Chapter 8
Water Quality

8.0 Readers' Guide

8.0.5 Organization of the Effects and Mitigation Approaches Discussion (Section 8.3.3)

The Effects and Mitigation Approaches section (Section 8.3.3) contains the analysis of the impacts and mitigation on water quality constituents for each alternative. The section begins with an analysis of the No Action Alternative and is then followed by the action alternatives. A discussion of cumulative effects is included as a standalone section (Section 8.3.4) after Alternative 9.

Each alternative begins with a brief description of the alternative itself, including the capacity of the North Delta intake structures, the operational scenario, and any other major aspects of the alternative. Following this is the "Effects of the Alternative on Hydrodynamics" section, which includes a brief discussion of how water quality constituents would be expected to change in general due to changes in Delta hydrodynamics, the general changes in hydrodynamics due to the alternative, and the types of water quality changes seen in the alternative.

To the extent there are similarities between the No Action Alternative or Alternative 1A and the other alternatives, the subsequent alternative analyses refer back to either the No Action Alternative or the Alternative 1A analysis. This approach allows the analysis of Alternative 1A and Alternatives 1B through Alternative 9 to minimize redundancy and emphasize those aspects of the alternatives that are different from the No Action Alternative or Alternative 1A. Hence, readers wishing to gain a better understanding of the impacts and mitigation for Alternatives 1B through 9 should first become familiar with the presentation of impacts and mitigation for the No Action Alternative and Alternative 1A. Alternatives ending in 'B' or 'C' are different from the corresponding 'A' variant of the alternatives. The difference is the physical type and/or location of water conveyance infrastructure. In all other respects, including water operations, the 'B' and 'C' variants are identical to the corresponding 'A' variant. For example Alternative 1B is different from Alternative 1A in that Alternative 1A would convey water from the north Delta to the south Delta through pipelines/tunnels, while Alternative 1B would convey water through a surface canal. The effects on water quality do not differ otherwise, so the analysis of the 'B' and 'C' alternatives is condensed and refers the reader back to the corresponding 'A' alternative for specific details.

Restoration and Other Conservation Measures are the same among all but two of the alternatives. The exceptions are Alternatives 5 and 7. Under Alternative 5, 25,000 acres of tidal habitat would be restored, compared to 65,000 acres for Alternative 1A. Under Alternative 7, there would be 20,000 acres of seasonally inundated floodplain and 40 miles of channel enhancement, versus 10,000 acres of seasonally inundated floodplain and 20 miles of channel margin enhancement under Alternative 1A. However, these differences do not substantially affect water quality impact conclusions discussed in this chapter, and thus for Alternatives 1B through 9, the reader is referred back to Alternative 1A for details. To help guide the reader, bookmark their location in the chapter, and maintain consistency with Alternative 1A, the impact headers are retained in these other alternatives and followed by a general summary in some instances and cross reference to appropriate analysis located elsewhere in the chapter.

The BDCP conservation measures (see Table 3~~.~~-3 ~~Summary of Proposed BDCP Conservation Measures of All Action Alternatives~~ in Chapter 3, *Description of Alternatives*) that are analyzed for each water quality constituent under each alternative are treated in two distinct categories for purposes of impact analysis. Those categories are as follows:

- Potential impacts resulting from water operations and maintenance of Conservation Measure (CM) 1 ~~(. Conservation Measure 1~~CM1 provides for the development and operation of a new water conveyance infrastructure and the establishment of operational parameters associated with both existing and new facilities). For the purposes of the assessment, the study area was divided into the three regions which are discussed separately for each constituent for ~~Conservation Measure~~ CM1:
    - Upstream of the Delta (including the Sacramento and San Joaquin River watersheds).
    - Plan Area, including the Yolo Bypass, SWP North Bay Aqueduct service area, and Suisun Marsh.
    - SWP/CVP Export Service Area (south of the Delta, areas served by the California Aqueduct, Delta Mendota Canal, and South Bay Aqueduct).
- Potential impacts resulting from other conservation measures, ~~Conservation Measures~~ CM2–CM~~-22~~ 21(these include habitat restoration measures that provide for the protection, enhancement and restoration of habitats and natural communities and measures to reduce the direct and indirect adverse effects of other stressors on covered species).

Operations-related water quality changes (i.e., CM1 under the BDCP Alternatives) would be partly driven by geographic and hydrodynamic changes resulting from restoration actions (i.e., altered hydrodynamics attributable to new areas of tidal wetlands (CM4), for example). There is no way to disentangle the hydrodynamic effects of CM4 and other restoration measures from CM1, since the Delta as a whole is modeled with both CM1 and the other conservation measures implemented. To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects were included in the modeling assessment of operations-related water quality changes (CM1 under the BDCP Alternatives). Other effects of ~~CM2–22CM2 through CM22~~CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a water quality constituent to the Delta, are discussed within the impact heading for ~~CM2–22CM2 through CM22~~CM2–CM21.

After the discussion for each water quality constituent, construction-related water quality effects are discussed. As opposed to discussing construction-related water quality effects for each water quality constituent within the constituent-specific assessments described above, construction-related water quality effects on all constituents are discussed in a single section for all ~~Conservation Measures~~ CM1–~~22~~CM21. Within each alternative discussion section, the impacts of the BDCP conservation measures are analyzed in the following order:

- Ammonia
- Boron
- Bromide
- Chloride

- Dissolved Oxygen
- Electrical Conductivity
- Mercury
- Nitrate
- Organic Carbon
- Pathogens
- Pesticides and Herbicides
- Phosphorus
- Selenium
- Trace Metals
- TSS and Turbidity
- Construction-related Activities
- Microcystis
- San Francisco Bay

It should be noted that because aquatic life beneficial uses are the only uses expected to be affected by temperature changes under the various Alternatives, the water quality chapter cross-references to Chapter 11, *Fish and Aquatic Resources*, for all impact assessments for temperature.

8.1 Environmental Setting/Affected Environment

8.1.1 Affected Environment

8.1.1.7 Water Quality Impairments

Water Quality–Limited Water Bodies, Watershed Monitoring Programs, and Total Maximum Daily Loads

Constituents of concern in the study area have been identified through ongoing regulatory, monitoring, and environmental planning processes. Important programs are CALFED, the Basin Plan functions of the Central Valley and San Francisco Bay Water Boards, Bay-Delta planning functions of the State Water Board, and the CWA Section 303(d) listing process for state water bodies that do not meet applicable water quality objectives.

The CALFED Bay-Delta Program was established in 1995 to develop a long-term comprehensive plan to restore ecological health and improve water management for beneficial uses of the Bay-Delta System. Senate Bill 1653 established the California Bay-Delta Authority to act as the governance structure, as of January 1, 2003, and is housed within the California Resources Agency.

Under CWA Section 303(d), states, territories, and authorized tribes are required to develop a ranked list of water quality–limited segments of rivers and other water bodies under their jurisdiction. Listed waters are those that do not meet water quality standards even after point sources of pollution have installed the minimum required levels of pollution control technology. The law requires that action plans, or TMDLs, be developed to monitor and improve water quality. TMDL is defined as the sum of the individual waste load allocations from point sources, load allocations from nonpoint sources and background loading, plus an appropriate margin of safety. A TMDL defines the maximum amount of a pollutant that a water body can receive and still meet water quality standards. TMDLs can lead to more stringent National Pollutant Discharge Elimination System (NPDES) permits (CWA Section 402).

The State Water Board and USEPA have approved TMDLs for organic enrichment/low DO and methylmercury in the Delta, and for salt and boron in the San Joaquin River at Vernalis. TMDLs for other constituents remain under planning or development. Additionally, the San Francisco Bay Water Board is currently developing a TMDL for Suisun Marsh to address impairment by methylmercury, DO, and nutrient enrichment (San Francisco Bay Water Board 2012). While Suisun Marsh is not within the officially designated Delta, the mercury and salinity impairments are primarily associated with loading from the Delta. Low dissolved oxygen is associated with seasonal organic loading from wetland and water management systems within the marsh. The salinity impairment was identified in the 1970's as an issue of changing marsh vegetation and potential adverse effects to marsh vegetation that was important to ducks as feed. The Suisun Marsh Salinity Control Gates were installed in Montezuma Slough in 1988 provide the means to control salinity intrusions from Suisun Bay during the periods of low Delta outflow.

The State Water Board recently compiled the 2010 Section 303(d) list of impaired waters based on recommendations from the Regional Water Boards and information solicited from the public (and other interested parties). In October 2011, USEPA gave final approval to the list. Table 8-2 lists the constituents identified in the Section 303(d) list for impaired Delta waters (State Water Resources Control Board 2011).

Table 8-2. Clean Water Act Section 303(d) Listed Pollutants and Sources in the Delta

Pollutant/Stressor	Listing Region	Listed Source	Delta Location of Listing
Boron	Central Valley	Agriculture	Exp
Chlordane	Central Valley and San Francisco Bay	Agriculture, nonpoint source	N, W
Chloride	Central Valley	Source unknown	TomP
Chlorpyrifos	Central Valley	Agriculture, urban runoff/ storm sewers	N, S, E, W, NW, C, Exp, Stk, CalvR, Duck, Five, French, MokR, Morm, Mosh, OldR, Pix
Copper	Central Valley	Resource extraction	MokR
DDT	Central Valley and San Francisco Bay	Agriculture, nonpoint source	N, S, E, W, NW, C, Exp, Stk
Diazinon	Central Valley	Agriculture, urban runoff/storm sewers	N, S, E, W, NW, C, Exp, Stk, CalvR, Five, French, Mosh, Pix
Dieldrin	San Francisco Bay	Nonpoint source	N, W
Dioxin compounds	Central Valley and San Francisco Bay	Source unknown, atmospheric deposition	W, Stk
Disulfoton	Central Valley	Agriculture	Pix
E. coli	Central Valley	Source unknown	E, French, Pix
Invasive species	Central Valley and San Francisco Bay	Source unknown, ballast water	N, S, E, W, NW, C, Exp, Stk
Furan compounds	Central Valley and San Francisco Bay	Contaminated sediments, atmospheric deposition	Stk
Group A pesticides[a]	Central Valley	Agriculture	N, S, E, W, NW, C, Exp, Stk

Pollutant/Stressor	Listing Region	Listed Source	Delta Location of Listing
Mercury	Central Valley and San Francisco Bay	Resource extraction, industrial-domestic wastewater, atmospheric deposition, nonpoint source	N, S, E, W, NW, C, Exp, Stk, CalvR, MokR, Mosh
Pathogens	Central Valley	Recreational and Tourism Activities (nonboating), Urban Runoff/Storm Sewers	Stk, CalvR, Five, Morm, Mosh, Walk
PCBs	Central Valley and San Francisco Bay	Source unknown	W, N, Stk
Unknown toxicity[b]	Central Valley	Source unknown	N, S, E, W, NW, C, Exp, Stk, French, MokR, Morm, Pix
EC	Central Valley	Agriculture	S, W, NW, Exp, Stk, OldR, TomP
Organic enrichment /low DO	Central Valley	Municipal point sources, urban runoff/storm sewers	Stk, CalvR, Five, MidR, MokR, Morm, Mosh, OldR, Pix, TomP
Sediment toxicity	Central Valley	(Not specified)	French
Selenium	San Francisco Bay	Refineries, invasive species, natural sources	W
TDS	Central Valley		S, OldR
Zinc	Central Valley	Resource extraction	MokR

Source: State Water Resources Control Board 2011.

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

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

Notes: DDT = dichlorodiphenyltrichloroethane, PCB = polychlorinated biphenyls, EC = electrical conductivity, DO = dissolved oxygen, TDS = total dissolved solids.

Delta Locations: C = Central, E = East, Exp = export area, N = north, NW = northwest, S = south, Stk = Stockton Deep Water Ship Channel, W = west (includes Central Valley list and San Francisco Bay list for “Bay-Delta” category).

Specific Delta Waterways: CalvR = Calaveras River, Duck = Duck Slough, Five = Five Mile Slough, French = French Camp Slough, MidR = Middle River, MokR = Mokelumne River, Morm = Mormon Slough, Mosh = Mosher Slough, OldR = Old River, Pix = Pixley Slough, TomP = Tom Paine Slough, Walk = Walker Slough.

There are several ongoing watershed-monitoring programs in the study area. These monitoring programs are associated with Section 303(d) TMDL programs, the State Water Board Surface Water Ambient Monitoring Program, and numerous other efforts of local governments and public/private entities.

Section 303(d) requires that states evaluate and rank water quality impairments that cannot be resolved through point source controls and, in accordance with the priority ranking, the TMDL for those pollutants the USEPA identifies under Section 304(a)(2) as suitable for such calculation. The TMDL must be established at a level necessary to implement the applicable water quality standards with seasonal variations and a margin of safety that takes into account any lack of knowledge concerning the relationship between effluent limitations and water quality. The TMDL is the amount of loading that the water body can receive and still meet water quality standards. The TMDL must include an allocation of allowable loadings to point and nonpoint sources, with consideration of background loadings. Table 8-3 summarizes the TMDLs that have been completed or are being developed for Section 303(d) listed constituents in the Delta, and the portion of the study area in the Sacramento and San Joaquin River basins (Central Valley Water Board 2009b).

Table 8-3. Summary of Completed and Ongoing Total Maximum Daily Loads in the Bay-Delta and Sacramento and San Joaquin River Portions of the Study Area

Pollutant/Stressor	Water Bodies Addressed	TMDL Status
Chlorpyrifos and diazinon	Sacramento County Urban Creeks	TMDL report completed—September 2004 State-Federal approval—November 2004
Chlorpyrifos and diazinon	Lower San Joaquin River	TMDL report completed—October 2005 State-Federal approval—December 2006
Chlorpyrifos and diazinon	Sacramento and San Joaquin Rivers and Delta	TMDL report completed—June 2006 State-Federal approval—October 2007
Chlorpyrifos and diazinon	Sacramento and Feather Rivers	TMDL report completed—May 2007 State-Federal approval—August 2008
Chlorpyrifos and diazinon	Lower San Joaquin River	TMDL report completed—October 2005 State-Federal approval—December 2006
DO	Stockton Deep Water Ship Channel	TMDL report completed—February 2005 State-Federal approval—January 2007
Mercury/methylmercury	Delta	TMDL report completed—April 2010
Mercury/methylmercury	Reservoirs	Ongoing
Pathogens	Tributaries affected by city of Stockton urban runoff	Ongoing
Pesticides	Basin-wide	Ongoing
Organochlorine pesticides	Specific Sacramento and San Joaquin River tributaries; Delta	Ongoing
Salt and Boron	San Joaquin River at Vernalis	TMDL report completed—October 2005 State-Federal approval—February 2007
Selenium	San Joaquin River at Vernalis	TMDL report completed—August 2001 State-Federal approval—March 2002

Source: Central Valley Water Board 2009b.
Notes: DO = dissolved oxygen, TMDL = Total Maximum Daily Load.

Table 8-4 summarizes only the total number of Section 303(d) listed water bodies in the regions of the Central Coast, Los Angeles, Santa Ana, and San Diego Regional Water Boards where SWP south-of-Delta exports are conveyed. This information is presented at a lesser level of detail than for the Delta and Sacramento–San Joaquin regions because the effects of storage and conveyance of Delta export water in the southern SWP service areas to the large majority of these listed water bodies are only indirect or nonexistent. Moreover, not all of the Section 303(d)–listed water bodies in these regions necessarily occur in the SWP service areas because the SWP service areas do not cover the entire regions.

Table 8-4. Clean Water Act Section 303(d) Listed Water Bodies in Regions of the Study Area Served by SWP South-of-Delta Exports

	Regional Water Board				
Pollutant	San Francisco	Central Coast	Los Angeles	Santa Ana	San Diego
Hydromodification			10		
Mercury	36	6	11	2	2
Other metals	27	44	142	24	159
Miscellaneous	17	147	52	11	36
Nuisance		3	27		14
Nutrients	15	321	183	29	179
Other inorganics	2		39		14
Other organics	64	11	102	10	18
Pathogens	32	451	171	44	324
Pesticides	95	142	187	16	32
Salinity	1	194	72	2	46
Sediment	10	168	23	10	20
Toxicity	7	105	49	8	109
Trash	27		87		7

Source: State Water Resources Control Board 2011.

8.1.3 Existing Surface Water Quality

8.1.3.3 Bromide

Existing Conditions in the Study Area

Locations in the northern Delta have had low concentrations of bromide in water years 2001–2006 with mean values of 0.02 and 0.04 mg/L at the Sacramento River at Hood and Barker Slough pump locations, respectively (Figure 8-15). Higher mean concentrations typically are seen in the southern Delta, with values of 0.18 mg/L at the Banks pumps, 0.27 mg/L at the San Joaquin River near Vernalis, and 0.28 mg/L at CCWD pumping plant #1. The highest mean value examined was 5.18 mg/L at the Sacramento River at Mallard Island.

Time series data indicate that bromide concentrations at the examined stations generally fluctuate on an annual basis (Figure 8-16) but depend on location. For example, higher values have tended to occur during the months of March through May at the Barker Slough pumps, while higher values occurred during the October to early January period at CCWD pumping plant #1. Bromide data for the north and south-of-Delta stations were sparse; values were available for the American River at WTP and were all reported as 0.01 mg/L.

There are presently no regulatory water quality objectives for bromide in the Delta. Bromide is not a priority pollutant; thus, the CTR has no criteria for bromide. There are no state or federal regulatory water quality objectives/criteria for bromide, or any USEPA-recommended criteria. The state drinking water primary MCL for bromate is 0.01 mg/L. To reduce the potential for DBP formation in municipal water supplies, the CALFED Drinking Water Quality Program has the goal of achieving either a bromide concentration of 0.05 mg/L at the southern and ~~western~~ central Delta water export locations, along with an average TOC concentration of 3 mg/L (CALFED Bay-Delta Program 2000), or an “Equivalent Level of Public Health protection” for municipal water supply purveyors. Specifically, the goal of the CALFED Drinking Water Program is to:

> achieve either: (a) average concentrations at Clifton Court Forebay and other southern and central Delta drinking water intakes of 50 µg/L bromide and 3.0 mg/L total organic carbon, or (b) an equivalent level of public health protection using a cost-effective combination of alternative source waters, source control, and treatment technologies.~~”~~ (CALFED Bay-Delta Program 2000)

In general, bromide concentrations are frequently above 0.05 mg/L at Delta locations influential to the water quality of surface water supply purveyors.

The basis of the bromide goal is described in the Final Draft of the CALFED Water Quality Program Stage 1 Final Assessment as follows:

> In 1998, a panel of three water quality and treatment experts, engaged by the California Urban Water Agencies (CUWA), produced a report titled “Bay-Delta Water Quality Evaluation, Draft Final Report”. CUWA had charged the panel with developing potential regulatory scenarios, defining appropriate treatment process criteria, and estimating the Delta source water quality required to achieve compliance under the anticipated regulatory scenarios…The panel identified two regulatory scenarios for their evaluation, a near-term scenario consisting of the then current treatment rules governing pathogen inactivation and disinfection and a long-term scenario which included the anticipated more stringent versions of these rules then under development.
>
> The long term scenario…were regulatory levels of 40 µg/L total trihalomethanes (TTHMs), 30 µg/L haloacetic acids (HAA5s), and 5 µg/L bromate (as running annual averages) as well as an additional 1 to 2-log inactivation of *Giardia* and 1-log inactivation of *Cryptosporidium*. The panel focused on inactivation requirements and the DBP precursors TOC and bromide as the constituents in Delta water that would be most likely to drive treatment technology decisions. Their basic finding was that, under the more stringent long-term scenario, it would be necessary to keep Delta water diverted for municipal use to no more than 3 mg/L TOC and 50 µg/L bromide to give users flexibility in their choice of treatment method (enhanced coagulation or ozone disinfection)…For the less stringent near-term regulatory scenario, TOC from 4 to 7 mg/L and bromide from 100 to 300 µg/L was determined to be acceptable. (CALFED Water Quality Program 2007).

The more stringent regulations envisioned at the time the 50 µg/L (0.05 mg/L) bromide goal for source waters was recommended have not yet been realized. The only changes implemented compared to the less stringent near-term regulatory scenario evaluated are that the running annual average bromate MCL has been changed to a locational running average that must be met at all points in the treatment and distribution system, and additional *Cryptosprodium* inactivation is required for higher risk systems, dependent on monitoring outcomes. In general, these do not affect the levels of bromide in source water that would require drinking water treatment or source water modification for compliance with current MCLs.

Although the projected long-term reduction in the bromate MCL has not occurred, it is still possible that it will be reduced in the future. The U.S. EPA maximum contaminant level goal (MCLG) for bromate is 0 µg/L, and the current MCL of 10 µg/L is set at the current analytical practical quantitation limit (PQL) for bromate, determined by the U.S. EPA through an analytical feasibility analysis. While the U.S. EPA’s most recent Analytical Feasibility Support Document for the Second Six-Year Review of Existing National Primary Drinking Water Regulations (U.S. EPA 2010) did not recommend a lowering of the bromate PQL, and thus MCL, below 10 µg/L, recent adoption of new analytical methods could lead to an improved PQL, and thus reduced MCL. This means that in 2016, or the time of the next Six-Year Review of National Primary Drinking Water Regulations, it is possible the bromate MCL will be lowered to the 5 µg/L value assumed in the derivation of the 50 µg/L CALFED bromide goal.

8.1.3.4 Chloride

Existing Conditions in the Study Area

Locations in the northern Delta had low concentrations of chloride in water years 2001–2006, with mean values of 6 and 22 mg/L at the Sacramento River at Hood and Barker Slough pump locations, respectively (Figure 8-17). Higher mean concentrations typically are seen in the southern Delta, with values ranging from 59 mg/L at the Banks pumps to 90 mg/L at both CCWD pumping plant #1 and Franks Tract. Chloride mean concentrations increased at the mouths of the Sacramento River and San Joaquin River, with the highest value of 6,380 mg/L at Suisun Bay at Bulls Head near Martinez.

Chloride mean concentrations in the north-of-Delta locations were very low (water years 2001–2006), ranging from 1 to 5 mg/L (Table 8-9). South-of-Delta locations had mean values of 69 mg/L, which were higher than that reported at the Banks headworks (59 mg/L, Figure 8-17).

Table 8-9. Chloride Concentrations at Selected North of Delta and South-of-Delta Stations, Water Years 2001–2006[a]

	Chloride (dissolved, mg/L)				
Location	Samples	Minimum	Maximum	Mean	Median
Sacramento River at Keswick	46	1	6	2	2
Sacramento River at Verona	21	2	15	5	4
Feather River at Oroville	29	1	3	1	1
American River at WTP	69	1	3	2	2
California Aqueduct at Check 13	69	23	138	69	64
California Aqueduct at Check 29	81	16	127	69	66

[a] Sample size represents water quality samples having values at or greater than the reporting limit.
Notes: mg/L = milligrams per liter; WTP = water treatment plant.
Source: California Department of Water Resources 2009b.

Time series data for chloride displayed annual fluctuations (Figures 8-18a, 8-18b,andFigure 8-19), with peaks typically occurring in fall/winter.

The Bay-Delta WQCP contains chloride objectives for municipal and industrial water supply beneficial uses protection, including a maximum mean daily concentration of 250 mg/L year-round at the five major municipal water supply diversion locations—Contra Costa Canal at pumping plant #1, West Canal at mouth of Clifton Court Forebay, Jones pumping plant, Barker Slough at North Bay Aqueduct, and Cache Slough at the City of Vallejo intake (abandoned). Table 8-9a summarizes the record of compliance with the Delta chloride objectives that are specified in the Bay-Delta WQCP. Thise 250 mg/L standard has been exceeded at the CCWD pumping plant #1 on several occasions ~~and, on rare occasions, at the Delta-Mendota Canal headworks~~ in four of the past 20 years. Additionally, the Bay-Delta WQCP contains a chloride objective for Contra Costa Canal at pumping plant #1 or the San Joaquin River at Antioch Water Works intake that specifies the number of days each calendar year that the maximum mean daily chloride concentration must be less than 150 mg/L (must be provided in intervals of not less than 2 weeks' duration). The days per year depend on water-year type, ranging from 155 days for critical water-year types to 240 days in wet water-year types. The industrial uses for which this objective was established (cardboard manufacturing in Antioch) no longer exist; however, the objective has been retained for general municipal use protection (CALFED Bay-Delta Program 2007a). Delta water supply operations have been able to maintain compliance with the 150 mg/L standard.

Table 8-9a. Summary of Compliance with Delta Chloride Objectives (1995 ¬ 2014)

	Objective[a, b]		Exceedances of Objective		
Location	Applicable Period (and narrative description)	Days/ year[c]	Years (#) With Objective Exceeded	Maximum Days Exceeded	Median Days Exceeded[d]
Municipal and Industrial Water Supply Objectives					
CCF	Jan 1-Dec 31 md Cl <= 250 mg/L	365	0	0	0
DMC @ Tracy PP	Jan 1-Dec 31 md Cl <= 250 mg/L	365	0	0	0
CCC at PP#1	Jan 1-Dec 31 md Cl <= 250 mg/L	365	4	7	2.5
CCC PP#1 or SJR @ Antioch Intake	Jan 1-Dec 31 Chloride (days <150 mg/L Cl varies by WY).	Varies by WY Type	0	0	0

Notes:

CCF = Clifton Court Forebay; DMC= Delta Mendota Canal; PP=Pumping Plant; CCC = Contra Costa Canal; PMI = previous month's Eight River Index

[a] This table also includes objectives/standards set by Water Rights Orders 95-6 and 98-6.

[b] Only partial description of objective provided; refer to Bay-Delta WQCP for full text of objective.

[c] Total number of days in year that requirement is applicable.

[d] Median calculated using only years when exceedances occurred.

The secondary MCL for chloride is specified as a range: 250 mg/L (recommended), 500 mg/L (upper), and 600 mg/L (short-term) and is applicable to all surface waters in the affected environment, other than the Delta, that have the municipal and domestic supply beneficial use designation. The USEPA's recommended chloride ambient water quality criteria for the protection of freshwater aquatic life are 230 mg/L (chronic 4-day average) and 860 mg/L (acute 1-hour average). The San Francisco Bay Water Board Basin Plan has a 355 mg/L chloride objective for agricultural supply. CCWD has a goal of delivering treated water that has less than 65 mg/L chloride.

One channel in the southern Delta (Tom Payne Slough) and Suisun Marsh is on the state's CWA Section 303(d) list because of elevated chloride (State Water Resources Control Board 2011). Additionally, the lower San Joaquin River is on the 303(d) list as impaired for salt and boron, and a TMDL has been developed with chloride identified as composing about 23% of the total ions contributing to salinity in the lower San Joaquin River at the Vernalis location in the Delta (Central Valley Water Board 2002).

8.1.3.5 Dioxins, Furans, and Polychlorinated Biphenyls

Background

Dioxins and dioxin-like compounds are a ~~group of~~ chemical compounds with similar chemical structures and biotic effects (U.S. Food and Drug Administration 2009). There are several hundred of these compounds, which can be grouped into three families: chlorinated dibenzo-p-dioxins, chlorinated dibenzofurans, and certain polychlorinated biphenyls (PCBs). One of the most toxic (and most studied) dioxins is 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD). Chlorinated dibenzo-p-dioxins and chlorinated dibenzofurans are created unintentionally, usually through combustion processes. PCBs are manufactured products but are no longer produced in the United States. Dioxin~~s~~/furan compounds and PCBs break down very slowly in the environment, indicating that past and present emissions will continue to interact with soils, water, and biota (e.g., Wenning et al. 1999; Gullett et al. 2003; Brown et al. 2006).

The most common health effect in people exposed to large amounts of dioxins is chloracne, possibly followed by skin rashes, skin discoloration, and excessive body hair and possibly mild liver damage (U.S. Food and Drug Administration 2009). A substantial concern is the cancer risk associated with dioxins. High exposures over long periods (animal studies, human workplace studies) have suggested an increased cancer risk as well as possible reproductive and developmental effects. Toxicity levels are very broad between the various dioxin compounds, up to several orders of magnitude. The health effects associated with dioxins depend on a variety of factors, including the level, timing, duration, and frequency of exposure.

The class of PCBs consists of 209 individual congeners, of which 12 have dioxin-like properties. In general, PCBs can cause developmental abnormalities, growth suppression, disruption of the endocrine system, impairment of immune function, and cancer (State Water Resources Control Board 2007). PCBs can bioaccumulate and reach higher concentrations in higher levels of aquatic food chains; predatory fish, birds, and mammals (including humans that consume fish) at the top of the foodweb are particularly vulnerable to the effects of PCB contamination. Consequently, the beneficial uses (Table 8-1)most directly affected by dioxin/furan compounds and PCBs are aquatic organisms (cold freshwater habitat, warm freshwater habitat, and estuarine habitat); rare, threatened and endangered species if the community population level were to be reduced by exposure through the aquatic environment; harvesting activities that depend on aquatic life (shellfish harvesting, commercial and sport fishing); and drinking water supplies (municipal and domestic supply) ~~(Table 8-1)~~.

Dioxins may enter the environment through air, water, and land pathways. Because the majority of dioxin releases are to the atmosphere, some dioxins can be transported very long distances and can be found in most places in the world (National Research Council 2006; U.S. Food and Drug Administration2009). In water, dioxins tend to settle into sediments where they can move up the food chain. Dioxins can also be deposited on plants and enter the food chain. Animals tend to accumulate dioxins in fatty tissues.

USEPA (2006a) estimated that the primary pathway of dioxin releases to the environment is atmospheric (92.4%), with 5.7% to the land and 1.8% to water. It is important to note that this estimate did not include natural sources of dioxins, which exceed those produced by human activities (Centers for Disease Control 2005). Dioxins are ubiquitous, and all living organisms have had some form of low-level exposure. Natural brush and forest fires produce dioxins, so it is reasonable to assume that organisms have been exposed to dioxins for centuries. For example,54% of global dioxin emissions were from natural forest fires in 2004, with the remainder coming from anthropogenic sources (Figure 8-20).

PCBs were used commonly in the United States for the production of transformers and capacitors in electrical equipment (Brinkmann and de Kok 1980). Other uses included hydraulic fluids, lubricants, inks, and as a plasticizer (State Water Resources Control Board 2007). While production of transformers and capacitors containing PCBs ended in the United States in 1979, the persistent nature of PCBs in the environment is still a source of concern (Davis et al. 2007).

Importance in the Study Area

Assessment of how human atmospheric emission sources of dioxins, furans, and PCBs in the study area directly affect the Delta would be difficult, given the complexity of area meteorology. Based on the USEPA (2006b) analysis, the major sources likely would be backyard barrel burning of refuse and medical waste/pathological incineration. Such sources would need to be identified and undergo air transport modeling to determine deposition rates onto land and water in the study area.

Human activities related to land and water emissions may be more easily quantified and, based on the USEPA (2006b) analysis, likely would be dominated by application of municipal wastewater treatment sludge (land), ethylene dichloride/vinyl dichloride production (land, water), chlor-alkali facilities (water), and bleached, chemical wood pulp and paper mills (water).

Existing Conditions in the Study Area

There are two portions of the study area that are on the Section 303(d) listing for impairment with respect to dioxins, furans, and PCBs. The Stockton Deep Water Ship Channel is listed for dioxins/furans for the overall channel, and 3.3 miles of the channel are listed for PCBs. The north Delta has a PCB impairment listing for 15.5 miles of drainage canal near Sacramento.

Hayward et al. (1996) found that sediment concentrations of dioxins and furans near a USEPA Superfund site in the Stockton area (specifically, a wood treatment facility) were highly localized and likely attributable to pentachlorophenol use at the facility.

Contributions of dioxins to the Delta originate from several sources, including the Sacramento River, the San Joaquin River, the eastside tributaries, Delta agricultural return drains, and San Francisco Bay. The section below quantifies how these sources contribute to concentrations in the Delta.

Minimal dioxin and furan data have been collected as part of water quality monitoring programs in the study area. For example, pentachlorophenol and carbofuran have been analyzed at the Banks pumping plant three times a year since 1995 with no detections.

There was a large monitoring effort from 1988 to 1993 to assess PCBs in the Delta. ~~Analytes~~ The study examined the seven most common commercial mixtures of PCBs produced prior to the production ban in 1977 ~~included~~identified as PCB-1016, PCB-1221, PCB-1232, PCB-1242, PCB-1248, PCB-1254, and PCB-1260 (Bay Delta and Tributaries Project 2009). The stations from this monitoring that coincide with the stations examined in this section are the San Joaquin River at Buckley Cove, Sacramento River at Hood (actually collected at Greene's Landing), Sacramento River above Point Sacramento, San Joaquin River at Antioch Ship Channel, Old River at Rancho Del Rio, Suisun Bay at Bulls Head Point near Martinez, and Franks Tract. Analysis of the monitoring results indicated that no detections of PCBs occurred in any samples from these locations.

Recent monitoring efforts to assess PCBs in the study area are limited to four of the selected locations, including the Banks pumping plant, the Barker Slough pumping plant, the Sacramento River above Point Sacramento, and the San Joaquin River at Antioch Ship Channel. The latter two stations were sampled for forty of the individual PCB~~s~~ congeners (ranging from PCB 008 to PCB 203) on an annual basis by SFEI as part of its monitoring program (denoted as stations BG20 and BG30, respectively). The SFEI laboratory reporting limits are on the order of 0.01 picograms per liter (pg/L), which are about 10,000,000 times more sensitive than the laboratory reporting limits for the Banks and Barker Slough pumping plants.

Analytes examined in the present effort for the Banks and Barker Slough pumping plants included the PCB mixtures (i.e., PCB-1016, PCB-1221, PCB-1232, PCB-1242, PCB-1248, PCB-1254, and PCB-1260). The monitoring program sampled for each of these analytes approximately 16 times during the water years 2001 to 2006 for each location. No detections were found.

~~Forty different PCB compounds ranging from PCB 008 to PCB 203 were examined by the SFEI laboratory for the Sacramento River above Point Sacramento and the San Joaquin River at Antioch Ship Channel locations. As mentioned previously, laboratory detection limits for the SFEI laboratory are on the order of pg/L.~~ The~~se~~ very low detection limits of the SFEI monitoring ha~~ve~~s enabled the detection of many PCBs at the Sacramento River above Point Sacramento and the San Joaquin River at Antioch Ship Channel locations examined in the current study, which are presented as the sum of all PCB~~s~~ congeners in Table 8-10.

Table 8-10. Sum of All Polychlorinated Biphenyls at the Mouths of the Sacramento and San Joaquin Rivers, Water Years 2001–2006

Sum of all PCBs	Samples	Minimum (pg/L)	Maximum (pg/L)	Mean (pg/L)	Median (pg/L)
Sacramento River above Point Sacramento					
Dissolved	7	35	70	52	50
Total	6	67	138	99	95
San Joaquin River at Antioch Ship Channel					
Dissolved	5	47	60	53	53
Total	5	70	254	120	98

Source: San Francisco Estuary Institute 2010.
Notes: All concentrations in picograms per liter (pg/L). Sample size represents water quality samples having values at or greater than the reporting limit.
PCB = polychlorinated biphenyl

The samples were taken between late July and late August, which does not allow examination of wet versus dry season effects. The results indicate that ~~all selected~~ PCBs are still present in the Sacramento and San Joaquin River outflows during summer conditions, albeit at low concentrations. Values for the sum of all PCBs were comparable at the two locations.

Sampling at south-of-Delta locations at California Aqueduct Check 13 and Check 29 for the same constituents also resulted in no detections during the same time period. Sampling at the north-of-Delta locations (approximately 35 to 60 visits per site) resulted in multiple detections at the Sacramento River at Keswick, the Feather River at Oroville, and the Sacramento River at Verona;

however, the sampling and analytical protocol for these data were not available, and the validity of the data could not be confirmed.

Regulatory criteria with respect to dioxins, furans, and PCBs are as follows. Dioxin compounds are on the Section 303(d) list for San Francisco Bay (source of contamination unknown) and the Central Valley (source: unknown point source near the Stockton Deep Water Ship Channel). Furan compounds are on the Section 303(d) list for San Francisco Bay (source: atmospheric deposition) and the Central Valley (source: contaminated sediments). PCBs and dioxin compounds are on the Section 303(d) list for San Francisco Bay (sources: unknown nonpoint, unknown).

With regard to Basin Plan narrative objectives, any of the compounds above might be considered toxic at high concentrations. There are no numerical water quality objectives for the San Francisco Bay Water Board or Central Valley Water Board Basin Plans. The California drinking water standard MCL for 2,3,7,8-TCDD is 0.00000003 mg/L; the MCL for carbofuran in 0.018 mg/L. The CTR for 2,3,7,8-TCDD is 0.000000013 µg/L for Human Health: Water and Organisms, and 0.000000014 µg/L for Human Health: Organisms Only. Data are inadequate to assess whether the sites examined in this SFEI monitoring exceeded this standard.

The CTR criteria for PCBs (sum of six aroclors) is 0.014 µg/L (freshwater chronic), 0.03 µg/L (saltwater chronic), 0.00017 µg/L (Human Health: Water and Organisms), and 0.00017 µg/L (Human Health: Organisms Only). Data examined in this study indicate that these criteria have not been exceeded.

8.1.3.7 Salinity and Electrical Conductivity

Existing Conditions in the Study Area

During the water year 2001–2006 period, mean EC concentrations tended to increase from the northern Delta to the southern Delta, and from the eastern Delta to the western Delta (Figure 8-24). For example, EC mean concentrations in the northern Delta were 166 and 141µmhos/cm for the Sacramento River at Hood and the Mokelumne River (South Fork) at Staten Island, respectively. In the southern Delta region, EC mean concentrations were 590 and 673 µmhos/cm for the San Joaquin River at Buckley Cove and the San Joaquin River near Vernalis, respectively. As water exits the Delta, mean EC concentrations were 3,481 and 2,366 µmhos/cm for the Sacramento River above Point Sacramento and the San Joaquin River at Antioch Ship Channel, respectively. Mean EC concentrations increased to 4,920 µmhos/cm at the Sacramento River at Mallard Island and were highest at Suisun Bay at Bulls Head Point near Martinez, with a value of 19,331µmhos/cm.

Mean values for the north-of-Delta area were lower than in the Delta region, ranging from 65 µmhos/cm at the American River at the WTP to 120 µmhos/cm at the Sacramento River at Verona (Table 8-13). South-of-Delta mean values were higher than those for the north-of-Delta stations examined (439 to 460 µmhos/cm), and slightly higher than the mean at the Banks headworks (393µmhos/cm) (Figure 8-24).

Table 8-13. Electrical Conductivity Concentrations at Selected North- and South-of-Delta Stations, Water Years 2001–2006

	Electrical Conductivity (µmhos/cm)				
Location	Samples	Minimum	Maximum	Mean	Median
Sacramento River at Keswick	32	82	127	106	108
Sacramento River at Verona	15	92	148	120	117
Feather River at Oroville	29	53	239	86	83
American River at WTP	120	6	152	65	65
California Aqueduct at Check 13	69	217	981	460	465
California Aqueduct at Check 29	74	133	680	439	456

Notes: µmhos/cm = micro mhos per centimeter; WTP = water treatment plant.
[a] Sample size represents water quality samples having values at or greater than the reporting limit.
Sources: California Department of Water Resources 2009b.

Time series data indicate that EC concentrations at the examined stations generally fluctuate on an annual basis (Figures8-25a, 8-25b,andFigure 8-26). However, peak values occurred at different times of the year for the various locations. Factors influencing this variability may include hydrology, water operations, watershed sources, and hydrodynamics in the Delta.

Because EC is not a priority pollutant, there are no criteria established for EC in the NTR or CTR. The secondary MCL for EC is specified as a range: 900 microSiemens per centimeter (µS/cm) (1 µS/cm=1µmhos/cm) (recommended), 1,600 µS/cm (upper), and 2,200 µS/cm (short-term), and is applicable to all surface waters in the affected environment, other than the Delta, that have the municipal and domestic supply beneficial use designation. The Region 5 Basin Plan specifies EC objectives for the Sacramento River, Feather River, and San Joaquin River; it also contains EC objectives for the Delta, which have been superseded by the 2006 Bay-Delta WQCP. The Bay-Delta WQCP contains EC objectives for the Delta for agricultural and fish and wildlife beneficial use protection, which vary by month and water-year type (see Appendix 8A). The Bay-Delta WQCP EC objectives for agricultural protection are designed primarily to control salinity conditions in the interior and southern Delta channels, and San Joaquin River inflow to the Delta at Vernalis, which tend to have higher salinity concentrations and are influenced most by Delta exports.

Table 8-13a summarizes the record of compliance with the Delta EC objectives that are specified in the Bay-Delta WQCP. The compliance record indicates that with the exception of a 35 day period at the Sacramento River at Emmaton location during the severe drought of 2013, Delta water supply operations have been able to maintain compliance with the agricultural EC objectives in the interior and western Delta locations and all fish and wildlife EC objectives. The south Delta EC objectives have been exceeded at the San Joaquin River at Brandt Bridge, Old River at Tracy Bridge, and Old River at Middle River locations for various lengths of time in several years. Water quality in the southern Delta downstream of Vernalis is influenced primarily by San Joaquin River inflow; tidal action; agricultural return flows; and channel capacity. The Delta water supply operations have relatively little influence on salinity levels at these locations, and the elevated salinity in south Delta channels is affected substantially by local salt contributions discharged into the San Joaquin River downstream of Vernalis as evidenced by the comparatively lower EC levels at Vernalis and the Banks and Tracy export locations.

