delivery to Storage Partners. Therefore, the alternatives are evaluated together in this section with differences in operations impacts noted where appropriate.

Water Temperature

Sacramento River

Temperature effects of Sites Reservoir releases on Sacramento River water were estimated with the spreadsheet blending model for monthly water temperatures in TC Canal and CBD described in Section 6.3.2.5, *Water Temperature*. Under Alternative 1 or 3, Sites Reservoir releases would blend with CBD flows and then be discharged to the Sacramento River. Under Alternative 2, Sites Reservoir releases would be conveyed directly from the extended Dunnigan Pipeline to the Sacramento River. Tables 6-12a through 6-12d show estimated changes in Sacramento River water temperatures for Alternatives 1A, 1B, 2, and 3. The effect on Sacramento River water temperatures from either of the two conveyance methods is expected to be relatively small with the releases generally tending to cause a slight reduction in water temperature compared to the No Project Alternative. Modeled increases in water temperature are well below the Central Valley Basin Plan temperature objective that a discharge shall not increase natural receiving water temperature by 5ºF or more. More details regarding results of the monthly blending model are provided in Appendix 6D, *Sites Reservoir Discharge Temperature Modeling.*

Table 6-12a. Estimated Change in Sacramento River Water Temperature (°F) when Sites Reservoir Water is Released to the Dunnigan Pipeline under Alternative 1A

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Months[1]	0	0	0	10	8	32	45	67	70	67	27	11
10th Percentile	--	--	--	-0.5	-0.1	-0.1	-0.1	-0.3	-0.1	-0.2	-0.7	-0.1
Median	--	--	--	0.0	0.0	0.0	0.0	-0.2	0.0	0.0	-0.2	0.0
90th Percentile	--	--	--	0.0	0.2	0.1	0.0	0.0	0.3	0.1	0.0	0.0

[1] Number of months when Sites Reservoir releases to the Dunnigan Pipeline would occur during the 83-year CALSIM simulation.

Table 6-12b. Estimated Change in Sacramento River Water Temperature (°F) when Sites Reservoir Water is Released to the Dunnigan Pipeline under Alternative 1B

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Months[1]	0	0	0	15	14	43	46	67	68	66	27	10
10th Percentile	--	--	--	-0.4	-0.2	-0.1	-0.1	-0.3	-0.1	-0.2	-0.5	-0.2
Median	--	--	--	0.0	0.0	0.0	0.0	-0.2	0.0	0.0	-0.1	-0.1
90th Percentile	--	--	--	0.0	0.1	0.1	0.0	0.0	0.2	0.1	0.0	0.0

[1] Number of months when Sites Reservoir releases to the Dunnigan Pipeline would occur during the 82-year CALSIM simulation.

Table 6-12c. Estimated Change in Sacramento River Water Temperature (°F) when Sites Reservoir Water is Released to the Dunnigan Pipeline under Alternative 2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Months[1]	0	0	0	9	7	32	45	68	71	68	28	14
10th Percentile	--	--	--	-0.7	-0.3	-0.4	-0.3	-0.2	0.0	-0.2	-0.7	-0.1
Median	--	--	--	0.0	-0.2	-0.1	-0.2	0.0	0.0	0.0	-0.1	0.0
90th Percentile	--	--	--	0.0	0.1	0.0	0.0	0.0	0.1	0.1	0.0	0.0

[1] Number of months when Sites Reservoir releases to the Dunnigan Pipeline would occur during the 82-year CALSIM simulation.

Table 6-12d. Estimated Change in Sacramento River Water Temperature (°F) when Sites Reservoir Water is Released to the Dunnigan Pipeline under Alternative 3

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Months[1]	0	0	0	13	15	44	45	67	66	58	25	12
10th Percentile	--	--	--	-0.4	-0.5	-0.2	-0.2	-0.3	-0.1	-0.4	-0.5	-0.1
Median	--	--	--	0.0	0.0	0.0	0.0	-0.2	0.0	0.0	-0.2	-0.1
90th Percentile	--	--	--	0.0	0.1	0.1	0.0	0.0	0.1	0.0	0.0	0.0

[1] Number of months when Sites Reservoir releases to the Dunnigan Pipeline would occur during the 82-year CALSIM simulation.

Effect of Yolo Bypass Habitat Flows on Water Temperature in the North Delta

Alternatives 1, 2, and 3 could include releases of Sites Reservoir water to the CBD that would then pass through the Yolo Bypass for habitat improvements. This water would discharge into the Cache Slough Complex then into the Sacramento River upstream of Rio Vista. Potential temperature effects at the discharge site are considered here.

The simulated CALSIM flow increases in August–October through the Yolo Bypass expected under Alternatives 1, 2, and 3 do not exceed 470 cfs. Based on observations during North Delta Flow Actions (Davis pers. comm.), the comparable August–October habitat flows from Sites Reservoir through the Yolo Bypass may cause limited inundation of low-elevation parcels in the upper Yolo Bypass (north of the I-80 causeway). The intent of the releases from Sites to the Yolo Bypass during this period is to transport nutrients and food sources for fish species in the Delta. If the water inundates floodplain areas (i.e., areas outside existing channels), the food would remain on the floodplain and fail to move into the Delta. As such, Sites Reservoir would be operated to maintain flows within the existing Toe Drain, Tule Canal, and other channels, and adjustments in operations would be coordinated between the Authority and parcel owners using the existing Yolo Bypass monitoring network. Because these flows would generally be contained within the Yolo Bypass channels without spreading across the bypass floodplain, water temperatures within the bypass would not be expected to increase as a result of the habitat flows.

Differences between temperatures in the Yolo Bypass and temperatures in the Sacramento River at Rio Vista are shown in Table 6-2. Within the Cache Slough Complex between the Sacramento River and the Yolo Bypass there is likely a gradation of water temperatures intermediate between the temperatures of the Sacramento River and the temperatures of the Yolo Bypass. During August–October of 2015 through 2020, average temperatures in the Yolo Bypass were up to 5°F higher than temperatures in the Sacramento River at Rio Vista, with greater differences tending to occur in August.

Tidal fluxes play a large role, bringing Sacramento River water into the Cache Slough Complex, especially in the part of the complex that is closer to the Sacramento River. The Yolo Bypass flows are small compared to downstream tidal fluxes, so Yolo Bypass water must flow downstream and mix with tidal flows for an extended period to affect downstream water temperatures. For this reason, the average Yolo Bypass temperatures are more relevant to downstream effects than the short-duration daily maximum temperatures.

When Yolo Bypass temperatures are warmer than Sacramento River water temperature, it is possible that increased Yolo Bypass flows could extend the influence of the Yolo Bypass temperatures slightly downstream when compared to the No Project Alternative. This is more likely to occur when Project flow pulses are higher and occur during August when the temperature differential tends to be greater. Even under these Project conditions, however, tidal mixing with cooler water from the Sacramento River near Rio Vista is likely to quickly dissipate this effect as the Yolo Bypass water moves downstream. Due to tidal mixing and the limited temperature differential between the Sacramento River and Yolo Bypass temperatures, it is unlikely there would be any substantial zone where an increase in water temperature would be more than 5°F.

By the time the additional Yolo Bypass flow from Sites Reservoir releases reaches the Sacramento River, its potential temperature effect would be greatly reduced. Typically, habitat flows through the Yolo Bypass would be greater during Wet Water Years than during Critically Dry Water Years. However, even if the maximum Yolo Bypass habitat flow (470 cfs) were to occur when monthly average CALSIM net flow in the Sacramento River at Rio Vista were at its lowest value of approximately 3,000 cfs, the Sacramento River would still substantially dilute the Yolo Bypass flows such that the Yolo Bypass habitat flow would only represent about 13.5% of the water in the Sacramento River. If this occurred at a time when differences between Yolo Bypass temperatures and Sacramento River temperatures were relatively large (5°F difference), the maximum increase in Sacramento River water temperature would be about 0.7°F (i.e., 0.135*5°F), with the effect possibly diminished by tidal fluxes.

Salinity

Salinity in the Sacramento River between Red Bluff and Knights Landing is about 130 µS/cm with only small variation within and between months. This low value is below all water quality objectives for salinity, and it is expected that water diverted from the Sacramento River to Sites Reservoir would have low salinity based on measured data.

Sites Reservoir, Salt Pond, and Sacramento River

Salinity in Sites Reservoir could increase due to evapoconcentration and local inputs from Salt Pond and Funks and Stone Corral Creeks. However, these increases would not cause substantial degradation to surface water quality. The reservoir would be filled with Sacramento River water, which has relatively low EC of 130 µS/cm and, as explained below, evapoconcentration and local inputs would not substantially increase salinity in the reservoir and would not degrade water quality.

Salt Spring Water Mixing in Sites Reservoir. The effect of the Salt Pond on salinity in Sites Reservoir is expected to be very small, even at the lowest storage levels, assuming the Salt Pond water fully mixes with the Sites Reservoir water. Complete mixing might occur with annual fall turnover, which occurs when the surface water becomes cooler and denser than the deeper water. Mixing could also occur at other times if the spring water is substantially warmer than the reservoir water. It is unlikely the salt springs would flow during dry years. If the flow is assumed to be 0.1 cfs, this would represent a small fraction of the total reservoir volume even during the driest conditions when reservoir storage would be close to 40 TAF (approximate lowest reservoir storage volume, as estimated by CALSIM). Assuming 0.1 cfs of flow into a volume of 40 TAF, the annual volume of saline water from the Salt Pond would represent 0.18% of the total volume. The salinity of the Sacramento River water near the intakes is 130 µS/cm. If this salinity is blended with 0.18% of the Salt Pond water, the blended water would have EC of about 140–480 µS/cm depending on whether the calculation uses the Salt Pond measured concentrations of 7,200 or 194,100 µS/cm. The higher concentration (194,100 µS/cm) likely represents spring water that was extensively concentrated through evaporation. If the same calculation is done for a 100 TAF reservoir, a storage volume large enough to provide some releases for water supply, the resulting EC is 135–270 µS/cm.

Salt Spring Water Sinking to the Bottom of Sites Reservoir. The saline mineral water of the springs that supply Salt Pond would generally be much denser than the reservoir water (with density depending on the salinity and temperature of the spring water). Given the density, the spring water would generally accumulate at the bottom of the reservoir. The spring water may tend to move downward following Funks Creek channel, with some water mixing with the rest of the reservoir and some arriving at Golden Gate Dam. The distance from Salt Pond to the location of Golden Gate Dam is approximately 2.4 miles, providing a moderate distance for the spring water to mix with the reservoir water. There would be no outlet at the base of Golden Gate Dam, so spring water would accumulate to some degree behind the dam. The Sites I/O tower is located south of Golden Gate Dam, with the bottom intake at an invert elevation of approximately 300 feet. The volume of water below 300 feet that is adjacent to the I/O tower and Golden Gate Dam is approximately 5,300 AF, so a minimum of 74 years of the estimated spring discharge of 71 AF/yr would need to accumulate behind the dam before it would reach the elevation of the I/O tower.

If spring water accumulated behind Golden Gate Dam for more than 74 years and eventually reached the level of the I/O tower it potentially could mix directly with the reservoir release. If 0.1 cfs of spring flow is continually released with the Sites Reservoir outflow, the EC of the outflow would depend on the reservoir release (10 cfs to about 2,650 cfs) and the EC of the spring water (7,200 µS/cm to 194,100 µS/cm), with estimated outflow EC varying between 130 and 2,070 µS/cm (Table 6-13). The highest EC estimate is associated with the combination of a low reservoir release (10 cfs) and the highest EC value for the spring (194,100 µS/cm). This high EC value likely represents spring water that has been concentrated through evaporation and the low outflow of 10 cfs would likely occur only when water is being released solely to provide supply to Funks Creek.

Table 6-13. Estimated Electrical Conductivity (EC in µS/cm) of Reservoir Release If Salt Pond Water Were to Mix Directly with the Release [1]

Salt Pond EC (µS/cm)[2]	Electrical Conductivity with a 10 cfs Reservoir Release (µS/cm)	Electrical Conductivity with a 2,650 cfs Reservoir Release (µS/cm)
7,200	201	130
194,100	2,070	137

[1] Assuming 0.1 cfs salt spring flow is continually mixed with reservoir release and that EC in the rest of Sites Reservoir is 130 µS/cm.

[2] Salt spring EC is assumed to be between these two measured values because the low value was measured during a period of high precipitation and the high value was measured during the summer when salts from prolonged spring discharges would be accumulated and concentrated due to evaporation.

For the spring water to mix directly with the reservoir release, it would first need to accumulate in substantial quantities by the base of Golden Gate Dam (estimated to take 74 years). The RMP includes water quality monitoring before and after construction to verify that the Salt Pond water would have little to no effect on salinity in Sites Reservoir, and also describes measures that could be taken to prevent any temporary substantial increases in salinity in the reservoir release should monitoring indicate reason for concern (Section 2D.3).

Stone Corral and Funks Creeks. Inflows from Stone Corral Creek and Funks Creek are unlikely to cause substantial increases in reservoir salinity. Average EC in these creeks, about 2,000 µS/cm for Stone Corral Creek near Sites and 520 µS/cm for Funks Creek near Maxwell, is higher than the Sacramento River water used for filling Sites Reservoir (130 µS/cm). As described in Chapter 5, the volume of inflow from these creeks is small, estimated to be a combined average of 14 TAF/yr. In general, when creek inflow is high, Sites Reservoir storage would also be high, providing substantial dilution. Furthermore, if the more saline water of upper Stone Corral Creek does not mix within Sites Reservoir, it likely would sink to the bottom of the reservoir near Sites Dam and be released to lower Stone Corral Creek downstream of Sites Dam, where it would be no more saline than under the No Project Alternative.

Combination of Salt Springs and Maximum Evapoconcentration Effects at Low Reservoir Storage. Salinity in Sites Reservoir may also increase due evapoconcentration, which may increase EC by 16%–18% on average, with maximum increases of 104%–139% that are expected to be very rare. Maximum evapoconcentration would occur at the lowest reservoir storage of approximately 40 TAF as estimated by CALSIM. A rough estimate of the salt springs effect on reservoir salinity at this storage might be to increase EC to 300 µS/cm (1 year of spring flow fully mixed into a 40 TAF reservoir). If the maximum evapoconcentration occurred, reservoir EC of 300 µS/cm would increase to approximately 720 µS/cm. This value is unlikely to affect beneficial uses in the reservoir, especially considering that this would be temporary and lower than many of the EC values measured in Stone Corral Creek.

Combination of Salt Springs and Evapoconcentration Effects on Water Supply Releases to the Sacramento River. As described in Section 6.3, *Methods of Analysis*, the Sites Reservoir water subject to the highest evapoconcentration would not be released for water supply. The 90th percentile of the percent evapoconcentration in the reservoir when water supply releases would be made can be used as a high-end estimate of evapoconcentration for water released for water supply. These 90th percentile values range from 23% to 27% depending on alternative. When water is released for water supply, reservoir storage would be greater than the minimum CALSIM storage of about 40 TAF and the effect of the salt springs on EC would be smaller and could be approximately 200 µS/cm (1 year of spring flow fully mixed into a 100 TAF reservoir). If the 90th percentile evapoconcentration described above (23%–27%) occurred, reservoir EC of 200 µS/cm would increase to about 250 µS/cm. Sites Reservoir water would be greatly diluted when it is eventually discharged into the Sacramento River, either via the CBD (Alternatives 1 and 3) or via the Dunnigan Pipeline Sacramento discharge (Alternative 2). When Sites Reservoir releases are being made, they generally would contribute less than 15% of the flow in the Sacramento River (90th percentile values for the contribution are 14%–15%, depending on alternative). Even if EC in Sites Reservoir were to increase from 130 µS/cm to about 250 µS/cm (representing a combination of substantial evapoconcentration and saline input from Salt Pond), the effect of having this water contribute 15% to the Sacramento River water would be relatively small, potentially changing the Sacramento River EC from 130 µS/cm to approximately 148 µS/cm, which is substantially below any water quality standards for salinity and would not represent substantial degradation of water quality.

Delta

Delta outflow is a major driver of salinity in the Delta. As estimated by CALSIM and DSM2, slight changes in Delta salinity are anticipated to result from small differences in Delta inflow and exports associated with Alternatives 1, 2, and 3. Most Delta objectives (i.e., 17 salinity objectives for agriculture and fish and wildlife and 5 chloride objectives for drinking water), are always attained for the No Project Alternative and Alternatives 1, 2, and 3. While the CALSIM results generally correspond to attainment of the Delta water quality objectives for salinity, due to the coarse scale (monthly time step) of CALSIM analysis for the Delta, there can be instances when the more detailed analysis (15-minute time step) with the DSM2 model shows non-attainment (i.e., non-compliance). At multiple locations there are a few instances of non-compliance indicated by the DSM2 results for conditions under the No Project Alternative, but the number of instances of non-compliance are not increased as a result of Alternatives 1, 2, and 3 (Appendix 6B).

The relatively small magnitude of changes in salinity expected in the southern Delta at the CVP and SWP export locations is shown in Tables 6-14 and 6-15. Salinity at these locations is partially affected by changes in seawater intrusion and also influenced by other factors such as the relationship between export volume and the Delta withdrawal zone affected by the exports. The average results for Critically Dry and Wet Water Years for the SWP exports (Table 6-14), show that the changes in salinity would be small, with slightly larger percent changes occurring during Critically Dry Water Years; ranging from reductions of 1%–3% for November to increases of 2% for September and October, with all values remaining well below the water quality standard of 1,000 µS/cm. The CVP receives a higher percentage of water from the San Joaquin River; therefore, its salinity is slightly less affected by Alternatives 1, 2, and 3 because

Alternatives 1, 2, and 3 would not affect flow from the San Joaquin River (Table 6-15). Modeled changes in salinity at these export locations and differences between Alternatives 1, 2, and 3 are small, and no substantial degradation or violations of water quality objectives are expected.

Table 6-14. Clifton Court Forebay (SWP Banks Pumping Plant) Electrical Conductivity: No Project Alternative (µS/cm) and Percent Change between No Project and Alternatives 1, 2, and 3 (positive value indicates an increase)

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Critically Dry Water Years												
NPA (µS/cm)	670	646	714	753	622	496	462	449	423	456	496	556
Alt 1A % Change	2	-2	0	-1	0	0	0	0	0	-1	0	2
Alt 1B % Change	2	-2	0	0	0	0	-1	-1	0	0	0	2
Alt 2 % Change	0	-3	0	-1	0	0	0	0	0	-1	0	0
Alt 3 % Change	1	-1	0	1	1	0	-1	-1	0	-1	-1	0
Wet Water Years												
NPA (µS/cm)	269	286	443	455	397	350	301	288	295	281	280	291
Alt 1A % Change	-1	0	0	1	0	0	0	0	0	0	0	-1
Alt 1B % Change	-1	0	0	1	0	0	0	0	0	0	0	-1
Alt 2 % Change	-1	0	0	1	0	0	0	0	0	0	0	-1
Alt 3 % Change	-1	0	0	1	0	0	0	0	0	0	0	-1

Alt = Alternative, NPA = No Project Alternative
Note: The salinity objective for the SWP exports is 1,000 uS/cm.