1 **Table 8-13a. Summary of Compliance with Delta EC Objectives (1995 ‒ 2014)**

	Objective[a, b]		Exceedances of Objective		
Location	Applicable Period (and narrative description)	Days/ year[c]	Years (#) With Objective Exceeded	Maximum Days Exceeded	Median Days Exceeded[d]
Agricultural Water Supply Objectives					
ac @ Emmaton	Apr 1- date end varies by WY. 14-d avg EC varies by WY.	137	1	35	35
SJR @ Jersey Pt.	Jun 1[e] - period end varies by WY. 14-d avg EC varies by WY.	76	0	0	0
SF Mokelumne @ Terminous	Apr 1- Aug 15 14-d avg EC varies by WY.	137	0	0	0
SJR @ San Andreas	Apr 1- date end varies by WY. 14-d avg EC varies by WY.	137	0	0	0
Old R. @ Tracy	Apr 1-Aug 31 30-d avg EC<= 0.7 mS/cm Sep 1-Mar 31 30-d avg EC<= 1.0 mS/cm	365	9	289	88
Old R. @ Middle R.	Apr 1-Aug 31 30-d avg EC<= 0.7 mS/cm Sep 1-Mar 31 30-d avg EC<= 1.0 mS/cm	365	2	47	41
SJR @ Brandt Bridge	Apr 1-Aug 31 30-d avg EC<= 0.7 mS/cm Sep 1-Mar 31 30-d avg EC<= 1.0 mS/cm	365	3	68	28
SJR @ Vernalis	Apr 1-Aug 31 30-d avg EC<= 0.7 mS/cm Sep 1-Mar 31 30-d avg EC<= 1.0 mS/cm	365	0	0	0
CCF	Oct 1-Sep 30 Monthly avg EC<= 1.0 mS/cm	365	0	0	0
DMC @ Tracy PP	Oct 1-Sep 30 Monthly avg EC<= 1.0 mS/cm	365	0	0	0
Fish & Wildlife Objective					
Chipps Is. and Pt. Chicago	Feb 1-Jun 30 "X2" objective for EC (min days/month vary by PMI).	150	0	0	0
SJR betw. Jersey and Prisoners Pt.	Apr 1-May 31 14-d avg EC<= 0.44 mS/cm	61	0	0	0
Eastern Suisun Marsh (Sac @ Collinsville)	Oct 1-May 31 Monthly avg high tides EC varies by month.	243	0	0	0

Location	Objective[a, b] Applicable Period (and narrative description)	Days/year[c]	Exceedances of Objective: Years (#) With Objective Exceeded	Maximum Days Exceeded	Median Days Exceeded[d]
Eastern Suisun Marsh (Mont Sl. @ Nat. Steel)	Oct 1-May 31 Monthly avg high tides EC varies by month.	243	0	0	0
Eastern Suisun Marsh (Mont Sl. near Beldon Land.)	Oct 1-May 31 Monthly avg high tides EC varies by month.	243	0	0	0
Western Suisun Marsh (Chadbourne Sl.)	Oct 1-May 31 Monthly avg high tides EC varies by month & deficiency period.	243	0	0	0
Western Suisun Marsh (Suisun Sl.)	Oct 1-May 31 Monthly avg high tides EC varies by month & deficiency period.	243	0	0	0

Notes:

CCF = Clifton Court Forebay; DMC= Delta Mendota Canal; PP=Pumping Plant; CCC = Contra Costa Canal; PMI = previous month's Eight River Index

[a] This table also includes objectives/standards set by Water Rights Orders 95-6 and 98-6.

[b] Only partial description of objective provided; refer to Bay-Delta WQCP for full text of objective.

[c] Total number of days in year that requirement is applicable.

[d] Median calculated using only years when exceedances occurred.

[e] Applicable Period was reduced by 61 days as a result of the overlapping criteria between Western Delta Ag WQ and SJR Fish & Wildlife Objectives

The Region 2 Basin Plan contains agricultural EC objectives; however, the affected environment of the Delta and downstream Bay waters in Region 2 are generally saline and do not likely serve as a major water source for agricultural activity. For the protection of fish and wildlife habitat, the Bay-Delta WQCP regulates EC in western and interior Delta locations and Suisun Marsh.

The Central Valley Water Board and the State Water Board, in coordination with funding from the Central Valley Salinity Coalition, are overseeing the Central Valley Salinity Alternatives for Long-Term Sustainability (CV-SALTS) program, which is a science, policy, and regulatory planning process that began in 2006 to address the long-tem build up of salts, including nitrates, throughout the Central Valley in a comprehensive, consistent, and sustainable manner. Through a collaborative multistakeholder process, the CV-SALTS program will result in development of a Central Valley Salt and Nutrient Management Plan (SNMP), along with Basin Plan amendments to implement the SNMP. A goal for CV-SALTS is to foster regional collaborations for more efficient and effective salinity and nutrient management from regulated discharges and actions beyond the jurisdiction of the Central Valley Water Board and State Water Board, such as regional salt storage or conveyance systems, treatment facilities, Real-Time Management, water or salt trading, or other actions that the regulators are unable to require, but which could facilitate sustainable salinity management in the region.

CV-SALTS prepared an updated strategy and workplan in February 2012 that identified necessary studies to develop the SNMP. CEQA scoping meetings were held in late 2013 to solicit comments on potential components of the Central Valley SNMP. CV-SALTS has completed many studies identified in the early planning stages for CV-SALTS, including review and evaluations of applicable and potential alternative salinity and nutrient regulatory policies and water quality objectives for beneficial use protection. Many more studies, including economic and environmental review of proposed SNMP alternatives, are underway. A Strategic Salt Accumulation Land and Transport Study (SSALTS) is being prepared to identify the range of viable salt disposal methods for the Central Valley (taking into account regulatory, institutional, economic, and technological issues) and inclusion in the SNMP. The SSALTS study will evaluate existing salt disposal areas, establishment of new salt disposal areas within the Central Valley, export or transport of salt out of the Central Valley, or some combination of the above. Two parts of the study have been completed to date including a "Phase 1" report in December 2013 of potential study areas, and a "Phase 2" report in September 2014 that identifies potential salt disposal options. The final report (scheduled for late 2014) will identify and prioritize acceptable salt disposal alternatives.

As envisioned by CV-SALTS, the major final phases to develop the SNMP by mid-2016 are as follows:

- Initial Conceptual Model (ICM): The ICM study report was prepared in August 2013 and provides an approximate water, salt, and nitrate load balance analysis for the Central Valley floor in 22 areas of analysis referred to as Initial Analysis Zones (IAZs). The analysis uses the USGS' 2009 Central Valley Hydrologic Model (CVHM) model, coupled with the Watershed Analysis Risk Management Framework (WARMF) model, to evaluate TDS, chloride, and nitrate mass loading and transport in the Central Valley.
- Development of the Draft SNMP: This phase will utilize the data collected and/or organized as well as the methods and results developed as a part of the ICM. The Draft SNMP will provide refined spatial detail in some locations for the water balance, salt, and nitrate modeling of the Central Valley floor.
- Regulatory Approval Process: During this phase, the SNMP will be finalized and the documents that are necessary for the regulatory approval process for the adoption of the SNMP will be developed and submitted as a part of the Basin Plan Amendments.
- Development of Local SNMPs: It is anticipated that, upon completion of SNMP, focused SNMPs (Local SNMPs) may be developed and implemented by local and/or regional entities as needed.

Multiple water bodies in the affected environment are on the state's CWA Section 303(d) list for impairment by elevated EC levels, as follows: (a) southern, northwestern, and western channels in the Delta; (b) Delta export area; (c) Grasslands drainage area, Mud Slough, and Salt Slough in the San Joaquin River valley; (d) San Joaquin River from Bear Creek to Delta boundary; and (e) Suisun Marsh (State Water Resources Control Board 2011). A TMDL has been prepared for the lower San Joaquin River at Vernalis, and the TMDL for segments upstream from Vernalis is under development.

8.1.3.8 Emerging Pollutants: Endocrine-Disrupting Compounds, Pharmaceutical and Personal Care Products, and Nitrosamines

Background

Emerging water quality contaminants represent a broad range of chemicals that have not traditionally been part of monitoring programs because they were not deemed important until recently or the ability to quantify them had not been possible until recent laboratory advances allowed their detection. As such, data for these parameters in the study area are relatively sparse.

The beneficial uses (Table 8-1)most directly affected by emerging pollutant concentrations are aquatic organisms (cold freshwater habitat, warm freshwater habitat, and estuarine habitat) and drinking water supplies (municipal and domestic supply) (Table 8-1). The focus of the following section is on three classes of emerging contaminants: EDCs, PPCPs, and nitrosamines (e.g., NDMA).

Endocrine-Disrupting Chemicals

EDCs interfere with hormone (endocrine) systems in animals. Hormones are released by body organs (e.g., thyroid, ovaries, testes) and act as chemical messengers to other organs and tissues. Hormones bind with receptor sites in a way similar to how a key fits into a lock. Upon binding, the receptor carries out the hormone's instructions by either altering the cell's existing proteins or turning on genes that will build a new protein (U.S. Environmental Protection Agency2009b). Both of these actions create reactions throughout the body. The hormone system operates from conception through old age, affecting development, reproduction, metabolism, and other crucial body functions.

The problem with EDCs is that they can bind to hormone receptor sites in the body. The effect of this action varies but usually involves altering the function of the hormone system (U.S. Environmental Protection Agency 2009b). For example, an EDC that mimics a natural hormone can result in over- or underproduction of a chemical or response (e.g., too much growth hormone) or generation of a response at an inappropriate time (e.g., producing insulin when not needed). Other EDCs can block natural hormones from binding. Overall, the action of EDCs is typically undesirable because EDCs can disrupt normal body function.

EDCs have been studied with respect to their potential impacts on aquatic organisms (e.g., Snyder 2003, 2008). For example, studies of the impact of estrogen exposure on fish downstream of WTPs have detected elevated levels of vitellogenin, a female-specific egg yolk protein, in male fish. In a 7-year study, investigators found that concentrations of estrogens/estrogen mimics observed in freshwater could affect the sustainability of wild fish populations by altering the male population (Kidd et al. 2007).

Examples of EDCs include natural plant and animal compounds, metals (e.g., arsenic, cadmium, lead, mercury), dioxins, polycyclic aromatic hydrocarbons (PAHs), pesticides, PPCPs, and PCBs (Snyder 2008). Sources of anthropogenic EDCs include WTPs, private septic systems, urban stormwater runoff, industrial effluents, landfill leachates, discharges from fish hatcheries and dairy facilities, runoff from agricultural fields and livestock enclosures, and land amended with biosolids or manure.

WTPs are not specifically designed to treat and remove CECs, and the WTP industry is just beginning to examine their ability to treat for EDCs, with ~~an encouraging~~some degree of success (e.g., Snyder 2008; Benotti et al. 2009; Contra Costa Water District 2009); however, our understanding of treatability for CECs is incomplete. Related research suggests that estrogen compounds can be biodegraded in the stream sediments below plant outfalls (Bradley et al. 2009).

Pharmaceuticals and Personal Care Products

PPCPs generally represent products used by humans for personal health (e.g., prescription and over-the-counter drugs) or cosmetic (e.g., fragrances, lotions) reasons, as well as products used to enhance livestock growth or health (e.g., hormones, antibiotics).

PPCPs in the environment have not yet been shown to adversely affect human health, but some studies suggest that they contribute to ecological harm (U.S. Environmental Protection

Agency 2009c). PPCPs have been found in most places sampled but typically at very low concentrations. Research to study the long-term exposure to very low PPCP concentrations is in its infancy. Concern exists because so much is unknown about the effects of PPCPs and because the number of PPCPs is growing.

According to the USEPA (2009c), people contribute PPCPs to the environment when medication residues pass out of the body and into sewer lines, when externally applied drugs and personal care products they use wash down the shower drain, and when unused or expired medications are placed in the trash or flushed down a toilet. ~~WTP operators are just beginning to examine their ability to treat for PPCPs, with an encouraging degree of success (e.g., Snyder 2008; Benotti et al. 2009; Contra Costa Water District 2009)~~.

Municipal WTPs are not specifically designed to treat and remove CECs, however, activated sludge treatment processes are known to exhibit CEC treatment and removal effectiveness for many compounds. The Water Environment Federation (WEF) has sponsored research that investigated factors of WTP processes that result in PPCP removal performance (Oppenheimer and Stephenson 2006). The study evaluated monitoring data for 20 PPCP compounds in a variety of secondary biological and filtration treatment processes, including processes with nitrification and denitrification. The study determined that in general, an increase in solids residence time (SRT) was an important factor resulting in enhanced removal efficiency for the majority of the monitored chemicals. The SRT required to achieve consistent removal above 80% is compound-specific, with many of the target compounds well removed by activated sludge processes with SRTs of 5 to 15 days. Half of the 20 PPCP target compounds showed frequent occurrence in secondary influent, but were also efficiently removed (>80%) at SRT of less than 5 days, consisting of caffeine, ibuprofen, oxybenzone, chloroxylenol, methylparaben, benzyl salicylate, 3-phenylpropionate, butylbenzyl phthalate, and octylmethoxycinnamate. An SRT of more than 30 days was necessary to achieve 80% removal for certain compounds. Miège et al. (2010) evaluated PPCP removal performance based on monitoring data from 117 WTPs and determined that PPCP removal efficiency was highest in facilities utilizing activated sludge with nitrogen removal processes. They determined that the main mechanisms involved in removal efficiency of the PPCPs were biodegradation (e.g., oxidation, hydrolysis, demethylation, cleavage of glucuronide conjugates), sorption on sludge or particulate matter (by hydrophobic or electrostatic interactions), and filtration.

Given the hundreds of EDCs and PPCPs that exist, determining which compounds to monitor presents a challenge (e.g., Hoenicke et al. 2007; de Voogt et al. 2009; Southern California Coastal Water Research Project 2009). National reconnaissance studies have keyed in on several dozen chemicals that are known to have or may have the potential to affect humans and wildlife.

The first nationwide study took place in 1999 and 2000 and examined 95 chemicals in 139 streams across 30 states (Kolpin et al. 2002). According to the study, the most frequently detected compounds were coprostanol (fecal steroid); cholesterol (plant and animal steroid); N,N-diethyltoluamide (insect repellant); caffeine (stimulant); triclosan (antimicrobial disinfectant); tri(2-chloroethyl)phosphate (fire retardant); and 4-nonylphenol (nonionic detergent metabolite). In a follow-up study, the most frequently detected chemicals targeted in surface water were cholesterol, metolachlor (herbicide), cotinine (nicotine metabolite), and β-sitosterol (natural plant sterol).

Nitrosamines

Nitrosamines are a family of semi-volatile organic chemicals containing a nitroso and an amine functional group. N-Nitrosodimethylamine (NDMA) is the best-known nitrosamine, although there are several others of importance, including N-Nitrosodiethylamine (NDEA) and N-Nitrosodi-n-propylamine (NDPA).Chlorination or chloramination of water containing organic-nitrogen, such as occurs during water and wastewater treatment, can lead to the production of NDMA and other nitrosamines. NDMA and other nitrosaminesalso can form or be leached during treatment of water by anion exchange resins. NDMA and other nitrosamines are not easily removed during treatment, as they do not readily biodegrade, adsorb, or volatilize.(Najm and Trussell 2001). "NDMA Formation in Water and Wastewater")

NDMA has been used in the production of liquid rocket fuel, and in a variety of other industrial uses. It has been found in foods, beverages, drugs, and tobacco smoke (National Toxicology Program 2011). NDMA and other nitrosamines can cause cancer in laboratory animals. The USEPA classifies a number of them as probable human carcinogens. In 2006, the Office of Environmental Health and Hazard Assessment established a public health goal of 3 nanograms per liter (ng/L) for NDMA. The DPH also has a 10 ng/L notification level for several nitrosamines, including NDMA. (http://www.cdph.ca.gov/certlic/drinkingwater/pages/NDMA.aspx accessed 4-23-12)

8.1.3.10 Nitrate/Nitrite and Phosphorus

Background and Importance in the Study Area

Nutrients, primarily nitrogen (N) and phosphorus (P), play a complex role in water quality (ammonia-N is discussed in a previous section) and the health of aquatic ecosystems. Phosphorus is generally considered a limiting nutrient in freshwater systems, while nitrogen is generally considered a limiting nutrient in marine systems. A limiting nutrient is one that is in shorter supply for organisms that depend on nutrients for growth relative to the other nutrients, and thus increases or decreases in the limiting nutrient affect primary productivity. In freshwater rivers, phosphorus is usually bound to particles, complexing with elements such as iron. When this freshwater enters estuaries and becomes more saline, the P-iron complex disassociates and the phosphorus is released in a form that can be readily absorbed by algae. Hence there is, in many instances, adequate phosphorus available for algal growth in estuary conditions.

The beneficial uses (Table 8-1)most directly affected by nutrient concentrations include those relevant to aquatic organisms (cold freshwater habitat, warm freshwater habitat, and estuarine habitat), drinking water supplies (municipal and domestic supply), and recreational activities (water contact recreation, noncontact water recreation), which can be indirectly affected by the nuisance eutrophication effects of nutrients ~~(Table 8-1)~~. Aquatic life depends on the availability of nutrients; however, elevated concentrations of nutrients can cause eutrophication, as discussed in the previous sections (DO, ammonia, and turbidity and total suspended solids [TSS]).

There are presently no applicable water quality standards for P. Drinking water standards have been set for nitrate (10 mg/L) and nitrite (1 mg/L) because nitrate and nitrite can compete with oxygen for receptor sites on hemoglobin in the bloodstream, thereby interfering with normal respiration and causing effects in humans such as blue-baby syndrome. The USEPA in 1998 published the "National Strategy for the Development of Regional Nutrient Criteria" where it identified that, due to the highly variable relationships of nutrient levels to biostimulatory responses across the county, it would not develop national recommended nutrient criteria. Instead, USEPA expects states and tribes to develop water quality standards for nutrients, or nutrient numeric endpoints (NNEs), in their geographic regions. The primary goal of NNEs is to establish nutrient levels that support the health of aquatic systems and also limit excessive growth of macrophytes or phytoplankton, public health threats, and general degradation of aquatic resources. The NNE framework has two components: a) response indicators and regulatory endpoints that specify how to assess water body condition, and b) nutrient-response models that can be used to link response indicators to nutrients and other management controls (e.g., hydrology) on a water body-specific basis.

The SWRCB and USEPA Region 9 office are working to develop NNEs to regulate nutrient levels for inland surface waters in California, excluding inland bays and estuaries. The San Francisco Bay Water Board is working with Southern California Coastal Water Research Program and San Francisco Estuary Institute staff to develop NNEs for the San Francisco Bay. The Delta Stewardship Council's 2013 Delta Plan recommended that the San Francisco and Central Valley Water Boards prepare study plans for the development of NNEs for the Delta and Suisun Bay. The Delta Plan states that the Water Boards should adopt and begin implementation of nutrient objectives, either narrative or numeric, where appropriate, by January 1, 2018. The Central Valley Water Board has embarked on a Nutrient Study Plan, that will be closely coordinated with the San Francisco Bay study effort, to determine whether separate nutrient criteria for the Delta are necessary. The Nutrient Study Plan is considered a necessary prerequisite for any decisions about creating NNEs for the Delta and determining how they would be implemented. The Nutrient Study Plan consists of four topical study areas (i.e., macrophyte, cyanobacteria, nutrient concentrations-forms-ratios, and modeling tools) to assess the fundamental question of whether there is evidence that nutrients contribute to Delta problems associated with macrophytes and algae.

Nutrients in the Delta are derived from a variety of point sources, including municipal discharges, and nonpoint sources, including agricultural and urban runoff. As discussed previously (see the Ammonia section), nutrient concentrations in the Delta are high enough that they are probably not a true limiting factor for algal growth. However, excessively high nutrient concentrations also can be associated with algal blooms and decreased water quality, and it is unclear whether nutrient concentrations are adversely affecting primary productivity, which may be a contributing factor to pelagic organism decline (POD) (see the Ammonia section for more information on POD). Excessive algae growth also can be a concern for municipal beneficial uses as a result of the elevated organic carbon associated with organic biomass, and toxin formation potential of some species, in particular members of the blue-green algae.

Aquatic life depends on the availability of nutrients; however, elevated concentrations of nutrients such as nitrate can cause eutrophication, in which high algal and bacterial growth and subsequent microbial respiration deplete oxygen, producing anoxic waters and sediments. Waters of the Delta are not considered nutrient-limited; that is, algal growth rates are limited by availability of light, and thus increases or decreases in nutrient levels are, in general, expected to have little effect on productivity (Jassby et al. 2002). However, when waters of the Delta are exported into conveyance canals, algae may no longer be light-limited, and thus increases in nutrient levels in Delta export waters may increase phytoplankton growth in the canals. Algal blooms are problematic in that they create biomass that can obstruct water conveyance facilities and clog filters, and they may also lead to taste and odor problems for municipal supplies (State Water Project Contractors Authority 2007:3-69).

However, regarding the potential for taste and odor concerns, Jones-Lee (2008) summarized a presentation by P. Hutton (Metropolitan Water District), given at the March 25, 2008, California Water and Environmental Modeling Forum (CWEMF) Delta Nutrient Water Quality Modeling Workshop, that stated:

> "there is limited ability to relate nutrient loads or in-channel concentrations to domestic water supply water quality. While there is some ability to model the relationship between the nutrient load to a waterbody and the planktonic algal biomass that develops in the waterbody, it is not possible to adequately model the relationship between nutrient load to a waterbody and the development of benthic and attached algae in that waterbody (Jones-Lee 2008:6)."

This is important in that benthic and attached algae are potentially more important for taste and odor concerns than is planktonic biomass generally (Juttner and Watson 2007:1-2, Taylor et al. 2006).

In addition, changes in ratios of nutrients may affect aquatic life by causing changes in the proportions of algal species, macrophytes and higher species (Glibert et al. 2011).While the impact of nutrient ratios on the proportions of algal species, macrophytes and higher species is unsettled within the scientific community, some analyses demonstrate that the ratio of one nutrient to another, nutrient stoichiometry, may influence primary productivity and community composition. Glibert et al. (2011) analyzed over 30 years of Delta water quality data and conclude that numerous aquatic organism population shifts were correlated with changes in the quality and quantity of nutrients.

This relationship between nutrient ratios and organism population shifts is not unique to the Delta. Studies in Hong Kong, Tunisia, Germany, Florida, Spain, Korea, Japan and Washington D.C. (Chesapeake Bay), to name a few, have all concluded that nutrient stoichiometry influences phytoplankton community composition (Ruhl and Rybicki 2010; Ibanez et al. 2008; Hodgkiss and Ho 1997; and Glibert et al. 2004). Furthermore, studies by Glibert et al. (2004; 2006), Lomas and Glibert (1999, and Dortch (1990) concluded that diatoms have a preference for nitrate while dinoflagellates and cyanobacteria generally prefer more reduced forms of nitrogen. Hessen (1997) found that a shift from calanoid copepods to *Daphnia* tracked N:P changes in Norwegian lakes. Sterner and Elser (2002) found that zooplankton size, composition and growth rates changed as the N:P ratio changed. Similar changes have been observed in the Delta, though these researchers did not differentiate the form of N between nitrate and ammonium. Glibert et al. (2011) found significant correlations between nutrient ratios and the dominant zooplankton in the Delta over the last 30 years.

The beneficial uses most directly affected by nitrogen and phosphorus concentrations are aquatic organisms (cold freshwater habitat, warm freshwater habitat, and estuarine habitat), drinking water supplies (municipal and domestic supply), and recreational activities (water contact recreation, non-contact water recreation), which can be indirectly affected by the nuisance eutrophication effects of nutrients.

8.1.3.11 Organic Carbon

Existing Conditions in the Study Area

The lowest observed mean concentrations of DOC in the Delta during the waters years 2001–2006 ranged from 1.9 to 2.2 mg/L, with the lowest concentrations occurring in the Sacramento River at Hood (Figure 8-38). Higher mean concentrations of DOC occurred in the southern Delta, ranging from 3.3 mg/L at the Banks headworks location to 3.8 mg/L at the San Joaquin River near Vernalis. The highest observed mean DOC concentration occurred at the North Bay Aqueduct pumping plant on Barker Slough (5.7 mg/L).The quality of water in Barker Slough is substantially influenced by local sources located in its immediate upland watershed. These local sources contribute a significant organic carbon load to Barker Slough, particularly during winter months when concentrations of DOC often exceed 10 mg/L (State Water Project Contractors Authority 2007: 3-19, 3-26).

DOC measured in the Sacramento River shows a trend of gradually increasing DOC with distance from Shasta Dam, where median concentrations of about 1 to 1.5 mg/L increase to about 1.5 mg/L to 2 mg/L at Hood (CALFED Bay-Delta Program 2007b:5–58). Major tributaries such as the Feather and American Rivers contain relatively low DOC as well, with median measured concentrations of 1.5 mg/L–2 mg/L. DOC on the lower San Joaquin River is comparatively greater but generally decreases with downstream distance, where median concentrations at Stevinson are nearly 6 mg/L and median concentrations at Vernalis are about 3 mg/L (CALFED Bay-Delta Program 2007b:5–49). This decrease in DOC can be attributed to inputs from tributaries such as the Merced, Tuolumne, and Stanislaus Rivers, with median DOC concentrations of 2 mg/L. Mean values for the north-of-Delta area during water years 2001–2006 ranged from 1.5 mg/L at the Feather River at Oroville to 2.0 mg/L at the Sacramento River at Veterans Bridge (Table 8-21). South-of-Delta mean values were higher than north-of-Delta stations examined (3.2 to 3.4 mg/L), and comparable to the mean at the Banks headworks (3.3 mg/L, Figure 8-38).

Time series data indicate that DOC concentrations at the examined stations generally fluctuate on an annual basis (Figure 8-39 and Figure 8-40). Higher values have tended to occur during the months of December through March at most locations, particularly the Sacramento River and in-Delta locations, whereas the San Joaquin River concentrations tend to be higher in the summer months as a result of irrigated agricultural drainage (Tetra Tech 2006b).

Table 8-21. Dissolved Organic Carbon Concentrations at Selected North- and South-of-Delta Stations, Water Years 2001–2006[a]

	Dissolved Organic Carbon (mg/L as C)				
Location	Samples	Minimum	Maximum	Mean	Median
Sacramento River at Keswick	10	0.9	2.5	1.6	1.5
Sacramento River at Veterans Bridge	18	1.2	4.3	2.0	1.6
Feather River at Oroville	28	1.0	2.2	1.5	1.5
American River at WTP	156	1.1	3.7	1.6	1.5
California Aqueduct at Check 13	115	2.1	8.0	3.4	3.1
California Aqueduct at Check 29	86	1.8	7.4	3.2	3.0

Notes: mg/L = milligrams per liter; WTP = water treatment plant.

[a] Sample size represents water quality samples having values at or greater than the reporting limit.

Sources: California Department of Water Resources 2009b; Sacramento Regional County Sanitation District 2004, 2005, 2006, 2007, 2008, 2009.

The lowest observed mean concentrations of TOC in the Delta during the water years 2001–2006 ranged from 2.7 to 3.0 mg/L, occurring at the Sacramento River at Hood and in the Delta export region (Figure 8-41). Higher mean concentrations of TOC occurred in the southern Delta region, ranging from 3.8 mg/L at CCWD pumping plant #1 to 5.1 mg/L at the San Joaquin River near Vernalis. The highest observed mean TOC concentration occurred at the Barker Slough pump (7.8 mg/L).

Mean values for the north-of-Delta area ranged from 1.5 mg/L at the Sacramento River at Keswick to 2.1 mg/L at the Sacramento River at Veterans Bridge (Table 8-22). South-of-Delta mean values were higher than north-of-Delta stations examined (3.9 to 4.2 mg/L) and slightly lower than the mean at the Banks headworks (4.3 mg/L, Figure 8-41).

Time series data indicate that TOC concentrations at the examined stations generally fluctuate on an annual basis (Figure 8-42 and Figure 8-43). Higher values have tended to occur during the months of December through March.

Table 8-22. Total Organic Carbon Concentrations at Selected North- and South-of-Delta Stations, Water Years 2001–2006[a]

	Total Organic Carbon (mg/L as C)				
Location	Samples	Minimum	Maximum	Mean	Median
Sacramento River at Keswick	15	1.0	2.6	1.5	1.4
Sacramento River at Veterans Bridge	18	1.2	5.9	2.1	1.6
Feather River at Oroville	28	1.4	3.6	2.0	1.9
American River at WTP	162	1.2	4.8	1.8	1.6
California Aqueduct at Check 13	203	2.1	12.6	4.2	3.5
California Aqueduct at Check 29	158	1.9	14.5	3.9	3.5

Notes: mg/L = milligrams per liter; WTP = water treatment plant.

[a] Sample size represents water quality samples having values at or greater than the reporting limit.

Sources: California Department of Water Resources 2009b; Sacramento Regional County Sanitation District 2004, 2005, 2006, 2007, 2008, 2009.

Organic carbon is not a priority pollutant; thus, the CTR has no criteria. There are no state or federal regulatory numerical water quality objectives/criteria for organic carbon or any USEPA-recommended criteria. As a consequence, none of the water bodies in the affected environment are listed as impaired on the state's CWA Section 303(d) list because of elevated organic carbon. However, The Central Valley Water Board recently (July 2013) amended the Drinking Water Policy in the Basin Plan to include new directives to ensure that risks to drinking water quality associated with organic carbon from Delta source water does not increase over current levels. The Basin Plan narrative chemical objective (i.e., "Waters shall not contain chemical constituents in concentrations that adversely affect beneficial uses.") was amended to include a new footnote stating "*This includes drinking water chemical constituents of concern, such as organic carbon.*" The revised policy requires the Central Valley Water Board to consider the necessity for inclusion of monitoring of organic carbon, salinity, and nutrients when renewing waste discharge requirements based on the discharge loading, proximity to drinking water intakes, and trends in ambient conditions for these constituents.

Uunder USEPA's Disinfectants and Disinfection Byproducts Rule (63 FR 69390), municipal drinking water treatment facilities are required to remove specific percentages of TOC in their source water through enhanced treatment methods, unless the drinking water treatment system can meet alternative criteria. USEPA's action thresholds begin at 2–4 mg/L TOC and, depending on source water alkalinity, may require a drinking water utility to employ treatment to achieve as much as a 35% reduction in TOC. Where source water TOC is between 4 and 8 mg/L TOC, drinking water utilities may be required to achieve a 45% reduction in TOC. Existing Delta water quality regularly exceeds 2 mg/L TOC, and existing treatment plants already are obligated to remove some amount of TOC. Nevertheless, changes in source water quality at municipal intakes may trigger additional enhanced TOC removal, and associated increased treatment costs.

The CALFED Program established a goal to in addition to USEPA's Disinfectants and Disinfection Byproducts Rule, to achieve TOC of 3 mg/L as a long-term average as applied to municipal drinking water intakes drawing water from the Delta (CALFED Bay-Delta Program 2000). The goal was established based on a study prepared by California Urban Water Agencies (CUWA) recommending Delta source water quality targets sufficient to achieving DBP criteria in treated drinking water and sufficient to allow continued flexibility in treatment technology. Specifically, the goal of the CALFED Drinking Water Program is to:

> achieve either: (a) average concentrations at Clifton Court Forebay and other southern and central Delta drinking water intakes of 50 μg/L bromide and 3.0 mg/L total organic carbon, or (b) an equivalent level of public health protection using a cost-effective combination of alternative source waters, source control, and treatment technologies. (CALFED Bay-Delta Program 2000)

The USEPA promulgated the Stage 1 Disinfectants and Disinfection Byproducts (D/DBP) Rule in 1998 and the Stage 2 D/DBP Rule in 2006 under the Safe Drinking Water Act (SDWA) which collectively establish the treatment standards for DBPs, tightened compliance monitoring requirements for DBPs, and strengthened public health protection related to DBP exposure in municipal water distribution systems. The Long Term 2 Enhanced Surface Water Treatment Rule focuses on reducing illness from cryptosporidium and other disease-causing microorganisms in drinking water distribution systems and requires water utilities to balance long-term and short-term health concerns posed by DBPs and pathogens, respectively. The compliance challenge for WTP operators is to provide adequate disinfection to protect against pathogens without forming DBPs. Development of the Delta Drinking Water Policy by the Central Valley Water Board was identified as a future need during the 1998 and 2001 triennial reviews of the Basin Plan, and by the CALFED process, with a goal of completing the policy and associated Basin Plan amendments in 2013.

8.1.3.12 Pathogens

Existing Conditions in the Study Area

A conceptual model of pathogens and pathogen indicators was developed for the Central Valley Drinking Water Policy Workgroup (Tetra Tech 2007). The pathogen and indicator data compiled for the model consisted primarily of measurements of total and fecal coliforms and E. coli, some limited data on other species of coliforms, and even more limited data on pathogens such as Cryptosporidium and Giardia. Fecal indicator concentrations are highly variable both temporally and spatially and can vary by orders of magnitude (Tetra Tech 2007). The variable nature of pathogen and indicator concentrations in surface waters, and the rapid die-off of many of these organisms in the ambient environment, makes it very difficult to quantify the importance of different sources on a scale as large as the Central Valley, especially for coliforms that are widely present in water. A single source close to the sampling location can dominate the coliform concentrations observed at a location downstream of several thousand square miles of watershed.

Of the known sources of coliform discharges into the waters of the Central Valley, it was found that wastewater total coliform concentrations for most plants were fairly low (<1,000 most probable number per 100 milliliters [MPN/100 ml]), whereas the highest total coliform concentrations in water (>10,000 MPN/100 ml) were observed near samples influenced by urban areas (Tetra Tech 2007). In fact, the regional water boards limit publicly owned treatment works discharges to <23 MPN/100 ml in NPDES permits, with most plants limited to <2.2 MPN/100 ml. In the San Joaquin River valley, comparably high concentrations of E. coli were observed for waters affected by urban environments and intensive agriculture in the San Joaquin Valley (Tetra Tech 2007). Fecal indicator data showed minimal relationships with flow rates, although most of the high concentrations were observed during the wet months of the years, possibly indicating the contribution of stormwater runoff (Tetra Tech 2007).

Regulatory criteria with respect to pathogens are as follows. The Central Valley Water Board Basin Plan specifies numerical water contact recreation criteria for fecal coliform bacteria not to exceed a geometric mean of 200 organisms/100 ml in any 30-day period (based on a minimum of five samples), nor more than 10% of the total number of samples taken during any 30-day period to exceed 400 organisms/100 ml. The Central Valley Water Board Basin Plan numerical water quality objectives for pathogens are detailed in Appendix 8A. The Central Valley Water Board recently (July 2013) amended the Drinking Water Policy in the Basin Plan to include new directives to ensure that risks to drinking water quality associated with pathogens from Delta source water does not increase over current levels. A new narrative objective was added stating, "Waters shall not contain Cryptosporidium and Giardia in concentrations that adversely affect the public water system component of the MUN beneficial use." The new objective applies to the Delta and tributaries below the first major dams, and allows utilities to request assistance from the state to conduct source evaluations and implement potential control actions if the drinking water utility monitoring at intakes indicates increased risks to treatment from these constituents. The Stockton Deep Water Ship Channel and various sloughs and creeks in the western and eastern Delta are on the state's CWA Section 303(d) list as impaired because of pathogens, with sources identified as recreational and tourism activities [nonboating] and urban runoff/storm sewers (State Water Resources Control Board 2011). A TMDL for the Stockton Urban Waterbodies was approved by EPA on 13 May 2008. TMDLs for other listed water bodies in the affected environment are proposed for completion in 2021(State Water Resources Control Board 2011).

USEPA's surface water treatment rules require that systems using surface water, or groundwater under the direct influence of surface water, to: (1) disinfect water to destroy pathogens and (2) filter water or meet criteria for avoiding filtration to remove pathogens, so that the following contaminants are controlled at the following levels (U.S. Environmental Protection Agency 2009d).

- Total coliform: no more than 5% positive samples in a month (for water systems that collect fewer than 40 routine samples per month, no more than one sample can be positive per month). Every sample that has total coliform must be analyzed for either fecal coliforms or *E. coli*. If two consecutive total coliform positive samples occur, and one is also positive for *E. coli*/fecal coliforms, the system is deemed as having an acute MCL violation.
- Viruses: 99.99% removal/inactivation.
- *Giardia lamblia*: 99.9% removal/inactivation.
- *Cryptosporidium*: 99% removal.

8.1.3.14 Polycyclic Aromatic Hydrocarbons

Background

PAHs are toxic compounds formed primarily as products of incomplete combustion (burning) of substances such as gasoline, coal, oil, wood, garbage, grilled meat, and tobacco (Agency for Toxic Substances and Disease Registry 1995). Some PAHs are manufactured for specific uses such as asphalt, creosote, roofing tar, medicines, dyes, pesticides, and plastics. Mahler et al. (2005) suggest that parking lot sealcoat can be a major source of PAHs to urban water bodies. PAHs in oil products also may exist in a watershed from spills and leaking vehicle fluids, which can then enter the aquatic environment from pavement runoff. PAHs in the environment tend to be found together as complex mixtures rather than single compounds (Oros et al. 2007).

PAHs can lead to red blood cell damage, leading to anemia, suppressed immune system, developmental and reproductive effects, and possibly cancer over a lifetime of exposure (U.S. Environmental Protection Agency 2009e). Wildlife effects (e.g., mammals, birds, invertebrates, plants, amphibians, fish) also have been observed (Eisler 1987). The typical means of exposure to PAHs occurs through inhalation. Other exposure pathways are skin contact of PAH-containing products and ingestion of foods and liquids containing PAH compounds. Consequently, the beneficial uses(Table 8-1) most directly affected by PAHs are aquatic organisms (cold freshwater habitat, warm freshwater habitat, and estuarine habitat); rare, threatened and endangered species, if the community population level were to be reduced by exposure through the aquatic environment; harvesting activities that depend on aquatic life (shellfish harvesting and commercial and sport fishing); and drinking water supplies (municipal and domestic supply)~~ (Table 8-1)~~.

PAHs enter the environment mostly as releases to air from volcanoes, forest fires, residential wood-burning, and exhaust from automobiles and trucks (Agency for Toxic Substances and Disease Registry 1995). They also can enter surface water through discharges from industrial plants and WTPs and can be released to soils at hazardous waste sites if they escape from storage containers.

PAHs are present in air as vapors or adhere to the surfaces of small solid particles. They can travel long distances before they return to earth through rainfall or particle-settling. Some PAHs evaporate into the atmosphere from surface waters, but most stick to solid particles and settle to the bottoms of rivers or lakes. The solubility of PAHs in water is often very low. PAHs stay adsorbed to soil particles, although some tend to evaporate or contaminate groundwater.

PAHs can break down to longer-lasting products by reacting with sunlight and other chemicals in the air, generally over a period of days to weeks. Breakdown in soil and water generally takes weeks to months and is caused primarily by the actions of microorganisms.

Benzo[a]pyrene is an example of an environmental PAH that can behave as described above (U.S. Environmental Protection Agency 2009e). Benzo[a]pyrene is expected to bioconcentrate in aquatic organisms that cannot metabolize it. Reported bioconcentration factors include: oysters 3,000; rainbow trout 920; bluegills 2,657; and zooplankton 1,000 to 13,000. The presence of humic acid in solution has been shown to decrease bioconcentration. Organisms that lack a metabolic detoxification enzyme system tend to accumulate these compounds. For example, bioconcentration factors have been found to be very low (<1) for mudsuckers, sculpins, and sand dabs.

There are two major sources of PAHs in drinking water: contamination of raw water (untreated) supplies from natural and human-made sources, and leachate from coal tar and asphalt linings in water storage tanks and distribution lines. PAHs in raw water will tend to adsorb to any particulate matter and be removed by filtration before reaching the drinking water supply. Background levels of PAHs in drinking water range from 4 to 24 ng/L (U.S. Environmental Protection Agency 2009e).

The MCL for benzo[a]pyrene is 0.0002 mg/L. Potential health effects from exposure above the MCL include reproductive difficulties and increased risk of cancer. The public health MCL goal (MCLG) is a concentration of zero (U.S. Environmental Protection Agency 2009e).

8.1.3.15 Selenium

Importance in the Study Area

Selenium is an essential trace element for human and other animal nutrition that occurs naturally in the environment. In the Delta watershed, selenium is most enriched in marine sedimentary rocks of the Coast Ranges on the western side of the San Joaquin Valley (Presser and Piper 1998). Because of erosion of the selenium-enriched sedimentary rock and irrigation practices used in the Central Valley, selenium concentrations in this watershed are high. It is also highly bioaccumulative and is of greatest concern because it can cause chronic toxicity (especially impaired reproduction) in fish and aquatic birds (Ohlendorf 2003; State Water Resources Control Board 2011). Bioaccumulation of selenium in diving ducks has led to health advisories for local hunters. Monitoring of selenium in ducks, fish, and invertebrates in the northern part of San Francisco Bay has revealed concentrations that could cause health risks to people and wildlife. Although the entire Bay is listed as impaired by selenium, separate TMDLs for selenium will be developed for the North Bay and South Bay, ~~as~~ because the primary selenium loading to the North Bay and the Suisun Bay area is from the Delta and oil refineries in the vicinity of Carquinez Strait while the south Bay is affected by local and watershed sources not associated with the Delta or refineries (Lucas and Stewart 2007; Stewart et al. 2013).