Table 6-15. Jones CVP Pumping Plant Electrical Conductivity: No Project Alternative (µS/cm) and Percent Change between No Project and Alternatives 1, 2, and 3 (positive value indicates an increase)

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Critically Dry Water Years												
NPA (µS/cm)	669	643	788	817	736	702	586	495	419	461	511	590
Alt 1A % Change	0	-1	0	-1	0	0	0	0	0	0	1	1

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Alt 1B % Change	0	-1	0	0	0	-2	0	0	0	0	1	1
Alt 2 % Change	-1	-2	0	-1	0	0	0	0	0	0	0	-1
Alt 3 % Change	0	-1	0	0	0	-2	0	0	0	0	0	0
Wet Water Years												
NPA (µS/cm)	347	341	526	510	413	359	271	285	323	320	310	333
Alt 1A % Change	-1	0	0	0	0	0	0	0	0	0	0	-1
Alt 1B % Change	-1	0	0	0	0	0	0	0	0	0	0	-1
Alt 2 % Change	-1	0	0	0	0	0	0	0	0	0	0	-1
Alt 3 % Change	-1	0	0	0	0	0	0	0	0	0	0	-1

Alt = Alternative, NPA = No Project Alternative
Note: The salinity objective for the CVP exports is 1,000 µS/cm.

Modeled changes in seawater intrusion during Critically Dry and Wet Water Years are demonstrated in Tables 6-16 and 6-17, which show X2 and salinity at Mallard Island, respectively. Note that changes for X2 are reported in kilometers (km) and those for Mallard Island EC are identified as percentages. X2 is an indicator of aspects of habitat suitability other than just salinity. The location of X2 is important to both aquatic life and water supply beneficial uses. Some of the correlation with fish habitat is due to increased area of suitable habitat at lower values of X2. This chapter considers seawater intrusion in general and attainment of X2 standards (changes in X2 related to habitat suitability and availability for fish are evaluated in Chapter 11, *Aquatic Biological Resources*).

The X2 results show reductions of up to 0.7 km during July through October (i.e., less seawater intrusion), and variable small effects the rest of the year with some small increases. In Table 6-16, the largest increase in average X2 is 0.3 km for Alternative 1B during December of Wet Water Years. Reductions in X2 are generally bigger during Critically Dry Water Years than Wet Water Years because more water would be released from Sites Reservoir during Critically Dry Water Years and the changes in flow during Critically Dry Water Years would represent a larger percent of total flow. The differences between Alternatives 1, 2, and 3 are small, mostly less than 0.1 km.

Table 6-17 shows how these changes in seawater intrusion correspond with EC values at Mallard Island, located 74 km from the Golden Gate Bridge. The EC patterns at Mallard Island are roughly similar to the X2 results in terms of timing and magnitude of change. The largest increases in simulated EC are 3% in January and April of Wet Water Years, when salinity is low.

Based on the evaluation of DSM2 results for compliance with water quality objectives, attainment of numeric salinity and chloride objectives in the Delta, including X2, is not expected to be reduced by the Project. Small increases in seawater intrusion could occur, but these increases would occur during the time of year when salinity is lower because more water is moving through the Delta. Due to the timing and small magnitude of these increases, they do not represent a substantial degradation of water quality.

Table 6-16. X2: No Project Alternative (km) and Change between No Project and Alternatives 1, 2, and 3 (km)

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Critically Dry Water Years												
NPA (km)	92.6	92.2	87.7	83.8	77.5	76.9	79.0	84.1	87.1	89.5	91.5	92.9
Alt 1A Change	-0.3	-0.1	0.0	0.2	0.1	0.2	0.1	-0.1	-0.1	-0.3	-0.7	-0.7
Alt 1B Change	-0.2	0.0	0.0	0.2	0.1	0.2	0.1	0.0	0.0	-0.3	-0.6	-0.7
Alt 2 Change	-0.3	-0.1	0.0	0.2	0.1	0.2	0.1	-0.1	-0.1	-0.3	-0.7	-0.7
Alt 3 Change	-0.1	-0.1	-0.1	0.2	0.0	0.2	0.1	0.0	0.0	-0.3	-0.5	-0.3
Wet Water Years												
NPA (km)	77.7	78.9	74.9	57.6	54.8	55.5	56.8	59.3	65.4	73.6	80.9	77.9
Alt 1A Change	-0.3	0.1	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	-0.3	-0.5
Alt 1B Change	-0.3	0.2	0.3	0.2	0.0	0.0	0.0	-0.1	0.0	0.0	-0.3	-0.5
Alt 2 Change	-0.3	0.1	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	-0.3	-0.5
Alt 3 Change	-0.2	0.2	0.3	0.1	0.0	0.0	0.1	0.0	0.0	0.0	-0.3	-0.4

Alt = Alternative, NPA = No Project Alternative

Table 6-17. Mallard Island Electrical Conductivity: No Project Alternative (µS/cm) and Percent Change between No Project and Alternatives 1, 2, and 3

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Critically Dry Water Years												
NPA (µS/cm)	13,694	13,688	10,850	8,425	4,793	4,213	4,914	7,313	9,043	10,735	12,156	13,400
Alt 1A % Change	-1	0	0	0	1	1	1	0	-1	-1	-2	-3
Alt 1B % Change	-1	0	0	0	1	1	1	0	0	-1	-2	-3

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Alt 2 % Change	-1	0	0	0	1	1	1	0	-1	-1	-3	-3
Alt 3 % Change	0	0	-1	0	0	1	1	0	0	-1	-2	-1
Wet Water Years												
NPA (µS/cm)	4,076	5,480	5,287	658	229	241	320	605	1,490	3,120	5,899	4,386
Alt 1A % Change	-3	1	1	3	1	0	0	1	0	0	-2	-5
Alt 1B % Change	-2	1	1	3	0	0	1	-3	-1	0	-2	-4
Alt 2 % Change	-3	0	1	3	1	0	0	1	0	0	-2	-5
Alt 3 % Change	-1	1	2	0	0	0	3	-2	-1	0	-2	-4

Alt = Alternative, NPA = No Project Alternative

Nutrients, Organic Carbon, and Dissolved Oxygen

Shasta Lake, Lake Oroville, Folsom Lake, and San Luis Reservoir

Under Alternatives 1 and 3, storage in Shasta Lake would increase slightly relative to the No Project Alternative, with more increases expected during Critically Dry Water Years than Wet Water Years (Chapter 5, Table 5-11). Under Alternative 2 there would be a slight increase in storage in all months of Critically Dry Water Years except October, March, and April. Similarly, operation of Alternatives 1, 2, and 3 would result in minimal effects on storage in Lake Oroville and Folsom Lake (Chapter 5, Tables 5-22 and 5-24, respectively). Relative to the No Project Alternative, in Critically Dry Water Years there would be small reductions in storage in Lake Oroville (up to 3% from October through December) for Alternatives 1 and 2, and nominal increases in storage in the summer months for Alternatives 1, 2, and 3. In Folsom Lake, storage reductions in Critically Dry Water Years would be greatest for Alternative 1A (up to 4% reductions from October through December), otherwise, changes in storage would be small.

The Project would allow substantial increases in exports during the summer and early fall of Critically Dry Water Years (Chapter 5, Table 5-28). These greater exports could result in more storage in San Luis Reservoir, the main receiving reservoir for Delta exports (Chapter 5, Table 5-29), although these exports would eventually be released from San Luis Reservoir for water supply purposes.

Given these minimal changes in storage relative to the No Project Alternative and because most of the changes would be increases in storage, operation of Alternatives 1, 2, and 3 would not substantially change existing water quality conditions in these reservoirs with regard to nutrients, organic carbon, or DO. As such, Project operations would not violate water quality standards or waste discharge requirements or otherwise substantially degrade water quality in these reservoirs.

Sites Reservoir

In the long term, the concentrations of nutrients, organic carbon, and DO would be influenced by multiple factors including reservoir storage, thermal stratification, source water quality, rainfall, and watershed runoff. Stone Corral Creek is impaired by low DO; Sacramento River water is not impaired by nutrients, organic carbon, or DO. Flows in Stone Corral Creek and Funks Creek are intermittent and would collectively represent a small input to the reservoir compared to the Sacramento River. Therefore, these creeks are not expected to have a substantial influence on nutrients, organic carbon, or DO in Sites Reservoir.

A typical Northern California reservoir is relatively well-mixed during the winter and early spring. It thermally stratifies in late spring, summer, and early fall and turns over (i.e., complete vertical mixing) in late fall when temperatures become uniform throughout the vertical water column. Sites Reservoir is expected to follow this pattern and thermally stratify during the late spring, summer, and early fall. Thermal stratification in the summer would likely result in a reduction of oxygen toward the bottom of the reservoir in the hypolimnion. However, reservoir fish would likely not be affected by this reduction because they would not be in the hypolimnion. Further reduction of DO levels in the reservoir may be expected in late fall, generally, due to die-off of cyanobacteria and/or algae. The magnitude of the reduction would depend on the magnitude of the die-off; if there is a substantial reduction in DO in the reservoir, fish may be affected. Water with low DO may sometimes be released from the bottom of the reservoir to Stone Corral Creek, but this water would become oxygenated quickly due to reaeration at the water-air interface. The dominance of Sacramento River inflows to Sites Reservoir during the winter and spring (i.e., when diversions would occur) would bring relatively cool and oxygenated surface water to the reservoir. Accordingly, water quality effects related to reduced DO in Sites Reservoir would not be expected in the long term.

Organic carbon concentrations may increase in the fall with die-off and decomposition of cyanobacteria and algae. This would not result in adverse water quality effects in Sites Reservoir because any increase would be temporary. Organic carbon levels would be diluted in the wet season and organic carbon is a critical part of the aquatic food web.

In Sites Reservoir, similar to other Central Valley reservoirs, nutrient concentrations would likely be sufficient for HABs formation and sustainment in the long term given that nitrogen and phosphorus would be available in water diverted to the reservoir from the Sacramento River and in watershed runoff. Water quality conditions would be conducive to the growth of HABs forming cyanobacteria as well as algae, particularly in the summer when water temperatures in the reservoir would be warmer and nutrients would be more concentrated due to reduced storage volume. Nutrients would also support the growth of invasive and noninvasive aquatic plants. Also, as with other Central Valley reservoirs, when the thermal stratification disappears in the late fall, phosphorus that may have been released from sediment under anoxic conditions would mix throughout the water column and may exacerbate potentially poor water quality conditions at this time of year. Nutrient concentrations in the Sacramento River upstream of Sites Reservoir are relatively low and nitrogen levels are below the California drinking water MCLs for nitrate and nitrite (as nitrogen). Given the dominance of Sacramento River inflows to Sites Reservoir during winter and spring, and the relatively low concentration of nutrients in those inflows, nutrient levels in Sites Reservoir would not violate any water quality objective or substantially degrade reservoir water quality.

Colusa Basin Drain and Sacramento River

Sites Reservoir releases to the CBD for Alternatives 1, 2, and 3 would likely have minimal effects on, or would potentially reduce, nutrient concentrations in the CBD because of the expected volume of those releases. Sites Reservoir water would be diluted once discharged into the Sacramento River, either via the CBD (Alternatives 1 and 3) or via the Sacramento discharge (Alternative 2) because releases would generally contribute less than 15% of the flow in the Sacramento River. (90th percentile values for the contribution are 14%–15%, depending on the alternative). Accordingly, there would be no downstream adverse water quality effects in the Sacramento River related to nutrients from Sites Reservoir.

Low DO concentrations in the hypolimnion in Sites Reservoir due to summer thermal stratification would not have any downstream effects on beneficial uses or water quality. Any releases made from this depth would be expected to become amply aerated once released and conveyed through Funks Reservoir and the TC Canal or through the TRR and the GCID. Accordingly, water quality in the CBD, which is impaired by low DO, may benefit from Sites Reservoir releases.

Organic carbon concentrations in Sites Reservoir may increase in the fall with die-off of cyanobacteria and algae. Initially, concentrations would likely be higher toward the water's surface where cyanobacteria and algae would be concentrated in areas of the reservoir where HABs and algae may be concentrated. Eventually, the decaying organic matter would settle to the reservoir bottom. Releases from Sites Reservoir would not be expected to contribute substantially to organic carbon levels in the CBD, which has relatively high levels of dissolved organic carbon due, in large part, to the agricultural drainage water received by the canal under the No Project Alternative. Sites Reservoir releases to the CBD may reduce the relatively high organic carbon concentrations in the CBD because of the expected volume of Sites Reservoir releases and likely low concentrations of organic material relative to the CBD. Further downstream in the Sacramento River, the organic carbon load in Sites Reservoir releases would be greatly diluted and thus would not substantially degrade water quality such that beneficial uses would be affected. There are no federal or state numeric surface water quality objectives for organic carbon. Water released from Sites Reservoir would not be expected to have a direct effect on the production of DBPs during chlorine treatment at downstream drinking water treatment plants along the Sacramento River.

Levels of nutrients, organic carbon, and DO in Sites Reservoir releases would not violate water quality standards or waste discharge requirements or otherwise substantially degrade water quality in the CBD.

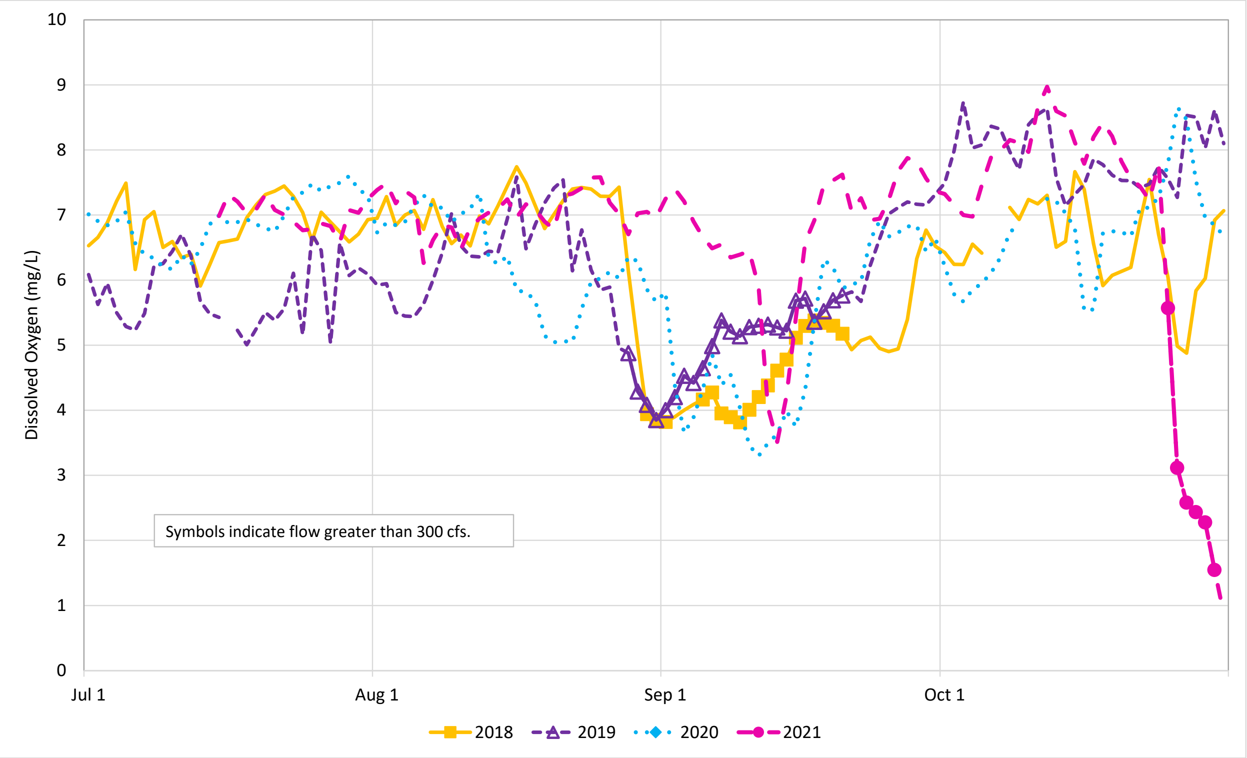
Yolo Bypass and the Delta

Most releases from Sites Reservoir would be made during Dry and Critically Dry Water Years. Yolo Bypass releases for habitat purposes would occur during all water year types in August–October, with the highest volume being released in wet years. Flows to the bypass are generally low historically during this 3-month period. These releases are intended to benefit listed fish species by enhancing flow through Yolo Bypass and thereby increase nutrient inputs to the north Delta to promote food (phytoplankton) production, although there remains some uncertainty as to whether these benefits would be realized given mixed results from past studies. In 2011 and 2012 it was observed that larger-than-normal agricultural flow pulses to Yolo Bypass were followed by downstream Delta phytoplankton blooms (Bay Delta Live 2019:1). Such flow pulses were tested in 2016 and 2018 in the North Delta Flow Action studies and had mixed results for phytoplankton production. In 2016, the managed high-flow pulse (12,700 AF) using Sacramento River water over 2 weeks in July coincided with an increase in phytoplankton (as measured by chlorophyll *a*) through Yolo Bypass and in the Delta at Rio Vista (Bay Delta Live 2019:2). In 2018, a larger managed high-flow pulse (19,824 AF) from August to September with agricultural return flows mostly from rice field drainage in the CBD did not coincide with an increase in phytoplankton through Yolo Bypass. The goal of habitat releases from Sites Reservoir through the CBD to Yolo Bypass is biostimulatory in nature; that is, the purpose is to increase phytoplankton production to benefit north Delta fish species. the Central Valley Basin Plan contains a narrative objective for biostimulatory substances, which is that "water shall not contain biostimulatory substances which promote aquatic growths in concentrations that cause nuisance or adversely affect beneficial uses" (Central Valley Regional Water Quality Control Board 2019a). Assuming that observed changes in phytoplankton biovolume during and after the habitat releases from Sites Reservoir are similar to those from the North Delta Flow Action studies, where there were generally lower median phytoplankton biovolumes in most years (2014–2019) at both upstream and downstream sites in Yolo Bypass following the flow pulse (Davis et al. 2022:158), there would be no detrimental changes in productivity in Yolo Bypass and downstream.