Selenium concentrations in whole-body fish or fish eggs are most useful for evaluating risks to fish, and concentrations in bird eggs are most useful for evaluating risks to birds (Skorupa and Ohlendorf 1991; Department of the Interior 1998; Ohlendorf 2003). Analyses of dietary items (such as benthic [sediment-associated] or water-column invertebrates) also can be used for evaluating risks through dietary exposure, although with less certainty than when using concentrations measured in fish or birds. When data are not available for the target receptors (fish and birds) or for their diets, concentrations can be estimated from selenium in water and suspended particulates. However, such modeling further increases the uncertainties in predictions of risk.

For evaluation of risks to human health, analyses of fish fillets are most common, although the fish should be analyzed in the form that people may eat (for example, for some species or ethnic groups, whole-body analyses may be appropriate) (California Office of Environmental Health Hazard Assessment 2008; see also Chapter 25, *Public Health*).

Existing Conditions in the Study Area

Water Concentrations

Selenium has been monitored most consistently at the mouth of the San Joaquin River at Vernalis (Table 8-28) mainly because agricultural drainage in the San Joaquin Valley is the primary source of selenium to the Delta (Cutter and Cutter 2004; Presser and Luoma 2006; Bureau of Reclamation 2006; Entrix 2008; Tetra Tech 2008).

Selenium also has been monitored frequently at selected locations north and south of the Delta and occasionally at a few locations in the Delta. In addition, a CALFED study (Lucas and Stewart 2007) provided results of several cruises in the study area during 2003–2004, focused primarily on the waterways between Stockton, Rio Vista, and Benicia (Table 8-29 and Figure 8-44).

Total selenium concentrations measured on a weekly basis by the Central Valley Water Board's Surface Water Ambient Monitoring Program at Vernalis (Airport Way monitoring station) show the variation in concentrations by season and year (Figure 8-45).

Before implementation of the Grassland Bypass Project in September 1996, selenium concentrations at Vernalis were commonly twice as high as those shown in Figure 8-45. Implementation of the Grassland Bypass Project has led to a 60% decrease in selenium loads from the Grassland Drainage Area in comparison to preproject conditions (Tetra Tech 2008). Cutter and Cutter (2004) reported a decreased mean concentration of 0.68 µg/L at Vernalis from 1997 to 2000 in comparison to values shown in Table 8-28 and data from a previous study from 1984 to 1988 (1.25 µg/L). More recent data show a mean of 0.54 µg/L (geometric mean of 0.45 µg/L) for the San Joaquin River at Vernalis in 2007-2014 (USGS 2014). It is likely that the selenium concentration at Vernalis will continue to decrease with continued operation of the Grassland Bypass Project and achievement of Basin Plan objectives in the amendment described above (Central Valley Water Board 2010b; State Water Resources Control Board 2010b, 2010c).

Much less sampling has been conducted for selenium analysis in the Sacramento River. The most recent available data for locations in or near the Delta are from Freeport (Table 8-28). A mean concentration of 0.072 µg/L was reported for Freeport in 1984 to 1988 and 1997 to 2000 (years combined, with no apparent difference between the two periods) (Cutter and Cutter 2004), but the detailed data (e.g., min-max values and sample numbers) are not available for comparison to the USGS data shown in the table. Because of the limited data from Freeport, additional values are provided from the Sacramento River at Verona and below Knights Landing (upstream from Sacramento but reflecting quality of water that may enter the Yolo Bypass during flooding). The maximum selenium concentration at those locations was ~~1.0~~0.39 µg/L, and the mean concentrations were all less than 0.25 µg/L. Only limited selenium data are available for other major tributaries to the eastern Delta.

Table 8-28. Selenium Concentrations in Surface Water in the Study Area

Site	No. of Samples	Selenium Concentration (µg/L) Min.	Max.	Mean	Years	Source
Selenium Concentrations North of the Delta						
Sacramento River at Keswick	86	0.061	0.40	0.21	2003–2008	DWR 2010
Sacramento River at Keswick[a]	80	0.090	0.40	0.19	2004–2008	DWR 2010
Feather River at Oroville	31	0.033	0.37	0.19	2003–2008	DWR 2010
Feather River at Oroville[a]	30	0.052	0.28	0.16	2003–2008	DWR 2010
Selenium Concentrations for Inflows to the Delta						
Sacramento River at Verona	24	0.061	0.39	0.21	2003–2009	DWR 2010
Sacramento River at Verona[a]	21	0.15	0.29	0.20	2004–2009	DWR 2010
Sacramento River ~~at~~ below Knights Landing	~~13~~5	0.19	~~1.0~~0.30	0.~~45~~23	~~2003,~~ 2004, 2007, 2008	DWR 2009
Sacramento River at Freeport[a]	~~62~~88	0.044	~~1.0~~0.23	0.~~32~~09	~~1996–2001,~~ 11/2007–07/201~~0~~4	USGS ~~2010~~2014
San Joaquin River at Vernalis (Airport Way)[~~c~~b]	~~105[d]~~105[c]	0.20	2.3	0.83	1999–2007	Bureau of Reclamation 2009d
San Joaquin River at Vernalis (Airport Way)	201	0.40	2.8	0.98	1999–2002	BDAT 2009
San Joaquin River at Vernalis (Airport Way)[~~c~~b]	453	0.40	2.8	0.84	1999–2007	SWAMP 2009
San Joaquin River at Vernalis	93	0.070	1.5	0.45	11/2007-08/2014	USGS 2014
Selenium Concentrations within/near the Delta						
North: Cache Slough near Ryer Island Ferry	7	0.05	0.24	0.12	1999–2000	BDAT 2009
South: Old River at Tracy Boulevard	1	0.61	0.61	0.61	2002	BDAT 2009
South: Old/Middle River	6	1.0	1.0	1.0	1999	DWR 2009
South: Old/Middle River[a]	6	1.0	2.0	1.6	1999	DWR 2009
Central-West: Sacramento River near Mallard Island (BG20)	11	0.06	0.45	0.11	2000–2008	SFEI 2010
Central-West: Sacramento River near Mallard Island (BG20)[a]	12	0.03	0.44	0.09	2000–2008	SFEI 2010
Central-West: San Joaquin River near Mallard Island (BG30)	11	0.03	0.40	0.11	2000–2008	SFEI 2010
Central-West: San Joaquin River near Mallard Island (BG30)[a]	11	0.03	0.45	0.09	2000–2008	SFEI 2010
Suisun Bay	38	0.02	0.21	0.12	2000–2008	SFEI 2010
Suisun Bay[a]	38	0.02	0.44	0.10	2000–2008	SFEI 2010
Selenium Concentrations for the Delta's Major Outputs						
Banks Pumping Plant[a]	71	1.0	2.0	1.0	2001–2007	MWQI 2003, 2005, 2006, 2008

Notes: Data include detected concentrations and reporting limits for undetected concentrations. Means are geometric means.
Max. = maximum; µg/L = micrograms per liter; Min. = minimum

[a] Dissolved selenium concentration.

~~[b] Includes data collected from Colusa Basin Drain near Knights Landing and Sacramento River below Knights Landing.~~

[~~c~~b] Not specified whether total or dissolved selenium.

[~~d~~c] Represents the number of months with an average concentration of selenium, not total samples collected.

Sources: Bay Delta and Tributaries Project (BDAT)2009; Department of Water Resources 2009b; Municipal Water Quality Investigations (MWQI) 2003a, 2005, 2006, 2008; Bureau of Reclamation 2009d; San Francisco Estuary Institute 2010; Surface Water Ambient Monitoring Program (SWAMP) 2009; U.S. Geological Survey ~~2010~~2014.

Table 8-29. Selenium Concentrations in Surface Water Reported by CALFED Bay-Delta Program

Site	Number of Samples	Dissolved Selenium (µg/L)			Particulate Selenium (µg/L)			Total Selenium (µg/L)		
		Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean
San Joaquin River at Stockton	5[a]	0.52	1.01	0.73	0.005	0.04	0.02	0.55	1.03	0.76
Calaveras River	2[a]	0.55	0.72	0.63	0.005	0.03	0.01	0.56	0.75	0.65
Fourteen Mile Slough	6[a]	0.35	0.94	0.59	0.01	0.03	0.01	0.36	0.95	0.61
McDonald-Empire	5[a]	0.09	0.91	0.17	0.005	0.03	0.01	0.10	0.94	0.18
Mildred Island South	1[a]	0.12	0.12	0.12	0.02	0.02	0.02	0.14	0.14	0.14
Mildred Island Center	1[a]	0.11	0.11	0.11	0.01	0.01	0.01	0.13	0.13	0.13
Mildred Island North	1[a]	0.09	0.09	0.09	0.01	0.01	0.01	0.10	0.10	0.10
Venice	1[a]	0.12	0.12	0.12	0.01	0.01	0.01	0.12	0.12	0.12
Franks Tract South	1	0.10	0.10	0.10	0.00	0.00	0.00	0.10	0.10	0.10
Franks Tract East	1	0.10	0.10	0.10	0.002	0.002	0.002	0.10	0.10	0.10
Franks Tract West	1[a]	0.12	0.12	0.12	0.01	0.01	0.01	0.14	0.14	0.14
Mokelumne River	6[a]	0.09	0.22	0.13	0.01	0.01	0.01	0.10	0.23	0.14
Three Mile Slough	6[a]	0.09	0.13	0.11	0.01	0.02	0.01	0.10	0.15	0.13
Sacramento River at Rio Vista	4	0.10	0.14	0.12	0.01	0.01	0.01	0.11	0.15	0.13
Antioch	5	0.08	0.17	0.12	0.01	0.03	0.02	0.10	0.19	0.14
Pittsburg East	2	0.07	0.15	0.10	0.01	0.01	0.01	0.08	0.16	0.11
Pittsburg West	2	0.11	0.12	0.11	0.02	0.03	0.02	0.13	0.14	0.14
Suisun East	2	0.10	0.14	0.12	0.01	0.01	0.01	0.11	0.15	0.13
Suisun Center	2	0.12	0.14	0.13	0.02	0.02	0.02	0.14	0.15	0.15
Suisun West	3	0.13	0.19	0.15	0.01	0.05	0.02	0.15	0.23	0.17
Grizzly Bay East	1	0.12	0.12	0.12	0.02	0.02	0.02	0.14	0.14	0.14
Grizzly Bay Center	3	0.10	0.17	0.13	0.010	0.017	0.013	0.11	0.18	0.14
Grizzly Bay West	1	0.16	0.16	0.16	0.011	0.011	0.011	0.17	0.17	0.17
Benicia	4	0.11	0.16	0.14	0.01	0.02	0.02	0.13	0.18	0.16

Notes: Data collected within 1 mile of sample stations were compiled in the same data location. Means are geometric means.

Max. = maximum, µg/L = micrograms per liter, Min. = minimum.

[a] One sample each station was collected during July 2000; all other data are from January 2003 to January 2004.

Source: Lucas and Stewart 2007.

Sporadic sampling has been conducted at a few locations in the Delta (Tables 8-26 28 and 8-2729). The only two locations at which sampling was conducted over several recent years are in the Sacramento and San Joaquin Rivers just upstream of Mallard Island (near the western limit of the Delta). Observed total selenium concentrations at these stations are considered more representative of generalized Delta concentrations than of the individual rivers (Tetra Tech 2008). Total and dissolved selenium concentrations were somewhat lower at those locations during low flow in a dry year (<0.1 µg/L in August 2001) than during high flow (>0.1 µg/L in February 2001) (Tetra Tech 2008). Cutter and Cutter (2004) reported similar flow-related patterns for those locations. The maximum selenium concentration found in the Delta was 2 µg/L at an Old/Middle River location in the south subarea of the Delta. Except for that location, the available data show mean concentrations well below 1 µg/L.

As noted in Table 8-28, inflow originating from the San Joaquin River has selenium concentrations several times higher than those from the Sacramento River, but flows in the San Joaquin River at Vernalis are usually only about 10–15% of the inflow from the Sacramento River at Freeport (Tetra Tech 2008). Therefore, on an annual basis, selenium loads from both rivers to the Delta are large, but selenium processes in the Delta are not well characterized. Besides the processes of settling and mixing, a large portion of the water in the Delta is exported for agricultural and urban uses in other parts of California. The relative contribution of the Sacramento and San Joaquin Rivers to the overall outflow from the Delta to the North Bay changes with tidal cycles and season, as well as operations of SWP/CVP reservoir release and related Delta water supply operations. The contribution from the San Joaquin River potentially can increase during the drier months of September through November (Presser and Luoma 2006; Tetra Tech 2008).

Regulatory criteria with respect to selenium are as follows. A TMDL for selenium in the San Joaquin River was completed by the Central Valley Water Board and approved by USEPA in March 2002. The TMDL is implemented through: (1) prohibitions of discharge of agricultural subsurface drainage water adopted in a Basin Plan Amendment for the Control of Subsurface Drainage Discharges (State Water Resources Control Board Resolution 96-078), with an effective date of January, 10 1997; and (2) load allocations in waste discharge requirements (Central Valley Water Board 2009c). As mentioned above, the Central Valley Water Board adopted a Basin Plan amendment in May 2010 to modify the compliance time schedule for regulated discharges to Mud Slough (north), which is a tributary to the San Joaquin River.

The water quality objective for the lower San Joaquin River at Vernalis is 5 µg/L as a 4-day average for above above-normal and wet water-year types, and 5 µg/L as a monthly mean for dry and below normal water-year types (Central Valley Water Board 2001, 2007). Selenium criteria were promulgated for all San Francisco Bay and Delta waters in the NTR(San Francisco Bay Water Board 2007). The NTR criteria specifically apply to San Francisco Bay upstream to and including Suisun Bay and the Delta. The NTR values are 5.0 µg/L (4-day average) and 20 µg/L (1-hour average). By comparison, the available data show that the maximum concentration at Vernalis has not exceeded 3 µg/L since implementation of the Grassland Bypass Project, and the mean is less than 1 µg/L for the period from 1999 through 20072014. The CTR criteria for aquatic life protection in saltwater are substantially higher than the freshwater criteria (i.e., chronic = 71 ▯g/L; acute = 290 µg/L).

Selenium concentrations in water exported from the Delta via Banks pumping plant ranged from 1 to 2 µg/L, with a mean of 1.02 µg/L for 2003–2007. Drinking water standards for selenium are average concentrations of 50 µg/L, both as the MCL—the enforceable standard that defines the highest concentration of a contaminant allowed in drinking water—and the MCLG—a nonenforceable health goal set at a level at which no known or anticipated adverse effect on human health would result, while allowing an adequate margin of safety (U.S. Environmental Protection Agency 2009f). On April 2, 2010, the California Office of Environmental Health Hazard Assessment (OEHHA) proposed establishing a public health goal of 30 µg/L in drinking water, based on data from adverse effects of selenium in a human population, with a 45-day comment period (California Office of Environmental Health Hazard Assessment 2010). Public health goals are developed for use by DPH in establishing primary drinking water standards (state MCLs). All concentrations that have been measured in the Delta, or in tributary streams immediately upgradient of the Delta, as well as those at Banks pumping plant and in the California Aqueduct, are less than 10% of the MCL and the MCLG (Table 8-28 and Table 8-29).

Sediment and Fish Tissue Concentrations

Very little information is available for selenium concentrations in sediment or biota from in the Delta (Table 8-30, Table 8-31, and Table 8-32) that would be useful for evaluating risks for fish, wildlife, or the people consuming them. Selenium concentrations in sediment usually are not closely related to effects on fish or wildlife resources, although screening-level values such as those provided by the U.S. Department of the Interior (DOI) are sometimes used for comparison to background or potential effect levels (U.S. Department of the Interior 1998). Background selenium concentrations in freshwater ~~environments~~ sediments are typically <1 mg/kg dry weight. Consequently, the concentrations reported for the Sacramento and San Joaquin Rivers near Mallard Island and in Suisun Bay (Table 8-~~31~~30) are consistent with background levels. They are well below the concentrations associated with effects on fish and bird populations (2.5 mg/kg). Selenium analyses of clams from the Mallard Island locations (Table 8-31) are consistent with other bivalves in the Bay-Delta (Linville et al. 2002; Stewart et al. 2004). Whole-body fish from the San Joaquin River near Manteca had selenium concentrations within the range of background (<1–4 mg/kg, typically <2 mg/kg), although the mean was slightly higher than typical background (Table 8-32). Selenium concentrations in delta smelt from Chipps Island also were consistent with background.

Table 8-30. Selenium Concentrations in Delta and Suisun Bay Sediment

Site	Number of Samples	Selenium Concentration (mg/kg)			Year Collected	Source
		Min.	Max.	Mean		
Central-West: Sacramento River near Mallard Island (BG20)	9	0.031	0.24	0.083	2000–2008	SFEI 2010
Central-West: San Joaquin River near Mallard Island (BG30)	9	0.087	0.34	0.21	2000–2008	SFEI 2010
Suisun Bay	69	0.016	0.58	0.17	2000–2008	SFEI 2010

Notes: Data include detected concentrations and reporting limits for nondetected concentrations. Means are geometric means.

Max. = maximum, mg/kg = milligrams per kilogram, dry weight concentration, Min. = minimum.

Source: San Francisco Estuary Institute (SFEI) 2010.

Table 8-31. Selenium Concentrations in Biota in or near the Delta

Site	Number of Samples	Selenium Concentration (mg/kg) Min.	Max.	Mean	Common Name	Year Collected	Source
Central-West: Sacramento River near Mallard Island (BG20)	5	4.0	19	8.1	Clam	1999–2001, 2008	SFEI 2010
Central-West: San Joaquin River near Mallard Island (BG30)	5	4.1	26	9.1	Clam	1999–2001, 2008	SFEI 2010
Chipps Island[a]	41	0.70	2.3	1.5	Delta Smelt	1993, 1994	Bennett et al. 2001
San Joaquin River, Dos Reis State Park and Mossdale Sites[b]	13	1.6	3.4	2.6	Silversides	May–July 1995	Bennett et al. 2001

Notes: Means are geometric means.

Max. = maximum, mg/kg = milligrams per kilogram, dry weight concentration, Min. = minimum.

[a] Most of the fish were collected at Chipps Island but included some fish (fewer than 5) from Garcia Bend (near Sacramento).

[b] Near Manteca.

Sources: Bennett et al. 2001; San Francisco Estuary Institute (SFEI) 2010.

Table 8-32. Selenium Concentrations in Largemouth Bass

Site	Number of Samples	Selenium Concentrations in Fish Fillets (mg/kg, wet weight) Min.	Max.	Mean	Selenium Concentrations in Whole-Body Fish (mg/kg, dry weight) Min.	Max.	Mean	Years
Sacramento River at Veterans Bridge	3	0.40	0.81	0.56	1.7	2.9	2.2	2005
Sacramento River at River Mile 44[a]	9	0.27	0.72	0.46	1.2	2.7	1.9	2000, 2005, 2007
Sacramento River near Rio Vista	9	0.30	0.80	0.44	1.3	3.2	1.9	2000, 2005, 2007
San Joaquin River at Vernalis	8	0.15	0.63	0.40	0.77	2.5	1.7	2000, 2005, 2007
Old River near Tracy	3	0.45	0.69	0.55	2.0	2.9	2.4	2005
San Joaquin River at Potato Slough	9	0.22	0.89	0.38	1.1	3.5	1.6	2000, 2005, 2007
Middle River at Bullfrog	6	0.37	0.58	0.47	1.6	2.3	2.0	2005, 2007
Franks Tract	8	0.15	0.70	0.37	0.79	3.0	1.7	2000, 2005, 2007
Big Break	9	0.15	0.82	0.38	0.81	3.1	1.6	2000, 2005, 2007
Discovery Bay	3	0.32	0.41	0.37	1.5	1.7	1.6	2005
Whiskey Slough	2	0.35	0.47	0.41	1.6	1.9	1.7	2005

Notes: Means are geometric means.

Max. = maximum, mg/kg = milligrams per kilogram, Min. = minimum.

[a] Near Clarksburg.

Source: Foe 2010.

A large number of fish tissue samples were collected from the Sacramento and San Joaquin River watersheds and the Delta between 2000 and 2007 for mercury analysis. As part of the Strategic Workplan for Activities in the San Francisco Bay/Sacramento–San Joaquin Delta Estuary (State Water Resources Control Board 2008), archived largemouth bass samples were analyzed for selenium to determine the primary source of the selenium being bioaccumulated in bass in the Delta and whether selenium concentrations in bass were above recommended criteria for the protection of human and wildlife health (Foe 2010). Results of this study are the most relevant biota data from the Delta, and they are summarized in Table 8-32.

There were no differences in selenium concentrations in largemouth bass caught in the Sacramento River between Veterans Bridge and Rio Vista in 2005, and there was no difference in selenium concentration on the San Joaquin River between Fremont Ford (not shown in Table 8-32) and Vernalis (Foe 2010). Also, there was no difference in bass selenium concentrations in the Sacramento River at Rio Vista and in the San Joaquin River at Vernalis in 2000, 2005, and 2007. The lack of a difference in bioavailable selenium between the two river systems was unexpected because the San Joaquin River is considered a significant source of selenium to the Delta. Selenium concentrations were unexpectedly higher in both river systems in 2007 than in other years;~~,~~ ~~and the~~ reasons for this difference are ~~unknown~~related to increased bioaccumulation during low-flow conditions, as discussed in Appendix 8M.

The Central Valley appeared to be the dominant source of bioavailable selenium to bass in the Delta because tissue concentrations generally decreased seaward (Foe 2010). Selenium concentrations in bass were highest in a dry water-year type (2007), consistent with predictions of the Presser and Luoma (2006) bioaccumulation model.

Selenium concentrations in the bass were compared to criteria recommended for the protection of human health (based on fillets; 2.5 mg/kg, wet weight) and wildlife health (based on whole-body fish; concern thresholds of 4 or ~~–~~9 mg/kg, dry weight) (Foe 2010). Average ~~and maximum~~ concentrations were always less than ~~the cri~~4 mg/kg;~~teri~~ only 1 of the 69 bass (4.24 mg/kg in a fish from San Joaquin River at Potato Slough in 2007) marginally exceeded that lowest threshold~~a~~.

Selenium concentrations in the livers of ~~two~~ 2 of 86 Sacramento splittail collected from Big Break, Nurse Slough, and Sherman Island exceeded the concentration (>27 mg/kg) (Teh et al. 2004) at which growth, survival, and histopathology effects were observed in long-term laboratory studies of juvenile splittail (Greenfield et al. 2008). Mean selenium concentrations ranged from 11.8 to 16.3 mg/kg in 2001 and from 8.36 to 8.84 mg/kg in 2002, with the highest mean concentrations occurring in fish from Nurse Slough (in Suisun Marsh). Other field and laboratory studies have been conducted with splittail (Deng et al. 2007, 2008) and with white sturgeon (Tashjian and Hung 2006; Tashjian et al. 2006, 2007) and other fish (Linville et al. 2002; Stewart et al. 2004), but no other analytical data for field-collected fish from in the Delta were found.

Species to be considered for linkage of waterborne or foodweb selenium to fish and birds will include those identified by the U.S. Fish and Wildlife Service (USFWS) as being at risk from selenium exposure in the San Francisco estuary, insofar as possible (U.S. Fish and Wildlife Service 2008a). However, species-specific and Delta-specific bioaccumulation and trophic transfer factors for those species are not available, so assessments focus on largemouth bass, which have been sampled at various locations in the Delta.

Current ambient water quality criteria are based on waterborne selenium concentrations, but USEPA ~~published~~ released draft water quality criteria for the protection of freshwater aquatic life from toxic effects of selenium in 2014, shown in Table 8-33 (USEPA 2014). The draft criteria emphasize the importance of tissue-based concentrations most closely associated with reproductive effects (in fish eggs or ovaries), then the concentrations in whole-body fish or muscle if egg/ovary data are not available, and finally, concentrations in water. Water-column criteria differ for lotic (flowing) and lentic (still-water) aquatic systems.

Table 8-33. Draft Water Quality Criteria for Selenium

Media Type	Fish Tissue		Water Column[c]	
Criterion Element	Egg/Ovary[a]	Fish Whole-Body or Muscle[b]	Monthly Average Exposure	Intermittent Exposure[d]
Magnitude	15.2 mg/kg	8.1 mg/kg whole body or 11.8 mg/kg muscle (skinless, boneless filet)	1.3 µg/l in lentic aquatic systems 4.8 µg/l in lotic aquatic systems	$WQC_{int} = \frac{WQC_{30-day} - C_{bkgrnd}(1 - f_{int})}{f_{int}}$
Duration	Instantaneous measurement[e]	Instantaneous measurement[e]	30 days	Number of days/month with an elevated concentration

Source: U.S. Environmental Protection Agency 2014

[a] Overrides any whole-body, muscle, or water column elements when fish egg/vary concentrations are measured.

[b] Overrides any water column element when both fish tissue and water concentrations are measured.

[c] Water column values are based on dissolved total selenium in water.

[d] Where $WQC_{30\text{-}day}$ is the water column monthly element, for either a lentic or lotic system, as appropriate. C_{bkgrnd} is the average background selenium concentration, and f_{int} is the fraction of any 30-day period during which elevated selenium concentrations occur, with f_{int} assigned a value ≥0.033 (corresponding to 1 day).

[e] Instantaneous measurement. Fish tissue data provide point measurements that reflect integrative accumulation of selenium over time and space in the fish at a given site. Selenium concentrations in fish tissue are expected to change only gradually over time in response to environmental fluctuations.

~~a draft ambient water quality criterion for selenium in 2004 that was based on selenium concentrations in whole-body fish (U.S. Environmental Protection Agency 2009g; State Water Resources Control Board 2010a). The recommendations were intended to protect aquatic life under the CWA. They incorporated the latest scientific information available to the agency at that time and reflect an improved approach to measuring this bioaccumulative pollutant in the aquatic environment. In October 2008, USEPA released a technical report describing the results from additional testing of the toxicity of selenium to juvenile bluegill sunfish under winter temperature conditions and also provided references for data obtained since 2004 (73 FR 63706).~~

~~Recent preliminary information concerning USEPA's pending revision of the draft chronic ambient water quality criterion suggests that the agency will propose a two-part criterion: selenium concentration in fish egg/ovary coupled with a water screening value (Delos pers. comm.). If the latter is exceeded, the former either must be measured or may be estimated using whole-body concentrations. It is expected the water screening value will be conservative (so that if the value is not exceeded, there will be no problem), and that it will be lower than the current 5 µg/L USEPA~~

water criterion. The number for egg/ovary selenium will be driven by the available trout, bluegill, and largemouth bass studies. EC_{10} values (concentration at which 10% of offspring are affected) for those species range from about 18 to 23 mg/kg dry weight based on egg/ovary data. Consistent with USEPA's criterion calculation methods, the egg/ovary criterion is likely to be extrapolated downward from the lowest observed value and is, thus, expected to be in the range of 15 to 18 mg/kg.

USEPA's Action Plan for Water Quality Challenges in the San Francisco Bay/Sacramento-San Joaquin Estuary (U.S. Environmental Protection Agency2012a) identifies selenium as one of seven priority items for action. The plan indicates that USEPA will draft new site-specific numeric selenium criteria by December 2012 to protect aquatic and terrestrial species dependent on the aquatic habitats of the Bay Delta Estuary. This planned action continues a long-term effort responding to scientific evidence that the current selenium water quality standards do not adequately protect sensitive species. USFWS and NMFS drafted a Biological Opinion in 2000 that found jeopardy under ESA for the selenium criteria that USEPA proposed in the California Toxics Rule. To avoid a final jeopardy opinion, USEPA agreed to develop site-specific water quality criteria for selenium, beginning in the Bay Delta Estuary. USEPA is using an ecosystem-based model created by the USGS with advice from the USFWS and NMFS. The model reflects the food web in the Bay Delta Estuary, the diet of sensitive species and their use of habitats, and hydrological conditions. (Note: this same modeling approach is used in estimating selenium bioaccumulation in this EIR/EIS.) More stringent selenium water quality criteria will may require actions that decrease allowable concentrations of selenium in surface waters of the Bay Delta Estuary and may set allowable levels of selenium in the tissue of fish and wildlife. The new criteria would reduce the chronic (long-term) exposure of sensitive species to selenium.

Following the development of the Bay Delta selenium criteria, USEPA plans to develop site-specific criteria for other parts of California, including the San Joaquin Valley watershed (U.S. Environmental Protection Agency2012a). USEPA also is engaged in other efforts to minimize selenium discharges to the San Joaquin River and the Bay Delta Estuary, including the Grasslands Bypass Project and the North San Francisco Bay TMDL.

8.1.3.16 Other Trace Metals

Background and Importance in the Study Area

Aluminum, Iron, and Manganese

Aluminum, iron, and manganese are common elements in mineral soils. The concentrations of these metals can be substantially elevated above background levels during watershed runoff events that transport high-suspended sediment loads. However, in general, a large majority of the metals are stable within the mineral matrices of the suspended particles and not available to interact chemically with other compounds or otherwise cause adverse water quality effects. When these constituents are in ionic and dissolved forms, they are more readily available to react chemically in the water, and their presence may result in adverse effects to certain water uses. The pH of water is a generally important regulator of the ionic activity of these metals, with lower pH generally resulting in dissociation and creation of ionic forms of the metals with resulting higher dissolved/reactive concentrations in the water. These metals are readily removed via conventional water treatment processes that remove suspended sediment and through chemical ion exchange and adsorption (i.e., chemical coagulation and filtration systems), and all surface waters require a minimum of coagulation and filtration to conform to federal SDWA regulations.

Aluminum, iron, and manganese are identified as "non-priority" pollutants by U.S. EPA. Aluminum can cause aquatic toxicity effects to some aquatic biota, and USEPA adopted ambient water quality criteria for dissolved aluminum. All three metals are regulated by secondary MCLs for their potential nuisance effects in domestic potable water supplies (e.g., staining, and taste and odor concerns). The secondary MCLs ~~are based~~ apply to the total metal concentration in treated potable water. Therefore, ambient concentrations in the total form above the secondary MCLs should not be interpreted as having a direct impact on potable supplies; rather, increased concentrations may indicate the potential for greater levels of treatment required to achieve the same treated concentrations.

Existing Conditions in the Study Area

In 2000, the Association of California Water Agencies conducted a study to summarize arsenic data from across the state and to assess the effect of USEPA's arsenic standard on California's drinking water programs (Saracino-Kirby 2000). Sampling data collected by USGS in 1990 and 2000, California Department of Health, DWR, Reclamation, and other sources were analyzed. The study found that the statewide average concentration of arsenic in groundwater measured between 1990 and 2000 was 9.8 µg/L, and that 22% of the 4,513 sampling stations recorded arsenic concentrations of 10 µg/L or higher during this time period (Saracino-Kirby2000) (Table 8-33). The study found no noticeable trend in arsenic concentrations through time (Saracino-Kirby 2000). Thirty percent of the state's groundwater basins were found to have average arsenic concentrations of 10 µg/L or higher at some point between 1990 and 2000 (Saracino-Kirby 2000). The Association of California Water Agencies study also analyzed samples from 188 sampling stations on surface water bodies and found that the statewide average concentration of arsenic in surface water between 1990 and 2000 was 42 µg/L; however, this average was influenced by a small number of data points with very high values—91% of the sampling locations recorded average concentrations less than 10 µg/L during the same time period (Saracino-Kirby 2000).

There was a large monitoring effort from 1988 to 1993 to assess metals in the Delta. Results for San Joaquin River at Buckley Cove, Sacramento River at Hood (actually collected at Greene's Landing), Sacramento River above Point Sacramento, San Joaquin River at Antioch Ship Channel, Old River at Rancho Del Rio, Suisun Bay at Bulls Head Point near Martinez, and Franks Tract are shown in Table 8-33. Analysis of the monitoring results indicated that most metal median values were similar between locations, with zinc median values being the highest of all the metals.

Results from recent monitoring efforts for trace metals at the Banks pumping plant and Barker Slough pumping plant are shown in Table 8-34.Analytes examined in the present effort for the Banks and Barker Slough pumping plants include arsenic, cadmium, copper, lead, nickel, silver, and zinc. The monitoring program sampled for each of these analytes approximately 72 times during the water years 2001 to 2006 at each location. Arsenic, copper, and nickel were detected in almost all sampling events for each location. Median values for these metals were similar at the two locations. Elevated values for these metals occurred primarily between January and March, although the copper maxima occurred during May. There were one detection of lead and three detections of zinc at the Banks pumping plant. There were no detections of cadmium or silver at either station, and no detections of lead or zinc at the Barker Slough pumping plant. Cadmium values matched the MCL of

0.005 mg/L at several locations during the 1988–1993 study, but there were no detections at either the Banks or Barker Slough pumping plants during water years 2001–2006.

SFEI data for the Sacramento River above Point Sacramento and the San Joaquin River at Antioch, which have very low detection limits, are presented in Table 8-35.The samples were taken between late July and late August, which does not allow examination of wet versus dry season results. The samples indicate that all selected metals are still present in the Sacramento and San Joaquin River outflows during summer conditions, albeit at low concentrations. Values for all metals were comparable for the two locations. For both locations, copper, nickel, and zinc occurred at higher concentrations than the other metals.

Monitoring efforts in the north Delta areas (water years 2001–2006) indicate that mean values for metals at the Feather River at Oroville tended to be lower than those for the Sacramento River sites, with the exception of cadmium and silver (Table 8-36).

Arsenic, cadmium, chromium, copper, lead, nickel, silver and zinc are among the 126 priority pollutants identified by the USEPA. Iron and manganese are identified as non-priority pollutants by USEPA. Federal water quality criteria contained in the CTR, state water quality objectives contained in the Region 2 and Region 5 Water Quality Control Plans, and drinking water MCLs are listed in Appendix 8A. Based on water quality criteria and objectives, and typical levels in surface waters, it is generally the case that aluminum, arsenic, iron, and manganese are of primary concern for drinking water, while aluminum, cadmium, chromium, copper, lead, nickel, silver, and zinc are of concern because of potential toxicity to aquatic organisms.

Table 8-33. Median Metal Concentrations for Selected Sites, May 1988–September 1993

Location	Arsenic Dissolved (µg/L)	Arsenic Total (µg/L)	Cadmium Dissolved (µg/L)	Cadmium Total (µg/L)	Copper Dissolved (µg/L)	Copper Total (µg/L)	Lead Dissolved (µg/L)	Lead Total (µg/L)	Zinc Dissolved (µg/L)	Zinc Total (µg/L)
San Joaquin River at Buckley Cove	3	3	5	5	5	5	5	5	6	10
Sacramento River at Green's Landing	2	2	5	5	5	5	5	5	6	8
Sacramento River above Point Sacramento	2	3	5	5	5	7	5	5	5	10
San Joaquin River at Antioch Ship Channel	2	2	5	5	5	6	5	5	5	11
Old River at Rancho Del Rio	2	2	5	5	5	5	5	5	5	8
Suisun Bay at Bulls Head Point near Martinez	2	3	5	5	5	7	5	5	6	15
Franks Tract	2	2	5	5	5	5	5	5	5	7
San Joaquin River at Vernalis	—	—	—	—	—	—	—	—	10	—

Notes: Units are in micrograms per liter. Sample sizes are 10 to 12 (exception: San Joaquin River at Vernalis, with a sample size of 15). Sample size represents water quality samples having values at or greater than the reporting limit.
Source: Bay Delta and Tributaries Project 2009.

Table 8-34. Metals Concentrations at the Harvey O. Banks and Barker Slough Pumping Plants, Water Years 2001–2006

	Harvey O. Banks Pumping Plant (µg/L)					Barker Slough Pumping Plant (µg/L)				
Metal	Samples	Minimum	Maximum	Mean	Median	Samples	Minimum	Maximum	Mean	Median
Arsenic	71	1	3	2	2	72	1	5	2	2
Cadmium	no detections					no detections				
Copper	71	1	9	2	2	72	1	8	3	2
Lead	one detection: 7 µg/L (11/19/03)					no detections				
Nickel	67	1	2	1	1	72	1	7	2	2
Silver	no detections					no detections				
Zinc	15 µg/L (1/16/02), 5 µg/L (9/17/03), 6 µg/L (10/15/03)					no detections				

Notes: Metals measured as dissolved. All units are in micrograms per liter (µg/L). Sample size represents water quality samples having values at or greater than the reporting limit.
Source: Bay Delta and Tributaries Project 2009.

Table 8-35. Metals Concentrations at the Mouths of the Sacramento and San Joaquin Rivers, Water Years 2001–2006

		Sacramento River above Point Sacramento (µg/L)					San Joaquin River at Antioch Ship Channel (µg/L)				
Metal	Fraction	Samples	Minimum	Maximum	Mean	Median	Samples	Minimum	Maximum	Mean	Median
Arsenic	Dissolved	8	0.800	2.270	1.729	1.758	7	1.190	2.310	1.861	1.900
Arsenic	Total	8	0.800	2.420	2.039	2.253	7	1.250	2.500	2.014	2.130
Cadmium	Dissolved	7	0.007	0.016	0.011	0.010	7	0.006	0.015	0.010	0.011
Cadmium	Total	7	0.015	0.032	0.027	0.026	6	0.013	0.033	0.022	0.020
Copper	Dissolved	8	1.253	3.539	1.738	1.468	7	1.410	1.888	1.654	1.606
Copper	Total	8	2.534	4.613	3.418	3.257	7	2.435	4.811	3.028	2.729
Lead	Dissolved	8	0.019	0.091	0.043	0.034	7	0.017	0.196	0.055	0.027
Lead	Total	8	0.427	1.035	0.663	0.580	7	0.263	0.950	0.530	0.445
Nickel	Dissolved	8	0.766	2.641	1.218	1.006	7	0.727	1.470	1.059	0.975
Nickel	Total	8	2.410	6.503	3.970	3.933	7	2.034	6.726	3.157	2.523
Silver	Dissolved	4	0.001	0.002	0.001	0.001	5	0	0.001	0.001	0.001
Silver	Total	7	0.001	0.009	0.004	0.003	5	0.001	0.005	0.002	0.002
Zinc	Dissolved	8	0.160	1.410	0.711	0.595	7	0.253	1.818	0.712	0.510
Zinc	Total	8	2.283	7.022	4.291	3.924	7	1.983	7.055	3.321	2.705

Note: All units in micrograms per liter. Sample size represents water quality samples having values at or greater than the reporting limit.
Source: San Francisco Estuary Institute 2010.

Table 8-36. Metals Concentrations at Selected North- and South-of-Delta Stations, Water Years 2001–2006

	Sacramento River at Keswick (µg/L)					Sacramento River at Verona (µg/L)					Feather River at Oroville (µg/L)					Check 13 (µg/L)					Check 29 (µg/L)				
Metal	Samples	Minimum	Maximum	Mean	Median	Samples	Minimum	Maximum	Mean	Median	Samples	Minimum	Maximum	Mean	Median	Samples	Minimum	Maximum	Mean	Median	Samples	Minimum	Maximum	Mean	Median
Arsenic (d)	25	0.81	1.93	1.27	1.22	8	0.87	1.48	1.18	1.24	22	0.38	0.67	0.52	0.51	69	1	3	2	2	62	1	4	2	2
Arsenic (t)	28	0.84	1.94	1.36	1.30	11	0.92	1.91	1.29	1.20	23	0.47	0.99	0.60	0.56										
Cadmium (d)	8	0.007	0.036	0.021	0.023	1		0.009			1		0.023												
Cadmium (t)	14	0.008	0.095	0.028	0.019	2	0.010	0.020	0.010	0.010	2	0.029	0.033	0.031	0.031										
Copper (d)	25	0.49	3.18	1.40	1.06	8	0.62	4.22	1.55	1.33	22	0.42	1.54	0.70	0.61	69	1.00	5.00	2.00	2.00	81	1.00	4.00	2.00	2.00
Copper (t)	28	0.71	4.30	1.72	1.23	11	0.85	6.54	2.62	1.91	23	0.47	2.82	1.00	0.88										
Lead (d)	13	0.000	0.113	0.026	0.009	6	0.010	0.170	0.080	0.070	9	0.003	0.077	0.019	0.006										
Lead (t)	21	0.008	1.560	0.139	0.040	11	0.090	1.150	0.340	0.130	20	0.001	0.300	0.050	0.015										
Nickel (d)	25	0.49	2.49	1.39	1.32	8	0.58	2.57	1.27	1.13	22	0.40	1.38	0.89	0.88	67	1.00	3.00	1.00	1.00	79	1.00	3.00	1.00	1.00
Nickel (t)	28	0.50	2.73	1.56	1.47	11	0.99	8.94	2.80	1.71	23	0.79	1.93	1.12	1.05										
Silver (d)	1		0.015			1		0.005			2	0.020	0.030	0.030	0.030										
Silver (t)	4	0.003	0.091	0.037	0.027						3	0.020	0.070	0.040	0.040										
Zinc (d)	25	0.31	7.84	2.28	1.91	7	0.16	1.37	0.63	0.30	18	0.04	2.41	0.46	0.27						1		5.00		
Zinc (t)	28	1.02	11.90	3.44	2.38	11	0.53	8.18	2.68	1.16	23	0.13	2.66	0.79	0.48										

Notes: All units in micrograms per liter. Sample size represents water quality samples having values at or greater than the reporting limit.
d = dissolved.
t = total.
Source: Bay Delta and Tributaries Project 2009.

The CTR contains criteria for protection of freshwater aquatic life, saltwater aquatic life, and human health from consumption of water (drinking water) and organisms (eating fish and shellfish) and consumption of organisms only. For waters in which the salinity is equal to or less than 1 part per thousand 95% or more of the time, the applicable CTR criteria are the freshwater criteria. For waters in which the salinity is equal to or greater than 10 parts per thousand 95% or more of the time, the applicable CTR criteria are the saltwater criteria. For waters in which the salinity is between 1 and 10 parts per thousand, the applicable CTR criteria are the more stringent of the freshwater or saltwater criteria.

CWA Section 303(d) listings in the affected environment include cadmium, copper, and zinc in Lake Shasta and Keswick Reservoir; copper and zinc in the Mokelumne River (eastern portion of Delta waterways);copper in Bear Creek (eastern portion of Delta waterways); and many listings in the Central Coast, Los Angeles, Santa Ana, and San Diego Regions, which include the SWP and CVP Export Service Areas (State Water Resources Control Board 2011).

8.1.3.18 Microcystis

Background and Importance in the Study Area

This section provides a brief summary of the background and importance of *Microcystis* in the study area. A detailed discussion of the importance of *Microcystis* in the Delta, its biology, and potential adverse effects due to bloom formation is provided in Appendix 5F of the BDCP, section 5.F.7. The occurrence of *Microcystis aeruginosa* (*Microcystis*), a harmful species of cyanobacteria (also referred to as a blue-green algal species), in the Delta was first observed in 1999 (Lehman et al. 2005). In addition to producing surface scums that interfere with recreation and cause aesthetic problems, it also produces taste and odor compounds and toxic microcystins that are associated with liver cancer in humans and wildlife. Microcysin-LR is the most widely studied congener of the known microcystins, and it has been associated with most incidents of toxicity involving microcystins. *Microcystis* blooms can cause toxicity to phytoplankton, zooplankton, and fish, and also can affect feeding success or food quality for zooplankton and fish. Blooms of *Microcystis* require high levels of nutrients and low turbidity, but also require high water temperature (i.e., above 19°C) and long residence time, since the species is fairly slow growing (Lehman et al. 2008; Lehman et al. 2013). In addition, low vertical mixing associated with high residence time allows *Microcystis* colonies to float to the surface of the water column, where they out compete other species for light.

Existing Conditions in the Study Area

Since its first observance in the Delta in 1999, annual *Microcystis* blooms have occurred at varying levels throughout the Delta, with blooms typically beginning in the central Delta and spreading seaward into saline environments (Lehman et al. 2008; Lehman et al. 2013). Section 5.F.7.4 of Appendix 5F cites numerous studies showing that *Microcystis* blooms produce adverse effects on phytoplankton, zooplankton and fish populations in the Delta. Water temperatures greater than 19°C, low water velocities, and high water clarity are necessary for *Microcystis* levels to reach bloom-forming scale (Paerl 1988; Lehman et al. 2008; Lehman et al. 2013). The water temperature requirement is considered the primary factor that restricts bloom development to the months of June through September (Lehman et al. 2013). Sufficiently high water temperature (i.e., 19°C), low flow and thus sufficiently long residence time, and increased clarity enable bloom formation, which occurs in the San Joaquin River, Old River, and Middle River earlier, and to a greater extent, than other areas of the Delta. Likewise, the Delta’s shallow, submerged islands sustain high levels of *Microcystis* during the growing season because the physical drivers of bloom formation are amplified in these areas due to low flushing rates (Lehman et al. 2008). Although elevated pH is tolerated by *Microcystis*, pH is not currently thought to be a primary driver of seasonal and interannual variation in bloom formation (Lehman et al. 2013).

Nutrients have historically been sufficiently high to support *Microcystis* growth in the Delta, yet there is currently little evidence that levels of nitrogen, phosphorus, or their ratio control the seasonal or inter-annual variation in the bloom (Lehman 2005; Lehman et al. 2008; Lehman et al. 2013; Lehman et al. 2015). This is likely because nutrient concentrations in the Delta are above the thresholds that limit *Microcystis* growth (Lehman et al. 2008; Lehman et al. 2013). However, blooms of *Microcystis* in the Delta have been shown to utilize ammonia from the Sacramento River over other forms of nitrogen (Lehman et al. 2015).

Impacts from *Microcystis* blooms upstream of the Delta have only occurred in highly eutrophic lakes, such as Clear Lake, because most upstream reservoirs have relatively low nutrient levels. Hydrodynamic conditions of upstream rivers and watersheds are not conducive to *Microcystis* bloom formation. Problematic *Microcystis* blooms have not occurred in the Export Service Areas, but microcystins produced in waters of the Delta have been exported from Banks and Jones pumping plants to the SWP and CVP (Sanitary Survey Update 2011). Levels of microcystin measured in water exported from the Delta have been below the World Health Organization advisory level of 1 μg/L for microcystin-LR, which was developed to protect against adverse liver effects associated with human consumption of microcystin-LR.

8.3 Environmental Consequences

8.3.1 Methods for Analysis

8.3.1.1 Models Used and Their Linkages

The models used in support of the quantitative water quality analyses were: (1) Reclamation~~’s~~ and DWR’s~~’~~ CALSIM II hydrologic model; and (2) DWR’s DSM2. A ~~brief~~ description of each model is provided below, ~~followed~~ including~~by~~ a discussion of how the models were used to assess compliance with water quality objectives for ~~electrical conductivity~~ EC and chloride in the Delta, as well as how results from these models were used to quantify changes in other water quality constituent concentrations/parameter levels. More information on these models and the assumptions included in their application is described in Appendix 5A.

CALSIM II

The CALSIM II model, which has been jointly developed and maintained by DWR and Reclamation to provide hydrologic-based information for planning, managing, and operating the integrated SWP and CVP system, was used to simulate system operations and resulting hydrologic conditions under the Alternatives. CALSIM II operates on a monthly time step from water year 1922 through 2003 using historical rainfall and runoff data which have been adjusted for changes in water and land uses that have occurred or are projected to occur in the future. In the model, the reservoirs and pumping facilities of the SWP and CVP are operated to ensure the flow and water quality requirements for these systems are met. The model assumes that facilities, land uses, water supply contracts, and regulatory requirements are constant throughout the 82-year hydrologic period of record, thus providing a simulation representing a fixed level of development.

Among other output, CALSIM II provides end-of-month ~~mean monthly output for~~ reservoir storage levels, and mean monthly reservoir releases, flows at various locations along the major rivers, X2 location, Delta inflow, and Delta outflow for ~~an~~the 82-year hydrologic period of record. Input assumption details for each scenario modeled using CALSIM II are provided in Appendix 5A.

The primary linkage of these models is for CALSIM II output to serve as input to ~~the~~ DSM2 ~~model and the Reclamation temperature models~~, as shown in Figure 8-50. ~~Input assumption details for each scenario modeled using CALSIM II are provided in Appendix 5A.~~ Key considerations in the CALSIM II modeling logic for the water quality assessment include how CALSIM II operations rules ~~is~~are configured to meet particular Delta water quality objectives for salinity and how daily patterning techniques were applied to the monthly CALSIM II ~~refines monthly~~ operations ~~based on internally-projected daily flows~~. These topics are addressed further below.

Artificial Neural Network for Flow-Salinity Relationship

~~Determination of f~~Flow-salinity relationships in the ~~Sacramento-San Joaquin~~ Delta ~~is~~ are critical to both ~~project~~SWP/CVP and ecosystem management. Operation of the SWP/CVP facilities and management of Delta ~~flows~~ exports is often dependent on Delta flow needs for meeting salinity standards. Salinity in the Delta cannot be simulated accurately by the simple mass--balance routing and coarse time-step used in CALSIM II. An Artificial Neural Network (ANN) has been developed (Sandhu et al. 1999) that attempts to mimic the flow-salinity relationships as simulated in DSM2, but provide a rapid transformation of this information into a form usable by the CALSIM II operations model. The ANN is implemented in CALSIM II to constrain the operations of the upstream reservoirs and the Delta export pumps in order to satisfy particular salinity requirements. A more detailed description of the use of ANNs in the CALSIM II model is provided in Wilbur and Munévar (2001).

The flow-salinity ANN developed by DWR (Sandhu et al. 1999, Seneviratne and Wu~~,~~ 2007) attempts to statistically correlate the salinity results from a particular DSM2 ~~model~~ run to the various peripheral flows (Delta inflows, exports and diversions), gate operations, and an indicator of tidal energy. The ANN is calibrated, or trained, on DSM2 results that ~~may~~ represent a ~~historical or future conditions~~ specific Delta configuration using a full circle analysis (Seneviratne and Wu~~,~~ 2007). For example, a future reconfiguration of the Delta channels to improve conveyance may significantly affect the hydrodynamics of the system. The ANN would be able to represent this new configuration by being retrained on DSM2 ~~model~~ results that included the new configuration.

The ANN ~~model~~ approximates DSM2~~-model~~-generated salinity at the following key locations for the purpose of modeling Delta water quality standards:~~ X2,~~ Sacramento River at Emmaton, San Joaquin River at Jersey Point, Sacramento River at Collinsville, and Old River at Rock Slough. In addition, the ANN is capable of providing salinity estimates for Clifton Court Forebay, CCWD Alternate Intake Project (AIP) and Los Vaqueros diversion locations. The ANN may not fully capture the dynamics of the Delta under conditions other than those for which it was trained. It is possible that the ANN will exhibit errors in flow regimes beyond those for which it was trained. Therefore, a new ANN was developed for scenarios with sea level rise and/or restoration areas in the Delta which result in changed flow–-salinity relationships in the Delta. A more complete description of the ANNs developed and used is included in Appendix 5A, section A.5.3.

Monthly-to-Daily Patterning for Sacramento River at Freeport

In an effort to better represent the sub-monthly flow variability, particularly in early winter, a monthly-to-daily flow ~~mapping~~ patterning technique is applied directly in CALSIM II for the Fremont Weir, Sacramento Weir, and the north Delta intakes. The technique applies historical daily patterns, based on the hydrology of the year, to transform the monthly volumes into daily flows. In all cases, the monthly volumes are preserved between the daily and monthly flows. It is important to note that this daily ~~mapping~~ patterning approach does not in any way represent the flows resulting from operational responses on a daily time step. It is simply a technique to incorporate representative daily variability into the flows resulting from CALSIM II's monthly operational decisions to help provide a better estimate of the Fremont and Sacramento weir spills which are sensitive to the daily flow patterns and allows in providing the upper bound of the available north Delta diversion in the Alternatives. The incorporation of daily ~~mapping~~patterning in CALSIM II is described in the Section A.3.3 of Appendix 5A.

DSM2

DSM2 is a one-dimensional mathematical model for dynamic simulation of hydrodynamics, water quality, and particle tracking throughout the Delta. DSM2 can be used to calculate stages, flows, velocities, mass transport processes for conservative constituents, and transport of individual particles. The model runs on a 15-minute time step for a 16-year (1976–1991) hydrologic period of record. DSM2 currently consists of three modules: HYDRO, QUAL, and PTM. HYDRO simulates one-dimensional hydrodynamics including flows, velocities, depth, and water surface elevations. HYDRO provides the flow input for QUAL and PTM. QUAL simulates one-dimensional fate and transport of conservative water quality constituents given a flow field simulated by HYDRO. PTM simulates pseudo three-dimensional transport of neutrally buoyant particles based on the flow field simulated by HYDRO. Input assumption details for each scenario modeled are provided in Appendix 5A~~, and a discussion of uncertainty and model validation is also included in Appendix 5A~~.

Monthly-to-Daily Patterning

DSM2 is simulated on a 15-minute time step to address the changing tidal dynamics of the Delta system. However, the boundary flows, which are ~~typically~~ provided from ~~monthly~~ CALSIM II ~~results~~output, are mean monthly flows. ~~In all previous planning-level evaluations, the DSM2 boundary flow inputs were applied on a daily time step but used constant flows equivalent to the monthly average CALSIM II flows except at month transitions.~~

As shown in Figures A-6 and A-7 of Appendix 5A, Sacramento River flow at Freeport exhibits significant daily variability around the monthly mean in the winter and spring periods in ~~the~~ most water year types. The winter-spring daily flow variability is deemed important to aquatic species of concern. ~~In an effort t~~To better represent the sub-monthly flow variability, particularly in early winter, a monthly-to-daily flow ~~mapping~~patterning technique ~~i~~was applied to the boundary flow inputs to DSM2. The monthly-to-daily flow patterning ~~mapping~~ approach used in CALSIM II and DSM2 are consistent. ~~The incorporation of daily mapping in CALSIM II is described in the Section A.3.3 of Appendix 5A.~~ A detailed description of the implementation of the daily variability in DSM2 boundary ~~conditions~~ flows is provided in Appendix 5A Section D.9.

It is important to note that this monthly-to-daily ~~mapping~~patterning approach does not in any way represent the flows that would result from any operational responses on a daily time step. It is simply a technique to incorporate representative daily variability into the flows resulting from CALSIM II's monthly operational decisions.

Calibration and Validation

DSM2 hydrodynamics and salinity (EC), which is directly modeled by DSM2, were initially calibrated in 1997 (DWR 1997). In 2000, a group of agencies, water users, and stakeholders recalibrated and validated DSM2 in an open process resulting in a model that could replicate the observed data more closely than the 1997 version (DSM2PWT, 2001). In 2009, CH2M HILL performed a calibration and validation of DSM2 by including the flooded Liberty Island in the DSM2 grid, which allowed for an improved simulation of tidal hydraulics and EC transport in DSM2 (CH2M HILL, 2009). The technical report documenting this calibration and validation effort is included in Appendix 5A Section D.5. Simulation of DOC transport in DSM2 was successfully validated in 2001 by DWR (Pandey, 2001). The version of DSM2 used for evaluating the BDCP alternatives incorporates these latest calibrations. ~~Additional discussion of model validation is included in Appendix 5A.~~

Corroboration

To evaluate DSM2's ability to represent the effects of sea level change and the proposed restoration actions on Delta hydrodynamics and salinity, DSM2 results were compared with results from two other Delta simulation models. The effects of sea level rise were ~~determined from~~ simulated by the three-dimensional UNTRIM Bay-Delta model and the effects of tidal marsh restoration were ~~determined from~~ simulated by the two-dimensional RMA Bay-Delta model. ~~DSM2 model results were corroborated for the effects of sea level rise and tidal marsh restoration using the UnTRIM and RMA model results.~~ Detailed descriptions of the UnTRIM modeling of the sea level rise scenarios, RMA modeling of the tidal marsh restoration, and DSM2 corroboration are included in Appendix 5A Sections D.7, D.6 and D.8, respectively. Overall the results show that DSM2 is capable of simulating similar incremental changes in flows and salinity at most Delta locations as in the RMA model. Further, DSM2 is capable of simulating similar incremental changes in salinity as UnTRIM in the west Delta where sea level rise is expected to have an influence.

Modeling Limitations and Uncertainty

Because DSM2 is a ~~1D~~ one-dimensional model, it has ~~with~~ inherent limitations in simulating hydrodynamic and transport processes in a complex estuarine environment such as the ~~Sacramento – San Joaquin~~ Delta. DSM2 assumes that velocity in a channel can be adequately 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. DSM2 does not have the ability to model short-circuiting of flow through a reach, where a majority of the flow in a cross-section is confined to a small portion of the cross-section. DSM2 does not conserve momentum at the channel junctions and does not model the secondary currents in a channel. DSM2 also does not explicitly account for dispersion due to flow accelerating through channel bends. It cannot model the vertical salinity stratification in the channels. It has inherent limitations in simulating the hydrodynamics related to the open water areas. Since a reservoir surface area is constant in DSM2, it impacts the stage in the reservoir and thereby impacting the flow exchange with the adjoining channel. Due to the inability to change the cross-sectional area of the reservoir inlets with changing water surface elevation, the final entrance and exit coefficients were fine tuned to match a median flow range. This causes errors in the flow exchange at breaches during the extreme spring and neap tides. Using an arbitrary bottom elevation value for the reservoirs representing the proposed marsh areas to get around the wetting-drying limitation of DSM2 may increase the dilution of salinity in the reservoirs. Accurate representation of ~~RMA's~~ tidal marsh areas, bottom elevations, location of breaches, breach widths, cross-sections, and boundary conditions in DSM2 is critical to the ~~agreement of~~ corroboration with RMA results for tidal marsh areas.

For open water bodies DSM2 assumes uniform and instantaneous mixing over entire open water area. Thus it does not account for the any salinity gradients that may exist within the open water bodies. Significant uncertainty exists in flow and EC input data related to in-Delta agriculture, which leads to uncertainty in the simulated EC values. Caution needs to be exercised when using EC outputs on a sub-monthly scale. Water quality results inside the water bodies representing the tidal marsh areas were not validated specifically. Additionally, localized withdrawals and returns are not simulated for Suisun Marsh in DSM2. In some areas of Suisun Marsh where these play a major role in water quality, DSM2 modeling may not be accurate.

Use of CALSIM II and DSM2 for Assessment of Meeting of ~~D1641~~Bay-Delta WQCP Water Quality Objectives

~~Section 3.1~~ Water Quality Objectives Incorporated into CALSIM II

In CALSIM II, the reservoirs and facilities of the SWP and CVP are operated to assure the flow and water quality requirements for these systems are met. ~~The model assumes that facilities, land use, water supply contracts, and regulatory requirements are constant over 82 years from 1922 to 2003, representing a fixed level of development. Thus, m~~Meeting regulatory requirements, including Delta water quality objectives, is the highest operational priority in CALSIM II. ~~Regarding water quality objectives for salinity, a~~As mentioned above, ~~the~~ CALSIM II uses an ANN ~~model is used so that CALSIM II can~~ to configure system operations to meet salinity objectives ~~according to the ANN, even though salinity is not directly modeled in CALSIM II~~. Because CALSIM II operates on a monthly time step, the model attempts to meet these objectives on a monthly average basis, even though the objectives themselves are often based on 14-day or 30-day running averages, and may start or end in the middle of a month. The ANN can only predict salinity at a few of the locations ~~which~~that have water quality objectives for salinity, which are specific to Delta beneficial uses:

- Municipal and Industrial Use:
    - Old River at Rock Slough ~~Chloride~~
    - Banks/Jones ~~Chloride~~Pumping Plants
- Agricultural Beneficial Use:
    - Sacramento River at Emmaton or Threemile Slough*
    - San Joaquin River at Jersey Point
- Fish and Wildlife Beneficial Uses:
    - Sacramento River at Collinsville

At the locations denoted above, because meeting the objectives is the highest priority in CALSIM II, only two conditions in CALSIM II are possible: (1) applicable water quality objectives are met on a monthly average basis according to the ANN, or (2) there is no feasible way to meet the objective.

Note that the ~~project a~~Alternatives contain an important element regarding the Sacramento River at Emmaton water quality objective. All ~~project A~~Alternatives include~~d~~, as part of the definition of the alternative, a change in the compliance point ~~for the Sacramento River at Emmaton salinity standard~~ to the Sacramento River at Threemile Slough. The ANN for the~~r a~~Alternatives was ~~also~~ retrained based on this change, so CALSIM II operated in such a way as to meet this objective at Threemile Slough under the ~~Project A~~Alternatives. The Existing Conditions and No Action Alternative did not include this change to the compliance point or ANN.

Threemile Slough is located approximately two and one-half miles upstream of Emmaton. Because of their relative locations, when the water quality o-bjective is met at Emmaton, it is generally also met at Threemile Slough. However, it is not always the case that meeting the objective at Threemile Slough results in meeting the objective at Emmaton. Thus, under the ~~Project~~ Alternatives, there are more exceedances of the water quality objective at Emmaton (were it to be still in place) than under the Existing Conditions or No Action Alternative. This is partly a function of this change in the compliance location.

When DSM2 is run using the output from CALSIM II, exceedances of the water quality objectives above can occur for several reasons.

1. CALSIM II found no feasible way to meet the objective – i.e., both CALSIM II and DSM2 agree that the objective is exceeded.
2. The ANN that CALSIM II uses predicted that the objective would be met on a monthly average basis under the operations simulated in CALSIM II, but either:
    a. The ANN is an imperfect predictor of compliance generally, or specifically on the time-step and averaging basis by which these objectives are defined; or
    ~~Section 3.2~~b. The monthly-to-daily patterning discussed above resulted in a pattern of flows at the DSM2 boundary conditions that resulted in the objective being exceeded.

In the water quality analysis, if exceedances of these objectives were predicted via the DSM2 results, depending on the specific objective in question, various approaches were employed to determine if the exceedances fell into category 1 or 2 above. If they fell into category 2, additional sensitivity analyses were performed to determine if changes in modeling assumptions or operational changes could result in compliance with the objective. Additional information regarding these analyses is provided in Appendix 8H (Attachments 1 and 2).

Water Quality Objectives not Incorporated into CALSIM II

There are also water quality objectives for salinity that are not incorporated into the ANN and CALSIM II. These include objectives that apply for the following beneficial uses and locations:

- Municipal and Industrial Use:
    - Cache Slough at City of Vallejo Intake
    - Barker Slough at North Bay Aqueduct Intake
- Agricultural Beneficial Use:
    - Interior Delta
        - South Fork Mokelumne River at Terminous
        - San Joaquin River at San Andreas Landing
    - Southern Delta and Export Area

- San Joaquin River at Airport Way Bridge, Vernalis
- San Joaquin River at Brandt Bridge Site
- Old River near Middle River
- Old River at Tracy Road Bridge
- West Canal at mouth of Clifton Court Forebay
- Delta-Mendota Canal at Tracy Pumping Plant

- Fish and Wildlife Beneficial Uses:
  - San Joaquin River at and between Jersey Point and Prisoners Point
  - Suisun Marsh
    - Sacramento River at Collinsville
    - Montezuma Slough at National Steel
    - Montezuma Slough near Beldon Landing
    - Chadbourne Slough at Sunrise Duck Club
    - Suisun Slough, 300 feet south of Volanti Slough
    - Cordelia Slough at Ibis Club
    - Goodyear Slough at Morrow Island Clubhouse
    - ~~Section 3.3~~ Water supply intakes for waterfowl management areas on Van Sickle and Chipps Islands

Although CALSIM II does not specifically operate to meet these objectives, they are nonetheless often if not always incidentally met when DSM2 is run using the CALSIM II output as boundary conditions. When DSM2 is run using the output from CALSIM II, exceedances of the water quality objectives above can occur for several reasons.

1. The exceedances are real reflections of water quality conditions for the given scenario due to system operations simulated in the CALSIM II model run and other assumptions inherent in the DSM2 run.

~~Section 3.4~~2. The system operations that CALSIM II simulated were incidentally sufficient to meet the water quality objective on a monthly average basis, but the monthly-to-daily patterning discussed above resulted in a pattern of flows at the DSM2 boundary conditions that resulted in the objective being exceeded.

In the water quality analysis, if exceedances of these objectives were predicted via the DSM2 results, depending on the specific objective in question, various approaches were employed to determine if the exceedances fell into category 1 or 2 above. If they fell into category 1, additional sensitivity analyses were performed to determine if changes in modeling assumptions or operational changes could result in compliance with the objective. Additional information regarding these analyses is provided in Appendix 8~~O~~H, Attachments 1 and 2.

Real-Time Operations of the SWP and CVP

In reality, staff from DWR and ~~USBR~~Reclamation constantly monitor Delta water quality conditions and adjust operations of the SWP and CVP in real time as necessary to meet water quality objectives. These decisions take into account real-time conditions and are able to account for many factors that the best available models cannot simulate. In section 8.3.1.4 and 8.3.1.7, the history of compliance with Delta water quality objectives is summarized and discussed. In the 30+ year history of the water quality standards, there are relatively few instances in which water quality objectives were exceeded when SWP and CVP operations had any ability to prevent the exceedance (see section 8.3.1.4 and 8.3.1.7 for more detail). Environmental conditions arise that cannot be foreseen or simulated in the model that can affect compliance with water quality objectives. These include unpredictable tidal and/or wind conditions, gate failures, operational needs to improve fish habitat/conditions, and prolonged extreme drought conditions, among others. At times, negotiations with the State Water Resources Control Board occur in order to effectively maximize and balance protection of beneficial uses and water rights. These activities are expected to continue to occur in the future. Thus, it is likely that some objective exceedances simulated in the modeling would not occur under the real-time monitoring and operational paradigm that will be in place to prevent such exceedances.

~~CALSIM II output provides the hydrologic input to the temperature models for an 82-year hydrologic period of record (1922–2003). The temperature models consist of two basic model types: a reservoir model and a river model. Reclamation developed reservoir temperature models for Trinity Lake, Whiskeytown Reservoir, Shasta Lake, Folsom Lake, New Melones Lake, and Tulloch Reservoir. The reservoir models are used to simulate one-dimensional, vertical distribution of reservoir water temperature using monthly input data on initial storage and temperature conditions, inflow, outflow, evaporation, precipitation, radiation, and average air temperature. Temperatures in the downstream regulating reservoirs—Lewiston, Keswick, Natomas, and Goodwin—are computed from equilibrium temperature decay equations in the reservoir models, which are similar to the river model equations.~~

8.3.1.3 Plan Area

Quantitative Assessments

Using the methodology described below, changes in water quality were determined at 11 assessment locations across the Delta (Figure 8-7) for each of the constituents assessed quantitatively, with the exception of EC. Assessment locations for EC aligned with ~~D-1641 compliance locations contained in the Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta WQCP Estuary (~~compliance locations contained in the Bay-Delta WQCP~~)~~ and are described in further detail below. Chloride was also assessed at ~~D-1641~~ Bay-Delta WQCP compliance locations, in addition to the 11 other assessment locations.

Calculation of Changes in Constituent Levels

Output from DSM2 was used to calculate changes in constituent concentrations as they would be affected primarily from operations-related actions of the conveyance features of the Alternatives. DSM2 produced: (1) flow-fraction or "fingerprinting" output; and (2) EC and DOC concentrations for specified Delta locations. Because the DSM2 model directly simulated EC and DOC concentrations throughout the Delta, the estimated concentrations of these constituents were simply compared among alternatives for impact assessment purposes. Additionally, because DSM2 accounts for hydrodynamic conditions in the Delta, the effects of some of the habitat restoration actions (i.e., CM2 and CM4) on EC and DOC are evaluated quantitatively. Restoration actions that resulted in water quality changes associated with altered hydrodynamics, which were captured in the DSM2 modeling, are discussed in constituent-specific impact assessment sections as operations-related water quality changes. Restoration actions that could result in a potential increase in constituent loading (e.g., increased nutrient, organic carbon, or suspended solids) to the Delta region were assessed qualitatively.

~~As described above, these~~The ~~approach~~methodes described in the following sections were used to calculate ~~values~~levels/concentrations for water quality parameters on a daily or monthly average basis for the DSM2 period of record (1976–1991). Results were generally compiled and presented based on two averaging periods: all water years, and the drought period (water years 1987–1991). The drought period was chosen to represent water quality in "worst-case" conditions, as it includes several dry and critical years in sequence. This was done in lieu of calculating water quality effects on a water year type basis (using the Sacramento River Water Year Hydrologic Classification Index). The reasons for this included simplicity of presenting and discussing results, and also because the 1987–1991 drought period represents truly worst-case conditions, whereas discussion of dry or critical year water types ~~s results lumped together would~~ includess individual years ~~that~~ when water supply and quality ~~were~~ would not be significantly affected because they were preceded ~~by~~ and succeeded by wet or above normal water years (e.g., 1981, 1985). However, when necessary, analysis of effects during certain water year types was conducted (for example, for chloride and EC, whose water quality standards depend on the water year type).

In the following sections, the validity and/or validation studies that have been performed for the various modeling approaches are discussed. It must be noted that comparison of modeling results for Existing Conditions to historical water quality monitoring data is not an appropriate means of model validation. SWP/CVP operations have changed several times in the past as a result of various legal and regulatory determinations, and also vary as a result of changing land uses and water demands over time. Historical water quality data in general can represent times when the SWP/CVP system was operated differently than under the simulated Existing Conditions model run, which represents operation of the SWP and CVP at the time the Notice of Preparation was issued. The modeled Existing Conditions overlays this operational scheme on a period of varied historical hydrology. Therefore, it is not expected that the modeled Existing Conditions will approximate historical water quality data at a given location or time.

Mass-Balance Method

For ~~other~~ constituents assessed quantitatively (See Appendix 8C, Table SA-11) for which concentrations were not directly estimated by DSM2—boron, bromide, chloride, mercury, methylmercury, nitrate, selenium—~~,~~mean monthly flow-fraction output from DSM2 was used in mass-balance calculations (processed outside of DSM2) to estimate constituent concentrations. The flow-fraction output from DSM2 is the average percentage of water at each specified Delta location that was constituted by the five primary source waters (i.e., SAC, SJR, eastside tributaries [EST], BAY, and AGR). These flow-fractions were used together with source water constituent concentrations derived from historical data to estimate a given constituent concentration at assessment locations according to equation 1:

$$f_{SAC,i}(C_{SAC}) + f_{SJR,i}(C_{SJR}) + f_{EST,i}(C_{EST}) + f_{BAY,i}(C_{BAY}) + f_{AGR,i}(C_{AGR}) = C_i \qquad (1)$$

In the above equation, $f_{X,i}$ is the mean monthly flow fraction from source X at assessment location i, C_X is the constituent concentration from source X, and C_i is the constituent concentration at assessment location i. Contribution from the Yolo Bypass was added to contribution from the Sacramento River to constitute a single source, except in the case of selenium. Source water concentrations in the above equation are described for each of the constituents assessed via this method in Section 8.3.1.7, Constituent-Specific Considerations Used in the Assessment. Source water concentrations may vary seasonally, and this was examined. In some cases, source water concentrations were varied seasonally based on historical trends.

A key assumption for the mass-balance calculation is that the constituent acts in a conservative manner throughout the system, as the various source waters mix and flow through the Delta, although most behave, to some degree, in a nonconservative manner. For constituents where this assumption does not hold because of decay, uptake, or other losses, this mass-balance ~~approach~~method would be expected to overestimate the actual concentrations at any given Delta location.

The ~~general approach of the first method, referred to as the~~ mass--balance method~~,~~ for calculating constituent concentrations in the Delta was validated in 2011 and 2012 for chloride and bromide (MWH 2011, DWR 2012). There was one key difference, however, between ~~in~~ the validation study methodology ~~that the authors of the validation study used from~~ and the method used in ~~this study~~this water quality assessment. ~~That is~~In the validation study, the chloride and bromide concentrations for the Delta source waters ~~to the Delta~~ (Sacramento River, San Joaquin River, East Side Streams, and San Francisco Bay/Martinez) ~~was~~ were determined via ~~previously derived~~ regression equations relating the chloride or bromide concentration to modeled EC in the source waters. Thus, the source water concentration for chloride and bromide varied with each time step according to the EC at the boundaries. In this ~~study~~assessment, source water concentrations were not dependent on EC, but were either static (if review of historical data indicated little to no seasonality), or varied by month (if review of historical data indicated seasonality).

~~This approach~~ Because the bromide and chloride concentrations are relatively constant for the Sacramento River and East Side Streams, ~~T~~the mass-balance method is believed to be valid for modeling ~~the Sacramento River, and East Side Streams~~these. Likewise, although bromide and chloride from the San Joaquin River vary, the variations are small enough that for the purposes of this comparative study, the method is believed to be valid for~~, and . For the purposes of this study, it is also believed to be valid for the~~ San Joaquin River contributions to constituent concentrations in the Delta. However, this ~~approach~~ method does introduce uncertainty for areas influenced by San Francisco Bay~~/seawater~~ contributions. This ~~.~~

~~This~~ is because

~~I~~it is recognized that C_{BAY} in Equation 1 is dependent on flows in the Sacramento and San Joaquin Rivers as well as Delta exports (i.e., net Delta outflow), which may change due to climate change/sea level rise, and altered operations of the SWP/CVP system. It is also dependent on the tidal exchange volume, which may change as a result of restoration associated with CM4. However, beyond accounting for seasonal trends in the historical data, neither of these factors ~~were~~ was taken into account in determining a ~~value~~ constituent concentration for C_{BAY}. Therefore, for cases in which net ~~d~~Delta outflow increases or decreases relative to what has historically occurred, the ~~value~~ constituent concentration used for C_{BAY} may overestimate or underestimate the concentrations associated with San Francisco Bay water (as measured at Martinez). Additionally, if restoration component CM4 increases tidal exchange volume, the value used for C_{BAY} would underestimate concentrations associated with San Francisco Bay water (as measured at Martinez).

Finally, it must be noted that no formal validation studies have been performed to validate the mass-balance method that was used for boron, mercury, methylmercury, nitrate, or selenium. The validation studies performed to date on conservative constituents (e.g., EC, chloride, bromide) have validated the approach for using DSM2 to evaluate changes in mixing of Delta source waters on water quality constituents. Although it is known that mercury, methylmercury, and selenium do not behave conservatively in the Delta, the ~~approach~~mass-balance method is believed valid for assessing the impact of changed source water mixing on concentrations of these species, because the same mixing mechanisms apply to all dissolved constituents, and altered mixing of Delta source waters is one of the primary mechanisms by which the Alternatives change water quality in the Delta. The model results are not meant to be taken as predictions of future mercury, methylmercury, or selenium concentrations, since known mechanisms such as sorption, settling, and transformation are not quantitatively taken into account, but rather to be used to assess water quality differences between Alternatives and make determinations regarding potential effects to beneficial uses relative to assessment baselines..

~~For constituents associated with seawater intrusion that were not modeled directly in DSM2 (bromide, chloride), these considerations were addressed qualitatively.Additionally, due to the uncertainty inherent in using a constant historical monthly average concentration as the value of C_{BAY}, a second modeling approach was used for chloride and bromide for west Delta locations that were influenced by seawater intrusion. Results from this alternative modeling approach were used to supplement the results using the approach described above as a means of providing best available information related to chloride and bromide in the Delta.~~

Regression Method for Chloride and Bromide

For chloride, the ~~alternative modeling~~ quantitative assessment ~~approach~~ applied relationships between EC and chloride developed based on historical water quality data to the DSM2 output for EC. This relationship was developed based on data at Mallard Island, Jersey Island, and Old River at Rock Slough (Contra Costa Water District 1997). The relationship was:

$$Cl = max\begin{pmatrix} 0.15 * EC - 12 \\ 0.285 * EC - 50 \end{pmatrix} \qquad \textbf{(2)}$$

In the equation above, Cl is the chloride concentration in mg/L, and EC is in µS/cm.

The chloride regression method was developed using data for the west Delta and ~~has been validated~~is thus valid for that area (Contra Costa Water District 1997). The chloride regression method has not been validated for other areas of the Delta. However, chloride poses a risk of environmental impacts under the Alternatives only in the west Delta, where this method is valid. If the results of this method indicated that there may be environmental impacts in other areas of the Delta, further assessment was conducted to determine if the method is valid or if another method is more appropriate.

For bromide, the same EC to chloride relationship was used, followed by a relationship between chloride and bromide, to estimate bromide concentrations. The chloride to bromide relationship is approximately the same in multiple areas in the west ~~d~~Delta, including Old River at Rock Slough (Contra Costa Water District 1997), the intakes at Banks Pumping Plant (CALFED 2007a), and Mallard Island (Appendix 8E Figure 1). The relationship used was:

$$Br = 0.0035 * Cl \quad \textbf{(3)}$$

In the equation above, Br is the bromide concentration in mg/L, and Cl is the chloride concentration in mg/L.

~~It should be noted that this alternative modeling approach is limited in the sense that the relationships described above are based on historical water quality data that is representative of historical Delta hydrodynamics. It is unknown whether these relationships will still apply in the future with sea-level rise, and particularly under an altered Delta hydrodynamic regime (as would be expected under the project alternatives). Because each of the two approaches have limitations and uncertainty, there is no way to determine which method results in more accurate estimates of chloride or bromide. Thus, where applicable (i.e., for west Delta locations), both methods were applied and the results of both approaches discussed. In general, when the methods displayed disagreement, impacts were assessed based on the more conservative of the two approaches.~~

~~A key assumption for the mass-balance calculation is that the constituent acts in a conservative manner throughout the system, as the various source waters mix and flow through the Delta, although most behave, to some degree, in a nonconservative manner. For constituents where this assumption does not hold because of decay, uptake, or other losses, this mass-balance approach would be expected to overestimate the actual concentrations at any given Delta location.~~

~~As described above, these approaches were used to calculate values/concentrations for water quality parameters on a daily or monthly average basis for the DSM2 period of record (1976–1991). Results were generally compiled and presented based on two averaging periods: all water years, and the drought period (water years 1987–1991). The drought period was chosen to represent water quality in "worst-case" conditions, as it includes several dry and critical years in sequence. This was done in lieu of calculating water quality effects on a water year type basis (using the Sacramento River Water Year Hydrologic Classification Index). The reasons for this included simplicity of presenting and discussing results, and also because the drought period represents truly worst-case conditions, whereas discussion of dry or critical year water types includes years that water supply and quality were not significantly affected because they were preceded by and succeeded by wet or above normal water years (e.g., 1981, 1985). However, when necessary, analysis of effects during certain water year types was conducted (for example, for chloride and EC, whose water quality standards depend on the water year type).~~

8.3.1.5 Mercury and Selenium Bioaccumulation Assessment

Mercury and selenium are bioaccumulative constituents of concern in Delta waters. They also are listed as causes of impairment under the Clean Water Act Section 303(d), and a substantial amount is known about their fate and transport within the Delta or similar systems. Consequently, a specific analysis approach was developed for these two constituents.

Mercury and selenium concentrations in surface water were estimated at Delta assessment locations (Figure 8-51) as described previously (Section 8.3.1.3). Linkages between abiotic media (sediment and surface water, as applicable) and biological tissues (fish muscle, whole-body fish, and bird eggs) that provide an estimate of the potential bioaccumulation and impacts on ecological and human receptors were evaluated to determine the linkages with the greatest degree of confidence. Potential linkages explored included the following.

- **Literature-based regression models or bioaccumulation factors**. These resources provide a basis for estimating tissue concentrations for mercury and selenium from concentrations in surface water or sediment.

- **Site-specific linkages**. Methods were developed to describe existing relationships between waterborne concentrations of mercury and selenium at the nearest modeling nodes, existing sediment (for mercury), and fish tissue concentrations in an attempt to create predictive relationships for impact analysis and alternatives comparisons.

- **Delta methylmercury**. The TMDL translation equation for mercury (Central Valley Water Quality Board 2011b) was used to estimate fish tissue concentrations from waterborne concentrations. In addition, DSM2 water quality model predictions were investigated separately for their ability to predict measured fish tissue concentrations at discrete locations. The two translation models were compared for their predictive ability.

- **Delta ~~U.S. Geological Survey Bioaccumulation and Trophic Transfer Factors for~~ selenium**. U.S. Geological Survey bioaccumulation and trophic transfer factors for ~~Values for~~ uptake of selenium from water to the lowest trophic level~~s~~ (e.g., suspended particulates or algae) and ~~transfer factors~~ from that level to invertebrates and then to fish and bird eggs developed by Presser and Luoma (2009, 2010) were used initially to estimate uptake from water to fish and to bird eggs. In calibrating the Delta-wide bioaccumulation model for largemouth bass, the particulate selenium concentration initially was estimated using a default K_d of 1,000 (K_d = particulate/water ratio; Presser and Luoma 2010). Because this first step in selenium bioaccumulation typically is much more variable than other steps in the bioaccumulation model, the K_d was then adjusted to calibrate the model so that the modeled concentrations for fish approximated the measured concentrations in bass for normal and wet years (2000 and 2005) and for dry years (2007), as described in Appendix 8M, Section 8M.4. Initial modeling for fish was based on a model calibrated for largemouth bass as the representative species because of the available data for bass across the Delta ~~(Appendix 8M)~~. However, because there would be more bioaccumulation of selenium by species such as sturgeon that feed in part on clams that are known to bioaccumulate selenium readily in Suisun Bay, additional modeling was conducted for sturgeon in the western Delta ~~(sturgeon addendum M.A forto Appendix 8M)~~.

Adverse effects on ecological and human receptors were quantified through comparisons of measured and modeled surface water, and tissue (fish [fillets for mercury; whole body and fillets for selenium] and bird eggs [selenium only]) data to established benchmarks, including the following.

- Water quality objectives, criteria, and drinking water standards for mercury, methylmercury, and selenium.

- Literature-derived effect levels for mercury, methylmercury, and selenium in fish fillets for species most representative of the Delta.

- Literature-derived effect levels for selenium in whole-body fish for species most representative of the Delta.

- Literature-derived effect levels for selenium in eggs of bird species most representative of the Delta.

- State of California Office of Environmental Health Hazard Assessment's fish contaminant goals and advisory tissue levels for mercury, methylmercury, and selenium.

The alternatives were evaluated with regard to potential adverse impacts on ecological and human receptors through a weight-of-evidence approach. The Existing Conditions and each alternative were evaluated for their potential to cause exceedances of water quality or tissue benchmarks and for qualitative differences in the spatial extent of those exceedances. Exceedances of tissue benchmarks were determined by evaluating exceedance quotients, which are ratios of the modeled fish or bird egg tissue concentrations divided by the tissue benchmark (e.g., Level of Concern, Toxicity Level, or Advisory Tissue Level) in similar units. Values over 1.0 indicate modeled tissue concentrations exceed the lowest threshold (e.g., Level of Concern for selenium in whole-body fish or in bird eggs) or potentially toxic levels of bioaccumulation (if there is exceedance of the higher Toxicity Level benchmark). The water and tissue concentrations associated with modeled alternatives were compared to modeled Existing Conditions and the No Action Alternative. In addition, spatial changes in the extent of marshlands associated with each alternative (i.e., CM4–CM10) were evaluated qualitatively for their potential to enhance mercury or selenium bioavailability and risk.