If Yolo Bypass habitat releases from Sites Reservoir were to successfully increase phytoplankton, this increase in TOC would not likely be increased substantially near the Barker Slough Pumping Plant relative to the No Project Alternative. The tidal flow in the Delta would dilute any potential increase in TOC prior to it reaching Barker Slough. Yolo Bypass habitat releases from Sites Reservoir would not cause a substantial increase in the formation of DBPs at drinking water treatment plants that utilize Delta water. Further, water treatment plants are capable of removing phytoplankton (particulate TOC) from source water. For these reasons, Sites Reservoir habitat releases would not violate the Central Valley Basin Plan's narrative objective for drinking water constituents of concern or the Disinfectants and Disinfection Byproducts Rule or otherwise substantially degrade water quality.

DO levels in the Yolo Bypass may be temporarily affected by habitat releases from Sites Reservoir during the release period. Results from the 2018 and 2019 North Delta Flow Action studies indicated that the daily mean DO concentration at upstream locations in Yolo Bypass (from CBD at Rominger Bridge to the Yolo Bypass Toe Drain at Liberty Island near Courtland) decreased during the approximate 4-week managed pulse flow period beginning late August, particularly at monitoring locations in the lower Yolo Bypass (i.e., Toe Drain at Lisbon Weir); DO concentrations downstream at Cache Slough, Ryer Island and the Sacramento River at Rio Vista Bridge (Davis et al. 2022). Agricultural drainage water was used to generate the high-flow pulses (maximum daily average net flow at Lisbon Weir exceeded 300 cfs) in 2018 and 2019. In both years, during the high-flow pulse, the DO concentration dropped below the Central Valley Basin Plan 5.0 mg/L water quality objective for multiple days, but returned fairly quickly to prepulse flow concentrations after the flow action had ended (Twardochleb et al. 2021; Maguire et al. 2020; Davis et al. 2022). If the observed temporary reduction in DO levels during 2018 and 2019 is representative of what may occur due to Sites Reservoir water being released and pushing low DO water from the CBD downstream, a temporary reduction in DO in the levels in the Toe Drain, Tule Canal, and other channels in Yolo Bypass would potentially occur but would not be substantial. While DO in Yolo Bypass may temporarily drop below 5.0 mg/L as a result of the habitat releases from Sites Reservoir, this would not be substantially different than what occurs historically during non-managed flow pulses. For example, in 2020 and 2021, years in which there was no managed flow pulse but still a small to moderate flow pulse in the north Delta due to local agricultural activities (e.g., rice field drainage), daily average DO levels in the Toe Drain near Lisbon Weir temporarily dropped below 5.0 mg/L (Figure 6-5a). As shown in Figure 6-5b, in both managed and non-managed flow pulse years, as flows increase (up to approximately 250–300 cfs) there is an apparent reduction in DO as measured in the Yolo Bypass Toe Drain near Lisbon Weir.

Sites Reservoir habitat releases to the Yolo Bypass would not be expected to violate water quality standards or waste discharge requirements or otherwise substantially degrade water quality in Yolo Bypass or the Delta with regard to nutrients, organic carbon, or DO.



Notes: Managed flow pulses through the Yolo Bypass occurred during 2018 and 2019, and non-managed pulses occurred during 2020 and 2021. The large drop in dissolved oxygen during October 2021 was caused by an unusually large rain event that brought large amounts of organic material into the waterways of the Yolo Bypass.

Figure 6-5a. Daily Average Dissolved Oxygen Measured in the Yolo Bypass Toe Drain near Lisbon Weir.

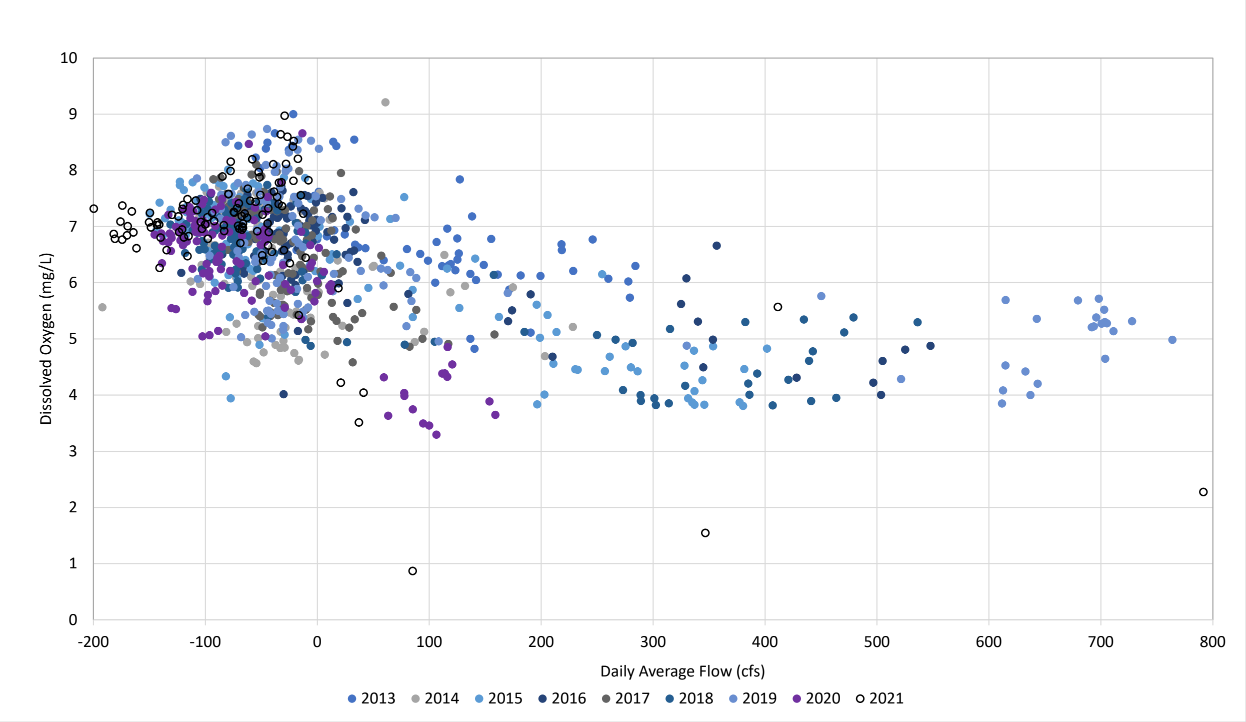


Figure 6-5b. Daily Average Dissolved Oxygen (mg/L) vs. Flow (cfs) Measured in the Yolo Bypass Toe Drain near Lisbon Weir during July–October.

Mercury and Methylmercury

Shasta Lake, Lake Oroville, and Folsom Lake

Modeling results for Lake Oroville, Shasta and Folsom Lakes, and San Luis Reservoir showed no substantial changes in end-of-month storage under Alternatives 1, 2, and 3 relative to the No Project Alternative in all water year types (Appendix 5B, Appendix 6F). Thus, mercury and methylmercury dynamics in these reservoirs, as influenced by storage levels, are not expected to be affected by Project operation.

Sites Reservoir

Mercury in Sites Reservoir would come from a variety of sources including existing soils in the inundation area due to atmospheric deposition, diversions from the Sacramento River, and atmospheric deposition to reservoir water. The potential atmospheric deposition of mercury to Sites Reservoir can be extrapolated from that in nearby reservoirs. Black Butte, Stoney Gorge, East Park, and Indian Valley Reservoirs are located in the Coast Range to the immediate west of the Project. These reservoirs are not affected by legacy mercury mines and the primary anthropogenic source of mercury to these reservoirs is from direct atmospheric deposition, ranging from 11.7 to 22.4 g/km/year (39th to 97th percentiles among 74 California reservoirs) based on REMSAD model estimates (State Water Resources Control Board 2017b). Inputs from Funks and Stone Corral Creeks are expected to be negligible given the intermittent flow in these creeks.

It is anticipated that Sites Reservoir would result in net methylation of mercury, with more methylmercury being generated within the reservoir than would be degraded, at least in the short term. The concentration of methylmercury in Sites Reservoir would be at least as high as that entering Sites Reservoir from the Sacramento River, and likely somewhat higher due to in-reservoir mercury methylation in the long term.

Thermal stratification of Sites Reservoir from late spring through early fall would affect in-reservoir mercury methylation. Due to thermal stratification, oxygen in the hypolimnion would become depleted which would in turn stimulate mercury methylation by bacteria. As such, reservoir releases from the epilimnion during the summer would be less likely to have elevated methylmercury concentrations relative to releases from the hypolimnion.

Reservoir fluctuations would also contribute to conditions favorable to mercury methylation. Modeled mean annual long-term average minimum and maximum WSEs at Sites Reservoir are presented in Table 6F-2 (Appendix 6F). Sites Reservoir water level fluctuations would also contribute to mercury methylation. Based on CALSIM results, the annual average fluctuation (maximum water year surface elevation minus the minimum water year surface elevation) are lowest for Alternative 1A (approximately 36 feet) and greatest for Alternative 3 (approximately 46 feet) (Appendix 6F, Figure 6F-1 and Table 6F-2). Based on a comparison of fluctuations in other reservoirs considered in Appendix B of the Statewide Mercury Control Program for Reservoirs, which range from 3.8 feet to 158 feet (median 25 feet), expected Sites Reservoir fluctuations would be within the ranges reported by other state reservoirs and greater than median fluctuations, which indicates that Sites Reservoir fluctuations would likely contribute to conditions favorable to mercury methylation.

Expected and reasonable worst-case long-term average mercury and methylmercury concentrations in Sites Reservoir for Alternatives 1, 2, and 3 are presented in Table 6-18.

Table 6-18. Estimated Long-Term Average Concentrations of Total Mercury and Methylmercury in Sites Reservoir

Estimated Concentration	Long-Term Average (>10 years after filling) (ng/L)
Expected Total Mercury	1.4
Reasonable Worst-case Total Mercury[1]	1.8
Expected Methylmercury	0.08
Reasonable Worst-case Methylmercury[1]	0.12

Notes: ng/L = nanogram per liter

[1] The term "reasonable worst-case" refers to an estimated upper bound of the expected average concentration based on the published literature and site-specific conditions. It is not necessarily the maximum concentration that could occur in Sites Reservoir.

The primary source of diversion to the Sites Reservoir would be from the Sacramento River at Red Bluff with up to 2,100 cfs, plus losses. Diversions from the Sacramento River at Hamilton City would be up to 1,800 cfs, plus losses. Considering such losses, CALSIM modeled data indicate that 73% of flow to Sites would originate from Sacramento River diversions at Red Bluff and 27% from Hamilton City on an annual average basis. Based on the Sacramento River mean and 75th percentile source water mercury and methylmercury concentrations diverted to

Sites Reservoir, the long-term average concentrations of total mercury and methylmercury entering Sites Reservoir was estimated to be from 1.4 to 1.8 ng/L and 0.04 to 0.06 ng/L, respectively. Total mercury concentrations in Sites Reservoir over the long-term are expected to range between the mean and 75th percentile concentrations entering the reservoir from Sacramento River diversions. Thus, the expected long-term average total mercury concentration is 1.4 ng/L and a reasonable worst-case total mercury concentration is 1.8 ng/L (Table 6-18). It is estimated that the long-term expected average aqueous methylmercury concentrations in Sites Reservoir would be approximately 0.08 ng/L. This value was calculated by doubling the estimated methylmercury concentration determined for average diversions to Sites Reservoir from the Sacramento River (i.e., 0.04 ng/L). This estimated concentration accounts for methylmercury generation within the reservoir and is consistent with the range of methylmercury concentrations among neighboring reservoirs (Table 6F-8). With the exception of Clear Lake, this value is slightly less than the maximum long-term average water column methylmercury concentration among nearby reservoirs (0.093 ng/L), which is from Indian Valley Reservoir in 2011 (the nearest reservoir for which methylmercury data were available). An estimate of the reasonable worst-case long-term methylmercury concentration in Sites Reservoir is approximately 0.12 ng/L (Table 6-18). This value was determined by doubling the 75th percentile of inflow concentrations in Sites Reservoir diversions. It is important to note that given that these are estimated concentrations, there is inherent uncertainty associated with these values and they may be conservative.

As described under Impact WQ-1, normalized fish tissue methylmercury concentrations among nearby reservoirs are relatively consistent despite the variation in the size, depth, and surrounding mercury sources. Assuming similar fish species and comparable food web structures with these reservoir counterparts, a reasonable expected average fish tissue concentration (normalized to 350 mm largemouth bass, ww) is approximately 0.47 mg/kg. This is the median value among reservoirs and is similar to the mean fish tissue mercury concentrations from East Park Reservoir in 2008. A reasonable worst-case fish tissue concentration is the 99th percentile value among these reservoirs (0.85 mg/kg, ww), which is similar to the mean fish tissue mercury concentrations from nearby Indian Valley Reservoir in 2008. These concentrations exceed the 0.2 mg/kg, ww sport fish objective.

Funks and Stone Corral Creeks

Because most of the flow in Funks and Stone Corral Creeks would originate from Sites Reservoir releases, mercury and methylmercury concentrations in these creeks would increase. The magnitude of these increases in the long term (i.e., approximately 10 years after initial filling of the reservoir) would be substantially lower than in the short term, as described for Impact WQ-1. Based on limited historical sampling data for Funks and Stone Corral Creeks (Table 6-5), average mercury concentrations in both creeks are lower than estimated long-term average mercury concentrations in Sites Reservoir releases (Table 6-18). Because estimated long-term mercury concentrations in Sites Reservoir releases would be substantially lower than the CTR mercury criterion of 50 ng/L, and because most of the flow in the streams would come from Sites Reservoir, the CTR criterion would not be exceeded.

The contribution of mercury and methylmercury from Sites Reservoir would be reflected in the tissue of fish in these creeks and could cause exceedances of the 0.2 mg/kg ww sport fish objective. Because releases from Sites Reservoir to Stone Corral Creek would be made from lower in the reservoir than releases to Funks Creek, increases in methylmercury in Stone Corral Creek may be greater than in Funks Creek. Releases to Stone Corral Creek made from the hypolimnion when the reservoir is thermally stratified from late spring through early fall would likely have lower oxygen and higher methylmercury concentrations compared with those to Funks Creek (i.e., from higher in the reservoir). Stone Corral Creek is impaired due to low DO and therefore conditions may be more conducive to mercury methylation compared to Funks Creek. However, although water with low DO concentrations may sometimes be released from the bottom of Sites Reservoir to Stone Corral Creek, this water would become oxygenated fairly quickly upon release due to reaeration at the water-air interface, and therefore may improve DO levels in the creek. Following release from Sites Reservoir, water in the creeks would eventually mix with other water sources downstream, which would reduce the potential effect of releases on water quality. Stone Corral Creek would mix with water from GCID and Funks Creek would mix with TCCA water at Funks Reservoir.

Colusa Basin Drain

Aqueous total mercury concentrations in the CBD are expected to be reduced by Sites Reservoir releases for Alternatives 1, 2, and 3 relative to the No Project Alternative. The highest estimated total mercury concentrations in Sites Reservoir releases in the long term would be 1.8 ng/L (Table 6-18). This concentration is lower than the mean total mercury concentrations in the CBD at Knights Landing measured prior to 1998 and from 1999–2007 (Table 6-5). A maximum reported concentration of 75 ng/L total mercury represents a stormwater sample collected in January 2003 and was the only one of 92 samples collected between 1996–2007 that exceeded the lowest CTR criterion of 50 ng/L.

Under Alternatives 1, 2, and 3, there would be increased flow in the CBD relative to the No Project Alternative due to Sites Reservoir releases. Increased flows, particularly during late summer-fall releases, would decrease residence time in CBD and potentially keep sediments suspended, which would increase turbidity and decrease bed sediments (where mercury methylation primarily occurs). Increased flows during low-flow periods would not cause flooding, a condition that would increase methylmercury production. The Colusa Basin Drain is an engineered water transmission channel and with limited natural habitat which would be conducive to mercury methylation and biological uptake. Although fish do inhabit the CBD, their abundance is generally low. Therefore, none of the changes anticipated from increased flows would be expected to substantially increase methylmercury concentrations or bioaccumulation in the CBD, and some may even serve to decrease methylation potential within the canal.

Mean aqueous methylmercury concentrations in the CBD at Knights Landing, based on data from 1996–1998 as well as from 2000– 2007 (Table 6-6), were greater than the estimated expected and reasonable worst-case long-term average methylmercury concentrations in Sites Reservoir releases (i.e., 0.08 and 0.12 ng/L, respectively). If methylmercury concentrations in the CBD were to increase somewhat from Sites Reservoir releases, it is unlikely that this increase would lead to substantial long-term increases in methylmercury fish tissue concentrations. Temporary increases in aqueous methylmercury concentrations in the CBD relative to the No Project Alternative may translate to short-term increases in fish tissue methylmercury concentrations. It is unlikely that there would be substantial long-term increases in methylmercury bioaccumulation and fish tissue concentrations because releases to CBD would not be continuous, mostly occurring during drier months (generally May–November) of drier water year types. There is a lag of several months for these increases to be reflected in fish tissues (State Water Resources Control Board 2017b). This delay was demonstrated by a temporary spike in aqueous methylmercury in the San Joaquin River of 0.75 ng/L over baseline levels of approximately 0.15 ng/L that was reflected in Mississippi silverside tissue concentrations 2 months after the spike. Fish tissue methylmercury concentrations returned to baseline concentrations 4 months after the temporary spike in aqueous methylmercury (State Water Resources Control Board 2017a). This 2- to 3-month lag for small fish tissue concentrations to reflect aqueous methylmercury changes would limit the duration over which potential increases in fish tissue methylmercury concentrations would occur. Fish tissue concentrations might increase in response to a sufficiently long period of elevated methylmercury concentrations but would also be expected to return to baseline concentrations after discharges with elevated aqueous methylmercury concentrations ceased.

Yolo Bypass

Aqueous mercury and methylmercury from Sites Reservoir releases for Alternatives 1, 2, and 3 would not substantially increase the concentrations in Yolo Bypass relative to the No Project Alternative. The mean total mercury concentration in the Yolo Bypass (73.2 ng/L; Table 6-5) currently exceeds the lowest CTR criterion of 50 ng/L and is substantially greater than the estimated long-term Sites Reservoir mercury concentrations. Similarly, the mean methylmercury concentration in Yolo Bypass is approximately 0.35 ng/L (Table 6-6), which is greater than the estimated long-term Sites Reservoir aqueous methylmercury concentrations. Furthermore, these estimated mercury and methylmercury concentrations in Sites Reservoir releases would be diluted in the Sacramento River prior to entering the Yolo Bypass via the Fremont Weir unless flows were conveyed directly into the bypass via Knights Landing Ridge Cut.