8.3.1.7 Constituent-Specific Considerations Used in the Assessment

Bromide

Bromide concentrations at a particular location and time in the Delta are determined primarily by the sources of water to that location, at a given time. Hence, long-term average concentrations at a particular Delta location are determined primarily by the long-term average sources of water to that location, and the long-term average concentration of bromide in each of the major source waters to the location. The major source waters to any given Delta location are: (1) Sacramento River, (2) San Joaquin River, (3) Bay water, (4) eastside tributaries, and (5) agricultural return water.

Bromide is not routinely monitored in surface water samples collected north of the Delta, primarily due to the low concentration of bromide in this region. Data available for the American River suggests that bromide concentrations are <10 μg/L. Table 8-43 provides a summary of bromide concentrations in the primary source waters of the Delta, as well as information on the source of the data and summary statistics. Due to the quality and quantity of data available, as well as the conservative nature of the constituent, a quantitative assessment utilizing a mass-balance approach was employed in the assessment of alternatives. Additionally, results of a second modeling approach utilizing EC to chloride and chloride to bromide relationships were used to supplement the results of the mass-balance approach (see Section 8.3.1.3). Because bromide is a precursor to the formation of DBPs which represent a long-term risk to human health, and because the existing source water quality goal is based on a running annual average, the quantitative assessment focuses on the degree to which an alternative may result in change in long-term average bromide concentrations at various locations throughout the affected environment. For municipal intakes located in the Delta interior, assessment locations at Contra Costa Pumping Plant No.1 and Rock Slough are taken as representative of Contra Costa's intakes at Rock Slough, Old River and Victoria Canal, and the assessment location at Buckley Cove is taken as representative of the City of Stockton's intake on the San Joaquin River. Municipal intakes at Mallard Slough, City of Antioch, and the North Bay Aqueduct are represented by their respective assessment locations. For the purposes of this assessment, bromide concentrations for water transported into the SWP/CVP Export Service Areas are assessed based on concentrations at the primary SWP and CVP Delta export locations (i.e., Banks and Jones pumping plants).

As demonstrated in Table 8-43, achieving the CALFED goal of 50 μg/L bromide at drinking water intakes is severely challenged by the ~~quality~~ bromide concentrations in two main ~~of at least three of the five primary~~ source waters to the Delta, the San Joaquin River and San Francisco Bay (seawater), where long-term average concentrations exceed this goal many fold ~~in the source waters themselves~~. In establishing its source water goal for bromide, CALFED assumed more stringent DBP criteria for treated drinking water than are currently in place. Source water with bromide between 100 μg/L and 300 μg/L is believed sufficient to meet currently established drinking water criteria for DBPs, depending on the amount of *Giardia* inactivation required (California Urban Water Agencies 1998, ES2). This assessment of alternatives evaluates how each alternative would affect the frequency with which predicted future bromide concentrations would exceed 50 μg/L (based directly on the CALFED goal) and 100 μg/L (based on the lower limit of the range considered sufficient for meeting currently established drinking water criteria) on a long-term average basis at the assessment locations. Because, in many cases, the existing condition is one already exceeding 50 μg/L, the frequency with which bromide would exceed~~s~~ 100 μg/L bec~~o~~ame~~s~~ a key focus of the assessment, as well as the change in long-term average bromide concentration.

As described in Section 8.3.1.3, there are uncertainties present in the two modeling approaches used to estimate bromide concentrations that would occur under the alternative. Regardless of whether the modeling may have overestimated or underestimated bromide concentrations that would occur under the alternatives, the modeling results allow for making determinations of whether concentrations would increase under a particular alternative, by comparing the modeled concentrations under the alternative to concentrations modeled for Existing Conditions and the No Action Alternative. Evaluating the magnitude and frequency of the modeled bromide increases, coupled with the comparison to water quality thresholds, allowed for making the NEPA/CEQA impact determinations. Thus, for bromide, the magnitude of change in long-term average bromide concentrations in addition to the comparison of exceedance of the 100 μg/L threshold served as the basis for the impact calls in the EIR/EIS. Because 100 μg/L is at the low end of the range of concentrations considered sufficient to meet current drinking water criteria for DBPs, the assessment is conservative relative to potential impacts on drinking water treatment facilities.

The modeling relies on several assumptions that could have large impacts on the predicted level of seawater intrusion. The two most major assumptions are the assumed level of sea level rise, and the assumed restoration area footprints used in the modeling. Changes in either of these assumptions would likely impact predicted bromide concentrations at Barker Slough. Additionally, DSM2 is known to not account well for local diversions and returns in the Barker Slough area, and the assumed modeled pumping schedule for the Barker Slough Pumping Plant may not accurately reflect actual operations, both of which can affect the hydrodynamics of Barker Slough. It is unknown whether these latter assumptions would play a major role in determining bromide concentrations in Barker slough under the alternatives.

1 **Table 8-43. Source Water Concentrations for Dissolved Bromide (µg/L)**

Source Water	Sacramento River	San Joaquin River	San Francisco Bay[a]	Eastside Tributaries	Agriculture in the Delta
Mean (µg/L)	15	251	13,149–32,951	16	456
Minimum (µg/L)	1	20	28–17,465	14	20
Maximum (µg/L)	100	650	33,985–44,100	17	2,720
75th Percentile (µg/L)	20	345	22,313–38,500	N/A	580
99th Percentile (µg/L)	44	565	22,313–38,500	N/A	1,850
Data Source	DWR	DWR	BDAT	BDAT	DWR
Station(s)	Sac River at Greene's Landing, Sac River at Hood	SJR at Vernalis	[b]	Mokelumne River at Sacto Road	[c]
Date Range	1990–2009	1990–2009	1980–2007	1990–1990	1990–2001
ND Replaced with RL	Yes	No	No	No	No
Data Omitted	None	None	None	None	Yes [d]
No. of Data Points	560	547	26–27	2	991

Notes:

[a] Values reported as range of monthly values (minimum monthly–maximum monthly). Trends in monthly average bromide at Martinez suggested a seasonality to concentration. Due to the appearance of seasonality in monthly average concentration at this location, average monthly concentration was used. Actual monthly values for the dataset are provided in Appendix 8E, Bromide Table 1.

[b] Measured bromide data at Martinez was not available for this analysis. Bromide data at Martinez was estimated from the regressed relationship of bromide to chloride at Mallard Island (Appendix 8E, Bromide Figure 1). The empirical relationship of bromide to chloride obtained at Mallard Island was similar to that of ocean water (Morris and Riley 1966), or 0.0035 parts bromide to 1 part chloride. Bromide data at Martinez used in this analysis therefore represents measured Martinez chloride multiplied by a factor of 0.0035.

[c] Values calculated from all agriculture drain data pooled together. All bromide data from agricultural drains contained in the DWR Water Data Library were placed into a single database. Due to the uneven distribution of agricultural drains in the Delta, geographical trends in agricultural drain water quality were evaluated by categorizing the data based on their associated location in the Delta. Categories included western, southern, northern, eastern, and central Delta, following the geographical delineations of the State Water Resources Control Board. With data pooled and categorized by region, average concentration by region were compared. Average bromide varied by less than a factor of 3, with highest concentration in the southern Delta and lowest in the central Delta. No bromide data was available for the northern Delta. Due to the apparent low regional variability, values were obtained by pooling all data together and obtaining summary statistics from this pooled database.

[d] Data for the Byron Tract #2 and Byron Tract #3 agricultural drains were omitted from the database due to their reported values being substantially outside the distribution of all other values. These values were: 65,000 µg/L and 46,800 µg/L. In total, 2 data points were omitted and 991 were retained.

2

Chloride

As an inorganic anion, chloride is generally conservative in the aquatic environment and its fate and transport characteristics are similar to other salinity constituents. Consequently, chloride concentrations at any location in the Delta primarily reflect the mass balance of the flow and concentrations of the major water sources. Therefore, a quantitative mass-balance approach using the source water flow fractions from the DSM2 model output and source water concentrations was used to estimate chloride concentration changes that would occur as a result of implementation of changed water conveyance features under CM1 for the alternatives.

In addition, the implementation CM4 would restore substantial areas of tidal habitat that would increase the magnitude of daily tidal water exchange at the restoration areas, and could alter other hydrodynamic conditions in adjacent Delta channels. San Francisco Bay water is a major source of chloride, thus, the increased tidal exchange resulting from tidal habitat restoration may increase chloride concentrations in the portion of the Bay water that enters the western Delta. The DSM2 modeling included assumptions regarding possible locations of tidal habitat restoration areas, and how restoration would affect Delta hydrodynamic conditions and source water flow fractions. However, the magnitude of increased chloride concentrations in Bay source water in the western Delta as a result of increased tidal exchange is uncertain. Consequently, the potential effects of tidal restoration on chloride concentrations in the Bay source water was assessed qualitatively based on predicted changes in the Bay source water fraction. The effects of other conservation measures (i.e., CM2, CM3, and CM5–CM~~22~~21) which do not substantially affect flows or Delta hydrodynamic conditions also were assessed qualitatively.

Applicable chloride objectives for the affected environment utilized in this assessment are summarized in ~~(~~Table 8-44~~)~~. The mass-balance modeling results were used to compare predicted changes in assessment variables (e.g., exceedances of objectives/criteria, amount of water quality degradation relative to chloride) based on averaging periods appropriate for each relevant beneficial use. Results of a second modeling approach utilizing relationships between EC and chloride were used to supplement those results (see Section 8.3.1.3).The assessment of effects relative to designated beneficial uses and associated water quality objectives/criteria was based on changes in long-term average concentrations modeled for all water year types for the 16-year (1976–1991) hydrologic period of record and for the drought years only (i.e., 1987–1991). Compliance for some applicable objectives/criteria are based on short-term averaging period concentrations; e.g., daily data for Bay-Delta WQCP objectives for municipal and industrial water supply for specific locations in the Delta (e.g., daily data)~~ and the U.S. EPA aquatic life criteria (i.e., 4-day chronic and 1-hour acute criteria)~~. The available monitoring data for source water chloride concentrations are not adequate to characterize daily variability, and the channel flows modeled in CALSIM, which provides the hydrologic input to the DSM2 model, ~~is~~ are on a monthly time-step. Therefore, the mass-balance approach can only be used for monthly average assessment, and thus for the chloride assessment cannot be used to evaluate exceedances of the 150 mg/L objective, and can only evaluate exceedances of the 250 mg/L objective on a monthly average basis instead of a daily average basis. Consequently, the assessment of potential effects of alternatives relative to the 150 mg/L objective was based only on daily chloride data obtained via the EC to chloride relationships and DSM2 EC output (as described in Section 8.3.1.3).Relative to the 250 mg/L objective, assessment was based on both monthly average concentrations from the mass-balance approach and daily average concentrations from the EC to chloride relationship approach.

Table 8-44. Applicable Federal Criteria, State Objectives, and Other Relevant Effects Thresholds for Chloride (mg/L unless specified)

Location	Bay-Delta WQCP		Region 5 Basin Plan	Region 2 Basin Plan	Drinking Water MCL	U.S. EPA Recommended Criteria
All Receiving Waters Other Than the Delta	- -		250 [a, b] 500 [a, c] 600 [a, d]	142/355 [e] 250 [a, b] 500 [a, c] 600 [a, d]	250 [b] 500 [c] 600 [d]	230/860 [f]
Delta-Specific						
Contra Costa Canal @ Pumping Plant No. 1 or San Joaquin River @ Antioch Water Works Intake	Year Type	Objective [g]	- -	- -	- -	- -
	W	<150–240 days/calendar year (66%)				
	AN	<150–190 days/calendar year (52%)				
	BN	<150–175 days/calendar year (48%)				
	D	<150–165 days/calendar year (45%)				
	C	<150–155 days/calendar year (42%)				
Contra Costa Canal @ Pumping Plant #1, West Canal @ Mouth of Clifton Court Forebay, Jones Pumping Plant, Barker Slough @ North Bay Aqueduct, and Cache Slough @ the City of Vallejo Intake	250 (Oct.–Sep.) [h]		- -	- -	- -	- -

Notes: A = Annual, etc.

[a] State secondary maximum contaminant level (MCL) incorporated by reference in the Basin Plan. No fixed consumer acceptance contaminant level has been established. Municipal water systems must monitor for compliance based on a running average of four quarterly values. The Region 5 Basin Plan incorporates the MCLs by reference, but do not specify an averaging period for assessment of compliance.

[b] Recommended Contaminant Level for the state secondary MCL. Constituent concentrations lower than the recommended contaminant level are desirable for a higher degree of consumer acceptance.

[c] Upper Contaminant Level for the state secondary MCL. Constituent concentrations ranging to the upper contaminant level are acceptable if it is neither reasonable nor feasible to provide more suitable waters.

[d] Short Term Contaminant Level for the state secondary MCL. Constituent concentrations ranging to the short term contaminant level are acceptable only for existing community water systems on a temporary basis pending construction of treatment facilities or development of acceptable new water sources.

[e] Objectives for agricultural water supply identified in Basin Plan as a “threshold value/limit value”; no averaging period is defined for assessment of compliance.

[f] U.S. EPA National Recommended Water Quality Criteria specified as Criterion Continuous Concentration (CCC)/Criteria Maximum Concentration (CMC).

[g] Municipal and industrial water supply beneficial use objective, specified as a maximum mean daily value for at least the number of days shown during the calendar year. Must be provided in intervals of not less than two weeks duration (percentage of calendar year shown in parentheses).

[h] Municipal and industrial water supply beneficial use objective, specified as a maximum mean daily value to be applied year-round for all water year types.

Understanding the uncertainties and limitations in the modeling and assessment approach is important for interpreting the results and effects analysis, including assessment of compliance with water quality objectives. Please refer to Section 8.3.1.1, *Models Used and Their Linkages*, and Section 8.3.1.3, *Plan Area*, for a description of these limitations. In light of these limitations, the assessment of compliance is conducted in terms of assessing the overall direction and degree to which Delta chloride would be affected relative to a baseline, and discussion of compliance does not imply that the alternative would literally cause Delta chloride to be out of compliance a certain period of time. In other words, the model results are used in a comparative mode, not a predictive mode.

The U.S. EPA has also published recommended national aquatic life criteria for chloride (Table 8-44). This recommended chloride criterion is not used in the assessment of Delta effects for several reasons. Firstly, the U.S. EPA recommended chloride criterion is only applicable to freshwater, and its appropriate application in a dynamic estuary such as the Delta is uncertain. Secondly, the national recommended criterion is currently being revised by U.S. EPA. New toxicity studies have resulted in a different understanding of species sensitivities in freshwater, and have revealed a hardness and sulfate dependence (i.e., similar to that of trace metals) that was not taken into consideration in the drafting of the most current criterion. Thirdly, with regard to aquatic life beneficial uses in the Delta, the State has taken the approach of regulating salinity through the establishment of EC objectives. Chloride is a major component of salinity, as measured by EC. Effects on compliance with EC-related aquatic life objectives is addressed for each project alternative relative to model predicted changes in Delta EC. In addition, salinity-based project alternative effects to covered and uncovered fish species, invasive benthic invertebrates, invasive aquatic vegetation, and blue-green algae are addressed in Chapter 11, *Fish and Aquatic Resources*.

Table 8-45 provides a summary of chloride concentrations in the primary source waters of the Delta used for the mass-balance approach, as well as information on the source of the data and summary statistics. The long-term average source water concentrations were used for most locations in the mass-balance assessment; however, due to the presence of a distinct seasonal pattern in the chloride concentrations of the San Francisco Bay source water at the interface with the Delta in relation to seasonal Delta outflow pattern, monthly average concentrations were used for this location.

Table 8-45. Historical Chloride (Dissolved) Concentrations in the Five Delta Source Waters

Source Water	Sacramento River	San Joaquin River	San Francisco Bay [a]	East Side Tributaries	Delta Agriculture Return Waters [b]
Mean (mg/L)	6.38	81.4	3,757–9,414	2.36	136
Minimum (mg/L)	1.00	1.00	8–4,990	0.30	3.0
Maximum (mg/L)	33.0	221	9,710–12,600	8.60	830
75th Percentile (mg/L)	8.00	111	6,375–11,000	3.05	175
99th Percentile (mg/L)	12.3	186	9,643–1,2574	5.79	636
Data Source	DWR, BDAT	DWR, BDAT	BDAT	USGS	DWR
Station(s)	Sac River at Greene's Landing, Sac River at Hood	SJR at Vernalis	Suisun Bay at Bulls Head near Martinez	Mokelumne River, Cosumnes River	[b]
Date Range	1980–2009	1980–2009	1980–2007	1952–1994	1987–2001
ND Replaced with RL	No	No	No	No	No
Data Omitted	None	None	None	Single <0.1 value from each data set, 0 values from Cosumnes River	None
No. of Data Points	867	844	26–27	391	1,543

Notes:

[a] Values reported as range of monthly values (minimum monthly–maximum monthly). Review of available sample data for the Martinez location suggests that there is a generally seasonal trend in monthly average chloride concentration.

Chloride concentrations used to represent San Francisco Bay water in the mass-balance assessment were determined on a monthly average basis. Refer to Appendix 8G, Table Cl-61 for additional information and tabulation of the calculated monthly average chloride concentrations for the Bay source water.

[b] Values calculated from all agriculture drain data pooled together. All chloride data from agricultural drains contained in the DWR Water Data Library were placed into a single database.

Seasonal or long-term changes in chloride concentrations at western Delta locations would be associated with changes in the location of the tidal mixing zone and interface of the elevated Bay salt water and freshwater Delta outflow. Changes in the salt water/freshwater interface may result in shifts of the acceptability of a location between freshwater- and salinity-tolerant aquatic fish, aquatic vegetation, and other aquatic organisms. The significance of these potential effects relative to applicable freshwater and estuarine water quality objectives is not assessed in the chloride assessment. Rather, the reader is referred to Chapter 11, *Fish and Aquatic Resources*, for the detailed assessment of changes in the location of the tidal mixing zone (e.g., as measured by the location of X2) and for its impact(s) to aquatic life beneficial uses.

Dissolved Oxygen

DO levels in the reservoirs and rivers upstream of the Delta are primarily affected by water temperature, flow velocity, turbulence, amounts of oxygen demanding substances present (e.g., ammonia, organics), and rates of photosynthesis (which is influenced by nutrient levels), respiration, and decomposition. Water temperature and salinity affect the maximum DO saturation level (i.e., the highest amount of oxygen the water can dissolve). Flow velocity affects the turbulence and re-aeration of the water (i.e., the rate at which oxygen from the atmosphere can be dissolved in water). High nutrient content can support aquatic plant and algae growth, which in turn generates oxygen through photosynthesis and consumes oxygen through respiration and decomposition.

Effects of the alternatives on temperature in the Delta relative to the No Action alternative were not considered in the DO assessment. This is because, as stated in the USFWS (2008b:194) OCAP BiOp:

> The [state and federal] water projects have little if any ability to affect water temperatures in the Estuary (Kimmerer 2004). Estuarine and Delta water temperatures are driven by air temperature. Water temperatures at Freeport can be cooled up to about 3°C by high Sacramento River flows, but only by very high river flows that cannot be sustained by the projects. Note also that the cooling effect of the Sacramento River is not visible in data from the west Delta at Antioch (Kimmerer 2004) so the area of influence is limited.

Since Delta water temperatures are driven by air temperature, climate change (as included in the No Action Alternative and all action alternatives) that increases air temperatures relative to existing conditions would be expected to increase water temperatures in the Delta as well. Effects of climate change on air and Delta water temperatures are discussed in Appendix 29C.In general, waters of the Delta would be expected to warm less than 5 degrees F, which translates into a < 0.5 mg/L decrease in DO.

The dissolved oxygen assessments were conducted in a qualitative manner based on anticipated changes in these factors.

Additionally, concerns have been raised that the project may increase flows on the San Joaquin River at Stockton, causing the location of the minimum DO point to shift downstream (see Section 8.1.3.6, *Dissolved Oxygen*, for a discussion of the existing DO impairment in the Stockton Deep Water Ship Channel). To assess this possibility, flows in San Joaquin River at Stockton were evaluated.

Electrical Conductivity

EC and TDS values tend to be highly correlated, because the majority of chemicals that contribute to TDS are charged particles that impart conductance of water. Because EC measurement is easily conducted with a portable meter, as compared to the requirement for physical sample collection and laboratory gravimetric analysis for TDS, the majority of water quality regulatory criteria/objectives are established for EC. Moreover, where regulatory objectives for TDS exist, they co-occur with the equivalent EC value (i.e., there are no independent TDS-only regulatory criteria/objectives or guidance values). EC also is the parameter modeled to represent salinity in DSM2. Therefore, this impact assessment for "salinity" as indicated by EC and TDS is based on EC values only and TDS is not addressed separately.

Applicable EC objectives for the affected environment utilized in this assessment are summarized in Table 8-46.

The assessment of effects on EC in the reservoirs and rivers upstream of the Delta was qualitative, and evaluates changes in EC based on anticipated changes in EC-contributing sources in the watersheds under the various BDCP alternatives assessed.

The assessment of hydrodynamic effects of the BDCP alternatives' CM1, CM2, and CM4 on EC in the Plan Area relied on DSM2 output. Because implementation CM4 would restore substantial areas of tidal habitat that would increase the magnitude of daily tidal water exchange at the restoration areas, and could alter other hydrodynamic conditions in adjacent Delta channels, the DSM2 modeling included assumptions regarding possible locations of tidal habitat restoration areas, and how restoration would affect Delta hydrodynamic conditions and source water flow fractions. The effects of other conservation measures (i.e., CM3 and CM5–CM~~22~~21) which do not substantially affect Delta hydrodynamic conditions were assessed qualitatively.

DSM2 directly models Delta EC levels on a 15-minute interval. DSM2 output for EC was post-processed to compare results to the Bay-Delta WQCP objectives at the following locations.

- Western Delta: Sacramento River at Emmaton and San Joaquin River at Jersey Point
- Interior Delta: South Fork Mokelumne River at Terminous, San Joaquin River at San Andreas Landing, and San Joaquin River at Prisoners Point
- Southern Delta: San Joaquin River at Vernalis, San Joaquin River at Brandt Bridge, Old River near Middle River, and Old River at Tracy Road Bridge

For the assessment of Alternatives 1–3~~1~~ and 5–9, the Sacramento River at Emmaton compliance location is relocated to Threem~~ M~~ile Slough near the Sacramento River. For comparing effects of the alternatives on EC in this portion of the Delta, two comparisons were made:

- changes in EC in the Sacramento River at Emmaton under the alternatives are compared to EC at Emmaton under Existing Conditions and the No Action Alternative, and
- changes in EC in Three~~ M~~mile Slough under the alternatives are compared to EC at Emmaton under Existing Conditions and the No Action Alternative.,

Alternative 4 does not include a change in compliance point from Emmaton to Threemile Slough. However, modeling was originally performed for Alternative 4 assuming the compliance point did shift from Emmaton to Threemile Slough. To understand the impact of maintaining the compliance point at Emmaton under Alternative 4, sensitivity analysis model runs were performed. These are discussed in the assessment of Alternative 4 to contextualize Alternative 4 results.

The western and interior Delta EC objectives are expressed as a 14-day running average, and the southern Delta EC objectives are expressed as a 30-day running average. Compliance with these EC objectives was assessed by calculating 14-day and 30-day running averages of the 15-minute DSM2 EC results and tallying the number of days out of compliance with the applicable objective. The Bay-Delta WQCP considers all days in an averaging period out of compliance, if the objective is exceeded on the last day of the averaging period. Because this could overestimate the general change in EC at compliance locations, the number of days the running average EC objective was exceeded was also assessed to identify general trends in EC changes under the alternatives assessed.

Some of the EC objectives are dependent on water year type. It must be noted that 3 of the 16 water years in the simulation change in the late long term, as compared to Existing Conditions, as a result of climate change. For each year of the DSM2 simulation for each scenario, the water year type that was used to define the objective was the water year type for the time step of interest. Thus, for the late long term scenarios, compliance was based on the objective defined according to the late long term water year types, and for Existing Conditions compliance was based on the objective defined according to the Existing Conditions water year types.

Table 8-46. Applicable State Objectives and Other Relevant Effects Thresholds for Electrical Conductivity (µmhos/cm[at 25°C] unless specified)

Location	Bay-Delta WQCP		Region 5 Basin Plan	Region 2 Basin Plan	Drinking Water MCL
All Receiving Waters Other than the Delta	- -		900 [a, b] 1,600 [a, c] 2,200 [a, d]	200-3,000 [e] 900 [f]	900 [a, b] 1,600 [a, c] 2,200 [a, d]
Delta-Specific	Year Type	Objective [g] for Agricultural Beneficial Uses			
Western Delta–Sacramento River @ Emmaton	W	450 (Apr. 1–Aug. 15)	- -	- -	- -
	AN	450 (Apr. 1–Jun. 30); 630 (Jul. 1–Aug 15)			
	BN	450 (Apr. 1–Jun. 19); 1,140 (Jun. 20–Aug 15)			
	D	450 (Apr. 1–Jun. 14); 1,670 (Jun. 15–Aug 15)			
	C	2,780 (Apr. 1–Aug. 15)			
Western Delta–SJR @ Jersey Point	W	450 (Apr. 1–Aug. 15)	- -	- -	- -
	AN	450 (Apr. 1–Aug. 15)			
	BN	450 (Apr. 1–Jun. 19); 740 (Jun. 20–Aug 15)			
	D	450 (Apr. 1–Jun. 14); 1,350 (Jun. 15–Aug 15)			
	C	2,200 (Apr. 1–Aug. 15)			
Interior Delta–S.F. Mokelumne @ Terminous	W	450 (Apr. 1–Aug. 15)	- -	- -	- -
	AN	450 (Apr. 1–Aug. 15)			
	BN	450 (Apr. 1–Aug. 15)			
	D	450 (Apr. 1–Aug. 15)			
	C	540 (Apr. 1–Aug. 15)			
Interior Delta–SJR @ San Andreas Landing	W	450 (Apr. 1–Aug. 15)	- -	- -	- -
	AN	450 (Apr. 1–Aug. 15)			
	BN	450 (Apr. 1–Aug. 15)			
	D	450 (Apr. 1–Jun. 24); 580 (Jun. 25–Aug 15)			
	C	870 (Apr. 1–Aug. 15)			

Location	Bay-Delta WQCP				Region 5 Basin Plan	Region 2 Basin Plan	Drinking Water MCL
Southern Delta	Objective for Agricultural Beneficial Uses				- -	- -	-
	700 (Apr. 1–Aug. 31)						
	1,000 (Sep. 1–Mar. 31) [h]						
Export Area	Objective for Agricultural Beneficial Uses				- -	- -	- -
	1,000 (Oct. 1–Sep. 30) [i]						
SJR at and between Prisoners Point and Jersey Point	Objective for Fish and Wildlife Beneficial Uses				- -	- -	- -
	440 (Apr. 1–May 31) [j]						
Eastern Suisun Marsh (Sacramento @ Collinsville; Montezuma Slough @ National Steel; Montezuma Slough near Beldon Landing)	Month	Objective [k] for Fish and Wildlife Beneficial Uses			- -	- -	- -
	Oct	19,000					
	Nov–Dec	15,500					
	Jan	12,500					
	Feb–Mar	8,000					
	Apr–May	11,000					
Western Suisun Marsh (Cadbourne Slough @ Sunrise Duck Club, Suisun Slough [300 ft south of Volanti Slough], Cordelia Slough at Ibis Club, Goodyear Slough at Morrow Is. Clubhouse, and water supply intakes for water fowl management areas on Van Sickle and Chipps Is.)	Month	Objective [l]	Month	Objective [m] for Fish and Wildlife Beneficial Uses	- -	- -	- -
	Oct	19,000	Oct	19,000			
	Nov	16,500	Nov	16,500			
	Dec	15,500	Dec–Mar	15,600			
	Jan	12,500	Apr	14,000			
	Feb–Mar	8,000	May	12,500			
	Apr–May	11,000					

Notes for Table 8-46

Notes:

[a] State secondary maximum contaminant level (MCL). No fixed consumer acceptance contaminant level has been established. Municipal water systems must monitor for compliance based on a running average of four quarterly values. The Region 5 Basin Plan incorporates the MCLs by reference, but do not specify an averaging period for assessment of compliance.

[b] Recommended Contaminant Level. Constituent concentrations lower than the recommended contaminant level are desirable for a higher degree of consumer acceptance.

[c] Upper Contaminant Level. Constituent concentrations ranging to the upper contaminant level are acceptable if it is neither reasonable nor feasible to provide more suitable waters.

[d] Short Term Contaminant Level. Constituent concentrations ranging to the short term contaminant level are acceptable only for existing community water systems on a temporary basis pending construction of treatment facilities or development of acceptable new water sources.

[e] Objectives for agricultural water supply specified as a “limit” consisting of a range of concentrations and no averaging period is defined for assessment of compliance.

[f] Objective for municipal supply.

[g] Agricultural objective is a 14-day running average of mean daily EC.

[h] Agricultural objective is a maximum 30-day running average of mean daily EC. Objectives applicable to all southern Delta channels and specified compliance stations (i.e., San Joaquin River @ Airport Way Bridge-Vernalis, San Joaquin River @ Brandt Bridge, Old River near Middle River, and Old River @ Tracy Road Bridge).

[i] Agricultural objective is a maximum monthly average of mean daily EC. Compliance stations are West Canal @ Mouth of Clifton Court Forebay and Delta-Mendota Canal at Tracy Pumping Plant.

[j] Fish and wildlife objective is a maximum 14-day running average of mean daily EC.

[k] Fish and wildlife objectives for Sacramento @ Collinsville, Montezuma Slough @ National Steel, and Montezuma Slough near Beldon Landing. Compliance based on maximum monthly average of both daily high tide EC values, or demonstrate that equivalent of better protection will be provided at the location. Applies in all water year types except during deficiency period.

[l] Fish and wildlife objectives for Cadbourne Slough @ Sunrise Duck Club, Suisun Slough (300 ft south of Volanti Slough), Cordelia Slough at Ibis Club, Goodyear Slough at Morrow Is. Clubhouse, and water supply intakes for water fowl management areas on Van Sickle and Chipps Is. Compliance based on maximum monthly average of both daily high tide EC values, or demonstrate that equivalent of better protection will be provided at the location. Applies in all water year types except during deficiency period.

[m] A deficiency period is: (1) the second consecutive dry water year following a critical year; (2) a dry water year following a year in which the Sacramento River Index (described in footnote e) was less than 11.35; or (3) a critical water year following a dry or critical water year. The determination of a deficiency period is made using the prior year’s final Water Year Type determination and a forecast of the current year’s Water Year Type; and remains in effect until a subsequent water year is other than a Dry or Critical water year as announced on May 31 by DWR and U.S. Bureau of Reclamation (Reclamation) as the final water year determination.

The effects on EC in SWP/CVP Export Service Areas also relied on DSM2 output. For assessment of alternatives involving conveyance of north Delta water to the Banks and Jones pumping plants, DSM2 results for the south Delta pumping plant locations were blended, or mass-balanced, with modeled north Delta diversions to provide an estimate of the EC of the water conveyed by these pumping plants to the SWP/CVP Export Service Areas south of the Delta. The resulting blended monthly mean EC levels were compared to the Bay-Delta WQCP objectives for the export areas, which are the objectives for protection of the agricultural beneficial uses in the south Delta SWP/CVP Export Service Areas.

Assessment of Suisun Marsh EC was conducted qualitatively, utilizing average EC for the entire period modeled (1976–1991) to determine the overall change and degree to which EC could be affected by the alternatives. The Suisun Marsh locations utilized in the analysis correspond to the EC compliance locations in the Bay-Delta WQCP: Sacramento River at Collinsville, Montezuma Slough at National Steel, Montezuma Slough near Beldon Landing, Chadbourne Slough at Sunrise Duck Club, and Suisun Slough 300 feet south of Volanti Slough. These locations represent a geographic range from which to assess changes.

The assessment of Bay-Delta WQCP EC objectives showed exceedances of these objectives at several locations under Existing Conditions, No Action, and BDCP Alternatives. Understanding ~~some basic input assumptions for DSM2~~the uncertainties and limitations in the modeling and assessment approach is important for interpreting the results and effects analysis, including assessment of compliance with water quality objectives. ~~While DSM2 simulates EC on a 15-minute time-step, the Delta inflow and agricultural return flow inputs, and Delta operations (e.g., Delta Cross Channel gate operations) inputs to DSM2 are on a monthly time-step. Because the DSM2 inputs are on a monthly time-step,~~ Please refer to Section 8.3.1.1, *Models Used and Their Linkages*, and Section 8.3.1.3, *Plan Area*, for a description of these limitations. In light of these limitations, the assessment of compliance ~~with sub-monthly objectives (e.g., 14-day running averages)~~ is conducted in terms of assessing the overall direction and degree to which Delta EC would be affected relative to a baseline, and discussion of compliance does not imply that the alternative would literally cause Delta EC to be out of compliance a certain period of time. In other words, the model results are used in a comparative mode, not a predictive mode.

Furthermore, there are several factors related to the modeling approach that may result in modeling artifacts that show objective exceedance, when in reality no such exceedance would occur ~~in reality~~. Sensitivity analyses and further other analyses were performed to evaluate whether exceedances were indeed modeling artifacts or were potential project related impacts that may actually occur. The sensitivity analysis modeling runs were limited to the Existing Conditions, No Action Alternative, and Alternative 4 Scenario H3, but the findings from these analyses can generally be extended to other scenarios of Alternative 4 and the other project alternatives. These analyses included modeling runs investigating the impact of: changing the Emmaton electrical conductivity compliance location to Threemile Slough, monthly-daily patterning at the Delta boundary locations, including the Montezuma Slough Salinity Control Gates under the Alternatives, removing 65,000 acres of Delta restoration (as a means of understanding the contribution to exceedances of restoration vs. CM1), and revising head of Old River Barrier operations during April-May. Additionally, evaluation of individual exceedances at Emmaton was conducted to determine the most likely cause of each exceedance. A complete discussion of the sensitivity analysis modeling runs performed and the results for EC is included in Appendix ~~XX~~8H, Attachment 1.

Nitrate

Applicable nitrate objectives for the affected environment utilized in this assessment are summarized in Table 8-50. The 5 mg/L-N threshold is for irrigation water as recommended by Ayers and Westcot (1994), who recommend a value of 5 mg/L nitrate-N for sensitive crops (e.g., sugar beets, grapes, apricot, citrus, avocado, grains). The concern for these crops is that too much nitrate may cause greater growth than desired, diluting sugars and flavors and thus lowering the value of the crop. However, at levels below 5 mg/L-N, it is assumed that nitrate is beneficial for these crops, and thus increases below the 5 mg/L-N threshold are generally not of concern for agriculture. This 5 mg/L-N Ayers and Westcot (1994) threshold has not been identified as a recommended criterion by U.S. EPA, nor has it been adopted by the state as a water quality objective.

Table 8-50. Applicable Federal Criteria, State Objectives, and other Relevant Effects Thresholds for Nitrate (mg N/L)

	Region 5 Basin Plan	Region 2 Basin Plan[a]	CTR	Drinking Water MCL	USEPA Recommended Criteria	Other Relevant Thresholds[b]
Nitrate-N	--	30 100	--	10	10[c]	5

[a] San Francisco Bay Water Board (2007). 30 mg/L nitrate-N criterion for irrigation water; 100 mg/L nitrate-N criterion for livestock watering.

[b] Ayers and Westcot (1994). Recommended goals for sensitive crops.

[c] For the consumption of water and organisms.

Table 8-51 characterizes nitrate concentrations in source waters to the Delta. Data indicate that the San Joaquin River and agriculture within the Delta contain the highest nitrate concentrations, while concentrations in the Sacramento River, San Francisco Bay, and East Side Tributaries are considerably lower. Both the Sacramento and San Joaquin Rivers exhibit seasonal patterns in nitrate concentration.

Table 8-51. Nitrate Concentrations in the Source Waters to the Delta

Source Water	Sacramento River [a]	San Joaquin River [a]	San Francisco Bay	East Side Tributaries	Agriculture within the Delta [a, b]
Mean (mg/L as N)	0.068–0.209	0.791–1.839	0.07	0.17	0.059–3.833
Minimum (mg/L as N)	0.023–0.113	0.068–1.175	0.026	0.010	0.002–0.339
Maximum (mg/L as N)	0.136–0.553	2.123–3.614	0.12	1.70	0.135–54.644
75th Percentile (mg/L as N)	0.09–0.248	1.017–2.169	0.09	0.16	0.068–4.516
99th Percentile (mg/L as N)	0.122–0.545	1.992–3.479	0.12	0.99	0.133–34.182
Data Source	DWR	DWR	SFEI	USGS	DWR
Station(s)	Sac River at Greene's Landing, Sac River at Hood	SJR at Vernalis	BD40 (Just W. of Carquinez Straight)	Mokelumne River, Cosumnes River	See footnote [b]
Date Range	1997–2008	1990–2009	1993–2001	1961–1993	1990–2001
ND Replaced with RL	No	No	No	No	Yes

Source Water	Sacramento River [a]	San Joaquin River [a]	San Francisco Bay	East Side Tributaries	Agriculture within the Delta [a, b]
Data Omitted	Data prior to 1992 (EPA Method 353.2; poor detection limit)	Two values > 9 mg/L as N	None	Values reported as "0"	None
No. of Data Points	25–33	29–35	25	45	5–81

[a] Values reported as range of monthly values (minimum monthly–maximum monthly). Trends in monthly average nitrate at these locations suggested a seasonality to concentration. Due to the appearance of seasonality in monthly average concentration at these locations, average monthly concentration was used. Tables of these parameters by month are show in the Nitrate Appendix, Appendix 8J.

[b] Values calculated from all agriculture drain data pooled together. All nitrate data from agricultural drains contained in the DWR Water Data Library were placed into a single database. Due to the uneven distribution of agricultural drains in the Delta, geographical trends in agricultural drain water quality were evaluated by categorizing the data based on their associated location in the Delta. Categories included western, southern, northern, eastern, and central Delta, following the geographical delineations of the State Water Resources Control Board. With data pooled and categorized by region, average concentration by region were compared. Average nitrate did not vary greatly between regions. Due to the apparent low regional variability, values were obtained by pooling all data together and obtaining summary statistics from this pooled database.

Nitrate does not behave conservatively in the environment. It can be created via conversion from ammonia to nitrate and can be taken up and metabolized by organisms and sediments. However, because nitrate concentrations vary considerably between the source waters to the Delta, conservative modeling via DSM2 and the mass-balance approach described in section 8.3.1.3 was employed to provide a characterization of changes in nitrate concentration anticipated as a result of changes in source water fractions throughout the Delta alone (using mean concentrations from Table 8-51, above). Addition and loss mechanisms are considered qualitatively in the context of the quantitative mixing results to characterize changes in nitrate concentrations under the alternatives assessed.

As discussed in Section 8.1.3.10, a host of biological and physical factors affect algal species composition and abundance in the Delta. For algal species in general, and Microcystis in particular, the research describing the link between nutrient concentrations/ratios and toxic algal blooms is not conclusive about the type of effect small changes in nutrient levels or nutrient ratios would have on such algal blooms (see also Section ~~[Microcystis background section]~~8.1.3.18). Our ability to model changes in nutrient ratios attributable to the project is limited by a lack of availability of a suitable model. Changes in nitrate levels that can be estimated using conservative mixing models are small enough that predictions of what these changes would mean to the makup of algal communities or to changes in the N:P ratio would be speculative. Further, since the Delta is thought to be light limited and nutrients are in excess relative to algal growth requirements, these types of changes would not be expected to measurably change the quantity or composition of algae in the Delta.

While temperature can affect the rates of creation and loss of nitrate in the affected environment, as discussed above for DO, temperature is not expected to change substantially under the project alternatives, relative to the No Action Alternative. Temperature increases due to climate change, relative to Existing Conditions, are expected to be < 5°F, which is not considered a great enough change to substantially affect nitrate levels.

Phosphorus

An analysis of nutrient loads to the Delta found that phosphorus concentrations showed little inter-seasonal variability between the Sacramento and San Joaquin Rivers (Tetra Tech 2006a). Data gathered for this assessment confirm this finding, and also show that little variability exists between these two rivers and between San Francisco Bay water at Martinez. Current estimates for in-Delta contribution of nutrients from agriculture on the Delta islands are small compared to tributary sources (Tetra Tech 2006a). Table 8-53 summarizes dissolved ortho-phosphate data for source waters to the Delta, and Figure 8-56 shows the seasonal variation in dissolved ortho-phosphate concentrations among the three major source waters. During April through December, ortho-phosphate concentrations from the three major source waters are very similar. During January through March, concentrations in the San Joaquin River at Vernalis are noticeably greater than from the Sacramento River at Hood/Greene's Landing or San Francisco Bay at Martinez. Phosphorus levels in the Sacramento River are not expected to change due to treatment upgrades at SRWTP. This is because SRWTP will implement treatment upgrades that will keep phosphorus levels in their discharge at or below what they are currently.