Diversions of Sacramento River water to Sites storage during high-flow events could sometimes reduce flow over the Fremont Weir into the Yolo Bypass relative to the No Project Alternative. The change in inundated acres in the Yolo Bypass would depend on month and water year type (Appendix 11M, *Yolo and Sutter Bypass Flow and Weir Spill Analysis*). The largest percent reductions would occur during March of Below Normal and Dry Water Years and April of Below Normal Water Years under all alternatives. There would also be a relatively large reduction in inundated acres in November of Above Normal Water Years under Alternatives 2 and 3. A reduction in inundation would lower the potential for methylmercury formation in Yolo Bypass because it would reduce the amount of soil and sediment available for mercury methylation.

Yolo Bypass habitat flows (maximum of 470 cfs), planned for August through October, would result in minimal inundation of land relative to the No Project Alternative during this same period because these flows would generally be contained within the Yolo Bypass channels (i.e., Tule Canal, Toe Drain and other channels). The intent of the releases from Sites Reservoir to the Yolo Bypass is to temporally and spatially distribute food sources for fish species. If the water inundates floodplain areas (i.e., areas outside existing channels), the food resources would be deposited and would fail to move into the Delta. Adjustments in operations would be coordinated between the Authority and parcel owners using the existing Yolo Bypass monitoring network. As such, measurable increases in methylmercury are not expected.

Mercury and methylmercury in Sites Reservoir releases would not violate water quality standards or waste discharge requirements or otherwise substantially degrade water quality in Yolo Bypass.

Delta

Mercury concentrations from Sites Reservoir releases would not substantially increase the total mercury concentration in the Delta relative to the No Project Alternative. The estimated long-term total mercury concentrations in Sites Reservoir releases would be lower than the historical average total mercury concentration entering the Delta from the Sacramento River (4.5 ng/L at Freeport; Table 6-5) and would be diluted in the Sacramento River before entering the Delta.

The historical average methylmercury concentration in the Sacramento River at Freeport is approximately 0.069 ng/L (Table 6-6). This concentration is lower than both the estimated short- and long-term methylmercury concentrations in Sites Reservoir releases (Tables 6-11 and 6-18). While the Sacramento River would substantially dilute releases from Sites Reservoir, there could be a slight increase in the methylmercury concentration at Freeport from Alternatives 1, 2, and 3. The potential effects associated with increases in methylmercury concentrations entering the Delta are discussed as part of the quantitative analysis below.

Freeport represents a conservative assessment location for mercury and methylmercury concentration for the rest of the Delta. It is a point of entry into the Delta for Sacramento River water with the maximum percent of Sites Reservoir water relative to other Delta locations. This is because Sacramento River flows past Freeport are combined and thus diluted with source waters from the San Joaquin River, eastside tributaries, agriculture return waters, and bay water intrusion when the flows are in the central, south, and western Delta.

The RWQCB model results for aqueous and fish tissue methylmercury concentrations at Freeport for the No Project Alternative and Alternatives 1, 2, and 3 for annual average flows are presented in Figures 6-6 and 6-7, respectively. The predicted No Project methylmercury concentration in 350 mm largemouth bass is 0.26 mg/kg ww based on an existing exposure concentration of 0.069 ng/L at Freeport. Aqueous methylmercury at Freeport is estimated to increase by no more than 4% to approximately 0.072 ng/L on a long-term average basis based on annual average flows under Alternatives 1, 2, and 3 compared to the No Project Alternative (Figure 6-6). As calculated by the RWQCB model, the resulting long-term average fish tissue methylmercury concentrations would not increase by more than approximately 6% (to approximately 0.27 mg/kg ww) under Alternatives 1, 2, and 3 (Figure 6-7). These potential changes do not differ substantially from the No Project Alternative and, as such, are not expected to result in long-term differences in aqueous or fish tissue methylmercury concentrations at Freeport that would be measurable by a typical field monitoring program.

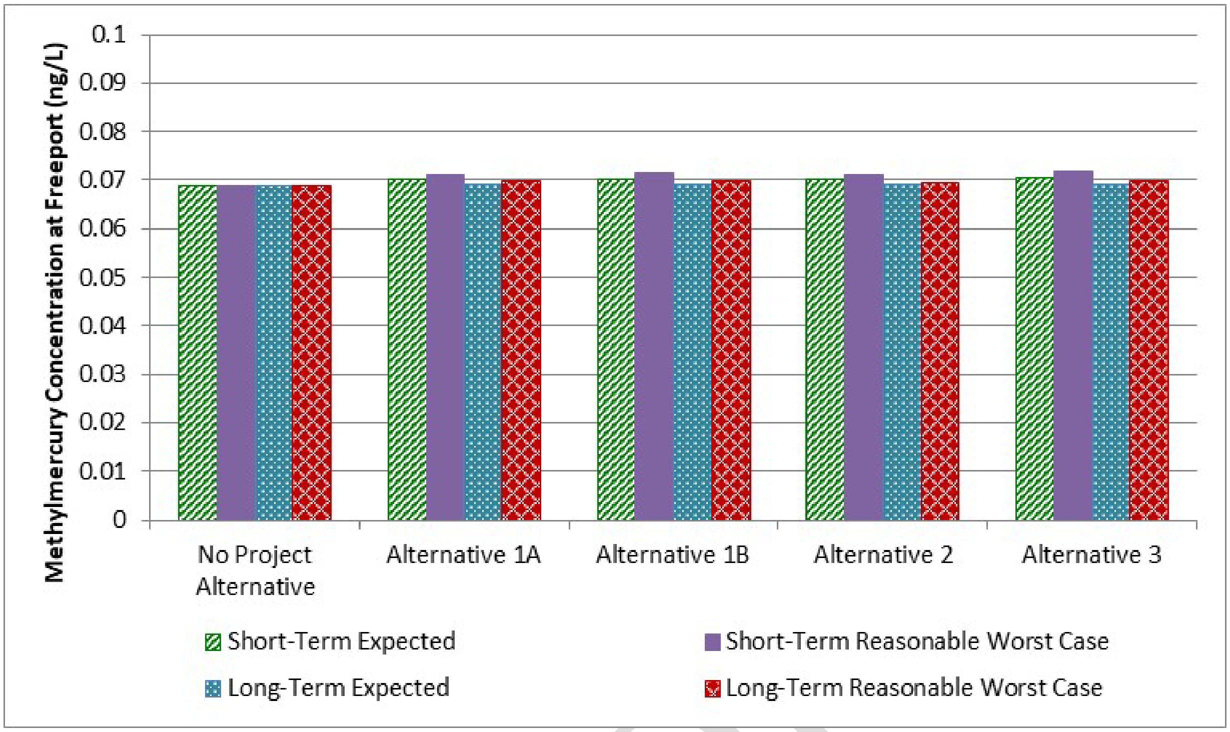


Figure 6-6. Estimated Aqueous Methylmercury Concentrations at Freeport for the No Project Alternative and Alternatives 1, 2, and 3 for Annual Average Flows.

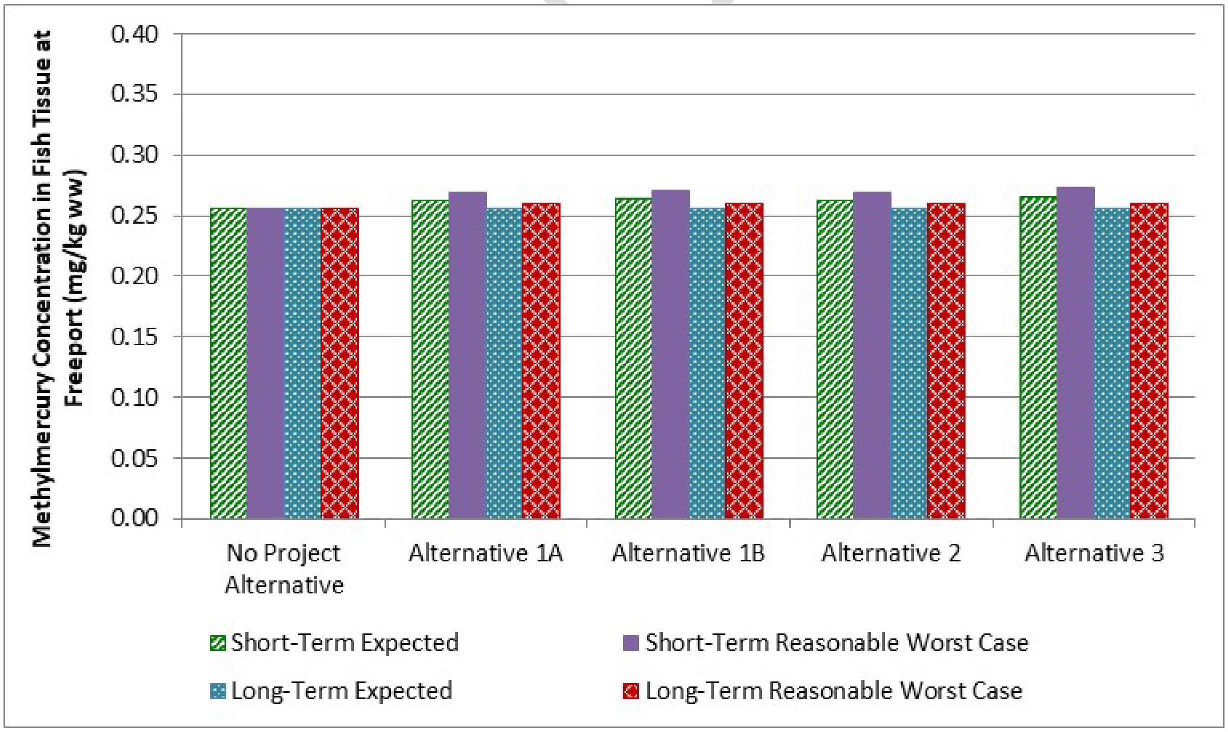


Figure 6-7. Estimated Fish Tissue Methylmercury Concentrations at Freeport for the No Project Alternative and Alternatives 1, 2, and 3 for Annual Average Flows.

The results of the quantitative sensitivity analysis performed for the Sacramento River at Freeport are provided in Appendix 6F (Figures 6F-4 and 6F-5; Table 6F-12). The sensitivity analysis indicated that Sites Reservoir discharge would need to have long-term average aqueous methylmercury concentrations ranging from approximately 0.25 ng/L to 0.30 ng/L (depending on the alternative) to increase the long-term average methylmercury concentration at Freeport by no more than 5% above the historical average (0.069 ng/L) to approximately 0.072 ng/L (Figure 6F-4). Such a change in aqueous methylmercury concentrations at Freeport would increase fish tissue methylmercury concentrations by approximately 7.2% (Figure 6F-5). However, even the estimated reasonable worst-case short-term methylmercury concentration in Sites Reservoir releases (0.24 ng/L) would not be sufficient to cause this change. Such concentrations would also need to exceed the typical mean aqueous methylmercury concentrations in reservoirs and lakes in the vicinity of the Project (i.e., <0.1 ng/L) to elevate the average concentrations of methylmercury in water at Freeport by 5% over the historical average (Figure 6F-6).

The preceding analysis is based on changes in long-term annual average concentrations in the Sacramento River at Freeport, which reflects long-term trends but does not capture the reasonable worst-case conditions that could occur during drought or extended drought conditions. Sites Reservoir exports to the Delta would be greatest during the summer and fall months of Dry and Critically Dry Water Years when Sacramento River flows are relatively low. The quantitative analyses described above were repeated using the mean monthly flows in the Sacramento River at Freeport and exports from the Sites Reservoir from May through November of Dry and Critically Dry Water Years when Sites Reservoir releases would be relatively high (Table 6F-13). This 7-month period is sufficiently long for methylmercury concentrations in Delta fish tissue to reflect potential increases in water column methylmercury concentrations due to Sites Reservoir releases during this timeframe. However, the effect could be transient as methylmercury concentrations in fish tissue decrease as surface water concentrations decrease.

Given the lower Sacramento River flows at Freeport under these conditions, and that a greater proportion of these flows would originate from Sites Reservoir, there would be a greater effect on aqueous mercury concentrations and in methylmercury concentrations in fish tissue. The RWQCB model results for aqueous and fish tissue methylmercury concentrations at Freeport for the No Project Alternative and Alternatives 1, 2, and 3 for Dry and Critically Dry Water Years (based on mean monthly flows) are presented in Figures 6-8 and 6-9, respectively. The sensitivity analysis for Dry and Critically Dry Water Years found that a 5% increase in aqueous methylmercury at Freeport, corresponding with a 7.2% increase in fish tissue methylmercury concentrations, could potentially occur when the aqueous methylmercury concentration in Sites Reservoir releases is approximately 0.11 ng/L. This concentration would not be substantially different from estimated long-term expected and long-term worst-case methylmercury concentrations for Sites Reservoir (i.e., 0.08 ng/L and 0.12 ng/L, respectively) (Table 6-18).

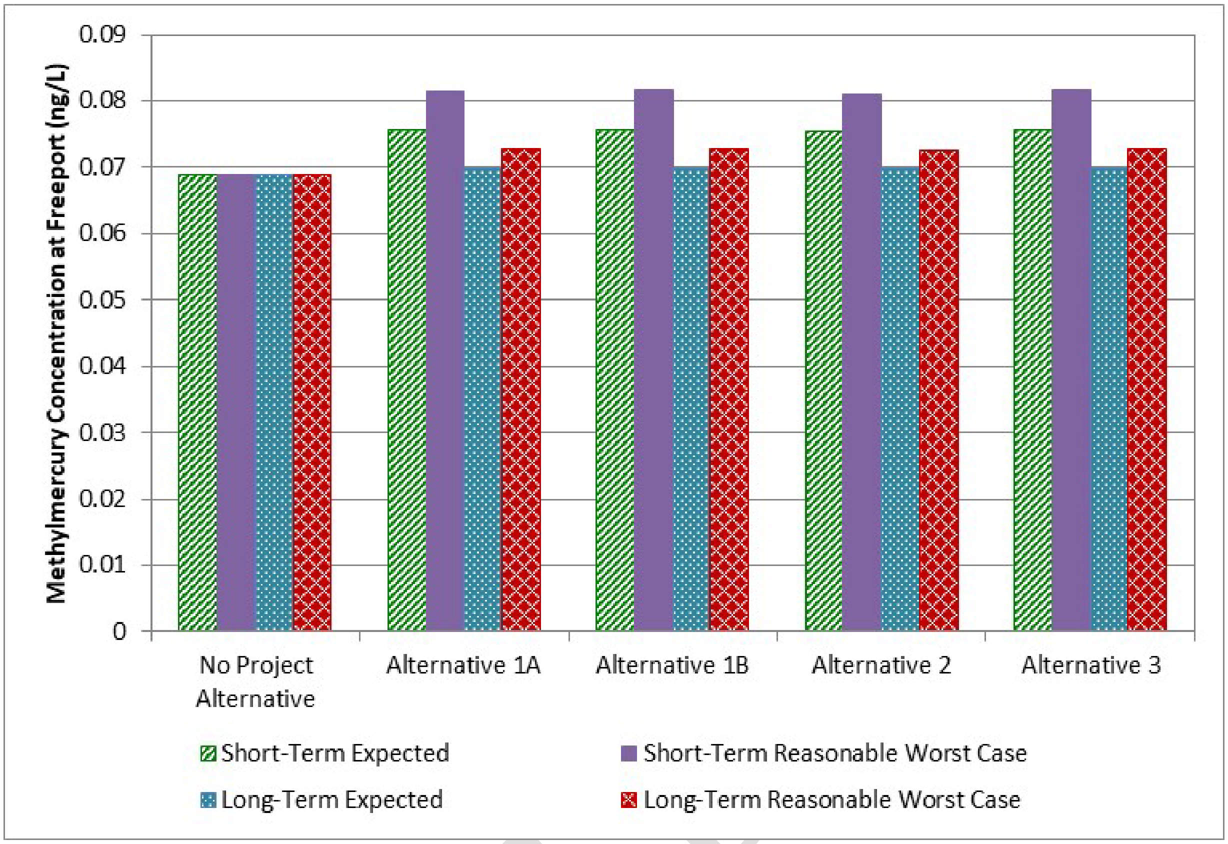


Figure 6-8. Estimated Aqueous Methylmercury Concentrations at Freeport for the No Project Alternative and Alternatives 1, 2, and 3 for Mean Monthly Flows in May–November of Dry and Critically Dry Water Years.

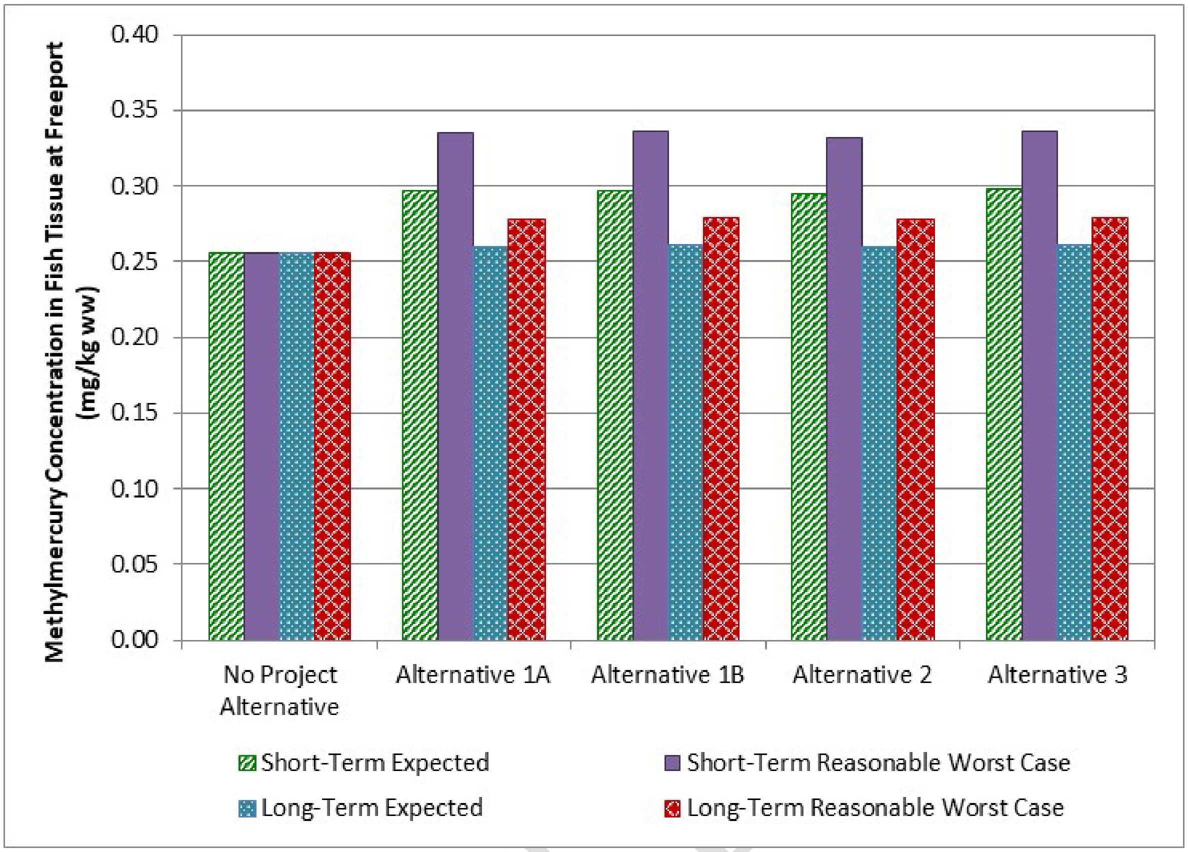


Figure 6-9. Estimated Fish Tissue Methylmercury Concentrations at Freeport for the No Project Alternative and Alternatives 1, 2, and 3 for Mean Monthly Flows in May–November of Dry and Critically Dry Water Years.

Alternatives 1, 2, and 3 would increase the aqueous methylmercury concentration at Freeport during summer and fall months of Dry and Critically Dry Water Years. These increases would range from approximately 1% above concentrations under the No Project Alternative when Sites Reservoir releases are at the long-term expected methylmercury concentration of 0.08 ng/L, to 18% above concentrations under the No Project Alternative when releases are at the short-term reasonable worst-case methylmercury concentration of 0.24 ng/L. Fish tissue methylmercury concentrations would increase by approximately 2% above concentrations under the No Project Alternative when the aqueous methylmercury concentration in Sites Reservoir releases is 0.08 ng/L (estimated long-term expected concentration), and up to approximately 32% above concentrations under the No Project Alternative when Sites Reservoir releases have the short-term reasonable worst-case methylmercury concentration of 0.24 ng/L.

These estimates are based on simplified modeling which assumes that fate and transport of methylmercury from Sites Reservoir is conservative (i.e., that there would be no loss or generation of methylmercury between Sites Reservoir and Freeport). This is unlikely to be the case under real-world conditions; methylmercury could adsorb to suspended sediment and settle prior to reaching Freeport, be taken up by biota, and degraded by light or bacteria. In addition, mercury present in Sites Reservoir discharge may be subject to methylation in transit.

Collectively, these processes would decrease mercury concentrations in surface waters and may increase or decrease aqueous methylmercury.

In summary, depending on the methylmercury concentrations in Sites Reservoir releases and the water year type, operation of Sites Reservoir may result in substantial degradation of water quality in the Delta with respect to methylmercury bioaccumulation in Delta fish. Potential increases in fish tissue methylmercury concentrations in the north Delta (Sacramento River at Freeport) based on annual average flows would be greatest in the short term during the initial filling period and for potentially 10 years after the reservoir is full, and in Dry and Critically Dry Water Years when methylmercury concentrations are equal to the estimated short-term expected and short- and long-term worst-case concentrations for Sites Reservoir, which would make the mercury impairment in the Delta worse. However, in the long term, based on annual average flows, even if the methylmercury concentrations in Sites Reservoir releases were at the estimated worst-case long-term concentration, corresponding increases in fish tissue methylmercury concentration in the north Delta would likely not be measurable.

Metals Other Than Mercury

Temporal Shift and Evapoconcentration

Metal concentrations in the Sites Reservoir discharge may be higher than concentrations in the Sacramento River receiving water due to differences in Sacramento River metal concentrations at the time of diversion to storage and the time of release from storage, as well as from evapoconcentration in Sites Reservoir. Most metal concentration measurements from the Sacramento River show a slight tendency to have higher values during the winter and spring period of diversion to Sites Reservoir than the summer and fall release period, with arsenic being an important exception. Sacramento River metal concentrations are sometimes higher during the months that water would be diverted to Sites Reservoir than during the months that water would be released. Therefore, concentrations of metals released from Sites Reservoir could be higher than their concentrations in the Sacramento River at the point of discharge, potentially degrading river water quality. High concentrations of total metals in the Sacramento River water diverted to storage may be reduced substantially by settling of suspended sediment. This would cause concentrations to drop and approach the dissolved, filtered measurements. This might not eliminate high concentrations of metals because dissolved metal concentrations are sometimes also high during the winter and spring diversion period, although even the dissolved portion of the metal concentration may eventually be reduced further through adsorption to particulates (Namiesnik and Rabajczyk 2010:5, 6, 12, 15; Pachana et al. 2010:6, 7; Rader et al. 2019:1386, 1398).

The release of Sites Reservoir water to the CBD under Alternatives 1, 2, and 3 would likely reduce metals concentrations in the CBD because metal concentrations in the CBD are generally higher than metals concentrations in the Sacramento River regardless of time of year (Appendix 6E) and are expected to generally be similar to or lower than metal concentrations released from Sites Reservoir for water supply.

A summary of the results of the detailed evaluation for the metals of greatest concern (aluminum, copper, iron, and lead) for Alternative 3 are shown in Figures 6-10 through 6-13. These figures show estimated total concentrations entering Sites Reservoir, estimated concentrations in Sites

Reservoir with and without settling, and anticipated effects of Sites discharges on concentrations in the Sacramento River. Because releases to the Sacramento River would occur after settling of suspended sediment, these graphs show concentrations assuming settling of suspended sediment. Two types of results for concentrations in the Sacramento River downstream of the Sites discharge are shown:

- Sites Reservoir concentrations mixed with median river concentrations measured during the approximate time and location of discharge (i.e., Sacramento River concentrations measured at Hamilton City and upstream of the CBD during May through September). This represents typical river concentrations mixed with Sites concentrations.
- Sites Reservoir concentrations mixed with 95th percentile river concentrations measured during the approximate time and location of discharge (i.e., Sacramento River concentrations measured at Hamilton City and upstream of the CBD during May through September). This represents high river concentrations mixed with Sites concentrations.

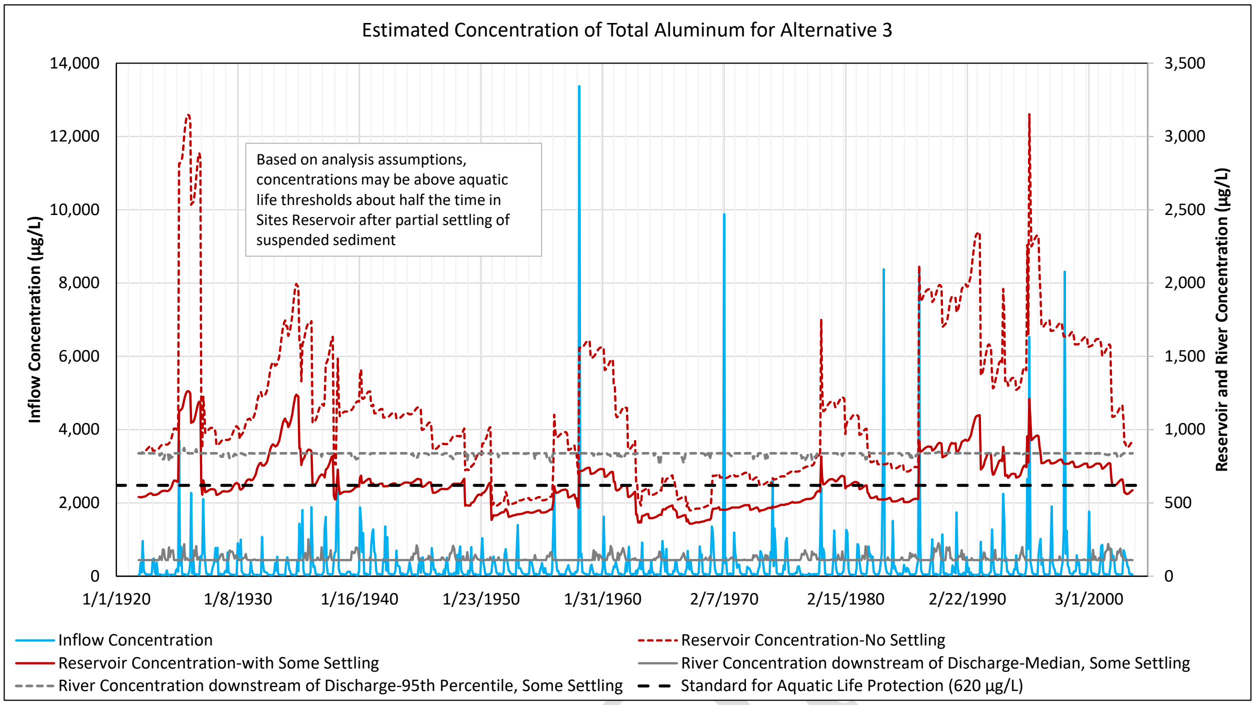
Results for Alternatives 1A, 1B, and 2 are similar to Alternative 3 and are shown in Appendix 6E. When high inflow concentrations occur at the same time as high inflow volumes, there could be sudden, large increases in concentrations in the reservoir. Evapoconcentration contributes to increased concentration in the reservoir, although its effects are sometimes obscured by the variability due to inflow concentrations. The total aluminum, total copper, and total iron concentrations in Sites Reservoir would be likely to frequently exceed aquatic life protection standards if settling did not reduce these concentrations. Based on the calculations that demonstrate the effect of partial settling of suspended sediments, settling of suspended sediment may have a substantial effect on total metal concentrations. With these assumptions for partial settling, concentrations for total aluminum in Sites Reservoir may exceed the 620 µg/L water quality standard for aquatic life protection about half the time, hovering between about 400 µg/L and 1,000 µg/L (Figure 6-10). Total copper concentrations (Figure 6-11) may occasionally exceed and total iron concentrations (Figure 6-12) may rarely exceed water quality standards for aquatic life protection, while total lead concentrations (Figure 6-13) are expected to be well below quality standards. If less conservative assumptions were used regarding settling of suspended sediment and the water quality parameters that affect the water quality standards, these calculated exceedances would not occur.

When Sacramento River water first enters the reservoir, total metal concentrations might temporarily exceed water quality standards for aquatic life, similar to what occurs in the river. These exceedances would be temporary and have limited detrimental effects on aquatic communities due to the short duration expected. Furthermore, these effects would occur on an aquatic community in a reservoir that is not present under the No Project Alternative so there would be no substantial degradation of water quality relative to the No Project Alternative.

Discharges to Funks Creek would originate from the I/O Works and would have metal concentrations similar to Sites Reservoir at the time of release. Concentrations of total aluminum, copper, and iron may occasionally be above water quality standards for aquatic life protection. However, exceedances could coincide with exceedances that would occur under the No Project Alternative (based on metal measurements in Stone Corral Creek, Appendix 6E). The effect of Sites Reservoir releases on Funks Creek water quality would be diluted 1.8 miles downstream upon mixing with Funks Reservoir. Discharges from the bottom of Sites Reservoir to Stone Corral Creek may have reduced water quality compared to other parts of the reservoir and the releases from the I/O tower. Anoxic conditions, accumulation of denser water with more dissolved constituents, and proximity to greater volumes of accumulated sediment could potentially generate higher concentrations of total metals. Water quality, including metal concentrations, in Funks and Stone Corral Creeks will be monitored before construction and after operations have commenced as part of the Stone Corral Creek and Funks Creek Aquatic Study Plan (Appendix 2D). As described in Appendix 2D, these studies will inform adaptive management of the creek flows to maintain fish in good condition consistent with California Fish and Game Code Section 5937.

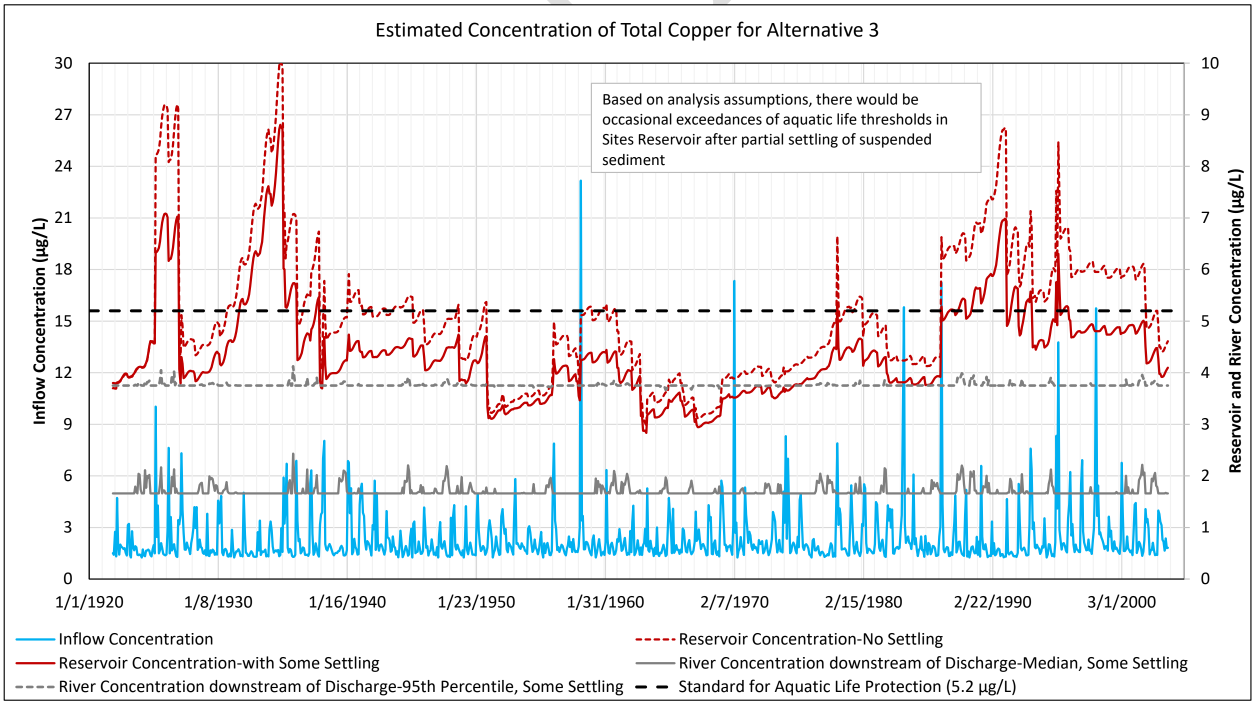
It is unlikely that Sites Reservoir releases would cause exceedance of water quality standards in the Sacramento River because discharges into the river would only occur after suspended sediment in the reservoir water has settled and because of dilution in the Sacramento River. When Sites Reservoir water would be discharged to the Sacramento River, substantial dilution would occur. Sites Reservoir releases would generally contribute less than 15% of the flow in the Sacramento River (90th percentile values for the contribution are 14%–15%, depending on alternative). Whether concentrations in the Sacramento River receiving water are at median levels or at 95th percentile levels, the Sites Reservoir discharge is unlikely to cause exceedance of water quality standards (Figures 6-10 through 6-13). In some instances, when concentrations in the Sacramento River receiving water are at 95th percentile levels, Sacramento River concentrations may be reduced by the Sites discharge.

Synergistic effects between metals may occur if the adverse effect of multiple metals is greater than what would be expected by adding the individual effects. Synergistic effects between metals are not well understood and in some cases they may have antagonistic effects. Antagonistic effects are the opposite of synergistic effects and occur when the presence of one metal reduces the harmful effects of another metal. Acute synergistic metal effects in the river would be similar to or greater than what might occur in Sites Reservoir because metal concentrations in the Sacramento River during high-flow events are much higher than concentrations expected in Sites Reservoir after settling of suspended sediment. As described above, once suspended sediment settles in Sites Reservoir, most metals are expected to occur at levels below water quality standards for aquatic life protection, which would limit the likelihood of synergistic effects. Effects of Alternatives 1, 2, and 3 on synergistic effects in the Sacramento River at the discharge location would be even smaller due to dilution.


Estimated Concentration of Total Aluminum for Alternative 3

Based on analysis assumptions, concentrations may be above aquatic life thresholds about half the time in Sites Reservoir after partial settling of suspended sediment

Figure 6-10. Estimated Total Aluminum Concentration in Inflow to Sites Reservoir, in Sites Reservoir, and in the Sacramento River at the Sites Discharge Location


Estimated Concentration of Total Copper for Alternative 3

Based on analysis assumptions, there would be occasional exceedances of aquatic life thresholds in Sites Reservoir after partial settling of suspended sediment

Figure 6-11. Estimated Total Copper Concentration in Inflow to Sites Reservoir, in Sites Reservoir, and in the Sacramento River at the Sites Discharge Location.

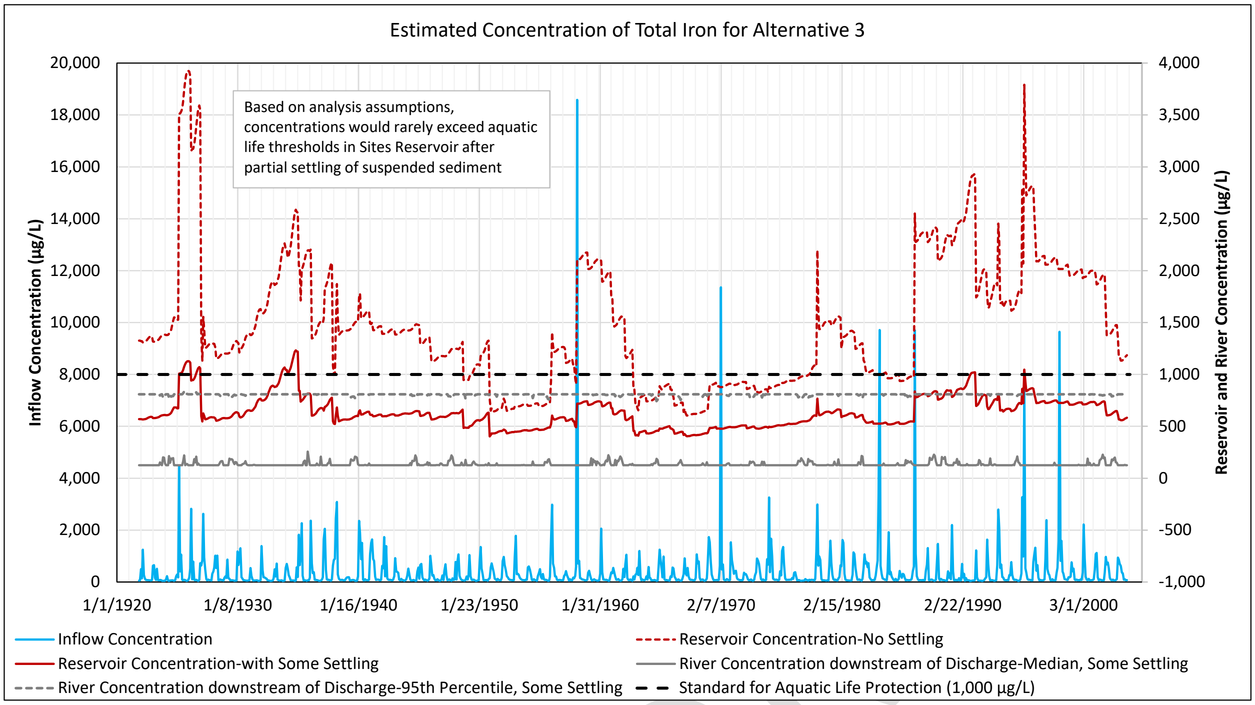


Figure 6-12. Estimated Total Iron Concentration in Inflow to Sites Reservoir, in Sites Reservoir, and in the Sacramento River at the Sites Discharge Location.