Table 8-53. Summary of Dissolved Ortho-Phosphate Concentrations (mg/L-P) in Delta Source Waters

Source Water	Sacramento River	San Joaquin River	San Francisco Bay	East Side Tributaries
Mean (mg/L as P)	0.068	0.106	0.092	0.018
Minimum (mg/L as P)	0.010	0.010	0.030	0.010
Maximum (mg/L as P)	0.24	0.45	0.18	0.090
75th Percentile (mg/L as P)	0.090	0.130	0.11	0.020
99th Percentile (mg/L as P)	0.18	0.28	0.17	0.06
Data Source	DWR, BDAT	DWR, BDAT	BDAT	USGS
Station(s)	Sac River at Greene's Landing (BDAT only), Sac River at Hood	SJR at Vernalis	Suisun Bay at Bulls Head near Martinez	Mokelumne River
Date Range	1975–2009	1975–2009	1975–2006	1977–1994
ND Replaced with RL	No	No	No	Yes
Data Omitted	None	None	None	Single value reported as "0"
No. of Data Points	523	502	203	100

Phosphorus does not behave conservatively in the environment. It can be taken up and metabolized by organisms or lost to or supplied by sediment. Because phosphorus concentrations do not vary considerably between the major source waters (as discussed above), phosphorus was assessed qualitatively. While at times phosphorus in the Delta and its source waters can be bound primarily in suspended sediment, we have limited ability to predict changes in total phosphorus concentrations because there are no sediment transport models for the Delta. Because our modeling tools assume dissolved, conservative constituents, we assumed conservative mixing to predict changes in ortho-phosphate concentrations based on the mixing of different water sources. The primary way in which the BDCP alternatives could affect phosphorus levels is by increasing the fraction of San Joaquin River water at point in the Plan Area during January through March. Thus, source water fractions for the San Joaquin River were analyzed for that period to determine if the changes would be expected to substantially affect phosphorus concentrations. As unpredictable as they may be, levels of total phosphorus could be directly influenced by changes in suspended sediment-bound phosphorus. Therefore, changes in phosphorus levels were qualitatively assessed on the basis of changes in TSS and turbidity levels.

As discussed in Section 8.1.3.10, a host of biological and physical factors affect algal species composition and abundance in the Delta. For algal species in general, and Microcystis in particular, the research describing the link between nutrient concentrations/ratios and toxic algal blooms is not conclusive about the type of effect small changes in nutrient levels or nutrient ratios would have on such algal blooms (see also Section 8.1.3.18). Our ability to model changes in nutrient ratios attributable to the project is limited by a lack of availability of a suitable model. Changes in phosphorus levels that can be estimated using conservative mixing models are small enough that predictions of what these changes would mean to the makup of algal communities or to changes in the N:P ratio would be speculative. Further, since the Delta is thought to be light limited and nutrients are in excess relative to algal growth requirements, these types of changes would not be expected to measurably change the quantity or composition of algae in the Delta.

Selenium

Potential impacts may occur from project-related changes to concentrations of selenium in water as well as changes to concentrations in fish tissues (whole-body and fillets) and bird eggs. Bioaccumulation models were developed linking selenium concentrations in water to concentrations in fish tissue and bird eggs, which were estimated for each assessment location and alternative based on the modeled selenium concentration estimates for water from DSM2 (as described in Appendix 8M), and from water to whole-body sturgeon in the western Delta (as described in sturgeon addendum M.A to Appendix 8M). Because of differences in bioaccumulation among water-year types, one model was used for all water years and a modified model was developed for drought years (when bioaccumulation was higher for fish). Detailed results are presented in Appendix 8M and Addendum sturgeon addendum M.A to Appendix 8M.

Applicable selenium objectives for water in the affected environment are summarized in Table 8-54, and selected benchmarks for assessment of selenium in whole-body fish, bird eggs, and fish fillets are presented in Table 8-55.

Table 8-54. Applicable Federal Criteria, State Standards/Objectives, and Other Relevant Effects Thresholds for Selenium

	Region 5 Basin Plan[a]	Region 2 Basin Plan[b]	CTR[c]	Drinking Water MCL[d]	USEPA Recommended Criteria[e]	Other Relevant Thresholds[f]
Selenium (µg/L)	5/12	5/20	5/20	50	5/variable 1.3	2

[a] Objectives apply to the lower San Joaquin River from the mouth of the Merced River to Vernalis as 5 µg/L (4-day average) and 12 µg/L (maximum concentration) total selenium concentration (Central Valley Water Board 2009a).

[b] Selenium criteria were promulgated as total recoverable concentrations for all San Francisco Bay/Delta waters in the National Toxics Rule (NTR) (U.S. Environmental Protection Agency 1992; San Francisco Bay Water Board 2007).

[c] Standard is Criterion Continuous Concentration as 5 µg/L total recoverable selenium; California Toxics Rule (CTR) deferred to the NTR for San Francisco Bay/Delta waters and San Joaquin River (U.S. Environmental Protection Agency 2000).

[d] Maximum Contaminant Level. In addition, the California Office of Environmental Health Hazard Assessment (OEHHA 2010) has recommended a Public Health Goal of 30 µg/L.

[e] Adopted Criteria for protection of freshwater aquatic life are 5 µg/L (continuous concentration, 4-day average) total recoverable selenium and they vary for the Criterion Maximum Concentration (CMC; 24-hour average) (U.S. Environmental Protection Agency 2012b). The CMC = 1/[(f1/CMC1) + (f2/CMC2)] where f1 and f2 are the fractions of total selenium that are treated as selenite and selenate, respectively. Draft Criterion for water concentrations in lentic systems 1.3 µg/L (USEPA2014).

[f] Concentration as total recoverable selenium identified as a Level of Concern for the Grassland Bypass Project (Beckon et al. 2008).

Table 8-55. Selected Benchmarks for Assessment of Selenium in Whole-body Fish, Bird Eggs, and Fish Fillets

	Whole-Body Fish[a]		Bird Eggs[a]		
	Low[c]	High[d]	Low[e]	High[f]	Fish Fillets[b]
Selenium	4	~~9~~8.1	6	10	2.5

[a] mg/kg, dry-weight basis.

[b] mg/kg, wet-weight basis; Advisory Tissue Level (OEHHA 2008).

[c] Level of Concern for whole-body fish (lower end of range) (Beckon et al. 2008). For sturgeon the low benchmark was 5 mg/kg, dry weight (Presser and Luoma 2013).

[d] Toxicity Level for whole-body fish (~~Beckon et al. 2008~~USEPA 2014). For sturgeon the high benchmark was 8 mg/kg, dry weight (Presser and Luoma 2013).

[e] Level of Concern for bird eggs (lower end of range) (Beckon et al. 2008).

[f] Toxicity Level for bird eggs (Beckon et al. 2008).

The State Water Board lists the western Delta as having impaired water quality for selenium and several other constituents under Clean Water Act Section 303(d) (State Water Resources Control Board 2011). The Central Valley Water Board completed a TMDL for selenium in the lower San Joaquin River (downstream of the Merced River) in 2001, and USEPA approved this in 2002 (Central Valley Water Board 2001, 2009d). Historical selenium concentrations in source waters to the Delta are shown in Table 8-56. DSM2 modeling for other constituents considered five sources of water to the Delta, as described in Section 8.3.1.3. However, for selenium, the Sacramento River mean concentration upstream of the American River (as measured b~~at~~ elow Knights Landing, upstream of the Yolo Bypass) was somewhat higher than that at Freeport (representing the main flow of the river to the Delta). Consequently, the value for Knights Landing was used as the input through the Yolo Bypass and the value for Freeport was used to represent the main flow of the Sacramento River to the Delta.

Table 8-56. Historical Selenium Concentrations in the Six Delta Source Waters for the Period 1996–2014~~0~~

Source Water	Sacramento River[a]	San Joaquin River[b]	San Francisco Bay[a]	East Side Tributaries[c]	Agriculture within the Delta[a]	Yolo Bypass[d]
Mean (µg/L)[e]	0.~~32~~09	0.~~45~~84	0.~~09~~10	0.10	0.11	0.~~45~~23
Minimum (µg/L)	0.04	0.~~40~~07	0.~~03~~06	0.10	0.11	0.19
Maximum (µg/L)	0~~1~~.23~~00~~	1.5~~2.8~~0	0.45	0.10	0.11	~~1.05~~0.30
75th percentile (µg/L)	~~1~~0.11~~00~~	~~1.20~~0.76	0.12~~1~~	0.10	0.11	0.~~65~~29
99th percentile (µg/L)	~~1.00~~0.23	~~2.60~~1.50	0.44~~1~~	0.10	0.11	~~1.04~~0.30
Data Source	USGS ~~2010~~2014	USGS 2014~~SWAMP 2009~~	SFEI ~~2010~~2014	None	Lucas and Stewart 2007	DWR 2009b
Station(s)	Sacramento River at Freeport	San Joaquin River at Vernalis ~~(Airport Way)~~	Central-West; San Joaquin River near Mallard Is. (BG30)	None	Mildred Island, Center	Sacramento River ~~at~~ below Knights Landing
Date Range	11/2007-7/2014~~1996–2001, 2007–2010~~	11/2007-8/2014~~1999–2007~~	2/2000–8/~~2008~~2013	None	2000	~~2003,~~ 2004, 2007, 2008
ND Replaced with RL	Not applicable~~Yes~~	Not applicable~~Yes~~	~~Yes~~No	Not applicable	No	Yes
Data Omitted	None	~~Pending Data~~None	None	Not applicable	None	None
No. of Data Points	~~62~~88	~~45~~293	~~11~~14	None	1	~~13~~5

[a] Dissolved selenium concentration.

[b] Not specified whether total or dissolved selenium.

[c] Dissolved selenium concentration in Mokelumne, Calaveras, and Cosumnes rivers are assumed to be 0.1 µg/L due to lack of available data and lack of sources that would be expected to result in concentrations greater than 0.1 µg/L.

[d] Total selenium concentration.

[e] Means are geometric means.

SFEI = San Francisco Estuary Institute

SWAMP = Surface Water Ambient Monitoring Program

Largemouth bass collected from sites near the source locations or within the Delta in 2000, 2005, and 2007 were analyzed for selenium (Foe 2010). Measured selenium concentrations in those fish and modeled selenium concentrations in whole-body fish at three source water locations are presented in Table 8-57. Selenium concentrations in fish fillets, whole-body fish, and bird eggs at assessment locations in the Delta were estimated using models described in Appendix 8M. ~~Additional modeling for selenium bioaccumulation in whole-body sturgeon was conducted for the two western-most locations in the Delta as described in sturgeon addendum M.A to Appendix 8M.~~

Table 8-57. Measured and Modeled Selenium Concentrations (mg/kg, dry-weight basis) in Whole-body Fish at or Near Source Water Locations to the Delta

	Sacramento River[a]		San Joaquin River[b]		Suisun Bay[c]	
Year	Measured	Modeled	Measured	Modeled	Measured	Modeled
2000	2.6	1.5~~4~~[d]	1.7	1.9~~8~~[e]	No Data	1~~0~~.5~~9~~[~~d~~f]
2005	1.5	1.5~~4~~[d]	1.9	1.9~~8~~[e]	No Data	1.6~~0~~[~~d~~f]
2007~~[g]~~	1.8	2.5~~3~~[~~f~~g]	2.4	2.~~4~~[~~g~~]4[h]	No Data	2~~1~~.5~~2~~[~~f~~i]

[a] Sacramento River Mile (RM) 44.

[b] Vernalis.

[c] Montezuma Slough near Grizzly Bay; bass were not sampled near here, so modeled values are for the nearest location where bass were sampled (Big Break), for which the waterborne selenium concentration (0.10 µg/L) was the same as that for the San Joaquin River at Mallard Island.

[d] Concentration of selenium estimated from Model ~~8~~4: Trophic level 4 (TL-4) fish eating TL-3 fish, using K_d = ~~1760~~4909 to 4997 (varying by year and quarter in 2000 [4910 to 4997] and 2005 [4909 to 4910]), $TTF_{invertebrate}$ = 2.~~1~~8, and TTF_{fish} = 1.1.

[e] Concentration of selenium estimated from Model ~~8a~~4: Trophic level 4 (TL-4) fish eating TL-3 fish, using K_d = ~~850~~665 in 2000 and 651 in 2005, $TTF_{invertebrate}$ = 2.~~1~~8, and TTF_{fish} = 1.1.

[f] Concentration of selenium estimated from Model ~~9~~4: Trophic level 4 (TL-4) fish eating TL-3 fish, using K_d = 1683 to 4804 (varying by year and quarter in 2000 [2441 to 4593] and 2005 [1683 to 4804])~~2840~~, $TTF_{invertebrate}$ = 2.~~1~~8, and TTF_{fish} = 1.1.

[g] Concentration of selenium estimated from Model ~~9a~~5: Trophic level 4 (TL-4) fish eating TL-3 fish, using K_d = ~~11308~~8061 to 8064 (varying by quarter), $TTF_{invertebrate}$ = 2.~~1~~8, and TTF_{fish} = 1.1.

[h] Concentration of selenium estimated from Model 5: Trophic level 4 (TL-4) fish eating TL-3 fish, using K_d = 1206, $TTF_{invertebrate}$ = 2.8, and TTF_{fish} = 1.1.

[i] Concentration of selenium estimated from Model 5: Trophic level 4 (TL-4) fish eating TL-3 fish, using K_d = 6220 to 7926 (varying by quarter), $TTF_{invertebrate}$ = 2.8, and TTF_{fish} = 1.1.

K_d = particulate/water ratio.

TTF_{fish} = trophic transfer factor from diet to fish.

$TTF_{invertebrate}$ = trophic transfer factor from particulate to invertebrate.

Trace Metals

Water quality criteria used in the assessment of trace metals are presented in Table 8-~~51~~58. The CTR criteria for cadmium, chromium (III), copper, lead, nickel, silver, and zinc are promulgated as equations that contain three adjustments: 1) the water-effect ratio (WER), 2) the conversion factor (CF) from total to dissolved fraction, and 3) hardness (freshwater criteria only), which are used to adjust the criteria based on site-specific water quality conditions in order to provide the level of protection intended by U.S. EPA. Table8-~~52~~ 59presents hardness adjusted CTR criteria for the primary Delta source waters, including the Sacramento and San Joaquin Rivers. Criteria were calculated based on each source waters average and 5th percentile hardness (See Appendix 8N, *Trace Metals*, for hardness data). Due to lower average and 5th percentile hardness on the Sacramento River, calculated hardness-based metals aquatic life criteria are lowest on the Sacramento River.

The quality of water representative of the Bay source water fraction is highly seasonal, with conditions ranging between freshwater and saltwater conditions. In such a case, CTR metals criteria guidance states that the more stringent of the freshwater or saltwater criteria is to be used. Comparing saltwater criteria listed in Table 8-58 to freshwater criteria in Table 8-59, saltwater criteria for copper and nickel are more stringent than the corresponding hardness-based freshwater criteria.

Table 8-58. Water Quality Criteria and Objectives for Trace Metals (µg/L)

	Freshwater		Saltwater		Human Health		Region 5	California
Metal	Acute[a]	Chronic[a]	Acute[a]	Chronic[a]	Water & Organisms	Organisms Only	Basin Plan	Drinking Water MCLs[e]
Aluminum	87[f]	750[f]	n/a	n/a	n/a	n/a	n/a	200
Arsenic	340	150	69	36	n/a	n/a	10[b]	10
Cadmium	4.3/3.9[c]	2.2/1.1[c]	42	9.3	n/a	n/a	0.22[d]	5
Chromium (III)	550	180	n/a	n/a	n/a	n/a	n/a	50
Copper	13	9	4.8	3.1	1,300	n/a	5.6[d]/10[b]	1,000
Iron	n/a	1,000[f]	n/a	n/a	n/a	n/a	300[b]	300
Lead	65	2.5	210	8.1	n/a	n/a	n/a	15
Manganese	n/a	n/a	n/a	n/a	n/a	n/a	50[b]	50
Nickel	470	52	74	8.2	610	4,600	n/a	100
Silver	3.4	n/a	1.9	n/a	n/a	n/a	10[b]	100
Zinc	120	120	90	81	n/a	n/a	100[b]/16[d]	5,000

All values in micrograms per liter (µg/L) and expressed as dissolved metal, unless otherwise noted.
n/a = non-applicable.
[a] Values represent both CTR/NTR criteria and criteria contained within the Region 2 Basin Plan. Acute values are applicable to short periods of time, generally defined as 1-houraverage concentrations. Chronic values are defined as 4-day average concentrations. For metals whose CTR criteria allow for adjustments based on WER, CF, and hardness, values in the table assume a default WER of 1.0, default CFs contained within the CTR, and a default hardness of 100 mg/L (as $CaCO_3$).
[b] Applies at the following locations: Sacramento River from Keswick Dam to the I Street Bridge at City of Sacramento; American River from Folsom Dam to the Sacramento River; Folsom Lake; and the Sacramento-San Joaquin Delta.
[c] First value is the CTR cadmium criterion, second value is Region 2 Basin Plan criterion.
[d] Applies to the Sacramento River and its tributaries above State Hwy 32 bridge at Hamilton City.
[e] Expressed as total recoverable metal.
[f] EPA 304(a) national recommended criteria.

Metals differ in their physical and chemical parameters and thus in their fate, transport, and bioavailability in the aquatic environments. Throughout the trace metals assessment dissolved metals concentrations are utilized, because the dissolved fraction better approximates the bioavailable fraction to aquatic organisms. Furthermore, drinking water treatment plants readily remove particulate and suspended matter from raw water. While maximum contaminant levels for treated drinking water are measured on a total recoverable basis, the dissolved fraction of these metals is taken as the more accurate predictor of metals concentration post-treatment. This is particularly the case with aluminum, iron, and manganese which are ~~both~~ naturally abundant in soil. Total recoverable aluminum, iron, and manganese concentrations can be very high in water carrying a substantial load of suspended matter (i.e., TSS). Therefore, assessment of aquatic life and drinking water effects utilizes the dissolved fraction of trace metals in the environment.

Table 8-59. Hardness-Based Dissolved Freshwater Aquatic Life Criteria by Primary Source Water (µg/L)

	Criteria for Sacramento Source Water Based on 5th Percentile Hardness		Criteria for Sacramento Source Water Based on Average Hardness	
Metal	Acute	Chronic	Acute	Chronic
Cadmium	0.81	0.128	1.19	0.168
Copper	5.53	4.006	8.04	5.623
Chromium (III)	263.50	34.276	364.71	47.441
Lead	22.86	0.891	35.52	1.384
Nickel	211.11	23.448	295.34	32.803
Silver	0.64	--	1.26	--
Zinc	52.77	53.199	73.86	74.464
	Criteria for San Joaquin Source Water Based on 5th Percentile Hardness		Criteria for San Joaquin Source Water Based on Average Hardness	
Metal	Acute	Chronic	Acute	Chronic
Cadmium	1.13	0.162	2.93	0.321
Copper	7.65	5.373	19.32	12.447
Chromium (III)	349.18	45.421	781.14	101.610
Lead	33.49	1.305	97.98	3.818
Nickel	282.37	31.362	648.66	72.046
Silver	1.15	-	6.24	--
Zinc	70.61	71.187	162.41	163.742
	Criteria for Bay Source Water Based on 5th Percentile Hardness		Criteria for Bay Source Water Based on Average Hardness	
Metal	Acute	Chronic	Acute	Chronic
Cadmium	1.11	0.160	13.98	0.981
Copper	7.52	5.290	88.25	49.357
Chromium (III)	343.97	44.744	2925.17	380.504
Lead	32.82	1.279	518.97	20.224
Nickel	278.02	30.879	2537.13	281.796
Silver	1.11	--	99.88	--
Zinc	69.52	70.089	636.59	641.798

Criteria calculated based on each source waters average and 5th percentile hardness.

Research has shown that elevated copper levels in water bodies are of concern for disruption of olfactory cues in salmonids when migrating to their natal streams to spawn, which can lead to increased straying. However, the U.S. EPA-developed biotic ligand model (BLM)-based copper criteria have been shown to always be protective of these concerns (Meyer and Adams 2010: 2096). Because of this, BLM-based copper criteria were derived for the Sacramento and San Joaquin Rivers, as shown in Table 8-60. The BLM criteria account for the aggregate effect of several different water quality parameters on copper toxicity in addition to hardness (e.g., dissolved organic carbon, pH, and various salt concentrations), with the protective criterion being sensitive to DOC concentrations in water. When calculated based on the average of all necessary parameters and the 5th percentile DOC, copper BLM-based criteria were higher (i.e., less sensitive) than the corresponding non WER-adjusted copper criteria presented in Table 8-59. Therefore, the calculated hardness-based CTR copper criteria are found to be adequately protective of fish olfaction.

Table 8-60. BLM-Based Criteria For Dissolved Copper (µg/L)

Sacramento	CMC	CCC
Average of all BLM parameters	10.9299	6.7888
5th Percentile DOC; Average of remaining parameter	6.9774	4.3338
San Joaquin	CMC	CCC
Average of all BLM parameters	15.9659	9.9167
5th Percentile DOC; Average of remaining parameter	10.0879	6.2658

There is currently no single program or effort for the coordinated and comprehensive measurement of trace metals in the Delta and its primary source waters. Moreover, analytical techniques for trace metals measurement have improved considerably over time, often resulting in substantially lower detection limits and at time showing earlier techniques to be prone to analytical error. Nevertheless, local monitoring efforts such as the San Francisco Bay Regional Monitoring Program (RMP) and the Sacramento Coordinated Regional Monitoring Program have collected trace metals on the Sacramento River and the San Francisco Bay for more than a decade, resulting in an adequate long-term characterization of these waters. Unfortunately, there has been no equivalent effort on the San Joaquin River, east-side tributaries, or within the Delta itself. This imbalance in available data limits the effects assessment approach. Effects are qualitatively assessed.

Summaries of trace metals data compiled for this qualitative assessment are provided in Appendix 8N, *Trace Metals*. Data of sufficient quality were available for the Bay, Sacramento River and San Joaquin River source waters, although data for the San Joaquin are very few. These data used to inform the qualitative assessment on trace metal effects upstream of the Delta, within the Delta, and the SWP and CVP service areas. Due to the relatively short exposure durations related to aquatic life acute and chronic effects, long-term trace metals effects are evaluated on a 95th percentile concentration basis. Due to the relatively long exposure durations related to drinking water effects, long-term trace metals effects are evaluated on an average concentration basis.

Microcystis

The conceptual model for evaluating effects of the project alternative on *Microcystis* includes consideration of abiotic factors considered to be the primary drivers of seasonal and inter-annual *Microcystis* abundance in the Delta. These factors include water temperature, residence time, nutrients, and water clarity.

Regarding nutrients, as mentioned above, the maintenance of *Microcystis* blooms in the Delta requires the availability of the nitrogen and phosphorus. However, the body of science produced by scientists studying *Microcystis* blooms in the Delta and elsewhere does not indicate that the specific levels of these nutrients, or their ratio, currently control the seasonal or inter-annual variation in the bloom. A large fraction of ammonia in the Sacramento River will be removed due to planned upgrades to the Sacramento Regional County Sanitation District's Sacramento Regional Wastewater Treatment Plant (SRWTP) which will result in >~~99~~95% removal of ammonia from the effluent discharge from this facility. Following the SRWTP upgrades, levels of ammonia in Sacramento River are expected to be similar to background ammonia concentrations in the San Joaquin River and San

Francisco Bay (See Section 8.3.3.1, Impact WQ-1). The response of *Microcystis* production in the Delta to the substantial reduction in river ammonia levels (from removing ammonia from the SRWTP discharge) is unknown because nitrate and phosphorus levels in the Delta will remain well above thresholds that would limit *Microcystis* blooms. To the extent that current levels of *Microcystis* production are dependent on the exclusive uptake of ammonia, the frequency, magnitude, and geographic extent of *Microcystis* blooms in the Delta may decrease, but it is not known whether or to what extent this will happen.

Nutrient ratios in excess of the Redfield N:P ratio of 16 have also been hypothesized to favor *Microcystis* growth in the Delta (Glibert et al. 2011). However, considerable doubt has been cast on this hypothesis because median N:P molar ratios in the Delta during peak bloom periods are usually near or a little lower than the Redfield ratio of 16 needed for optimum phytoplankton growth, and when ammonia is considered the sole N source, the N:P ratio drops substantially to a median of 1.31:1 (Lehman et al. 2013). Based on this information, there is no evidence as to what type of effect small changes in nutrient concentrations and ratios would have on *Microcystis* blooms, given that such blooms are largely influenced by a host of other physical factors including water temperature and water residence time within channels.

High water clarity is also considered a pre-requisite for *Microcystis* bloom formation (Lehman et al. 2013). As described under WQ-29 (Effects on TSS and Turbidity from CM1), changes in TSS and turbidity levels within the Delta under the project alternatives could not be quantified, but are expected to be similar under the project alternatives to Existing Conditions and the No Action Alternative. Minimal changes in water clarity would result in minimal changes in light availability for *Microcystis* under the project Alternatives. As such, the project alternatives' influence on *Microcystis* production in the Delta, as influenced by the project alternatives' effects on Delta water clarity, is considered to be negligible.

Based on the above, nutrient and water clarity effects on *Microcystis* were determined to not have substantial effects on *Microcystis* abundance under the project alternatives, relative to Existing Conditions and the No Action Alternative. A qualitative evaluation was performed to determine if the action alternatives would result in an increase in frequency, magnitude, and geographic extent of *Microcystis* blooms in the Delta based on the following two additional abiotic factors that may affect *Microcystis*~~.~~: 1) c

~~C~~changes to water operations and creation of tidal and floodplain restoration areas that change water residence times within Delta channels, and 2) ~~I~~increases in Delta water temperatures.

The methodology used to determine residence time is described in the Draft BDCP, Appendix 5C, Section 5C.4.4.7, *Residence Time*. Briefly, residence time in different subregions of the Plan Area was assessed using the results of the DSM2 Particle Tracking Model for multiple neutrally buoyant particle release locations. Residence time was defined as the time at which 50% of particles from a given release location exited the Plan Area (either by movement downstream past Martinez or through entrainment at the south Delta export facilities, north Delta diversion, North Bay Aqueduct, of agricultural diversions in the Delta). The data were reduced into mean residence time by subregion and season. The data do not represent the length of time that water in the various subregions spends in the Delta in total, but do provide a useful parameter with which to compare generally how long algae would have to grow in the various subregions of the Delta. Table 8-60a shows the residence time results that are used in the Microcystis assessments. Results for summer and fall are most relevant for the Microcystis assessment, but all seasons are presented for completeness.

Table 8-60a. Average Residence Time for Subregions of the Plan Area by Season and Alternative

		Average Residence Time (days)										
Subregion	Season	Ex Cond.	No Act.	Alt 1	Alt 2	Alt 3	Alt 4 Scn H3	Alt 5	Alt 6	Alt 7	Alt 8	Alt 9
North Delta	Summer	33	38	43	38	41	39	41	43	40	46	40
	Fall	49	50	61	56	60	57	55	55	57	58	55
	Winter	36	37	40	40	40	39	41	37	37	37	40
	Spring	30	33	37	35	36	35	36	34	34	29	35
	Overall	35	38	43	41	43	41	41	40	40	40	41
Cache Slough	Summer	18	21	46	40	45	39	39	49	46	59	46
	Fall	46	46	44	39	43	40	39	39	45	56	39
	Winter	29	31	33	32	33	32	33	28	29	27	31
	Spring	22	24	33	33	33	33	33	31	30	33	31
	Overall	27	29	38	36	38	35	36	36	36	42	36
West Delta	Summer	22	24	32	28	30	28	29	40	27	33	28
	Fall	25	27	34	30	33	30	30	30	31	32	27
	Winter	18	20	21	21	21	21	21	19	19	19	19
	Spring	18	20	24	22	24	22	23	20	20	17	20
	Overall	20	22	27	25	26	25	25	27	23	24	23
East Delta	Summer	22	26	40	34	35	34	31	76	32	48	21
	Fall	15	35	33	47	32	48	48	58	55	55	21
	Winter	28	32	40	42	40	42	40	50	51	50	26
	Spring	42	47	57	54	59	54	56	61	57	54	35
	Overall	29	36	45	45	44	45	44	61	49	52	27
South Delta	Summer	8	10	16	17	14	16	11	70	23	33	35
	Fall	5	11	8	42	8	43	34	79	53	52	33
	Winter	10	11	19	19	14	16	15	59	57	56	28
	Spring	25	26	24	29	20	28	27	65	60	58	31
	Overall	13	16	18	26	15	25	21	67	49	50	32
Suisun Marsh	Summer	51	58	38	35	37	35	36	37	36	39	42
	Fall	17	19	39	34	38	34	33	32	34	34	38
	Winter	9	9	28	28	29	27	29	24	24	24	32
	Spring	45	51	32	31	31	30	30	29	28	25	33
	Overall	33	37	33	32	33	31	32	30	30	30	36

8.3.1.8 San Francisco Bay

The western seaward boundary of the Plan Area for the BDCP has been delineated at Carquinez Strait. There are no actions proposed to occur in the bays seaward of the Plan Area. Nevertheless, because a portion of Delta waters does flow seaward, an assessment of the effects of Delta water quality changes under the project alternatives on the San Francisco Bay water quality was conducted to identify potential effects in the Bay. The assessment addresses potential direct and indirect effects on water quality of areas seaward of the Delta, based on the best available scientific understanding. No hydrologic or hydrodynamic modeling was conducted seaward of Suisun Bay.

Because net Delta flows move seaward, water quality constituents present in the Delta water column could potentially be transported seaward. The Screening Analysis (see Sections 8.3.1.3, 8.3.2.1, and Appendix 8C) identified constituents present in Delta waters warranting detailed assessment in the Plan Area based on their historical concentrations in the water column or importance to beneficial uses of Delta waters. These same constituents were addressed in the assessment of effects on San Francisco Bay. The assessment of effects in San Francisco Bay was based on projected changes in constituent concentration/levels that would occur in the Delta and changes in Delta outflow under the project alternatives. The following sections describe constituent-specific considerations and methods for calculating changes in Delta loading that are common to the assessment of all project alternatives in the San Francisco Bay for nutrients (ammonia, nitrate, and phosphorus), mercury, and selenium.

Nutrients: Ammonia, Nitrate, Phosphorus

Constituent-specific Considerations

Nutrients in freshwater outflows from the Delta have the potential to impact the embayments that make up the San Francisco Bay, although oceanic flows in and out of the Golden Gate mute the influence of Delta-derived freshwater flows on the Central Bay, South Bay, and Lower South Bay (Senn and Novick 2013). Thus, nutrients effects to San Francisco Bay from changes in Delta outflow would be limited almost entirely to the northern part of San Francisco Bay, namely San Pablo Bay. The assessment specifically addresses effects on San Pablo Bay, but relies on research conducted in Suisun Bay, because very little research specific to San Pablo Bay has been conducted and because San Pablo Bay and Suisun Bay experience similar nutrient loading. Existing effects from nutrients on San Pablo Bay and Suisun Bay have been hypothesized, yet widespread impairment due to nutrients in these embayments is not thought to be occurring (Senn and Novick 2013).

Suisun Bay is currently characterized by levels of phytoplankton biomass and a community composition insufficient to support the pelagic food web. The highly altered phytoplankton community and low biomass levels are thought to be linked primarily to the invasive clam Corubula amurensis, which was established in Suisun Bay in 1987, and grazing by other aquatic macroinvertebrates, specifically zooplankton (Kimmerer and Thompson 2014). Notwithstanding, Dugdale et al. (2007; 2012) has argued that nitrate is preferred by and fuels blooms of diatoms, and that uptake of nitrate by diatoms is impaired until ammonia levels are depleted below 0.03–0.06 mg/L-N. The onset of diatom blooms in Suisun Bay, and to a lesser extent San Pablo Bay, has been attributed to the drawdown of ammonia levels in these embayments. Ammonia levels are infrequently lower than this threshold. Currently, there is a lack of experimental results substantiating the ammonia-inhibition hypothesis and conflicting mechanistic interpretations of the available studies (Senn and Novick 2013; Senn and Novick 2014).

Other research has hypothesized that a high N:P ratio in the Delta and Suisun Bay has caused a transition away from a diatom-based food web, resulting in a cascading effect on higher trophic levels compared to conditions prior to the onset of phytoplankton biomass and community composition changes which occurred around 1986 (Glibert et al. 2011). As some have indicated, the introduction of C. amurensis is likely to have caused these alternations in phytoplankton biomass and composition (Senn and Novick 2014). The influence of a high N:P ratio on changes in chlorophyll levels and phytoplankton composition in Suisun Bay or downstream embayments receiving freshwater from the Delta cannot be ruled out, nor the magnitude of its effect determined. Nonetheless, these effects are likely to be small compared to the obvious and documented effects of the introductions of clams and copepods, which cannot reasonably be linked to nutrient conditions in the estuary (Senn and Novick 2014; Kimmerer and Thompson 2014).

Harmful algal blooms are considered a stressor of Suisun Bay. Summer-fall blooms of Microcystis aeruginosa have occurred with increasing frequency and intensity in the Delta and Suisun Bay since 2000. While blooms of Microcystis have not been documented in embayments downstream of Suisun Bay, the toxin produced by some Microcystis strains, microcystin, was detected in pilot monitoring measurements throughout the low salinity zone and in the central and southern embayments of San Francisco Bay (Senn and Novick 2014). In the San Francisco Estuary, nutrient levels are not considered a primary driver Microcystis bloom formation (Lehman et al. 2013), however there is evidence that Microcystis tends to prefer an ammonia nitrogen source compared to other forms of nitrogen (Senn and Novick 2014).

Load Estimates

Effects of the project alternatives on nutrient loads to Suisun Bay and San Pablo Bay were determined by estimating the percent change in phosphorus and nitrogen loads in Delta outflow due to the alternative. Because the project alternatives would not change net outflows between the upstream entrance of Suisun Bay (Mallard Island) and San Pablo Bay (Martinez or Carquinez Strait), nor would there be substantial changes in nutrient loading within Suisun Bay, estimated changes in loading to Suisun Bay were used as an approximation for the change in nutrient loading to San Pablo Bay. Changes in Delta-related nitrogen and phosphorus loads to Suisun Bay and San Pablo Bay were thus assumed to be proportional to the estimated change in loads in Delta outflow.

For nitrogen loads, changes of nitrate and ammonia loads at Mallard Island were estimated differently for Existing Conditions than for the project alternatives, due to differing assumptions regarding nitrogen loads from the SRWTP, the largest point source of nitrogen to the Delta. Loadings were estimated in the following manner.

Ammonia:

- Existing Conditions: The ammonia-nitrogen load was assumed to be equivalent to the current average ammonia load discharged from SRWTP (28.7 mg/L-N at 141 MGD; EchoWater FEIR 2014) plus the ammonia load of the Delta tributaries unaffected by the SRWTP discharge, calculated from the long-term average ambient ammonia concentration (0.04 mg/L-N; Central Valley Water Board 2010a:5) and the Delta outflow (provided in Appendix 5A, Section C.7).
- Project Alternative: Ammonia-nitrogen loads at Mallard Island were calculated from the long-term annual ammonia concentration downstream of the SRWTP calculated in the Impact WQ-1 and the long-term average net Delta outflow (provided in Appendix 5A, Section C.7).

Nitrate:

- Existing Conditions: The estimated nitrate-nitrogen load was based on the modeled long-term annual average nitrate concentration at Mallard Island (as shown in Appendix 8J) and the long term average net Delta outflow. The SRWTP contribution was not factored separately as it was for ammonia, because nitrate levels under Existing Conditions are below analytical detection levels in SRWTP effluent.
- Project Alternative: Nitrate-nitrogen loads were calculated as the sum of the nitrate load from modeled long-term annual average nitrate concentration at Mallard Island (which does not account for an increase in SRWTP effluent nitrate) and the average net Delta outflow, and nitrate load due to an increase in nitrate discharged from SRWTP (6.7 mg/L-N at 181 mgd; EchoWater FEIR 2014).

These mass-balance calculations assume that transformation and loss of nitrogen species within the Delta are negligible.

Phosphorus loads under the project alternatives could be altered by two factors: 1) change in the source water fraction, and thus phosphorus concentration, of outflows from the Delta; and 2) an increase or decrease in Delta outflow. The major source waters to the Delta—San Joaquin River, Sacramento River, and San Francisco Bay—have similar dissolved phosphorus concentrations for the months April through October (Figure 8-56), but during December through March, higher dissolved phosphorus concentrations occur in the San Joaquin River compared to the Sacramento River and San Francisco Bay. Under the project alternatives, changes in the fraction of San Joaquin River water in the Delta outflow during December through March are projected. Considering the dissolved phosphorus concentrations of these sources, mass balance calculations show that for the relative change in source water fractions at Mallard Island, the magnitude of change in the dissolved phosphorus concentration of Delta outflows during these months would be negligible (<0.01 mg/L-P). Therefore, the relative change in phosphorus load in Delta outflow was considered to be proportional to the change in net Delta outflow.

Mercury

Constituent-specific Considerations

San Francisco Bay is impaired because mercury contamination is adversely affecting existing beneficial uses, including sport fishing, preservation of rare and endangered species, and wildlife habitat (SFBRWQCB 2013). Mercury concentrations in San Francisco Bay fish are high enough to threaten the health of humans who consume them, while concentrations in some bird eggs harvested from the shores of San Francisco Bay are high enough to account for abnormally high rates of eggs failing to hatch (SFBRWQCB 2013). Because of these concerns, a mercury TMDL was approved for San Francisco Bay in 2007. Beneficial uses of the Delta are similarly impaired due to methylmercury, and the Central Valley Water Board adopted the Delta Methylmercury TMDL in 2011 to address the impairment. The geographic scope of the San Francisco Bay TMDL includes Suisun Bay, San Pablo Bay, Central Bay, South Bay, and Lower South Bay. The assessment addresses the effects of the project alternatives on mercury and methylmercury loads from the Delta to San Francisco Bay downstream of Suisun Bay.

The bioavailability and toxicity of elemental mercury (from whatever primary source) are greatly enhanced through the natural, bacterial conversion of mercury to methylmercury in marshlands, wetlands or bottom sediments. The dominant source of methylmercury that enters the aquatic food web of San Francisco Bay is the internal net production of methylmercury bay sediments (Davis et al. 2012). Historically, millions of pounds of inorganic mercury were used in gold mining operations within the San Francisco Bay watershed, and a large fraction of this mercury was washed downstream and accumulated in Bay sediment. The large pool of inorganic mercury currently contained in Bay sediments dominates the fraction converted to methylmercury and that accumulating the Bay's aquatic food web.

Exports from the Delta represent a sizable source of the overall mercury load to San Francisco Bay. The San Francisco Bay Mercury TMDL estimated that the Delta exported mercury at a rate of 440 kg/year to the Bay based on data from 2003 (SFBRWQCB 2006). David et al. (2009) estimated the Delta's mercury export as 260 kg/year based on sediment, flow, and mercury data from 1995 through 2006. The later estimation is recognized as the most reliable calculation of mercury exported from the Delta to date (SFBRWQCB 2006). Other sources contribute approximately 782 kg/year of mercury to San Francisco Bay, and include bed erosion, urban stormwater runoff, wastewater discharges, runoff from the Guadalupe River watershed and direct deposition (SFBRWQCB 2006).

Methylmercury loading to the waters of San Francisco Bay is estimated to be approximately 69 kg/year and is dominated by internal loading of methylmercury from Bay sediments (45 kg/year). External inputs also account for 22 kg/year of methylmercury loaded to the Bay, of which the Delta accounts for 9.8 kg/year (Yee et al. 2011).

The San Francisco Bay Water Board assigned a total mercury waste load allocation (WLA) for the Delta of 330 kg/year or a load reduction of 110 kg/year. The Central Valley Water Board has targeted the 110 kg/year total mercury load reduction in its planned implementation of the Delta Methylmerucry TMDL (SFBRWQCB 2006). Waste load allocations for methylmercury were not established in the San Francisco Bay Mercury TMDL.

Load Estimates

Mercury and methylmercury loads were estimated by taking into account the change in existing load due to modifications in Delta outflow and changes in the fraction of source waters of Delta outflows to San Francisco Bay that would occur under the project alternatives. The existing loads of mercury and methylmercury from the Delta to San Francisco Bay of 260 kg/year and 9.8 kg/year, respectively, were obtained from the published literature (David et al. 2009; Yee et al. 2011). These loads were calculated using historical water quality and flow data from Mallard Island, and as such, they account for the many sources of mercury and methylmercury to Delta waters. In assessing the effects on mercury and methylmercury loads in Delta outflows due to the project alternatives, the approach taken assumes that the multiple other sources of mercury and methylmercury to net Delta outflow, besides changes in source water fraction and net outflow, would remain constant. This assumption was made because data was only available to quantitatively estimate the change in mercury and methylmercury loads due to changes in the magnitude of Delta outflow and changes in mercury and methylmercury concentrations at Mallard Island due to conservative mixing of the source waters composing Delta outflows at that location. The project alternatives effects of floodplain and tidal restoration on methylmercury concentrations in the Delta, and thus, the San Francisco Bay were not quantifiable, and so were considered qualitatively in this analysis.

The long-term average mercury and methylmercury loads under the project alternatives were calculated as the sum of 1) the existing mercury and methylmercury loads from existing literature, and 2) the net change in the mercury and methylmercury load associated with changes in the source water fraction/net outflow variables. The change in the mercury and methylmercury load in Delta outflow was calculated as follows. Long-term average concentrations of mercury and methylmercury in water were modeled quantitatively for the Delta using a mass-balance approach (as described in Appendix 8I). Concentration data represent the concentration expected at a given location due to conservative mixing (i.e., no uptake, loss or transformation) of the various source water fractions under the project alternatives. Thus, the estimated concentrations do not account for other sources of mercury and methylmercury to Delta waters, including mobilization of sediment, flux from sediment, and in-Delta mercury methylation. Given its seaward location, the modeled long-term average concentration data for Mallard Island (Appendix 8I, Table I-5 and Table I-6) were assumed to represent the concentration of mercury and methylmercury in Delta outflow due to conservative mixing of the various source waters under the project alternatives. Modeled Mallard Island concentrations were converted to loads using the long-term annual average Delta outflow (as shown in Appendix 5A, Section C.7) at Mallard Island projected for Existing Conditions and the project alternative. The difference between the load estimate for the alternative and Existing Conditions is equivalent to the net change in the mercury and methylmercury load associated with changes in the source water fraction/net outflow variables (item 2, above).