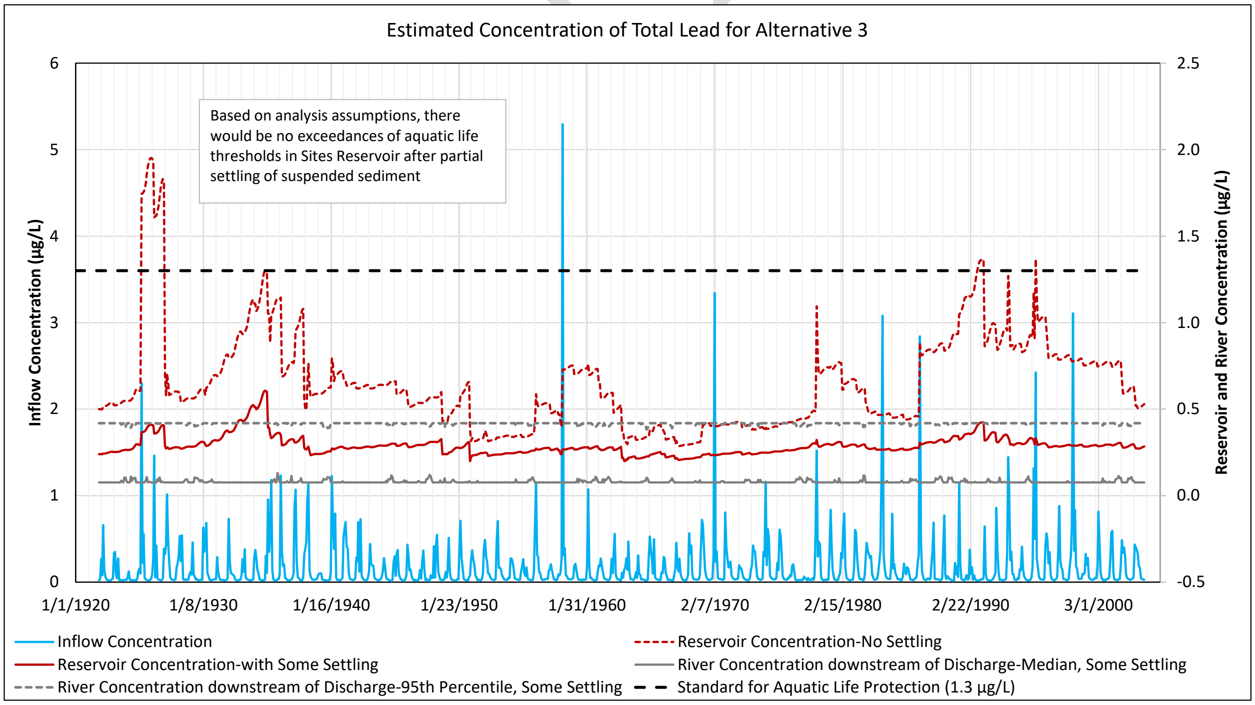


Figure 6-13. Estimated Total Lead Concentration in Inflow to Sites Reservoir, in Sites Reservoir, and in the Sacramento River at the Sites Discharge Location.

Arsenic

Arsenic levels measured in the Sacramento River are below regulatory standards, but because arsenic is highly toxic, it is evaluated here. The pattern of arsenic measurements from the Sacramento River is different from the pattern seen in most of the other metals. Arsenic shows little variation between seasons and has a trend for increasing concentrations as water moves down the Sacramento River (Appendix 6E). As such, arsenic would not be affected by a temporal shift of water being diverted during the winter and spring but would be affected by evapoconcentration in Sites Reservoir. Table 6-19 shows key concentrations for evaluating Project effects on arsenic. It is appropriate to use average values because arsenic effects would occur over time. The process of filling Sites Reservoir with relatively low concentrations of arsenic from upstream along the Sacramento River (1.59 µg/L) followed by evapoconcentration would lead to mostly small changes in arsenic concentrations. On average, estimated arsenic concentration in the Sites Reservoir releases (1.88 µg/L) is slightly lower than the average measured concentration in the Sacramento River receiving water (1.98 µg/L) and slightly higher than the average measured concentration in the Sacramento River at Hamilton City (1.71 µg/L). All these values are substantially less than regulatory standards for drinking water, aquatic life protection, and agriculture (Table 6-19). Maximum estimated concentrations in Sites Reservoir (3.80 µg/L, Table 6-19), which correspond to the period of peak evapoconcentration, would also be substantially less than regulatory standards and would occur when no water is available for water supply purposes.

Table 6-19. Arsenic Concentrations in the Sacramento River, Sites Reservoir, and Regulatory Standards.

Parameter	Arsenic Concentration (µg/L)
Average total arsenic concentration measured in the Sacramento River below Red Bluff and at Hamilton City during January–March (Sites primary period for diversion to storage)	1.59
Estimated average total mercury concentration in Sites Reservoir after evapoconcentration[1]	1.88
Estimated maximum total arsenic concentration in Sites Reservoir after evapoconcentration[2]	3.80
Average measured total arsenic concentration in the Sacramento River above the CBD during May–September (Sites primary period for releases to the Sacramento River)	1.98
Average measured total arsenic concentration in the Sacramento River at Hamilton City during May–September (representing water used by GCID for rice irrigation).	1.71
Average measured total arsenic concentration in the CBD during May–September	4.91
Maximum contaminant level for drinking water	10.0
Dissolved arsenic 4-day average threshold for freshwater aquatic life	150.0
FAO recommended maximum concentration in irrigation water (Ayers and Westcot 1985:96)	100, but noted that toxicity to rice may occur at less than 50.
Arsenic concentration associated with toxicity to rice in Taiwan (Murphy	40

Parameter	Arsenic Concentration (µg/L)
et al. 2018a:5)	
Dutch concentration requiring intervention or remediation (Murphy et al. 2018a:5)	55
For reference purposes: arsenic concentrations measured in Cambodian groundwater used for rice irrigation (Murphy et al. 2018b:4)	Up to 1,200

[1] 18% higher than inflow concentration based on the estimated average percent increases in concentration due to evapoconcentration (16%–18%, depending on alternative).

[2] 139% higher than inflow concentration based on the estimated maximum percent increase in concentration (104%–139%, depending on alternative), which represents the last portion of 1 year in the 82 years simulated by CALSIM and occurs at a time when no releases could be made for water supply purposes.

Other Potential Metal Sources

Contributions of metals from Stone Corral Creek and Funks Creek are expected to be minimal. The volume of inflow from these creeks is estimated to be a combined average of 14 TAF/yr. Furthermore, Stone Corral Creek does not have high concentrations of metals. No metals measurements were available for Funks Creek but given its proximity to Stone Corral Creek and similar adjacent land uses, it was assumed that the metals concentrations would be similar to those of Stone Corral Creek.

Contributions of metals from water leaching from the sediments in the inundation area would be small because the volume of this water would be low. In general, water would seep downward and away from the reservoir instead of flowing into the reservoir. In addition, groundwater quality in the inundation area, which is an indicator of water quality that may leach from sediments, does not have high concentrations of metals (Appendix 6E).

Redirection of CBD Metals to Yolo Bypass

Under Alternatives 1, 2, and 3, some of the Sites Reservoir releases may pass through the CBD and through Yolo Bypass for habitat purposes during August–October. Under the No Project Alternative, CBD water typically drains to the Sacramento River near Knights Landing. Operations for Alternatives 1, 2, and 3 would partially dilute the CBD metals concentration and redirect some of the CBD metals load to the Yolo Bypass. The CBD metal concentrations for total aluminum, copper, and iron are sometimes above the water quality standards for the protection of aquatic life and potentially could remain above the standards after dilution with Sites Reservoir water, depending on the volumes and concentrations in the two sources. Few measurements exist for metals concentrations in the Yolo Bypass, so it is unclear whether discharge of the CBD water to the bypass would cause exceedances of water quality standards.

HABS and Invasive Aquatic Vegetation

Shasta Lake, Lake Oroville, Folsom Lake and San Luis Reservoir

As described above for nutrients, organic carbon, and DO, changes in storage relative to the No Project Alternative in Shasta Lake, Lake Oroville, Folsom Lake, and San Luis Reservoir are expected to be minimal. As such, operation of Alternatives 1, 2, and 3 would not be expected to substantially affect HABs or invasive aquatic vegetation in these reservoirs.

Sites Reservoir

Operating Sites Reservoir would result in reservoir drawdown, reduced storage volume, and higher water temperatures from late spring through fall, particularly in Dry and Critically Dry Water Years. This would create favorable conditions for the initiation of HABs, and growth of algae and invasive aquatic vegetation. Because nutrients would be available in non-limiting concentrations in the reservoir, once HABs develop, the nutrient concentrations would be expected to be sufficient to sustain blooms as long as reservoir water temperature remained relatively warm (approximately 66°F minimum). The modeled average monthly near-surface reservoir water temperatures for Alternatives 1, 2, and 3 are shown in Table 6-20. Modeled temperatures would approach or exceed 66°F from approximately May through September for Alternatives 1, 2, and 3.

Table 6-20. Modeled Monthly Average Sites Reservoir Near-Surface Water Temperatures (°F)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Alternative 1A	44.5	46.5	50.9	56.9	64.8	70.9	75.3	74.2	69.8	62.1	54.2	47.7
Alternative 1B	44.2	46.4	50.9	56.8	64.8	70.8	74.9	73.7	69.4	61.6	54.0	47.4
Alternative 2	44.4	46.4	50.8	56.5	64.3	70.5	74.8	73.4	68.8	61.6	54.3	47.7
Alternative 3	43.9	46.2	50.9	56.8	64.7	70.3	74.1	73.2	68.5	61.2	53.5	47.0

If HABs occurred in the reservoir they would temporarily degrade water quality directly, potentially through the release of cyanotoxins, as well as indirectly by potentially lowering DO when blooms died and decomposed. Because Sites Reservoir would be a recreational destination, recreational use of the reservoir could be affected seasonally and visitors could be exposed to cyanotoxins while recreating in or near the water in the presence of HABs, as discussed in Chapter 27. This condition would be limited to the Project reservoir itself and would not cause adverse impacts beyond the reservoir on the surrounding environment.

Most releases from Sites Reservoir would be made during Dry and Critically Dry Water Years generally in May through November. CALSIM modeling results indicate that in Critically Dry Water Years, the lowest monthly average Sites Reservoir WSEs over the 82-year modeling period would occur under Alternative 3 in November and December (Table 6-8b) and would be approximately 3 feet below the elevation of the lowest I/O tower tier (centerline at 340 feet) and 26 feet above the elevation of the low-level intake (centerline at 311 feet). Under low storage conditions such as this, i.e., when the WSE is below 340 feet, reservoir releases would be limited to the low-level intake. For Alternatives 1 and 2, the lowest monthly average WSEs would be approximately 5–14 feet above the elevation of the lowest I/O tower tier and 34–43 feet above the elevation of the low-level intake (Table 6-8b). In Dry Water Years, the trend is similar between Alternatives 1, 2, and 3 (i.e., the lowest average WSE would also occur under Alternative 3 but would be higher than in Critically Dry Water Years) (Table 6-8a).

Planktonic cyanobacteria and cyanotoxins are generally concentrated closer to the water's surface where there is more light and the temperature is warmer. Cyanobacteria can also regulate their vertical distribution and cyanotoxins have been detected in stratified lakes and reservoirs approximately 16–33 feet below the surface in the water column, albeit at lower concentrations relative to higher positions in the water column, as well as in the sediment. If HABs were to occur in the reservoir near the I/O tower when releases were made, cyanobacteria and cyanotoxins could be released from the reservoir in varying concentrations. The concentration would depend on the magnitude of the bloom(s) and the depth from which water is released. This would be more likely to occur under Alternative 3 in Critically Dry Water Years if water were released through the lowest I/O tower tier but could also occur under Alternatives 1 and 2 in Critically Dry Water Years given how close the WSEs would be to the lowest I/O tower tier in in the early fall months. Downstream effects on water quality would not be expected if cyanobacteria and cyanotoxins were present in the releases because concentrations of cyanobacteria and cyanotoxins would be greatly diluted when eventually discharged into the Sacramento River. Furthermore, extracellular cyanotoxins would be expected to undergo biodegradation (e.g., over a period of several days for microcystins) and, to some degree, photodegradation. In addition, water quality management in Sites Reservoir as it relates to HABs would include implementation of a water quality monitoring program and a HABs action plan to minimize the potential for adverse effects on beneficial uses of water in Sites Reservoir and downstream (Section 2D.3). If cyanobacteria and cyanotoxins are confirmed near the I/O tower at a level at or exceeding the "Caution" action trigger level, releases could be made from lower in the water column (e.g., through the low-level intake) to reduce the potential for higher concentrations of cyanobacteria and cyanotoxins to be released downstream. This action would be informed by water quality monitoring for cyanobacteria and cyanotoxins at multiple depths and locations in the vicinity of the I/O tower if HABs appear to be present there based on visual monitoring, as well as downstream, as part of the HABs Action Plan and the Surface Water Ambient Monitoring Program Study component of the Stone Corral Creek and Funks Creek Aquatic Study Plan (Sections 2D.3.1, *Harmful Algal Blooms*, and 2D.4.2, *Surface Water Ambient Monitoring Program Study*, respectively).

Nutrients in the reservoir would support the growth of invasive aquatic vegetation. Boat use in Sites Reservoir during operations for Alternatives 1, 2, and 3 could result in the introduction and spread of aquatic invasive plant species. While it may be possible that if there were invasive aquatic vegetation in the reservoir and if viable fragments were in proximity to the I/O tower while releases were being made, these fragments could be released downstream. However, in the unlikely event that this were to occur, it is not likely that this would result in a substantial degradation of water quality downstream given the widespread nature of existing invasive aquatic plant species in the study area. Further, the Authority would implement actions to control the spread of both submerged and floating invasive aquatic vegetation (Section 2D.3). Control actions would be consistent with existing control methods employed by the DBW's AIPCP and would include monitoring for invasive aquatic vegetation in the reservoir, mechanical and chemical control methods, depending on the species present, and post-treatment monitoring for effectiveness of control actions.

Funks and Stone Corral Creeks

Potential water quality effects on Funks and Stone Corral Creeks related to HABs would depend on the timing (i.e., season), release volume, and water column depth from which releases are made from Sites Reservoir. Releases to Funks and Stone Corral Creeks will be adaptively managed as part of a comprehensive study plan and adaptive management plan, the Stone Corral Creek and Funks Creek Aquatic Study Plan (Section 2D.4, *Stone Corral Creek and Funks Creek*

Aquatic Study Plan and Adaptive Management). As part of the Surface Water Ambient Monitoring Program Study component of this study plan, monitoring for cyanobacteria and cyanotoxin in Stone Corral and Funks Creeks will be implemented to inform management of Sites Reservoir releases to ensure that there are no adverse water quality effects so that fish are maintained in good condition in these creeks in compliance with California Fish and Game Code 5937.

Yolo Bypass and the Delta

Water diversions to Sites Reservoir would not be expected to result in an increase in the frequency of HABs in the Delta or further downstream as a result of flow reductions in the Sacramento River. Diversions to the reservoir from Sacramento River would occur primarily during storm events in winter when conditions are less conducive to bloom formation and maintenance.

Most releases from Sites Reservoir would be made during Dry and Critically Dry Water Years generally in May through November, but Yolo Bypass habitat releases would be greater during Wet Water Years (Chapter 5, Table 5-20) in August–October. The August–October Yolo Bypass habitat releases, while potentially providing a beneficial increase in nutrients in the northern Delta, are unlikely to result in an increase in HABs in the Delta. Once the released flows enter the northern Delta at Rio Vista, the existing flows at that location may be high enough to prevent the formation of HABs. Also, to the extent that the habitat releases from Sites Reservoir would result in similar effects with regard to cyanobacteria as the 2018 and 2019 North Delta Food Subsidy studies, there would be no resultant HABs in the Yolo Bypass or the Delta. In the 2018 and 2019North Delta Flow Action studies, following the pulse flow (using agricultural return water), there was no substantial difference in the average biovolume of cyanobacteria in the lower Sacramento River (Rio Vista) after the flow pulse relative to before the flow pulse. Similarly, except for the Toe Drain at Road 22, there was no substantial difference in the average biovolume of cyanobacteria in the upper and lower Yolo Bypass following the pulse. In the Toe Drain at Road 22, there was an apparent decrease in biovolume in cyanobacteria in 2018, and an increase in 2019, after the flow pulse relative to before (Davis et al. 2022:165). In addition, although *Microcystis* cyanobacteria have been observed in the Yolo Bypass, as part of the Yolo Bypass Fish Monitoring Program, no bloom sightings were reported (Interagency Ecological Program et al. 2021), and according to the HABs voluntary reports database (California HABs Portal maintained by the California Water Quality Monitoring Council; State Water Resources Control Board 2021a) HABs have not been reported in Yolo Bypass in previous years.

Pesticides

Concentrations of pesticides in the Sacramento River upstream of Knights Landing, other than diazinon, tend to be lower than detection limits and therefore would also be expected to be low in Sites Reservoir. Of the 13 pesticides selected for investigation based on reported occurrence in the Central Valley (8 with sufficient data for graphing), diazinon was the only pesticide noted to occur in the Sacramento River during the Sites diversion period. Some of the diazinon measurements taken from the Sacramento River during February were above the 0.1 µg/L water quality objective in the Central Valley Basin Plan. This water is unlikely to have substantial effects on water quality because diazinon degrades in water in approximately 138 to 185 days, assuming a pH of 7. Its toxic degradate degrades in water in approximately 25 days for a total of approximately 210 days (U.S. Environmental Protection Agency 2008). If any diazinon remained in Sites Reservoir at discharge, it would be greatly diluted in the Sacramento River, which, based on measurements, is free of diazinon by March. Herbicides approved for aquatic use might occasionally be used to control invasive aquatic vegetation in Sites Reservoir, but herbicide application methods would be consistent with DBW's AIPCP to minimize their impacts on native aquatic plant and animal species (Section 2D.3). Releases from Sites Reservoir would generally have low to no concentration of pesticides and would therefore not degrade Sacramento River water quality. Furthermore, releases to CBD would dilute the relatively high pesticide concentrations in the CBD.

During the irrigation and drainage season (May–October), most CBD flow is released to the Sacramento River at Knights Landing. For Alternatives 1, 2, and 3, habitat flows from Sites Reservoir would pass through the CBD and the Yolo Bypass instead of being released to the Sacramento River at Knights Landing. When these flows are moved through the Yolo Bypass, the existing CBD load of pesticides would also move through the bypass. Combined flows of Sites Reservoir discharge and CBD water would occur in August–October (Table 5-20 and 5-21), with releases reaching approximately 350–450 cfs during August and September of Wet Water Years. When these releases are made to the Yolo Bypass, pesticide load to the Sacramento River between Knights Landing and Rio Vista is expected to be lower under Alternatives 1, 2, and 3.

The purpose of the habitat flows through Yolo Bypass is to enhance food production for north Delta fish species. The effect of these flows on pesticide concentrations has been investigated during flow pulses of 400–600 cfs through the Yolo Bypass that occurred in 2016 and 2018 (Orlando et al. 2020). The 2016 pulse occurred during the last half of July and the 2018 pulse occurred during most of September. In 2016, the additional flow came from the Sacramento River via pumping by local Reclamation Districts; in 2018 it came from increased drainage into the CBD that was primarily rice field discharge (Orlando et al. 2020:1). The effect of the Sites Reservoir releases on pesticides may be intermediate between the 2016 flow action and the 2018 flow action since it would blend Sites Reservoir water with minimal pesticides with CBD water.

The passage of CBD flows through the Yolo Bypass have some potential to increase pesticide concentrations in the Yolo Bypass and Cache Slough Complex. This possibility was, and continues to be, evaluated by the USGS and DWR (Orlando et al. 2020:99). The USGS monitored water in the Yolo Bypass and downstream in the Cache Slough Complex for 175 pesticides and degraded forms of pesticides before, during, and after the 2016 and 2018 north Delta flow actions (Orlando et al. 2020:1). All samples contained multiple pesticides at varying concentrations, with rice pesticides being most common and concentrations tending to be higher farther north, towards the upstream end of the Yolo Bypass.

There was some indication that the 2016 pulse of Sacramento River water reduced pesticide concentration at the upstream end of the Yolo Bypass, but it may have conveyed some pesticide downstream to the lower part of the bypass near Lisbon Weir. However, in Cache Slough near Ryer Island, where flow is much higher due to influence of the Sacramento River, there was no apparent increase in pesticides. There was more of an increase in pesticides at the downstream end of the Yolo Bypass during 2018. In 2018 there was no evident change in pesticide concentrations in Cache Slough at Ryer Island. (Orlando et al. 2020:93–99).

A more recent report provides a synthesis of pesticide studies performed between 2016 and 2019 in the Yolo Bypass during periods of flow pulses (Davis et al. 2022). This study reports that pesticides concentrations in water and zooplankton were higher during flow pulses than either before or after the pulses (Davis et al. 2022:146–150). This study also indicates several reasons it may be difficult to discern pesticide-related effects of managed flow pulses on fish relative to the No Project Alternative:

- Pesticides are already ubiquitous in the Yolo Bypass. "We detected pesticides exceeding EPA benchmarks for both acute and chronic toxicity to invertebrates and fish across all years, flow periods, and regions" (Davis et al. 2022:146, 147).
- Source water for the flow pulse may affect pesticide concentrations. "Pesticide concentrations in water were higher during the flow pulse in high-flow years with agricultural source water (2018 and 2019) than during the high-flow year using Sacramento River water (2016)" (Davis et al. 2022:153).
- Managed flow actions might not increase pesticide concentration much above pesticide effects associated with non-managed flow pulses. "Pesticide levels appear relatively high in both high-flow pulse years with a managed flow action (e.g., 2018, 2019) and low-flow pulse years without a managed flow action (e.g., 2017). It is therefore challenging to determine the effects of the flow pulse on contaminants versus the responses to local agricultural inputs in the Yolo Bypass, especially as we had limited availability of data to examine the effects of different types of flow pulses (e.g., low vs. high flow). More research is needed to distinguish differences among the flow pulse types and relative to events throughout the year that may increase contaminant loading (e.g., inundation during winter storms) (Orlando et al. unpublished data)." (Davis et al. 2022:153, 154).

There are several additional reasons why the effect of moving Sites Reservoir releases through the Yolo Bypass could have a limited effect on pesticides in the Delta.

- The pesticide load from the CBD to the Delta would not change; only the discharge location would change.
- The evaluation of the 2016 and 2018 Yolo Bypass flow augmentation events indicated some potential increased movement of pesticides downstream within the Yolo Bypass, but the effect seems to have disappeared by the time the flows reached Cache Slough at Ryer Island. This disappearance is potentially due to dilution.
- Discharge from the Yolo Bypass would be diluted by tidal flows and net flow in the Sacramento River. As described for water temperature, habitat flows through the Yolo Bypass are unlikely to represent more than about 5% of the flow in the Sacramento River at Rio Vista.

There is still some uncertainty about whether augmented flows through the Yolo Bypass could cause increases in pesticide levels in water or plankton within the bypass that would counteract potential benefits to special-status fish. This possibility is still under investigation by the U.S.

Geological Survey and DWR (Orlando et al. 2020:99) and future studies are recommended by DWR (Davis et al. 2022:269). The Delta Coordination Group now adaptively manages flow augmentation through Yolo Bypass (Davis et al. 2022:269).

CEQA Significance Determination and Mitigation Measures

Except as noted below, operation of Alternatives 1, 2, and 3 would not substantially degrade water quality and would have less than significant effects on water quality with respect to changes in salinity, water temperature at discharge sites, HABs, invasive aquatic vegetation, nutrients, organic carbon, DO, mercury, and, for most locations, pesticides and metals for the following reasons:

- Water Temperature: operation would not increase water temperature more than 5°F at discharge locations, in compliance with the Central Valley Basin Plan.
- Salinity: operation would not result in a substantial increase in salinity or violations of Delta or other water quality objectives due to the relatively low EC of the Sacramento River water used to fill the reservoir, the small volume of local inflows (Salt Pond and creeks), the requirements for salinity monitoring and I/O tower operation (Section 2D.3), dilution of the Sites Reservoir discharge by the Sacramento River, and limited effects of CVP/SWP reoperation on Delta water quality.
- Nutrients, Organic Carbon, Dissolved Oxygen: operation would not reduce drinking water quality downstream due to nutrients and organic carbon or cause low DO because nutrients and organic carbon in Sites Reservoir releases would be diluted and water would be aerated upon release. Any increases in reservoir nutrient concentrations may benefit fish. Yolo Bypass habitat releases from Sites Reservoir may cause a temporary reduction in DO (below the 5.0 mg/L water quality objective) in the Toe Drain, Tule Canal, and other Yolo Bypass channels, but this would not be substantially different than what occurs historically during non-managed flow pulses. Although habitat releases may stimulate phytoplankton growth, this would be unlikely to be of a magnitude that would result in a nuisance or adversely affect beneficial uses.
- HABs, Invasive Aquatic Vegetation: Operation would result in reservoir drawdown, reduced storage volume, and higher water temperatures from late spring through fall, particularly in Dry and Critically Dry Water Years. This would create favorable conditions for the initiation of HABs, and growth of invasive aquatic vegetation. If cyanobacteria and cyanotoxins were present in reservoir releases, potential downstream effects on water quality would not be expected because concentrations of cyanobacteria and cyanotoxins would be greatly diluted when eventually discharged into the Sacramento River, and cyanotoxins would undergo biodegradation and, to some degree, photodegradation. Furthermore, measures including monitoring and restricting in-water recreation based on the presence of cyanobacteria and cyanotoxins, and releasing water from lower in the reservoir if cyanobacteria and cyanotoxins are confirmed near the I/O tower at a level at or exceeding the "Caution" action trigger level, would further reduce any potential for adverse water quality effects (Section 2D.3). Releases to Funks and Stone Corral Creeks will be adaptively managed as part of a comprehensive study plan and adaptive management plan, the Stone Corral Creek and Funks Creek Aquatic Study

Plan (Section 2D.4). As part of the Surface Water Ambient Monitoring Program Study component of this study plan, monitoring for cyanobacteria and cyanotoxin in Stone Corral and Funks Creeks will be implemented to inform management of Sites Reservoir releases to ensure that there are no adverse water quality effects so that fish are maintained in good condition in these creeks in compliance with California Fish and Game Code Section 5937. Once the released flows enter the north Delta at Rio Vista, the existing flows at that location may be high enough to prevent the formation of HABs. Also, to the extent that the habitat releases from Sites Reservoir would result in similar effects with regard to cyanobacteria as the 2018 and 2019 North Delta Food Subsidy studies, there would be no resultant HABs in the Yolo Bypass or the Delta. In the 2018 and 2019 North Delta Flow Action studies, following the pulse flow (using agricultural return water), there was no substantial difference in the average biovolume of cyanobacteria in the lower Sacramento River (Rio Vista) after the flow pulse relative to before the flow pulse. Similarly, except for the Toe Drain at Road 22, there was no substantial difference in the average biovolume of cyanobacteria in the upper and lower Yolo Bypass following the pulse. In the Toe Drain at Road 22, there was an apparent decrease in biovolume in cyanobacteria in 2018, and an increase in 2019, after the flow pulse relative to before (Davis et al. 2022:165). In addition, although *Microcystis* cyanobacteria have been observed in the Yolo Bypass, as part of the Yolo Bypass Fish Monitoring Program, no bloom sightings were reported (Interagency Ecological Program et al. 2021).

Impacts with respect to invasive aquatic vegetation would be the same as described under Impact WQ-1. Potential effects of invasive aquatic vegetation on water quality would be managed and minimized by measures in Section 2D.3. Project operations would not increase HABs in the Delta because water would be diverted during the winter and would not reduce flows (i.e., increase residence time) when HABs typically occur in the Delta (i.e., summer).

- Pesticides: concentrations in Sites Reservoir and Sites releases are expected to be low because source water concentrations are low; operations would not change the overall pesticide load to the Delta as pesticides are already present in the Yolo Bypass; any increase as a result of habitat flows into Yolo Bypass would be reduced by net and tidal flows from the Sacramento River and the California Department of Fish and Wildlife (CDFW) would use habitat flows in the manner most advantageous to ecosystem benefits identified in the WSIP program.
- Mercury and Methylmercury: operation would not cause mercury concentrations to exceed the CTR criterion in Sites Reservoir. Sites Reservoir releases with estimated expected long-term aqueous methylmercury concentrations would be lower than that in the CBD under the No Project Alternative and therefore would not be expected to increase bioaccumulation of methylmercury in CBD fish. Sites Reservoir releases could increase aqueous and fish tissue methylmercury concentrations in the CBD, particularly during Dry and Critically Dry Water Years at estimated long-term worst-case methylmercury concentrations in releases. However, fish tissue methylmercury levels in the CBD would likely return to baseline levels within months following the May–November release period.

- Metals other than Mercury: operation would not cause significant effects on water quality in the CBD, Funks Creek, water used for local agriculture (e.g., arsenic), or the Sacramento River. Discharge of Sites Reservoir water to the CBD would likely reduce metals concentrations in the CBD because metal concentrations in the CBD are generally higher than metals concentrations in the Sacramento River regardless of time of year. Project effects on Funks Creek would be less than significant because of exceedances that likely already occur under 2020 baseline conditions, the limited channel length that would be maximally affected, reductions in total metal concentrations due to settling of suspended sediment, and because water would be released to the creek from the I/O Works (i.e., higher in the reservoir away from the bed sediment). Water quality, including metals concentrations, will be monitored in the creeks and adaptive management will occur as necessary to maintain fish in the creeks in good condition in compliance with California Fish and Game Code Section 5937 (Appendix 2D). In the Sacramento River, discharges to the river from Sites Reservoir would occur after reductions in total metal concentrations due to settling of suspended sediment. These discharges would not cause substantial increases in concentration or exceedances or exacerbation of exceedances of water quality standards for metals in the Sacramento River.

Operation of Alternatives 1, 2, or 3 could cause significant water quality impacts related to the following constituents:

- Methylmercury: Sites Reservoir releases may cause measurable long-term degradation of water quality downstream in the north Delta by causing increases in aqueous and fish tissue methylmercury concentrations, relative to the No Project Alternative, in Dry and Critical Water Years, and causing exceedances of the methylmercury TMDL fish tissue objectives to occur more frequently and/or by greater magnitudes during these years and release period. Mercury and methylmercury in reservoir releases to Funks and Stone Corral Creeks would be reflected in the tissue of fish in these creeks and could cause exceedances of the 0.2 mg/kg ww sport fish objective. This would be a significant impact. Mitigation Measure WQ-1.1, *Methylmercury Management,* would be implemented at Sites Reservoir to reduce the magnitude of this impact. Mitigation Measure WQ-1.1 would be implemented to reduce the methylation of mercury in Sites Reservoir. Although the potential to reduce methylmercury concentrations exists based on current research (State Water Resources Control Board 2017b), the effectiveness of the methylmercury minimization actions to reduce reservoir methylmercury concentrations such that there would be no substantial measurable increase in aqueous and fish tissue methylmercury concentrations at downstream locations is not known at this time. Therefore, this impact would be significant and unavoidable.
- Metals in Stone Corral Creek: operation could cause elevated concentrations of some metals in Stone Corral Creek because reservoir discharges to Stone Corral Creek would generally come from the bottom of Sites Reservoir, where metal concentrations may be greater than in other parts of the reservoir water column. Mitigation Measure WQ-2.1, *Prevent Metal Impacts in Stone Corral Creek Associated with Sites Reservoir Discharge*, would be implemented if metal concentrations in Stone Corral Creek exceed water quality standards for the protection of aquatic life during the drier parts of the year when exceedances would not be expected. Implementation of Mitigation Measure WQ-2.1

would reduce this impact to less than significant because releases would be controlled and metal concentrations would be reduced.

- Metals and Pesticides in Yolo Bypass: operation could cause elevated concentrations of some metals and pesticides in Yolo Bypass as a result of redirection of some of the CBD water from the Sacramento River to the Yolo Bypass. Mitigation Measure WQ-2.2, *Prevent Net Detrimental Metal and Pesticide Effects Associated with Moving Colusa Basin Drain Water Through the Yolo Bypass*, includes evaluation of metals and pesticide concentrations in Yolo Bypass to ensure net benefits for aquatic communities and discontinuing flows if shown otherwise. Implementation of Mitigation Measure WQ-2.2 would reduce impacts to less than significant because flow would be terminated if needed.

Mitigation Measure WQ-1.1: Methylmercury Management

See Impact WQ-1 for a description of this mitigation measure.

Mitigation Measure WQ-2.1: Prevent Metal Impacts in Stone Corral Creek Associated with Sites Reservoir Discharge

The metals of concern for Project operations include aluminum, copper, iron, and lead. Mercury is considered separately. The effect of the Project on metal concentrations in Stone Corral Creek is uncertain. To evaluate the potential effect, metal concentrations will be measured in samples collected from Stone Corral Creek approximately half a mile downstream from Sites Dam. Samples will be collected every other month for 1 year prior to construction and every other month after construction for a period sufficient to indicate that any impacts are less than significant, including during periods when the reservoir is at least 75% full. The measurements will include total and dissolved aluminum, copper, iron, lead, and hexavalent chromium. Hexavalent chromium is included because existing data are insufficient to evaluate potential Project effects. Measurements of metal concentrations will be accompanied by measurements of pH, dissolved organic carbon, and hardness because these parameters influence water quality standards for aquatic life protection for some metals. Additional metal measurements are planned for the Stone Corral Creek and Funks Creek Aquatic Study Plan (Section 2D.4).

Under the No Project Alternative, exceedances of standards for the protection of aquatic life for total aluminum, copper, iron, and lead (standards shown in Table 6-9) tend to occur in the Sacramento River and Stone Corral Creek during the rainy season. Stone Corral Creek would be considered as affected by elevated metal concentrations if they were found to exceed thresholds for aquatic life protection during the drier parts of the year when exceedances would not be expected. For evaluation purposes, this drier part of the year would begin in April or a month after the last diversions to Sites Reservoir storage, whichever is later, and run through November or until the commencement of diversions to storage, whichever is earlier (the flow regime for Funks and Stone Corral Creeks has not yet been established, so there may be no reservoir releases to the creeks during some of these months). If measurements from Stone Corral Creek taken during this dry period indicate that concentration of one or more of these metals is greater than water quality standards for the protection of aquatic life, actions to reduce metal concentrations in Stone Corral Creek will be implemented to reduce concentrations to levels that meet these standards. Mitigative actions may include, but are not limited to, one or more of the following types of measures.

- Modify the flow released to Stone Corral Creek. Changes in release flow could affect metal concentrations in the reservoir discharge by altering the withdrawal zone in the reservoir.
- Release occasional pulses of high flow. Flow pulses could flush away low-quality sediment and water from the bottom of the reservoir adjacent to Sites Dam.
- Add a vertical extension in the reservoir at the withdrawal point. This extension would pull water from higher in the reservoir, where metal concentrations are expected to be lower.
- Pump water from the top of Sites Reservoir for release into Stone Corral Creek. Based on the demonstration of the effect of partial settling of suspended sediment on total metal concentrations in Sites Reservoir and the conservative nature of this assessment, metal concentrations in Sites Reservoir are generally expected to meet water quality standards for metals for the protection of aquatic life during the drier parts of the year in water located above the deepest portions of the reservoir.

- During the drier parts of the year, which are the focus of this mitigation measure, concentrations of total aluminum, copper, and iron in Sites Reservoir may occasionally be above water quality standards for the protection of aquatic life. Aquatic life and water quality in Stone Corral Creek will be monitored as part of the RMP and the Stone Corral Creek and Funks Creek Aquatic Study Plan. These studies will provide additional information about baseline conditions in the creeks, monitor for effects of Sites Reservoir on aquatic life, and, if necessary, result in adaptive management.

Mitigation Measure WQ-2.2: Prevent Net Detrimental Metal and Pesticide Effects Associated with Moving Colusa Basin Drain Water Through the Yolo Bypass

The effect of the Project on metal and pesticide concentrations in the Yolo Bypass due to increased inflow from the CBD is uncertain. Flow augmentation with other water sources is continuing to be evaluated with oversight from the Delta Coordination Group. The effect of Yolo Bypass flow augmentation on pesticide levels in water and plankton is under investigation by the U.S. Geological Survey and DWR (Orlando et al. 2020:99). The effect of the Project on metal concentrations in the Yolo Bypass will be assessed as part of this mitigation measure.