Long-term average mercury and methylmercury loads in Delta exports to San Francisco Bay were then estimated by summing 1) the existing load (260 kg/year mercury; and 9.8 kg/year methylmercury) and 2) the net change in the mercury and methylmercury load associated with changes in the source water fraction/net outflow variables.

Selenium

Constituent-specific Considerations

Selenium is an essential trace element for human and other animal nutrition that occurs naturally in the environment. It is also highly bioaccumulative and is of concern because it can cause chronic toxicity (especially impaired reproduction) in fish and aquatic birds (Ohlendorf 2003). Examples of those effects include reduced hatchability of fertile eggs and the development of severe, often lethal, embryo deformities in fish and birds (Department of the Interior 1998; Ohlendorf 2003). Because of the known effects of selenium bioaccumulation from aquatic organisms to higher trophic levels in the food chain, the wildlife habitat and rare, threatened, or endangered species beneficial uses are the most sensitive receptors to selenium exposure. Selenium also affects other aquatic life beneficial uses, including warm freshwater habitat; cold freshwater habitat; migration of aquatic organisms; spawning, reproduction, and/or early development; and estuarine habitat. Additional non-habitat beneficial uses that may be affected include freshwater replenishment, municipal and domestic supply, and agricultural supply.

Selenium is a constituent of concern in San Francisco Bay for potential effects on aquatic and terrestrial resources, and (indirectly) human health. The State Water Board listed San Francisco Bay as having impaired water quality for selenium under CWA Section 303(d) in 1998 (State Water Resources Control Board 2011). Currently, North, Lower, and South San Francisco Bay are Section 303(d) listed for impairments from selenium due to reduced hatchability in nesting diving birds. Historical monitoring of selenium in ducks, fish, and invertebrates in the northern part of San Francisco Bay revealed concentrations that could cause health risks to people and wildlife. More recent monitoring has shown that selenium tissue concentrations of diving ducks have declined to be within the normal background range and white sturgeon muscle concentrations are substantially lower than observed before the North Bay was Section 303(d) listed (SFBRWQCB 2011; SFEI 2014).

Selenium levels in the North Bay have declined gradually since the early 1990s before the North Bay was first 303(d) listed (Tetra Tech 2008). This was due in part to the petroleum refineries, which were a major source of dissolved selenium to the North Bay at that time, implemented controls by 1999 that decreased selenium in their discharges by up to 66% (Tetra Tech 2008).

Although the entire San Francisco Bay is listed as impaired by selenium, separate TMDLs for selenium will be developed for the North Bay and South Bay, as the primary selenium loading to the North Bay and the Suisun Bay area is from the Delta and the South Bay is affected by local and watershed sources not associated with the Delta (Lucas and Stewart 2007). The San Francisco Bay Water Board is conducting a new TMDL project to address selenium toxicity in the North Bay, defined to include a portion of the Delta, Suisun Bay, Carquinez Strait, San Pablo Bay, and the Central Bay (SFBRWQCB 2011). The North Bay selenium TMDL will identify and characterize selenium sources to the North Bay and the processes that control the uptake of selenium by wildlife. The TMDL also will quantify selenium loads, develop and assign waste load allocations among sources, and include an implementation plan designed to achieve the TMDL and protect beneficial uses.

Of the major watersheds that contribute to outflow from the Delta to the North Bay, selenium is most enriched in marine sedimentary rocks of the Coast Ranges on the western side of the San Joaquin Valley (Presser and Piper 1998). Erosion of the selenium-enriched sedimentary rock and irrigation practices used in the Central Valley contribute to selenium concentrations in this watershed.

The San Francisco Bay Regional Monitoring Program (RMP) collects samples throughout San Francisco Bay annually for measurement of total and dissolved selenium. The San Francisco Bay Water Board (2011) recommends averaging selenium concentrations from samples collected across the North Bay on an annual basis to compare with water column selenium numeric thresholds. Total and dissolved selenium data generated by the RMP during the period 2002–2013 for samples collected north of the Bay Bridge and downstream of Mallard Island were averaged for each calendar year (SFEI 2015). For dissolved selenium, annual average concentrations in the North Bay ranged from 0.05–0.17 μg/L, averaging 0.11 μg/L over the entire period. For total selenium, annual average concentrations in the North Bay ranged from 0.07–0.22 μg/L, averaging 0.13 μg/L over the entire period. The ratio of dissolved to total selenium over this period was 90%.

Selenium criteria were promulgated for all San Francisco Bay and Delta waters in the NTR (SFBRWQCB 2013). The NTR criteria specifically apply to San Francisco Bay upstream to and including Suisun Bay and the Delta. The NTR values are 5.0 μg/L (4-day average) and 20 μg/L (1-hour average). By comparison, the available data show that the maximum concentration in the North Bay has not exceeded 0.44 μg/L since 2002. However, the NTR criteria are not considered protective of aquatic life in the San Francisco Bay because the current scientific information shows that selenium toxicity is driven by dietary exposures that are amplified through biomagnification of selenium through the aquatic food chain (USEPA 2014). The USEPA has published draft aquatic life ambient water quality criteria for selenium (USEPA 2014) that account for dietary exposure that recommend fish and fish egg/ovary tissue concentrations that are protective of aquatic life. The USEPA draft criterion for selenium is 15.2 mg/kg (dry weight) in fish eggs or ovaries, and 8.1 mg/kg (dry weight) in fish whole-body (or 11.8 mg/kg in fish muscle). Selenium concentrations in white sturgeon muscle throughout the entire San Francisco Bay, including fish from the North Bay, have mostly been below 10 mg/kg (dry weight) in the most recent fish surveys conducted by the RMP (2006 and 2009) (SFEI 2014). Because obtaining fish tissues is challenging, USEPA (2014) also recommends water column dissolved selenium criteria of 1.3 μg/L for lentic aquatic systems and 4.8

µg/L for lotic aquatic systems. Water column dissolved selenium concentrations in the North Bay have been substantially below the draft lentic or lotic recommended criteria.

Because the North Bay TMDL is currently in development, a final fish-tissue concentration target and method for translating this target to a dissolved selenium water column concentration for the North Bay has not yet been determined. Presser and Luoma (2013) translated a whole-body fish tissue target of 8 mg/kg to a dissolved selenium water column concentration using ecosystem modeling and data/assumptions specific to the North Bay. In the North Bay, white sturgeon are considered representative of the most sensitive aquatic species because its exposure to selenium is high due to its long lifecycle, its benthic feeding habits, and its diet consisting of selenium-rich benthic macroinvertebrates (i.e., Corbula amurensis) (SFBRWQCB 2011). A dissolved selenium concentration of 0.202 µg/L, applicable to the North Bay as a whole, was predicted by Presser and Luoma (2013) to coincide with a whole-fish tissue concentration in white sturgeon of 8 mg/kg under long-term average annual flow conditions (trophic transfer factors for predator and prey were 1.3 and 9.2, respectively; partitioning coefficient (Kd) was 3,317 L/g).

Annual average dissolved selenium concentrations in the North Bay as measured by the RMP (0.05–0.17 µg/L) have been below the 0.202 µg/L dissolved selenium water column target since 2002. The low long-term average dissolved selenium concentration of the North Bay (0.11 µg/L) and data from recent fish tissue surveys have led to the suggestion that the North Bay may ~~have assimilative capacity with regard to selenium~~not currently be impaired with respect to selenium, and this suggestion has led to continued efforts as part of the North Bay TMDL development to determine the current effects to aquatic life from selenium in the North Bay (SFBRWQCB 2011).

Existing annual average selenium loads for the entire North Bay have been calculated based on measured concentrations of the major source waters to the North Bay, with concentrations measured in samples from Mallard Island used to estimate the load of total selenium exported from the Delta (SFBRWQCB 2011). The Preliminary Project Report for the North Bay selenium TMDL has reported the existing load of total selenium to the North Bay is 5,605 kg/yr (assuming an average urban and non-urban runoff load of 595 kg/year). The existing total selenium load to the North Bay from the Delta is 3,940 kg/yr, which comprises 70.3% of the entire North Bay load (SFBRWQCB 2011). While the entire North Bay load of dissolved selenium was not determined, the dissolved selenium load to the North Bay from the Delta has been estimated as 2,700 kg/yr (SFBRWQCB 2011; Tetra Tech 2014).

Load Estimates

The project alternatives would primarily influence selenium loads to the North Bay through diversion of Sacramento River water at the proposed north Delta intakes, with the diverted fraction being replaced by flows from the San Joaquin River, which are naturally enriched with selenium. Because relatively minimal changes (<10%) in long-term average net Delta outflow relative to the project alternatives are expected (Appendix 5A, Section C.7), tidal velocities, and thus sedimentation rates, in the Plan Area and North Bay are expected to remain unchanged. Thus, increased sedimentation of particulates, and associated selenium enrichment of North Bay sediments, due to changes in net Delta outflow is not expected. Any changes in sediment selenium levels that would occur in the North Bay would track the relative changes in selenium water column concentrations due to the alternative. Changes in North Bay water column selenium concentrations and loads due to the project alternatives were determined as follows.

The long-term average total and dissolved selenium concentrations in the North Bay under the project alternatives were estimated assuming that the current long-term average selenium concentrations of the North Bay (0.11 and 0.13 µg/L for dissolved and total selenium) would change in proportion to the change in the long-term average total selenium load of the North Bay. North Bay selenium loads were estimated by taking into account the change in existing load due to modifications in net outflow and source water fractions of Delta exports to the North Bay expected for the alternative. Specifically, the long-term average selenium load of the North Bay under the alternative was calculated as the summation of 1) the existing North Bay selenium load (5,605 kg/yr), and 2) the incremental change in selenium load of net Delta outflow expected under the alternative.

The incremental change in selenium load in net Delta outflow under the project alternatives (item 2, above) was estimated as follows, assuming that loads to the North Bay besides those from the Delta would remain unchanged. First, the percent change in selenium load in net Delta outflow was calculated using modeling results. Long-term average concentrations of dissolved selenium in water were modeled for the Delta using a quantitative mass-balance approach (as described in Appendix 8M). Concentration data represent the concentration expected at a given location due to conservative mixing (i.e., no uptake, loss or transformation) of the various source water fractions under the alternative. Thus, the estimated concentrations do not account for other sources or sinks of selenium to Delta waters, including mobilization of sediment, flux from sediment, and sediment deposition. Given its seaward location, the modeled long-term average concentration data for the Mallard Island station (Appendix 8M, Tables M-9a and M-9b) were assumed to represent the concentration of dissolved selenium in Delta outflow due to conservative mixing of the various source waters under the alternative. Mallard Island concentration data were converted to selenium loads using the long-term annual average flow (as shown in Appendix 5A of the EIR/EIS, Section C.7) at Mallard Island. The percent change of the modeled selenium load ("modeled percent change") under the alternative relative to the modeled selenium load in Delta outflow under Existing Conditions was then calculated. The incremental change in total selenium load of net Delta outflow under the alternative (item 2, above) was calculated as the product of 1) the modeled percent change in selenium load, and 2) the current estimate for existing long-term average total selenium loads from the Delta to the North Bay (3,940 kg/yr).

8.3.2 Effects and Mitigation Approaches

8.3.2.1 No Action Alternative

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

Upstream of the Delta

DO levels in the reservoirs and rivers are primarily affected by water temperature, flow velocity, turbulence, amounts of oxygen demanding substances present (e.g., ammonia, organics), and rates of photosynthesis (which is influenced by nutrient levels), respiration, and decomposition. Water temperature and salinity affect the maximum DO saturation level (i.e., the highest amount of oxygen the water can dissolve). Flow velocity affects the turbulence and re-aeration of the water (i.e., the rate at which oxygen from the atmosphere can be dissolved in water). High nutrient content can support aquatic plant and algae growth, which in turn generates oxygen through photosynthesis and consumes oxygen through respiration and decomposition.

A reservoir can exhibit seasonal changes in the DO profile from the water surface to the sediments that is affected by its degree of thermal stratification, where oxygenated inflows enter and mix with the reservoir, its level of productivity that contributes DO through photosynthesis and consumes DO through respiration and decomposition, as well as the prevailing winds that cause mixing within the reservoir. Water temperature also is a factor in that it affects the level (between the surface and the bottom) at which oxygenated river inflows enter the reservoir, the DO saturation level, and photosynthesis and respiration rates. Cold inflows tend to move deep into the reservoir due to the lower density of cold water, whereas warm water inflows tend to mix with the surface waters, particularly when the reservoir is thermally stratified. Under the No Action Alternative, the primary factor that would change relative to Existing Conditions is that end-of-September carryover storage would be lower in all years (see Chapter 5, *Water Supply*, Section 5.3.3.1), which would affect the temperature profile of the reservoirs at the end of summer. Nevertheless, the reservoirs would continue to thermally stratify seasonally, as they do under Existing Conditions. Given the size of the reservoirs—Lake Oroville, Trinity Lake, Shasta Lake, and Folsom Lake—and their significant surface area, inflows and wind fetch that would still contribute to oxygenating these water bodies, the lower carryover storage that would occur under the No Action Alternative is not expected to cause DO depletions or substantial changes in DO that would adversely affect the beneficial uses of these water bodies.

The No Action Alternative would alter the magnitude and timing of water releases from reservoirs upstream of the Delta relative to Existing Conditions, altering downstream river flows. There would be some increases and decreases in the mean monthly river flows, depending on month and year. Mean monthly flows would remain within the range historically seen under Existing Conditions. Moreover, these are large, turbulent rivers with velocities typically in the range of 0.5 fps to 2.0 fps or higher. Consequently, flow changes that would occur under the No Action Alternative would not be expected to have substantial effects on river DO levels; likely, the changes would be immeasurable. This is because sufficient turbulence and interaction of river water with the atmosphere would continue to occur under this alternative to maintain water saturation levels (due to these factors) at levels similar to that of Existing Conditions.

The changes in the magnitude and timing of water releases from reservoirs upstream of the Delta, relative to Existing Conditions, could affect downstream river temperatures, depending on month and year. Water temperature affects the maximum DO saturation level; as temperature increases, the DO saturation level decreases. When holding constant for barometric pressure (e.g., 760 mm mercury), the DO saturation level ranges from 7.5 mg/L at 30°C (86°F) to 11 mg/L at 10°C(50°F) (Tchobanoglous and Schroeder 1987:735). As described in the affected environment section, DO in the Sacramento River at Keswick, Feather River at Oroville, and lower American River ranged from 7.3 to 15.6 mg/L, 7.4 to 12.5 mg/L, and 6.5 to 13.0 mg/L, respectively. Thus, these rivers are well oxygenated and experience periods of supersaturation (i.e., when DO level exceeds the saturation concentration). Because these are large, turbulent rivers, any reduced DO saturation level that would be caused by an increase in temperature under the No Action Alternative would not be expected to cause DO levels to be outside of the range seen historically. This is because sufficient turbulence and interaction of river water with the atmosphere would continue to occur under this alternative to maintain saturation levels.

Amounts of oxygen demanding substances present (e.g., ammonia, organics) in the reservoirs and rivers upstream of the Delta, rates of photosynthesis (which is influenced by nutrient levels/loading), and respiration and decomposition of aquatic life is not expected to change sufficiently under the No Action Alternative to substantially alter DO levels relative to Existing Conditions. Any minor reductions in DO levels that may occur under this alternative would not be expected to be of sufficient frequency, magnitude and geographic extent to adversely affect beneficial uses, or substantially degrade the quality of these water bodies, with regard to DO.

An effect on salinity (expressed as EC) would not be expected in the rivers and reservoirs upstream of the Delta. Thus, these parameters would not be expected to measurably change DO levels under the No Action Alternative, relative to Existing Conditions.

Delta

Similar to the reservoirs and rivers upstream of the Delta, DO levels in the Delta are primarily affected by water temperature, salinity, Delta channel flow velocities, nutrients (i.e., phosphorus and nitrogen) and aquatic organisms (i.e., photosynthesis, respiration, and decomposition). Sediment oxygen demand of organic material deposited in the low velocity channels also affects Plan Area DO levels.

Under the No Action Alternative, minor DO level changes could occur due to nutrient loading to the Delta relative to Existing Conditions (see WQ-1, WQ-15, WQ-23). The state has begun to aggressively regulate point-source discharge effects on Delta nutrients, and is expected to further regulate nutrients upstream of and in the Delta in the future. Although population increased in the affected environment between 1983 and 2001, average monthly DO levels during this period of record show no trend in decline in the presence of presumed increases in anthropogenic sources of nutrients (~~see Table 4.4-15~~Table 8-11)~~ in the ES/AE section)~~. Based on these considerations, excessive nutrients that would cause low DO levels would not be expected to occur under the No Action Alternative.

Various areas of the Delta could experience salinity increases due to change in quantity of Delta inflows (see WQ-11). For a 5 ppt salinity increase at 68°Fahrenheit, the saturation level of oxygen dissolved in the water is reduced by only about 0.25 mg/L. Thus, increased salinity under the No Action Alternative would generally have relatively minor effects on Delta DO levels where salinity is increased on the order of 5 ppt or less.

The relative degree of tidal exchange of flows and turbulence, which contributes to exposure of Delta waters to the atmosphere for reaeration, would not be expected to substantially change relative to Existing Conditions, such that these factors would reduce Delta DO levels below objectives or levels that protect beneficial uses.

As discussed in the section on DO in section 8.3.1.7 Effects of climate change on air and Delta water temperatures are discussed in Appendix 29C. In general, waters of the Delta would be expected to warm less than 5 degrees F under the No Action Alternative, relative to Existing Conditions, due to climate change, which translates into a < 0.5 mg/L decrease in DO saturation. Thus, increased temperature under the No Action Alternative would generally have relatively minor effects on Delta DO levels.

Some waterways in the eastern, southern, and western Delta are listed on the state's Clean Water Act section 303(d) list as impaired due to low oxygen levels. A TMDL for the Deep Water Ship channel in the eastern Delta has been approved and identifies the factors contributing to low DO in the Deep Water Ship Channel as oxygen demanding substances from upstream sources, Deep Water

Ship Channel geometry, and reduced flow through the Deep Water Ship Channel (Central Valley Water Board 2005:28). The TMDL takes a phased approach to allow more time to gather additional informational on source and linkages to the DO impairment, while at the same time moving forward on making improvements to DO conditions. One component of the TMDL implementation activities is an aeration device demonstration project.

In the Deep Water Ship Channel, low DO events have historically occurred in May-October, and typically in drier years and when flows in the San Joaquin River at Stockton are less than 1000 cfs (Central Valley Regional Water Quality Control Board 2014, ICF International 2010). Concerns have been raised that flows on the San Joaquin River at Stockton may increase, causing the location of the minimum DO point to shift downstream.

Figure 8-65 shows a box-and-whisker plot of the monthly average flows in the San Joaquin River at Stockton for the months of May-October for Dry and Critical water year types. The figure shows that while flows do change somewhat, they are generally within the range of flows seen under Existing Conditions. Reports indicate that the aeration facility performs adequately under the range of flows from 250-1000 cfs (ICF International 2010). Based on the above, the expected changes in flows in the San Joaquin River at Stockton are not expected to substantially move the point of minimum DO, and therefore the aeration facility will likely still be located appropriately to keep DO levels above basin plan objectives.

Overall, assuming continued operation of the aerators, the alternative is not expected to have a substantial impact on DO in the Deep Water Ship Channel. It is expected that under the No Action Alternative that DO levels in the Deep Water Ship Channel would remain similar to those under Existing Conditions or improve as the TMDL-required studies are completed and actions are implemented to improve DO levels. DO levels in other Clean Water Act section 303(d)-listed waterways would not be expected to change relative to Existing Conditions, as the circulation of flows, tidal flow exchange, and re-aeration would continue to occur similar to Existing Conditions.

SWP/CVP Export Service Areas

The primary factor that would affect DO in the conveyance channels and ultimately the receiving reservoirs in the SWP/CVP Export Service Areas would be changes in the levels of nutrients and oxygen-demanding substances and DO levels in the exported water. For reasons provided above, the Delta waters exported to the SWP/CVP Export Service Areas would not be expected to be substantially lower in DO compared to Existing Conditions. Exported water could potentially be warmer and have higher salinity relative to Existing Conditions. Nevertheless, because the biochemical oxygen demand of the exported water would not be expected to substantially differ from that under Existing Conditions (due to ever increasing water quality regulations), canal turbulence and exposure of the water to the atmosphere and the algal communities that exist within the canals would establish an equilibrium for DO levels within the canals. The same would occur in downstream reservoirs. Consequently, substantial adverse effects on DO levels in the SWP/CVP Export Service Areas would not be expected to occur under the No Action Alternative relative to Existing Conditions.

The effects on dissolved oxygen from implementing the No Action Alternative is determined to not be adverse.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

~~River flow rate and r~~Reservoir storage reductions that would occur under the No Action Alternative, relative to Existing Conditions, would not be expected to result in a substantial adverse change in DO levels in the reservoirs, because oxygen sources (surface water aeration, aerated inflows, vertical mixing) would remain. Similarly, river flow rate reductions that would occur would not be expected to result in a substantial adverse change in DO levels in the ~~and~~ rivers upstream of the Delta, given that mean monthly flows would remain within the ranges historically seen under Existing Conditions and the affected river are large and turbulent. Any reduced DO saturation level that may be caused by increased water temperature would not be expected to cause DO levels to be outside of the range seen historically. Finally, amounts of oxygen demanding substances and salinity would not be expected to change sufficiently to affect DO levels.

It is expected there would be no substantial change in Delta DO levels in response to a shift in the Delta source water percentages under this alternative or substantial degradation of these water bodies, with regard to DO. DO levels would be affected by nutrient loading, which the state has begun to aggressively regulate the discharges of, and this loading would not be expected to lower DO levels relative to Existing Conditions based on historical DO levels. Further, the anticipated changes in salinity would have relatively minor effects on DO levels, and tidal exchange, which contribute to the reaeration of Delta waters would not be expected to change substantially.

There is not expected to be substantial, if even measurable, changes in DO levels in the SWP/CVP Export Service Areas waters under the No Action Alternative, relative to Existing Conditions, because the biochemical oxygen demand of the exported water would not be expected to substantially differ from that under Existing Conditions (due to ever increasing water quality regulations), canal turbulence and exposure of the water to the atmosphere and the algal communities that exist within the canals would establish an equilibrium for DO levels within the canals. The same would occur in downstream reservoirs.

There would be no substantial, and likely no measurable, long-term change in DO levels Upstream of the Delta, in the Plan Area, or the SWP/CVP Export Service Areas under the No Action Alternative relative to Existing Conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would adversely affect beneficial uses. Because no substantial changes in DO levels are expected, long-term water quality degradation would not be expected, and, thus, beneficial uses would not be expected to be adversely affected. Various Delta waterways are Clean Water Act section 303(d)-listed for low DO, but because no substantial decreases in DO levels are expected, greater degradation and impairment of these areas is not expected to occur. This impact is considered to be less than significant.

Impact WQ-23: Effects on Phosphorus Concentrations Resulting from Facilities Operations and Maintenance

As described under Impact WQ-29, facilities operations and maintenance is not expected to result in substantial changes in TSS and Turbidity under the project alternative relative to Existing Conditions in surface waters upstream of the Delta, in the Delta, and in the SWP/CVP Export Service Areas. Thus in these areas, long-term changes in the levels of suspended sediment-bound phosphorus are not expected. Additional factors that may effect phosphorus levels are discussed below.

Impact WQ-25: Effects on Selenium Concentrations Resulting from Facilities Operations and Maintenance

Upstream of the Delta

~~The No Action Alternative, would have negligible, if any, effect on selefnium concentrations in the rivers and reservoirs upstream fo the Delta relative to Existing Conditions. Any negligible increases in selenium concentrations that could occur in the water bodies of the affected environment upstream of the Delta would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of thes water bodies, with regard to selenium.~~

Substantial point sources of selenium do not exist upstream in the Sacramento River watershed, in the watersheds of the eastern tributaries (Cosumnes, Mokelumne, and Calaveras Rivers), or upstream of the Delta in the San Joaquin River watershed. Nonpoint sources of selenium within the watersheds of the Sacramento River and the eastern tributaries also are relatively low, resulting in generally low selenium concentrations in the reservoirs and rivers of those watersheds. Consequently, any modified reservoir operations and subsequent changes in river flows under the No Action Alternative, relative to Existing Conditions, are expected to have negligible, if any, effects on reservoir and river selenium concentrations upstream of Freeport in the Sacramento River watershed or in the eastern tributaries upstream of the Delta.

Non-point sources of selenium in the San Joaquin River watershed are associated with discharges of subsurface agricultural drainage to the river or its tributaries. Selenium concentrations in the San Joaquin River upstream of the Delta comply with NTR criteria and Basin Plan objectives at Vernalis under Existing Conditions, and they are expected to do so under the No Action Alternative. This is because a TMDL has been developed by the Central Valley Water Board (2001), the Grassland Bypass Project has established limits that will result in reduced inputs of selenium to the Delta, and the Central Valley Water Board (2010a) and State Water Board (2010d, 2010e) have established Basin Plan objectives that are expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta, as previously discussed in 8.1.~~1~~3.15~~0~~.

Selenium concentrations at Vernalis are generally higher during lower San Joaquin River flows, with considerable variability in concentrations below about 3,000 cubic feet per second (cfs), as shown in Appendix 8M, *Selenium*, ~~(~~Table M-~~31~~ 33 and Figures M-~~4~~7 through M-20~~17)~~. ~~The only three monthly average selenium concentrations greater than 2 µg/L were in March 2002 (2.3 µg/L) and February and March 2003 (2.1 and 2.3 µg/L), when monthly average flows were 1,879 to 2,193 cfs.~~ Modeling of flows for the San Joaquin River at Vernalis indicates that average annual flows under the No Action Alternative ~~will~~ would vary by less than 10 percent from Existing Conditions (Appendix 5A). Given these relatively small decreases in flows and the considerable variability in the relationship between selenium concentrations and flows in the San Joaquin River, it is expected that selenium concentrations in the San Joaquin River would be minimally affected, if at all, by anticipated changes in flow rates under the No Action Alternative.

Thus, available information indicates selenium concentrations are well below the Basin Plan objective and are likely to remain so under the No Action Alternative. ~~Any~~ The negligible changes in selenium concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies as related to selenium.

Delta

Selenium concentrations and threshold comparisons for each of the 11 modeled Delta assessment locations under Existing Conditions and ~~,~~the No Action Alternative~~, and all action alternatives,~~ are presented in Appendix 8M, *Selenium*, Table M-~~10A~~9Aa ~~/B~~ for water, Tables M-~~11~~ 10 through M-~~20~~ 29 for most biota (whole-body fish (excluding sturgeon), bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets) throughout the Delta, and Tables ~~M.A~~M-30~~0~~ ~~through~~ through M-32 ~~8M-2 in the sturgeon addendum to Appendix 8M~~ for sturgeon at the two western Delta locations. Figures 8-59a and 8-59b ~~and Figures 8-60a and b~~ present graphical distributions of predicted selenium concentration changes (shown as changes in available assimilative capacity based on ~~2~~1.3 μg/L) in water at each modeled assessment location for all years. Appendix 8M, ~~(~~Figure~~s~~ ~~8~~M-~~4~~21 ~~through 8M-6)~~ provides more detail in the form of monthly patterns of selenium concentrations in water during the modeling period.

Relative to Existing Conditions, the No Action Alternative would result in little to no ~~small~~ changes in average selenium concentrations in water at all modeled Delta assessment locations. Long-term average concentrations at most locations would be the same or lower, with the exception of Old River at Rock Slough and North Bay Aqueduct during the drought period modeled (1987–1991) and Jones pumping plant for the entire (1976–1991) and drought periods modeled (Appendix 8M, Table M-9a). Long-term average concentrations at these locations would increase negligibly (0.01–0.02 μg/L) at these locations, resulting in a reduction of assimilative capacity of <1%, relative to the 1.3 μg/L ~~ecological risk benchmark~~USEPA draft water quality criterion (Figure 8-59a)~~with the largest increase being at the Contra Costa Pumping Plant #1 (hereafter Contra Costa PP) for drought years and largest decrease being in the San Joaquin River at Buckley Cove (Buckley Cove) for all and drought years (Table M-10A). These small changes in selenium concentrations in water are reflected in small percent changes in available assimilative capacity (10% or less) for selenium (based on 2 μg/L ecological risk benchmark). Relative to Existing Conditions, the No Action Alternative would result in the largest modeled increase in available assimilative capacity at Buckley Cove (5%) and the largest decrease at Contra Costa PP (0.4%) (Figure 8-59). Although some small negative changes in selenium concentrations in water are expected, the effect of the No Action Alternative would generally be minimal for the Delta locations.~~ . ~~Furthermore, t~~The long-term average selenium concentrations in water ~~(Table M-10A) for Existing Conditions (range 0.21–0.76 μg/L) and~~ under the No Action Alternative would ~~(~~range from 0.~~21~~09–0.~~69~~38 μg/L (Appendix 8M, Table 9a)~~)~~, well ~~would be~~ below the ~~ecological risk benchmark~~USEPA draft water quality criterion of ~~(2~~1.3 μg/L~~)~~.

Relative to Existing Conditions, the No Action Alternative would result in little to no change in estimated selenium concentrations in most biota (whole-body fish, bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets), with the largest increase being 0.01 mg/kg dry weight (dw) at Buckley Cove for the drought period (Table M-20). During the drought period, concentrations of selenium in sturgeon in the western Delta would increase slightly, with about a 0.09 mg/kg dw (1 percent) increase for the San Joaquin River at Antioch (Appendix 8M, Tables M-30 and M-31).

Modeled selenium concentrations in fish and bird eggs were compared with effect benchmarks to evaluate the potential for selenium to exceed levels of concern for toxicity or health advisories. These effects benchmarks included ~~High and Low~~ Levels of Concern ~~benchmarks~~ for whole fish and bird eggs, High and Low Toxicity Thresholds Level benchmarks for whole sturgeonfish, bird eggs, and sturgeon, and Advisory Tissue Levels for fish fillets consumed by people. Toxicity Level Threshold Exceedance Quotients (i.e., modeled tissue concentration divided by Toxicity Threshold Level benchmarks or, for sturgeon, the High Toxicity Threshold) were determined for selenium concentrations in all biota for all years the entire period modeled and for the drought yearsperiod modeled, . Likewise, and Level of Concern Exceedance Quotients (i.e., modeled tissue divided by Level of Concern benchmarks or, for sturgeon, the Low Toxicity Threshold) were also calculated for selenium concentrations in all biota for all years. All Toxicity Level Exceedance Quotients for whole fish, bird eggs, and fish fillets are were are less than 1.0, (indicating low probability of adverse effects) (Appendix 8M, Table M-20). However, Low Toxicity Threshold Exceedance Quotients for selenium concentrations in except for sturgeon in from the western Delta exceed 1.0 for the modeled drought period, (indicating a higher probability for adverse effects) for drought years (Appendix 8M, Table M-32). Level of Concern Exceedance Quotients for selenium concentrations in whole-body fish, bird eggs (invertebrate diet), and bird eggs (fish diet) for drought years are greater than 1.0 for some locations; however, Advisory Tissue Level Exceedance Quotients for selenium concentrations in fish fillets for all years and drought years are less than 1.0. Relative to Existing Conditions, there would be no increase in any exceedance quotient at any Delta assessment location, except for the whole body fish Toxicity Level Exceedance Quotient for the San Joaquin River at Buckley Cove for the drought period (from 0.29 to 0.30). Figures 8-61a and bthrough 8-64a and b through 8-65 [[Low Toxicity Threshold Exceedance Quotients for Selenium Concentrations in Whole-body Sturgeon for Drought Years]] show the Exceedance exceedance Quotients quotients based on the lowest benchmarks for whole-body fish, bird eggs (invertebrate diet), bird eggs (fish diet), and fish fillets, and sturgeon in drought years, respectively, at each modeled location. For sturgeon in the western Delta, whole-body selenium concentrations exceed both the low and high toxicity benchmarks (Table 8M-2 in the sturgeon addendum to Appendix 8MTable M.A-2). Detailed analyses of selenium concentrations in biota are presented in Appendix 8M, *Selenium*, (Tables M-11110 through M-3032) and the sturgeon addendum M.A, *Selenium in Sturgeon*, to Appendix 8M (Table 8M.A-2).

Relative to Existing Conditions, the No Action Alternative would result in small changes in average selenium concentrations in water at all modeled Delta assessment locations with the largest increase being at the Contra Costa Pumping Plant #1 (hereafter Contra Costa PP) for drought years and largest decrease being in the San Joaquin River at Buckley Cove (Buckley Cove) for all and drought years (Table M-10A). These small changes in selenium concentrations in water are reflected in small percent changes in available assimilative capacity (10% or less) for selenium (based on 2 µg/L ecological risk benchmark). Relative to Existing Conditions, the No Action Alternative would result in the largest modeled increase in available assimilative capacity at Buckley Cove (5%) and the largest decrease at Contra Costa PP (0.4%) (Figure 8-59). Although some small negative changes in selenium concentrations in water are expected, the effect of the No Action Alternative would generally be minimal for the Delta locations. Furthermore, the modeled selenium concentrations in water (Table M-10A) for Existing Conditions (range 0.21–0.76 µg/L) and the No Action Alternative (range 0.21–0.69 µg/L) would be below the ecological risk benchmark (2 µg/L).

In summary, Relative to Existing Conditions, the No Action Alternative would result in only small changes in estimated selenium concentrations in most biota (whole-body fish, bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets), with the largest increase being at Contra Costa PPBuckley Cove for drought years, and the largest decrease at Buckley Cove for drought yearsbut all changes are less than 1 percent. (Table M-1120). None of the concentrations would exceed the lowest toxicity thresholds for fish or birds or for human consumption of fillets (Figures 8-61a through 8-64b). Except forDuring drought years, concentrations of selenium in sturgeon in the western Delta would increase slightly, with about a 1 percent increase for San Joaquin River at Antioch (Table M-31)., concentrations of selenium in whole-body fish and bird eggs (invertebrate and fish diets) would exceed only the lower benchmarks (4 and 6 mg/kg dry weight, respectively, indicating a low potential for effects), under drought conditions, at Buckley Cove for Existing Conditions and the No Action Alternative (Figures 8-61 through 8-63). However, Exceedance exceedance Quotients quotients for these exceedances of the lower benchmarks are between 1.0 and 1.5, indicating a low risk to biota in the Delta. Selenium concentrations in fish fillets would not exceed the screening value for protection of human health (Figure 8-64). For sturgeon in the western Delta,W whole-body selenium concentrations in sturgeon would exceed both the low and high toxicity benchmark during drought yearss, but there would be essentially no change relative to Existing Conditions (Table 8M.A-2M-32 in the sturgeon addendum to Appendix 8Mand Figure 8-65).

Rrelative to Existing Conditions, the No Action Alternative would result in essentially no change in selenium concentrations throughout the Delta, though conditions would slightly improve at Buckley Cove. The No Action Alternative would not be expected to substantially increase the frequency with which applicable toxicity and level of concern benchmarks would be exceeded in the Delta or substantially degrade the quality of water in the Delta, with regard to selenium.

SWP/CVP Export Service Areas

Relative to Existing Conditions, the No Action Alternative would result in little to no small changes in long-term average selenium concentrations in water at both modeled Export Service Area assessment locations the south Delta pumping plants. At the Banks pumping plant, there would be no change in long-term average concentrations for the entire period modeled or the drought period modeled (Appendix 8M, Table M-9a). At the with the largest increase being at the Jones PPumping PPlant, selenium concentrations would increase by 0.01 µg/L for the entire period modeled and by 0.02 µg/L for the drought period modeled (Appendix 8M, Table M-9a), which would correspond to a reduction in assimilative capacity of about 1% (Jones PP) and largest decrease being at the Banks Pumping Plant (Banks PP) (Table M-11). These small changes in selenium concentrations in water are reflected in small percent changes (10% or less) in available assimilative capacity for selenium for all years. Relative to Existing Conditions, the No Action Alternative would result in less than a 1% change in assimilative capacity at both Export Service Area locations for all and drought years (Figures 8-6059a and 8-61).The effect of the No Action Alternative on selenium concentrations in water is minimal for both locations. Furthermore, the modeled selenium concentrations in water (Table M-109Aa) for Existing Conditions (range 0.37–0.58 µg/L) and the No Action Alternative (range 0.37–0.59 µg/L) would range from 0.21–0.29 µg/L, well be below the ecological risk benchmarkUSEPA draft water quality criterion of (21.3 µg/L).

Relative to Existing Conditions, the No Action Alternative would result in very small changes (less than 1 percent) in estimated selenium concentrations in biota (whole-body fish, bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets), with the largest increase being at Jones PP for drought years, and the largest decrease at Banks PP for all years (Table M-1120). Concentrations of selenium in biota would not be expected to exceed only the lowerany benchmarks (6 mg/kg dry weight, indicating a low potential for effects) for bird eggs (fish diets), under drought conditions, at Jones PP for Existing Conditions and the No Action Alternativefor biota (Figures 8-61a through 8-64b, Appendix 8M, Table M63). However, Exceedance Quotientsexceedance quotients for these exceedances of the lower benchmarks are between 1.0 and 1.1, indicating a low risk to biota in the

Export Service Areas, and they do not differ substantially among Existing Conditions and the No Action Alternative. Selenium concentrations in whole-body fish, bird eggs (invertebrate diet), and fish fillets would not exceed the screening value of the lower benchmarks (Figures 8-61, 8-62, and 8-64).

Relative to Existing Conditions, the No Action Alternative would result in essentially no change in selenium concentrations at the SWP/CVP Export Service Areas, because there would essentially be no change in selenium concentrations at the Bank and Jones pumping plants locations. Thus, Tthe No Action Alternative would not be expected to substantially increase the frequency with which applicable benchmarks would be exceeded in the Export Service Areas or substantially degrade the quality of water in the Export Service Areas, with regard to selenium.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for selenium. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

There are no substantial point sources of selenium in watersheds upstream of the Delta, and no substantial nonpoint sources of selenium in the watersheds of the Sacramento River and the eastern tributaries. Nonpoint sources in the San Joaquin Valley that contribute selenium to the Delta will be controlled through a TMDL developed by the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the Grassland Bypass Project, and Basin Plan objectives (Central Valley Water Board 2010d) and State Water Board (2010d, 2010e) that are expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta. Consequently, any modified reservoir operations and subsequent changes in river flows under the No Action Alternative, relative to Existing Conditions, are expected to cause negligible changes in selenium concentrations in water. Any negligible changes in selenium concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies as related to selenium.

Relative to Existing Conditions, modeling estimates indicate that the No Action Alternative would result in essentially no change in selenium concentrations throughout the Delta, though conditions would slightly improve at Buckley Covewith all changes on the order of 0.02 µg/L1 percent or less (i.e., <1%). Furthermore, there would not be an increased risk of exceeding toxicity and level of concern benchmarks for biota.

Assessment of effects of selenium in the SWP/ and CVP Export Service Areas is based on effects on selenium concentrations at the Banks and Jones pumping plants. Relative to Existing Conditions, the No Action Alternative would result in essentially no change in long-term average selenium concentrations at the Bank pumping plant, and very little increase (0.01 µg/L) at the Jones those two pumping plant locations.

Based on the above, selenium concentrations that would occur in water under this alternative would not cause additional exceedances of applicable state or federal numeric or narrative water quality objectives/criteria, or other relevant water quality effects thresholds identified for this assessment (Table 8-54), by frequency, magnitude, and geographic extent that would result in adverse effects to one or more beneficial uses within affected water bodies. In comparison to Existing Conditions, water quality conditions under this alternative would not increase levels of selenium by frequency, magnitude, and geographic extent such that the affected environment would be expected to have measurably higher body burdens of selenium in aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish) or humans consuming those organisms. Water quality conditions under this alternative with respect to selenium would not cause long-term degradation of water quality in the affected environment, and therefore would not result in use of available assimilative capacity such that exceedances of water quality objectives/criteria would be likely and would result in substantially increased risk for adverse effects to one or more beneficial uses. This alternative would not further degrade water quality by measurable levels, on a long-term basis, for selenium and, thus, cause the CWA Section 303(d)-listed impairment of beneficial uses to be made discernibly worse. This impact is considered to be less than significant.

Impact WQ-27: Effects on Trace Metal Concentrations Resulting from Facilities Operations and Maintenance

Delta

For metals of primarily aquatic life concern (copper, cadmium, chromium, lead, nickel, silver, and zinc), average and 95th percentile trace metal concentrations of the primary source waters to the Delta are very similar, with difference typically not greater than a factor of 2 to 5 (Appendix 8N, *Trace Metals*, Tables1-–7). For example, average dissolved copper concentrations on the Sacramento River, San Joaquin River, and Bay (Martinez) are 1.7 µg/L, 2.4 µg/L, and 1.7 µg/L, respectively. The 95th percentile dissolved copper concentrations on the Sacramento River, San Joaquin River, and Bay (Martinez) are 3.4 µg/L, 4.5 µg/L, and 2.4 µg/L, respectively. Given this similarity, very large changes in source water fraction would be necessary to effect a relatively small change in trace metal concentration at a particular Delta location. Moreover, average and 95th percentile trace metal concentrations for these primary source waters are all below their respective water quality criteria, including those that are hardness-based without a WER adjustment (Tables 8-51 58and 8-5259). No mixing of these three source waters could result in a metal concentration greater than the highest source water concentration, and given that the average and 95th percentile source water concentrations for copper, cadmium, chromium, led, nickel, silver, and zinc do not exceed their respective criteria, more frequent exceedances of criteria in the Delta would not occur under the operational scenario for this alternative.