To evaluate the potential metal effect, metal concentrations will be measured in samples collected at the downstream end of the CBD and at two locations in the Yolo Bypass, one in the Tule Canal and the other in the Toe Drain. Samples will be collected monthly during June–October to evaluate concentrations before and during the period of CBD discharge to the Yolo Bypass.

> If the pesticide studies indicate that flow augmentation would increase pesticide concentrations to a level that could be detrimental to fish or if the metal measurements indicate that the Project habitat flows could cause Yolo Bypass concentrations of metals to exceed water quality standards for aquatic life protection, the potential net effects of these elevated concentrations on aquatic communities will be evaluated. Net effects include additive or synergistic effects, effects on food supply for fish, and direct effects on fish. This evaluation will be part of the ongoing evaluation conducted by CDFW and other agencies to determine net benefits of the Yolo Bypass habitat flows and the Project's funded ecosystem benefits under the WSIP. CDFW would have the discretion to modify WSIP water that is released to Yolo Bypass, depending on the state of the science and fish needs, and flows would cease if there were no net benefit.

NEPA Conclusion

Operation effects would be the same as described above for CEQA. There would be no adverse effects for water temperature at discharge sites, salinity, nutrients, organic carbon, DO, HABs, invasive aquatic vegetation, mercury, pesticides, and, for most locations, pesticides and metals as compared to the No Project Alternative. Due to mercury and methylmercury in Sites Reservoir releases there would be substantial adverse water quality effects as compared to the No Project Alternative as a result of increases in aqueous and fish tissue methylmercury in the north Delta in Dry and Critically Dry Water Years, and in Funks and Stone Corral Creeks. Mitigation Measure WQ-1.1 would be implemented to reduce the magnitude of the methylmercury effect on water quality. However, the effectiveness of the methylmercury minimization actions to reduce reservoir methylmercury such that there would be no substantial measurable increase in aqueous and fish tissue methylmercury concentrations at these downstream locations is not known at this time. Therefore, this effect would remain substantially adverse. There could be substantial adverse effects for metals in Stone Corral Creek and the Yolo Bypass and for pesticides in the Yolo Bypass as compared to the No Project Alternative. As described above for CEQA, the metals and pesticides effects would be reduced and would not be adverse with implementation of Mitigation Measures WQ-2.1 and WQ-2.2.

Impact WQ-3: Violate any water quality standards or waste discharge requirements or otherwise substantially degrade surface water quality during maintenance activities

No Project

Under the No Project Alternative, the operations and maintenance of the existing TC Canal, RBPP, and GCID Main Canal would continue, and no new facilities would be built and operated. Existing surface water quality conditions in the study area would not be expected to change substantially.

Significance Determination

The No Project Alternative would not violate any water quality standards or waste discharge requirements or otherwise substantially degrade surface water quality during maintenance because no new Project-related facilities would be built and operated. No maintenance of new Project facilities would be required. There would be no impact/no effect.

Alternatives 1, 2, and 3

Under Alternatives 1, 2, and 3, multiple facilities (including the adjacent areas) and structures would require maintenance. These include pumps, turbines, pipes, canals, the transition manifold, valves, gates, I/O tower, fish screens, head gates, trash racks, and the landscape and buffer lands around the facilities. Maintenance activities that could affect water quality either directly or indirectly include pesticide use (e.g., vector or rodent control, or vegetation management), painting, cleaning, lubricating equipment, debris removal, road maintenance, and dewatering for inspection or fixing/changing equipment. Maintenance activities for the RBPP, TC Canal, Hamilton City Pump Station, GCID Main Canal, and the CBD already occur, so Project maintenance at these facilities would not represent a change relative to the No Project Alternative. The activities are not expected to increase in frequency or intensity.

The Authority would implement BMP-12 and BMP-13 to minimize water quality impacts potentially associated with facility operations and maintenance. These BMPs would minimize potential water quality effects by preventing spills and reducing runoff that may cause sediment or contaminants to flow into waterbodies. The limited extent of possible water quality effects associated with facility maintenance combined with BMP-12 and BMP-13 would prevent facility operation and maintenance activities from causing substantial degradation of water quality.

CEQA Significance Determination and Mitigation Measures

Maintenance activities for Alternatives 1, 2, and 3 would have a less-than-significant impact on water quality.

NEPA Conclusion

Maintenance effects would be the same as described above for CEQA. Maintenance activities of Alternatives 1, 2, or 3 would have a limited extent of possible water quality effects as compared to the No Project Alternative. Furthermore, BMP-12 and BMP-13 would prevent facility operation and maintenance activities from causing substantial degradation of water quality as compared to the No Project Alternative. Maintenance activities would have no adverse effect on water quality.

Impact WQ-4: Be placed in a flood hazard or seiche zone, risking release of pollutants due to Project inundation

This impact is dependent on the location of various Project facilities. As such, this impact evaluation is not divided into separate analyses for construction and operations.

A seiche is a standing wave that forms in a semi- or fully enclosed body of water, such as a lake, reservoir, or river. Seiches and the potential for seiche effects are described more fully in Chapter 12.

No Project

The No Project Alternative represents the continuation of the existing conditions in the study area. Under the No Project Alternative, the operations of the existing TC Canal, RBPP, and

GCID Main Canal would continue, and Sites Reservoir would not be constructed or operated. No new facilities would be constructed or placed in a flood hazard or seiche zone.

Significance Determination

The No Project Alternative would not result in facilities being placed in flood hazard or seiche zones or introduce the risk of release of pollutants from Project inundation. There would be no impact/no effect.

Alternatives 1, 2, and 3

As described for Impact GEO-2 in Chapter 12, the risk of seiche in the TRR East and West is expected to be low, but a seiche could occur in the Sites Reservoir. Reservoir-triggered seismic motions and seismic shaking generated by regional faults (whose movement is unrelated to the presence of the reservoir) could cause a seiche in the Sites Reservoir. Based on the characteristics of the Boxer Formation (which underlies the reservoir footprint and adjoins the reservoir slopes), it is possible that a landslide, whether triggered by seismic shaking or high rainfall, could also be capable of causing significant seiche waves. Based on current understanding of the ground shaking hazard, it is unlikely that any seiche would be large enough to overtop the main and saddle dams or bridge. As part of final design, recreational facilities would be located outside of a potential seiche run-up elevation, so no release of pollutants such as wastewater from vaulted toilets is expected in association with seiches.

There are multiple Project facilities located within 100-year inundation areas (Figures 5-2, 5-3, 5-4, and 5-5). The facilities most likely to release pollutants during a 100-year flood event are those that would be used to store chemicals or other potential contaminants. Project facilities that may store chemicals or other potential contaminants and that are located in or close to 100-year inundation areas include the Hamilton City Pump Station and RBPP, However, these are existing facilities, and this storage does not represent the presence of new pollutants in the 100-year inundation area. New facilities include the TRR PGPs and associated electrical substation and switchyard near TRR East or TRR West, and the administration and operations building and the maintenance and storage building near Funks Reservoir and the Funks PGP. Possible sources of pollutants at these sites include petroleum products such as lubricants and fuel, herbicides, and sewage. As part of BMP-13, hazardous materials (including bulk storage tanks) would be stored with secondary containment, and petroleum products would be stored in nonleaking containers at impervious storage sites. During a flood event, these measures would avoid or minimize the spread of contaminants that may be stored on site.

Pollutants located both inside and outside of the 100-year inundation area could be released in the unlikely event of a pipeline or canal failure, Sites Reservoir emergency release, or dam failure. Due to the unlikely nature of these events, these pollutants are not considered to be a substantial threat to water quality. Emergency releases and dam failure are discussed in more detail in Chapter 5.

CEQA Significance Determination and Mitigation Measures

Project-related facilities would not be placed in areas that could be affected by seiches. There are multiple Project facilities that would be in a flood hazard area; however, only some of them would store materials that could result in water quality effects. With BMP-13, SPCCPs for facilities with potential sources of pollutants would prevent releases of pollutants that would affect water quality in the event of a flood. This impact would be less than significant.

<u>*NEPA Conclusion*</u>

Project effects would be the same as described above for CEQA. Alternatives 1, 2, or 3 would not locate facilities in areas that could be affected by seiches, and only some Project facilities in a flood hazard area would store materials that could result in water quality effects as compared to the No Project Alternative. With BMP-13, SPCCPs for facilities with potential sources of pollutants would prevent releases of pollutants that would affect water quality in the event of a flood. There would be no adverse effects associated with the release of pollutants due to seiche or flooding.

Impact WQ-5: Conflict with or obstruct implementation of a water quality control plan

No Project

Under the No Project Alternative, the operations of the existing TC Canal, RBPP, and GCID Main Canal would continue, and Sites Reservoir would not be constructed or operated. Existing surface water quality conditions in the study area would not be expected to change substantially.

<u>*Significance Determination*</u>

The No Project Alternative would not conflict with or obstruct implementation of a water quality control plan because no new Project-related facilities would be constructed and operated. There would be no impact/no effect.

Alternatives 1, 2, and 3

The main water quality control plans relevant to this impact are the Bay-Delta Plan and the Central Valley Basin Plan. The Central Valley Basin Plan incorporates chemical constituent objectives for domestic or municipal water supply from Title 22 of the California Code of Regulations and provisions of multiple TMDL plans, including the 2011 TMDL for control of methylmercury and total mercury in the Delta.

<u>*Operation, Construction, and Maintenance*</u>

As described for Impact WQ-1 and Impact WQ-3, water quality effects would be limited and implementation of BMP-11, BMP-12, BMP-13, and BMP-14 is expected to minimize water quality effects associated with construction and maintenance activities. Aside from the initial filling of Sites Reservoir, adverse effects on water quality are not expected. Thus, construction and maintenance activities are not expected to conflict with or obstruct any water quality control plan.

As described for Impact WQ-2, Project operation could cause degradation of water quality by increasing the concentration of water quality constituents such as mercury and other metals. These effects would be addressed through the implementation of the RMP and Mitigation Measures WQ-1.1, WQ-2.1, and WQ-2.2. Aqueous and fish tissue methylmercury concentrations in some waterbodies downstream of Sites Reservoir could remain elevated relative to the No

Project Alternative even after mitigation. Water quality control plans include consideration of all beneficial uses. As stated in the Central Valley Basin Plan (p. 2-1):

> “Beneficial uses are critical to water quality management in California. State law defines beneficial uses of California's waters that may be protected against quality degradation to include (and not be limited to) “...domestic; municipal; agricultural and industrial supply; power generation; recreation; aesthetic enjoyment; navigation; and preservation and enhancement of fish, wildlife, and other aquatic resources or preserves” (Water Code Section 13050(f)). Protection and enhancement of existing and potential beneficial uses are primary goals of water quality planning.”

Similarly, Chapter 3 in the Bay-Delta Plan (p. 9):

> “…establishes water quality objectives which, in conjunction with the water quality objectives for the Bay-Delta Estuary watershed that are included in other State Water Board adopted water quality control plans and in water quality control plans for the Central Valley and San Francisco Bay Basins, when implemented, will:
> (1) provide for reasonable protection of municipal, industrial, and agricultural beneficial uses;
> (2) provide reasonable protection of fish and wildlife beneficial uses at a level which stabilizes or enhances the conditions of aquatic resources; and (3) prevent nuisance. These water quality objectives are established to attain the highest quality of water that is reasonable, considering all the demands being made on waters in the Estuary watershed.”

The net effect of the Project would be to enhance beneficial uses of water, and water quality could improve in parts of the study area. For example, during some months the increases in Delta outflow could reduce seawater intrusion and under certain circumstances Alternatives 1, 2, and 3 could allow for seasonal storage changes in Shasta Lake that could help to preserve cold-water supply for fish through exchanges with Sites Project water. This would add flexibility to Shasta Lake operations. Shasta Lake, in part, is operated to time releases from its cold-water pool later in the summer to prevent exceeding temperature thresholds for endangered winter-run Chinook salmon. The development of Sites Reservoir for Alternative 1, 2, or 3 would create in-reservoir habitat and thus net benefits for Reservoir cold-water and warm-water fish species. Alternatives 1, 2, and 3 would also result in supporting and increasing water supply reliability for other beneficial uses designated by the water quality control plans including recreation, municipal supply, and agricultural supply. The operation of Sites Reservoir would provide new recreational opportunities. Operations would increase water supply reliability for refuges, municipalities, and agriculture, particularly in Dry and Critically Dry Water Years (Table 5-30).

CEQA Significance Determination and Mitigation Measures

Construction, operation, and maintenance of Alternative 1, 2, or 3 would increase overall beneficial use of water in the Sacramento River watershed. The Project would not conflict or obstruct a water quality control plan and this impact would be less than significant.

NEPA Conclusion

This effect would be the same as described above for CEQA. Construction, operation, and maintenance of Alternative 1, 2, or 3 would not conflict or obstruct a water quality control plan as compared to the No Project Alternative. There would be no adverse effect.

Impact WQ-6: Create or contribute runoff water which would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff

No Project

The No Project Alternative represents the continuation of the existing conditions within the study area. Under the No Project Alternative, the operations of the existing TC Canal, RBPP, and GCID Main Canal would continue, and Sites Reservoir would not be constructed or operated. Under the No Project Alternative, no actions would be taken that would affect stormwater drainage systems or provide substantial additional sources of polluted runoff.

Significance Determination

The No Project Alternative would not create or contribute runoff water which would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff. There would be no impact/no effect.

Alternative 1, 2, and 3

Construction

The potential for Alternatives 1, 2, and 3 to result in polluted runoff due to construction activities is considered under Impact WQ-1. As described for Impact WQ-1, implementation of BMP-12 will include erosion control measures to stabilize soil via different procedural or mechanical techniques such as silt fencing or straw bale barriers. These techniques would prevent soil particles from detaching and becoming suspended in stormwater runoff by keeping soil in place and reducing the velocity of runoff. Sediment control measures, including the use of sediment and turbidity barriers when ground-disturbing activities are required adjacent to surface waters, would complement/enhance soil stabilization measures and would intercept runoff and capture suspended soil particles. Postconstruction stormwater management and runoff reduction measures would also be implemented as part of BMP-12 and would reduce or eliminated sediment discharges. Postconstruction erosion control measures, such as placement of silt fencing, vegetative plantings, and hydraulic mulch in areas with steeper slopes or other characteristics making them potentially susceptible to erosion would reduce stormwater velocity and prevent road and parking lot runoff from reaching nearby waterways. As part of BMP-15, site-specific drainage evaluations/studies will be implemented as part of final Project design. Under Alternatives 1, 2, and 3 there will be equivalent functioning of the existing drainage systems during and after construction because strategies and other appropriate practices (based on the pre-development hydrology) will be developed and implemented onsite. These strategies and practices may include relocation of facilities within the existing footprints, reduction in footprint sizes, and the use of appropriate drainage systems and practices that mimic natural processes to infiltrate and recharge (e.g., green infrastructure, such as vegetation plantings, or low-impact development practices, bioswales, infiltration basins). Construction and postconstruction conditions would not create or contribute to runoff that would exceed the capacity of existing or planned stormwater drainage systems or provide additional sources of polluted runoff.

Operation

Most of the study area is rural in nature and has no formal stormwater management system. Stormwater is primarily collected in existing receiving waters such as Funks Creek, Stone Corral Creek, and the CBD and carried to the Sacramento River. There are no extensive urban stormwater drainage systems that would be affected by the Project, but small drainage features such as culverts and swales are present. Operations could generate small amounts of polluted runoff. The main Project facilities that could create runoff include paved roads, bridges, buildings, and parking lots. Vehicle related pollutants (e.g., hydrocarbons, metals, and rubber) could wash off these impervious surfaces during storm events. There may be more stormwater runoff associated with Alternative 2, given that South Road would add approximately 20 miles of additional new roadway relative to Alternatives 1 and 3.

Impervious surfaces would be designed to drain stormwater and would not contribute to runoff water that would exceed the capacity of existing or planned drainage system or provide substantial additional sources of polluted runoff. Accordingly, drainage evaluations for BMP-15 would be made as part of Project design (35% completion or greater). Project civil engineers and professional hydrologists would evaluate preconstruction and postconstruction drainage needs and design features to ensure local drainage infrastructure (e.g., ditches and culverts) will not be disrupted. Site-specific drainage evaluations/studies will consider design flows of existing facilities that would be crossed by Project features and develop strategies to ensure equivalent functioning of the existing drainage systems after construction. These evaluations/studies will be applicable to aboveground facilities ultimately resulting in impervious surfaces. Strategies and other appropriate practices (based on the pre-development hydrology) include potential relocation of facilities within the existing footprints, reduction in footprint sizes, and use of appropriate drainage systems and practices that mimic natural processes to infiltrate and recharge (e.g., green infrastructure or low-impact development practices, bioswales, infiltration basins).

The bridge across Sites Reservoir that is part of Alternatives 1 and 3 is an additional potential source of polluted runoff. Implementation of BMPs to convey stormwater runoff from bridges to land is generally not recommended for rural bridges (National Academies Press 2014:5). Further, because of the large water volume in Sites Reservoir, any runoff generated by the bridge would likely have minimal effect on water quality in the reservoir.

CEQA Significance Determination and Mitigation Measures

Construction of Alternatives 1, 2, or 3 would not contribute runoff water that would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff. Sediment and other pollutants in stormwater runoff would be reduced or avoided through implementation of BMP-12, as well as postconstruction erosion control measures. In addition, BMP-15 will require site-specific drainage evaluations/studies that will consider design flows of existing facilities that would be crossed by Project features and develop strategies to ensure equivalent functioning of the existing drainage systems during construction and after construction. Impacts from construction would be less than significant.

Operation of Alternative 1, 2, or 3 would not exceed the capacity of stormwater drainage systems. Runoff volume would be relatively small compared to receiving water volume given the potential size of impervious surfaces and the implementation of the SWPPPs and drainage evaluations. Polluted runoff potentially generated by new impervious surfaces would be reduced or avoided through implementation of site-specific SWPPPs and the development and implementation of drainage evaluations. Operation of Alternative 1, 2, or 3 would not create or contribute runoff water that would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff. Impacts from operations would be less than significant.

NEPA Conclusion

Project effects would be the same as described above for CEQA. Runoff volume would be relatively small compared to receiving water volume given the potential size of impervious surfaces during construction and operation as compared to the No Project Alternative. Construction and operation of Alternative 1, 2, or 3 would not contribute runoff water that would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff as compared to the No Project Alternative. BMP-12 and postconstruction erosion control measures will reduce sediment and other pollutants in stormwater runoff, and BMP-15 will require site-specific drainage evaluations/studies under construction and operation. There would be no adverse effects associated with increases in polluted runoff.

6.5 References

6.5.1. Printed References

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6.5.2. Personal Communication

Davis, Brittany E., PhD. Environmental Program Manager. California Department of Water Resources. July 6, 2021—Email to John Spranza, Integration Environmental Permitting Lead, HDR, Inc., Sacramento, CA.