Based on comments received during public review of the initial draft EIR/EIS, further evaluation of aluminum data and potential effects are included herein. Aluminum has potential to result in aquatic toxicity effects as well as nuisance aesthetic concerns in potable water. Regarding potential aquatic life effects, monthly DWR data collected in 2013-2014 indicate that the maximum and 95th percentile dissolved aluminum in the Sacramento River exceed the USEPA's default chronic criterion of 87 µg/L, whereas the San Joaquin River concentrations are well below the criterion, and no data were identified for the Bay source water. However, the USEPA national recommended criteria developed in 1988 is recognized as a highly conservative value based on limited toxicity test data and very low water hardness levels. A recent study evaluated aluminum criteria with the USEPA recalculation procedure using an updated and comprehensive toxicity test database that determined a hardness-based relationship for aluminum (Pima County Wastewater Management Department 2006). The Pima County study hardness-dependent equation for dissolved aluminum indicates that a chronic criteria of 287 µg/L (at 25 mg/L hardness as $CaCO_3$) better represents potential aluminum toxicity in ambient water. Similar to the analysis for the other trace metals above, based on the relatively similar Sacramento and San Joaquin River aluminum concentrations, and maximum concentrations not having potential to cause chronic (or acute) toxicity, no change in mixing of the source waters would result in more frequent or potential for toxicity or degradation in the Delta.

For metals of primarily human health and drinking water concern (aluminum, arsenic, iron, manganese), average and 95th percentile concentrations are also very similar(Appendix 8N, Tables 8~~-~~–10). The arsenic criterion was established to protect human health from the effects of long-term chronic exposure, while secondary maximum contaminant levels for aluminum, iron, and manganese were established as reasonable goals for drinking water quality. The primary source water average concentrations for aluminum, arsenic, iron, and manganese are below these criteria. No mixing of these three source waters could result in a metal concentration greater than the highest source water concentration, and given that the average water concentrations for aluminum, arsenic, iron, and manganese do not exceed water quality criteria, more frequent exceedances of drinking water criteria in the Delta would not be expected to occur under this alternative.

Relative to Existing Conditions, facilities operation under the No Action Alternative would result in negligible change in trace metal concentrations throughout the Delta. The No Action Alternative would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or CTR criteria would be exceeded in the Delta or substantially degrade the quality of water in the Delta, with regard to trace metals.

Impact WQ-32. Effects on *Microcystis* Bloom Formation Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Impacts from *Microcystis* upstream of the Delta have only been documented in lakes such as Clear Lake, where eutrophic levels of nutrients give cyanobacteria a competitive advantage over other phytoplankton during the bloom season. Large reservoirs upstream of the Delta are typically characterized by low nutrient concentrations, where other phytoplankton outcompete cyanobacteria, including *Microcystis*. In the rivers and streams of the Sacramento River watershed, watersheds of the eastern tributaries (Cosumnes, Mokelumne, and Calaveras Rivers), and the San Joaquin River upstream of the Delta, under Existing Conditions, bloom development is limited by high water velocity and low residence times. These conditions are not expected to change under the No Action Alternative. Consequently, any modified reservoir operations under the No Action Alternative are not expected to promote *Microcystis* production upstream of the Delta, relative to Existing Conditions.

Delta

Modeled residence times in the six Delta sub-regions during the *Microcystis* bloom season of June through September under the No Action Alternative are greater than under than Existing Conditions by 0–7 days (Table ~~Ms-1~~8-60a), a small increase, given that modeled residence times of the six Delta sub-regions range from 5–49 days under Existing Conditions. One exception is the East Delta, where modeled residence times are expected to increase by up to 20 days relative to Existing Conditions. The changes in residences time are driven by a number of factors accounted for in the modeling, including climate change, sea level rise, and changes in operations and maintenance that affect net Delta outflows. Variability in local residence times is expected within any Delta sub-region because major portions of the Delta are comprised of complex networks of intertwining channels, shallow back water areas, and submerged islands. Thus, the summer and fall period average residence times provide a general direction and degree to which water residence times may change. Because the change is relatively small, it is unknown whether the increase in modeled residence times expected under the No Action Alternative relative to Existing Conditions will result in measurable increases in the frequency, magnitude, and geographic extent of *Microcystis* blooms throughout the Delta.

The relationship between Delta water temperatures, climate change, and changes in water deliveries from upstream reservoirs is discussed in Appendix 29C. In short, ambient meteorological conditions are the primary driver of Delta water temperatures, meaning that climate warming and not water operations will determine future water temperatures in the Delta. Climate projections for the Central Valley, California discussed in Appendix 5A-D indicate substantial warming of ambient air temperatures with a median increase in annual temperature of about 1.1°C (2.0°F) by 2025 and 2.2°C (4.0°F) by 2060. The projected water temperature change ranges from 0.7 to 1.4°C (1.3 to 2.5°F) by 2025 and 1.6 to 2.7°C (2.9-4.9°F) by 2060. Increasing water temperatures could lead to earlier attainment of the water temperature threshold of 19°C required to initiate *Microcystis* bloom formation, and thus earlier occurrences of *Microcystis* blooms in the Delta, relative to Existing Conditions. Elevated ambient water temperatures in the Delta, and thus an increase in *Microcystis* bloom duration and magnitude, are expected under the No Action Alternative, relative to Existing Conditions.

CVP/SWP Export Service Area

The assessment of effects on *Microcystis* in the SWP/CVP Export Service Areas is based on the assessment of *Microcystis* production in source waters to Banks and Jones Pumping plants, and upon the effects of residence time and water temperature on the potential for *Microcystis* blooms to occur in the Export Service Area.

Under the No Action Alternative, exports from Banks and Jones pumping plants will consist of water characteristic of Sacramento and San Joaquin River water that has flowed through various portions of the North, South, and West Delta. Water flowing through the Delta that reaches the existing south Delta intakes is expected to be influenced by an increase in the frequency, magnitude, and geographic extent of *Microcystis* blooms discussed in the "Delta" section above. Therefore, an increase in *Microcystis* blooms, and thus microcystins concentrations, is expected in the mixture of source waters exported from Banks and Jones pumping plants under the No Action Alternative relative to Existing Conditions.

Microcystis blooms have not occurred in the Export Service Areas even though source waters to the SWP and CVP have been affected. Conditions in the Export Service Areas under the No Action Alternative may become more conducive to *Microcystis* bloom formation, relative to Existing Conditions, because water temperatures will increase in the Export Service Areas due to the expected increase in ambient air temperatures resulting from climate change. Residence times in this area are not expected to substantially change under the No Action Alternative, relative to Existing Conditions.

CEQA Conclusion: Based on the above, the No Action Alternative would not be expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause significant impacts on any beneficial uses of waters in the affected environment. Microcystis and microcystins are not 303(d) listed within the affected environment and thus any increases that could occur in some areas would not make any existing Microcystis impairment measurably worse because no such impairments currently exist. Because Microcystis and microcystins are not bioaccumulative, increases that could occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. However, because it is possible that increases in the frequency, magnitude, and geographic extent of Microcystis blooms in the Delta will occur due to increased water temperatures from climate change under the No Action Alternative, long-term water quality degradation may occur in the Delta and water exported from the Delta to the SWP and CVP Export Service Areas. Thus, impacts on beneficial uses could occur. This impact is considered to be significant.

Impact WQ-34: Effects on San Francisco Bay Water Quality Resulting from Facilities Operations and Maintenance

The effects analysis presented in the preceding impacts (Impact WQ-1 through WQ-33) concluded that the No Action Alternative would have a less than significant impact/no adverse effect on the following constituents in the Delta:

- Boron
- Bromide
- Dissolved Oxygen
- Dissolved Organic Carbon (DOC)
- Pathogens
- Pesticides
- Trace Metals
- Turbidity and TSS

Elevated concentrations of boron are of concern in drinking and agricultural water supplies. Elevated concentrations of bromide and DOC also are of concern in drinking water supplies. However, waters in the San Francisco Bay are not designated to support municipal water supply (MUN) and agricultural supply (AGR) beneficial uses. The strong tidal nature of this area and proximity to the ocean make salinities too high to be suitable for these uses. Changes in Delta dissolved oxygen, pathogens, pesticides, and turbidity and TSS are not anticipated to be of a frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of the Delta. Thus, changes in boron, bromide, dissolved oxygen, DOC, pathogens, pesticides, and turbidity and TSS in Delta outflow are not anticipated to be of a frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of the of San Francisco Bay.

The effects of the No Action Alternative on chloride and EC in the Delta were determined to be significant/adverse. Increases in chloride concentrations are of concern for their potential to impact municipal drinking water aesthetics; however, as described previously, the San Francisco Bay does not have a designated MUN use. Thus, changes in chloride in Delta outflow would not adversely effect any beneficial uses of San Francisco Bay. Elevated EC, as assessed for this alternative, is of concern for its effects on the agricultural beneficial use (AGR) and fish and wildlife beneficial uses. As discussed above, San Francisco Bay does not have an AGR beneficial use designation. However, potential effects on bay salinity are discussed further below, with consideration to effects on fish and wildlife beneficial uses.

While effects of the No Action Alternative on the nutrients ammonia, nitrate, and phosphorus were determined to be less than significant/not adverse, these constituents are addressed further below because the response of the seaward bays to changed nutrient concentrations/loading may differ from the response of the Delta. Because the potential change in *Microcystis* levels were found to be significant in the Delta, potential effects on *Microcystis* levels and microcystin concentrations in San Francisco Bay are discussed. Selenium and mercury are discussed further, because they are bioaccumulative constituents where changes in load due to both changes in Delta concentrations and exports are of concern.

Nutrients: Ammonia, Nitrate, and Phosphorus

Total nitrogen loads in Delta outflow to Suisun and San Pablo Bays under the No Action Alternative would be dominated almost entirely by nitrate, because planned upgrades to the SRWTP will result in >95% removal of ammonia in its effluent. Relative to Existing Conditions, total nitrogen loads to Suisun and San Pablo Bays would decrease by 32% (Appendix 8O, Table O-1). The change in nitrogen loading to Suisun and San Pablo Bays under the No Action Alternative would not adversely impact primary productivity in these embayments because light limitation and grazing current limit algal production in these embayments. To the extent that algal growth increases in relation to a change in ammonia concentration, this would have net positive benefits, because current algal levels in these embayments are low. Nutrient levels and ratios are not considered a direct driver of *Microcystis* and cyanobacteria levels in the North Bay.

The phosphorus load exported from the Delta to Suisun and San Pablo Bays for the No Action Alternative is estimated to increase by 5% relative to Existing Conditions (Appendix 8O, Table O-1). . The only postulated effect of changes in phosphorus loads to Suisun and San Pablo Bays is related to the influence of nutrient stoichiometry on primary productivity. However, there is uncertainty regarding the impact of nutrient ratios on phytoplankton community composition and abundance. Any effect on phytoplankton community composition would likely be small compared to the effects of grazing from introduced clams and zooplankton in the estuary (Senn and Novick 2014; Kimmerer and Thompson 2014). Therefore, the projected decrease in total nitrogen loading and increase in phosphorus loading that would occur in Delta outflow to San Francisco Bay are not expected to result in adverse effects to beneficial uses or substantially degrade the water quality with regard to nutrients.

Mercury

The estimated long-term average mercury and methylmercury loads in Delta exports are shown in Appendix 8O, Table O-2. Loads of mercury and methylmercury from the Delta to San Francisco Bay are estimated to change relatively little due to changes in source water fractions and net Delta outflow that would occur under the No Action Alternative. Mercury load to the Bay, relative to Existing Conditions, is estimated to increase by 3 kg/yr (1%). Methylmercury load, relative to Existing Conditions, is estimated to increase by 0.09 kg/yr (3%). The estimated total mercury load to the Bay is 263 kg/yr, which would be less than the San Francisco Bay mercury TMDL WLA for the Delta of 330 kg/yr. The estimated changes in mercury and methylmercury loads would be within the overall uncertainty associated with the estimates of long-term average net Delta outflow and the long-term average mercury and methylmercury concentrations in Delta source waters. The estimated changes in mercury load under the alternative would also be substantially less than the considerable differences among estimates in the current mercury load to San Francisco Bay (SFBRWQCB 2006; David et al. 2009). Similar uncertainty is expected in the existing methylmercury load in net Delta exports, for which the best available current load estimate is based on approximately one year of monitoring data (Foe et al. 2008).

Given that the estimated incremental increases of mercury and methylmercury loading to San Francisco Bay would fall within the uncertainty of current mercury and methylmercury load estimates, the estimated changes in mercury and methylmerucy loads in Delta exports to San Francisco Bay due to the No Action Alternative are not expected to result in adverse effects to beneficial uses or substantially degrade the water quality with regard to mercury, or make the existing CWA Section 303(d) impairment measurably worse.

Salinity

Salinity throughout San Francisco Bay is largely a function of the tides, as well as to some extent the freshwater inflow from upstream. Thus, Delta outflow is the main mechanism by which the alternative could affect salinity in San Francisco Bay. According to the Delta Atlas (DWR 1995), average historical tidal flow through the Golden Gate Bridge is 2,300,000 cubic feet per second (cfs) and average historical tidal flow at Chipps Island is 170,000 cfs. The historical average tidal flows are two to three orders of magnitude larger than the largest mean monthly change in Delta outflow due to the No Action Alternative (shown in Appendix 5A, Section C.7). Thus, the changes in Delta outflow due to the No Action Alternative would be minor compared to tidal flows, and thus no substantial adverse effects on salinity, or fish and wildlife beneficial uses, downstream of the Delta are expected.

Selenium

Changes in source water fraction and net Delta outflow under the No Action Alternative, relative to Existing Conditions, are projected to cause the total selenium load to the North Bay to increase by 3% (Appendix 8O, Table O-3). Changes in long-term average selenium concentrations of the North Bay are assumed to be proportional to changes in North Bay selenium loads. Under the No Action Alternative, the long-term average total selenium concentration of the North Bay is estimated to be 0.13µg/L and the dissolved selenium concentration is estimated to be 0.11 µg/L, which would be the same as Existing Conditions (Appendix 8O, Table O-3). The dissolved selenium concentration would be below the target of 0.202 µg/L developed by Presser or Luoma (2013) to coincide with a white sturgeon whole-body fish tissue selenium concentration not greater than 8 mg/kg in the North Bay. The incremental increase in dissolved selenium concentrations in the North Bay, relative to Existing Conditions, would be negligible (0.00 µg/L) under this alternative. Thus, the estimated changes in selenium loads in Delta exports to San Francisco Bay due to the No Action Alternative are not expected to result in adverse effects to beneficial uses or substantially degrade the water quality with regard to selenium, or make the existing CWA Section 303(d) impairment measurably worse.

Microcystis

Microcystis has not been detected in embayments of the San Francisco Bay downstream of Suisun Bay. Low levels of microcystins occur throughout San Francisco Bay, but their concentrations do not correspond to *Microcystis* abundance, nor is there evidence that they have been transported downstream from *Microcystis* blooms that have occurred in the Delta (Senn and Novick 2013). The low levels of microcystins present in San Francisco Bay are likely derived from cyanobacteria besides *Microcystis*, such as *Cyanobium sp.* and *Synechocystis*, which are currently resident in the San Francisco Bay at levels well below bloom magnitude (Senn and Novick 2013). Elevated microcystin levels could occur at various locations in the Delta during *Microcystis* blooms under the No Action Alternative, but because of the sufficient dilution available in San Francisco Bay, downstream transport of Delta-derived microcystins are not expected to result in measurable changes in the microcystin levels of San Francisco Bay.

The absence of *Microcystis* in San Francisco Bay is likely directly related to its intolerance of elevated salinity, as its growth ceases and breakdown of its cellular tissues starts at salinities of 10–12.6 ppt (Tonk et al. 2007; Black et al. 2011). San Pablo Bay is the only embayment of San Francisco Bay downstream of Suisun Bay that would experience salinities of this magnitude for any significant duration of the year, although these and lower salinities would only occur under conditions of high Delta outflow. However, high Delta outflows occur during wet years and during the winter and spring runoff season, under which water temperatures are expected to be low, turbidity high, and water residence times low, making the environment of San Pablo Bay unsuitable for *Microcystis* growth. Additionally, these hydrodynamics conditions typically only occur when the potential for *Microcystis* blooms to occur upstream of, and thus potentially seed *Microcystis* to, San Pablo Bay are minimal. The No Action Alternative is not expected to result in significant modification to net Delta outflows or the timing of high outflow events related to wet season runoff. Thus, the effects of the No Action Alternative on *Microcystis* levels in San Francisco Bay are expected to be negligible.

CEQA Conclusion: Based on the above, the No Action Alternative would not be expected to cause long-term degradation of water quality in San Francisco Bay resulting in sufficient use of available assimilative capacity such that occasionally exceeding water quality objectives/criteria would be likely and would result in substantially increased risk for adverse effects to one or more beneficial uses. Further, based on the above, this alternative would not be expected to cause additional exceedance of applicable water quality objectives/criteria in the San Francisco Bay by frequency, magnitude, and geographic extent that would cause significant impacts on any beneficial uses of waters in the affected environment. Any changes in boron, bromide, chloride, and DOC in the San Francisco Bay would not adversely affect beneficial uses, because the uses most affected by changes in these parameters, MUN and AGR, are not beneficial uses of the Bay. Further, no substantial changes in dissolved oxygen, pathogens, pesticides, trace metals or turbidity or TSS are anticipated in the Delta, relative to Existing Conditions, therefore, no substantial changes these constituents levels in the Bay are anticipated. Changes in Delta salinity would not contribute to measurable changes in Bay salinity, as the change in Delta outflow would two to three orders of magnitude lower than (and thus minimal compared to) the Bay's tidal flow. Adverse changes in Microcystis levels that could occur in the Delta would not cause adverse Microcystis blooms in the Bay, because Microcystis are intolerant of the Bay's high salinity and, thus not have not been detected downstream of Suisun Bay. The 32% reduction in total nitrogen load and 5% increase in phosphorus load, relative to Existing Conditions, are expected to have minimal effect on water quality degradation, primary productivity, or phytoplankton community composition. The estimated increase in mercury load (3 kg/yr; 1%) and methylmercury load (0.09 kg/yr; 3%), relative to Existing Conditions, is within the level of uncertainty in the mass load estimate and not expected to contribute to water quality degradation, make the CWA section 303(d) mercury impairment measurably worse or cause mercury/methylmercury to bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. The estimated increase in selenium load would be 3%, but estimated total and dissolved selenium concentrations under the No Action Alternative would be the same as Existing Conditions, and less than the target associated with white sturgeon whole-body fish tissue levels for the North Bay. Thus, the small increase in selenium load is not expected to contribute to water quality degradation, or make the CWA section 303(d) selenium impairment measurably worse or cause selenium to bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant.

8.3.2.2 Alternative 1A—Dual Conveyance with Pipeline/Tunnel and Intakes 1–5 (15,000 cfs; Operational Scenario A)

Impact WQ-5: Effects on Bromide Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of ~~CM2-22~~CM2–~~ through ~~CM2~~22~~21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for ~~CM2-22~~CM2–~~ through~~ CM2~~22~~21. See section 8.3.1.3 for more information.

Using the mass-balance modeling approach for bromide (see Section 8.3.1.3), relative to Existing Conditions, Alternative 1Awould result in small decreases in long-term average bromide concentration at most Delta assessment locations, with the exceptions being the North Bay Aqueduct at Barker Slough, Staten Island, and Emmaton on the Sacramento River (Appendix 8E, *Bromide*, Table 4). Overall effects would be greatest at Barker Slough, where predicted long-term average bromide concentrations would increase from 51 µg/L to 71 µg/L (38% relative increase) for the modeled 16-year hydrologic period and would increase from 54 µg/L to 104 µg/L (94% relative increase) for the modeled drought period. At Barker Slough, the predicted 50 µg/L bromide threshold exceedance frequency would increase from 49% under Existing Conditions to 51% under Alternative 1A(55% to 75% during the modeled drought period) and the predicted 100 µg/L exceedance frequency would increase from 0% under Existing Conditions to 22% under Alternative 1A(0% to 48% during the modeled drought period). In contrast, increases in bromide at Staten Island would result in a 50 µg/L bromide threshold exceedance increase from 47% under Existing Conditions to 73% under Alternative 1A(52% to 75% during the modeled drought period). However, unlike Barker Slough, modeling shows that the long-term average bromide concentrations at Staten Island would exceed the 100 µg/L assessment threshold concentration 1% under Existing Conditions and 3% under Alternative 1A(0% to 2% during the modeled drought period) (Appendix 8E, *Bromide*, Table 4). The long-term average bromide concentrations would be about 61 µg/L (62 µg/L during the modeled drought period) at Staten Island under Alternative 1A. Changes in exceedance frequency of the 50 µg/L and 100 µg/L concentration thresholds, as well as relative change in long-term average concentration, at other assessment locations would be less substantial. The comparison to Existing Conditions reflects changes in bromide due to both Alternative 1A operations (including north Delta intake capacity of 15,000 cfs and numerous other operational components of Scenario A) and climate change/sea level rise.

In comparison, Alternative 1A relative to the No Action Alternative would result in predicted increases in long-term average bromide concentrations at all locations with the exception of the Banks and Jones pumping plants (Appendix 8E, *Bromide*, Table 4). Increases would be greatest at Barker Slough, where long-term average concentrations are predicted to increase by about 43% (93% for the modeled drought period). Increases in long-term average bromide concentrations would be less than 27% at the remaining assessment locations. Due to the relatively small differences between modeled Existing Conditions and No Action Alternative, changes in the frequency with which concentration thresholds of 50 μg/L and 100 μg/L are exceeded are of similar magnitude to those previously described for the existing condition comparison (Appendix 8E, *Bromide,* Table 4).Unlike the comparison to Existing Conditions, the comparison to the No Action Alternative reflects changes in bromide due only to operations.

At Barker Slough, modeled long-term average bromide concentrations for the two baseline conditions are very similar (Appendix 8E, *Bromide*, Tables 4~~-~~ and 5). Such similarity demonstrates that the modeled Alternative 1A change in bromide is almost entirely due to Alternative 1A operations, and not climate change/sea level rise. Therefore, operations are the primary driver of effects on bromide at Barker Slough, regardless of whether Alternative 1A is compared to Existing Conditions, or compared to the No Action Alternative. Results of the modeling approach, which used relationships between EC and chloride and between chloride and bromide (see Section 8.3.1.3), differed somewhat from what is presented above for the mass-balance approach (see Appendix 8E, *Bromide*, Table 5).For most locations, the frequency of exceedance of the 50 μg/L and 100 μg/L were similar. The greatest difference between the methods was predicted for Barker Slough. The increases in frequency of exceedance of the 100 μg/L threshold, relative to Existing Conditions and the No Action Alternative, were not as great using this alternative EC to chloride and chloride to bromide relationship modeling approach as compared to that presented above from the mass-balance modeling approach. However, there were still substantial increases, resulting in 10% exceedance over the modeled period under Alternative 1A, as compared to 1% under Existing Conditions, and 2% under the No Action Alternative. For the drought period, exceedance frequency increased from 0% under Existing Conditions and the No Action Alternative, to 22% under Alternative 1A.Because the mass-balance approach predicts a greater level of impact at Barker Slough, determination of impacts was based on the mass-balance results.

The increase in long-term average bromide concentrations predicted at Barker Slough, principally the relative increase in the 100 μg/L exceedance frequency, would result in a substantial change in source water quality to existing drinking water treatment plants drawing water from the North Bay Aqueduct. Drinking water treatment plants in this region utilize a variety of conventional and enhanced treatment systems to achieve DBP drinking water criteria. Depending on the necessary disinfection requirements surrounding removal of pathogenic organisms, as well as the aggregate quality of water such as pH and alkalinity, a change in long-term average bromide of the magnitude predicted may necessitate changes in treatment plant operation or treatment plant facilities in order to maintain DBP compliance. For example, for a water treatment plant utilizing ozone to achieve disinfection equivalent to 1 or 2 log inactivation of *Giardia*, an increase in long-term average bromide above 50 μg/L may require pH control systems (California Urban Water Agencies 1998:4-18). For a water treatment plant utilizing chlorine to achieve 1 or 2 log inactivation of *Giardia*, an increased frequency of bromide in excess 100 μg/L may require a switch to ozonation with pH control (California Urban Water Agencies 1998: 4-20). While the implications of such a modeled change in bromide at Barker Slough are difficult to predict, the substantial modeled increases could lead to adverse changes in the formation of disinfection byproducts such that considerable water treatment plant upgrades would be necessary in order to achieve equivalent levels of health protection. This would be an adverse effect. Because many of the other modeled locations already frequently exceed the 100 μg/L threshold under Existing Conditions and the No Action Alternative, these locations likely already require treatment plant technologies to achieve equivalent levels of health protection, and thus no additional treatment technologies would be triggered by the small increases in the frequency of exceeding the 100 µg/L threshold. Hence, no further impact on the drinking water beneficial use would be expected at these locations.

The seasonal intakes at Mallard Slough and city of Antioch are infrequently used because of water quality constraints related to sea water intrusion. On a long-term average, bromide at these locations exceeds 3,000 µg/L, but during seasonal periods of high Delta outflow levels can be <300 µg/L. Based on modeling using the mass-balance approach, use of the seasonal intakes at Mallard Slough and city of Antioch under Alternative 1Awould experience a period average increase in bromide during the months when these intakes would most likely be utilized. For those wet and above normal water year types where mass balance modeling would predict water quality typically suitable for diversion, predicted long-term average bromide would increase from 103 µg/L to 173 µg/L (68% increase) at city of Antioch and would increase from 150 µg/L to 204 µg/L (36% increase) at Mallard Slough relative to Existing Conditions (Appendix 8E, *Bromide,* Table 23). Increases would be similar for the No Action Alternative comparison. Modeling results using the EC to chloride and chloride to bromide relationships show increases during these months, but the relative magnitude of the increases is much lower (Appendix 8E, *Bromide*, Table 24).Regardless of the differences in the data between the two modeling approaches, the decisions surrounding the use of these seasonal intakes is largely driven by acceptable water quality, and thus have historically been opportunistic. Opportunity to use these intakes would remain, and the predicted increases in bromide concentrations at the city of Antioch and Mallard Slough intake would not be expected to adversely affect MUN beneficial uses, or any other beneficial use, at these locations.

Important to the results presented above is the assumed habitat restoration footprint on both the temporal and spatial scales incorporated into the modeling. Modeling sensitivity analyses have indicated that habitat restoration (which are reflected in the modeling—see Section 8.3.1.3), not operations covered under CM1, are the driving factor in the modeled bromide increases. The timing, location, and specific design of habitat restoration will have effects on Delta hydrodynamics, and any deviations from modeled habitat restoration and implementation schedule will lead to different outcomes. Although habitat restoration near Barker Slough is an important factor contributing to modeled bromide concentrations at the North Bay Aqueduct, BDCP habitat restoration elsewhere in the Delta can also have large effects. Because of these uncertainties, and the possibility of adaptive management changes to BDCP restoration activities, including location, magnitude, and timing of restoration, the estimates are not predictive of the bromide levels that would actually occur in Barker Slough or elsewhere in the Delta.

Mitigation Measure WQ-5: Avoid, Minimize, or Offset, as Feasible, Adverse Water Quality Conditions; Site and Design Restoration Sites to Reduce Bromide Increases in Barker Slough

It remains to be determined whether, or to what degree, the available and existing salinity response and countermeasure actions of SWP and CVP facilities or municipal water purveyors would be capable of offsetting the actual level of changes in bromide that may occur from implementation of Alternative 1A. Therefore, to determine the feasibility of reducing the effects of increased bromide levels, and potential adverse effects on beneficial uses associated with CM1 operations (and hydrodynamic effects of tidal restoration under CM4), the proposed mitigation requires a series of phased actions to identify and evaluate existing and possible feasible actions, followed by development and implementation of the actions, if determined to be necessary. The development and implementation of any mitigation actions shall be focused on those incremental effects attributable to implementation of Alternative 1A operations only.

Development of mitigation actions for the incremental bromide effects attributable to climate change/sea level rise are not required because these changed conditions would occur with or without implementation of Alternative 1A.The goal of specific actions would be to reduce/avoid additional degradation of Barker Slough water quality conditions with respect to the CALFED bromide goal.

BDCP proponents shall consider effects of site-specific restoration areas proposed under CM4 on bromide concentrations in Barker Slough. Design and siting of restoration areas shall attempt to reduce potential effects to the extent possible without compromising proposed benefits of the restoration areas. It is anticipated that these efforts will be able to reduce the level of projected increase, though it is unknown whether it would be able to completely eliminate any increases.

Additionally, fFollowing commencement of initial operations of CM1, the BDCP proponents will conduct additional evaluations described herein, and develop additional modeling (as necessary), to define the extent to which modified operations could reduce or eliminate the increased bromide concentrations currently modeled to occur under Alternative 1A. The additional evaluations should also consider specifically the changes in Delta hydrodynamic conditions associated with tidal habitat restoration under CM4 (in particular the potential for increased bromide concentrations that could result from increased tidal exchange) once the specific restoration locations are identified and designed. The evaluations will also consider up-to-date estimates of climate change and sea level rise, if and when such information is available. If sufficient operational flexibility to offset bromide increases is not practicable/feasible under Alternative 1A operations, and/or siting and design of restoration areas cannot feasibly reduce bromide increases to a less than significant level without compromising the benefits of the proposed areas, achieving bromide reduction pursuant to this mitigation measure would not be feasible under this alternative.If sufficient operational flexibility to offset bromide increases is not practicable/feasible under Alternative 1A operations, achieving bromide reduction pursuant to this mitigation measure would not be feasible under this alternative.

Impact WQ-7: Effects on Chloride Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2-22CM2– through CM2221 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for CM2-22CM2– through CM2221. See section 8.3.1.3 for more information.

Relative to Existing Conditions, modeling predicts that Alternative 1A would result in decreased long-term average chloride concentration at some assessment locations for the 16-year period modeled (i.e., 1976–1991), in particular at interior and south Delta assessment locations (i.e., San Joaquin River at Buckley Cove, Franks Tract, and Old River at Rock Slough) (Appendix 8G, *Chloride*, Table Cl-7 and Table Cl-8) Long-term average chloride concentrations would remain relatively unchanged at the San Joaquin River at Antioch and Contra Costa Canal at Pumping Plant #1 locations, and, depending on modeling approach (see Section 8.3.1.3), would increase at the Sacramento River at Emmaton (i.e., ≤18%), Sacramento River at Mallard Island (i.e., ≤6%), North Bay Aqueduct at Barker Slough (i.e., ≤32%), and ~~San Joaquin River~~SF Mokelumne at Staten Island (i.e., ≤21%). Additionally, implementation of tidal habitat restoration under CM4 would increase the tidal exchange volume in the Delta, and thus may contribute to increased chloride concentrations in the Bay source water as a result of increased salinity intrusion. More discussion of this the assessment methods for changes in source water concentrations caused by project-related hydrodynamic changes is included in Section 8.3.1.3. Consequently, while uncertain, the magnitude of chloride increases may be greater than indicated herein and would have the greatest effect on the western Delta assessment locations which are influenced to the greatest extent by the Bay source water. The comparison to Existing Conditions reflects changes in chloride due to both Alternative 1A operations (including north Delta intake capacity of 15,000 cfs and numerous other operational components of Scenario A) and climate change/sea level rise.

Relative to the No Action Alternative conditions, the mass balance analysis of modeling results indicated that Alternative 1A would result in increased long-term average chloride concentrations for the 16-year period modeled at nine of the Delta assessment locations (Appendix 8G, Table Cl-7). The increases in long-term average chloride concentrations would be largest compared to the No Action Alternative condition, ranging from 2% at the San Joaquin River at Buckley Cove to 36% at the North Bay Aqueduct at Barker Slough. The comparison to the No Action Alternative reflects chloride changes due only to operations.

The following discussion outlines the modeled chloride changes relative to Existing Conditions and the No Action Alternative regarding the applicable objectives and beneficial uses of Delta waters.

Municipal and Industrial Beneficial Uses–Relative to Existing Conditions

Estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3) were used to evaluate the 150 mg/L Bay-Delta WQCP objective for municipal and industrial beneficial uses on a basis of the percent of years the chloride objective is exceeded for the modeled 16-year period. The objective is exceeded if chloride concentrations exceed 150 mg/L for a specified number of days in a given water year at both the Antioch and Contra Costa Pumping Plant #1 locations. For Alternative 1A, the modeled frequency of objective exceedance would ~~approximately double~~increase from ~~6~~7% of modeled years under Existing Conditions, to 13% of modeled years under Alternative 1A (Appendix 8G, Table Cl-64).

Similarly, estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3) were also used to evaluate the 250 mg/L Bay-Delta WQCP objective for chloride at Contra Costa Pumping Plant #1 where daily average objectives apply. The basis for the evaluation was the predicted number of days the objective was exceeded for the modeled 16-year period. For Alternative 1A, the modeled frequency of objective exceedance would decrease by approximately one half, from 6% of modeled days under Existing Conditions, to 3% of modeled days under Alternative 1A (Appendix 8G, *Chloride,* Table Cl-63).Given the limitations inherent to estimating future chloride concentrations (see Section 8.3.1.3), estimation of chloride concentrations through both amass balance approach and an EC-chloride relationship approach was used to evaluate the 250 mg/L Bay-Delta WQCP objectives in terms of both frequency of exceedance and use of assimilative capacity. When utilizing the mass balance approach to model monthly average chloride concentrations for the 16-year period, the predicted frequency of exceeding the 250 mg/L objective would increase at the San Joaquin River at Antioch location from 66% under

Existing Conditions to 74%, and would increase by 2% at the Sacramento River at Mallard Island location (i.e., from 85% under Existing Conditions to 87%) (Appendix 8G, Table Cl-9). The increased chloride concentrations at the Antioch and Mallard Slough locations would occur during the months of January through June, thus reducing water quality during the period of seasonal freshwater diversions (Appendix 8G, Figure Cl-1). The available assimilative capacity would decrease substantially at the Antioch location in the months of March and April (i.e., maximum reduction of 66% for the 16-year period modeled, and 100% reduction, or elimination of assimilative capacity, during the drought period modeled) (Appendix 8G, Table Cl-9). Similar to modeling results that predicted daily exceedance frequency, the frequency of monthly average exceedances at the Contra Costa Canal at Pumping Plant #1 would decrease (Appendix 8G, Table Cl-9); however, available assimilative capacity would be reduced compared to the Existing Conditions up to 100% in October (i.e., eliminated) (Appendix 8G, Table Cl-11). Additional long-term degradation at the Antioch and Contra Costa Canal at Pumping Plant #1 locations would occur when chloride concentrations would be near, or exceed, the objectives, thus increasing the risk of exceeding objectives.

In comparison, when utilizing the chloride-EC relationship to model monthly average chloride concentrations for the 16-year period, trends in frequency of exceedance and use of assimilative capacity would be similar to that discussed when utilizing the mass balance modeling approach (Appendix 8G, *Chloride,* Table Cl-10 and Table Cl-12).However, the predicted magnitude change at western Delta locations are substantially different when the predictions from both modeling approaches are compared. For example, both modeling approaches indicated that the frequency of exceeding the 250 mg/L objective at Contra Costa Canal at Pumping Plant #1 on a monthly average basis would decrease relative to Existing Conditions, but their predictions of the magnitude use of assimilative capacity varied substantially. Modeling using the mass balance approach predicted that 100% of assimilative capacity would be utilized in October, but modeling using the chloride-EC relationship approach predicted that only 20% of assimilative capacity would be utilized. As discussed in Section 8.3.1.3, in cases of such disagreement, the approach that yielded the more conservative predictions was used as the basis for determining adverse impacts.

Based on the additional predicted seasonal and annual exceedances of one or both Bay Delta WQCP objectives for chloride, and the associated long-term water quality degradation and use of assimilative capacity, the potential exists for adverse effects on the municipal and industrial beneficial uses in the western Delta, particularly at the Contra Costa Pumping Plant #1 and Antioch locations.

303(d) Listed Water Bodies–Relative to Existing Conditions

With respect to the 303(d) listing for chloride in Tom Paine Slough, the monthly average chloride concentrations for the 16-year period modeled at Old River at Tracy Road would generally be similar or lower compared to Existing Conditions, and thus, would not be further degraded on a long-term basis (Appendix 8G, Figure Cl-2). With respect to Suisun Marsh, the long-term average chloride concentration at the Sacramento River at Mallard Island for the 16-year period modeled would increase by 91 mg/L (4%) compared to Existing Conditions (Appendix 8G, Table Cl-7) and chloride concentrations would increase in some months during October through May at Mallard Island (Appendix 8G, Figure Cl-1) and in the Sacramento River at Collinsville (Appendix 8G, Figure Cl-3). Monthly average chloride concentrations at the Montezuma Slough at Beldon's Landing would increase substantially compared to Existing Conditions in October through May, with over a doubling of concentrations in December through February (Appendix 8G, Figure Cl-4). However, modeling of Alternative 1A assumed no operation of the Montezuma Slough Salinity Control Gates, but the project description assumes continued operation of the Salinity Control Gates, consistent with assumptions included in the No Action Alternative. A sensitivity analysis modeling run conducted for Alternative 4 with the gates operational consistent with the No Action Alternative resulted in substantially lower EC levels than indicated in the original Alternative 4 modeling results for Suisun Marsh, but EC levels were still somewhat higher than EC levels under Existing Conditions for several locations and months. Although chloride was not specifically modeled in these sensitivity analyses, it is expected that chloride concentrations would be nearly proportional to EC levels in Suisun Marsh. Another modeling run with the gates operational and restoration areas removed resulted in EC levels nearly equivalent to Existing Conditions, indicating that design and siting of restoration areas has notable bearing on EC levels at different locations within Suisun Marsh (see Appendix 8H Attachment 1 for more information on these sensitivity analyses). These analyses also indicate that increases in salinity are related primarily to the hydrodynamic effects of CM4, not operational components of CM1. Based on the sensitivity analyses, optimizing the design and siting of restoration areas may limit the magnitude of long-term chloride increases in the Marsh. However, the chloride concentration increases at certain locations could be substantial, depending on siting and design of restoration areas. Thus, these increased chloride levels in Suisun Marsh are considered to contribute to additional, measureable long-term degradation that potentially would adversely affect the necessary actions to reduce chloride loading for any TMDL that is developed.

~~Therefore, additional, measurable long-term degradation would occur in Suisun Marsh that potentially would adversely affect the necessary actions to reduce chloride loading for any TMDL that is developed.~~

Municipal Beneficial Uses–Relative to No Action Alternative

Similar to the assessment conducted for Existing Conditions, estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3) were used to evaluate the 150 mg/L Bay-Delta WQCP objective for municipal and industrial beneficial uses. For Alternative 1A, the modeled frequency of objective exceedance would increase ~~by 6%~~from 0% under the No Action Alternative to 13% of years under Alternative 1A (Appendix 8G, Table Cl-64).

Similarly, estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3) were also used to evaluate the 250 mg/L Bay-Delta WQCP objective for chloride at Contra Costa Pumping Plant #1 where daily average objectives apply. For Alternative 1A, the modeled frequency of objective exceedance would decrease from 5% of modeled days under the No Action Alternative to 3% of modeled days under Alternative 1A (Appendix 8G, Table Cl-63).

Similar to Existing Conditions, a comparative assessment of modeling approaches was utilized to evaluate the 250 mg/L Bay-Delta WQCP objectives in terms of both frequency of exceedance and use of assimilative capacity on a monthly average basis. When utilizing the mass balance approach to model monthly average chloride concentrations for the 16-year period, the exceedance frequency of the 250 mg/L objective is predicted relative to the No Action Alternative would increase slightly by 1% at the Antioch location (i.e., from 73% to 74%),by 7% at the Contra Costa Canal at Pumping Plant #1 (i.e., from 14% to 21%), and by 1% at Mallard Island (i.e., from 86% to 87%) (Appendix 8G, *Chloride,* Table Cl-9). The available assimilative capacity for the 16-year period modeled would be reduced at the Antioch location during the months of February and March by approximately 28% and44%, respectively, compared to the No Action Alternative (Appendix 8G, Table Cl-11). The available assimilative capacity would be reduced at the Contra Costa Canal at Pumping Plant #1 in September through April compared to the No Action Alternative (i.e., reduction ranging from 18% in

January up to 100%, or eliminated, in October), reflecting substantial degradation during the months October through December when average concentrations would be near, or exceed, the objective.

In comparison, when utilizing the chloride-EC relationship to model monthly average chloride concentrations for the 16-year period, trends in frequency of exceedance and use of assimilative capacity would be similar to that discussed when utilizing the mass balance modeling approach (Appendix 8G, Table Cl-10 and Table Cl-12).But like the assessment relative to Existing Conditions, the predicted magnitude change at western Delta locations are substantially different. For example, both modeling approaches indicated that the frequency of exceeding the 250 mg/L objective at Contra Costa Pumping Plant #1 on a monthly average basis would increase slightly or remain unchanged relative to the No Action Alternative. Modeling using the mass balance approach predicted that 100% of assimilative capacity would be utilized in October, but modeling using the chloride-EC relationship approach predicted that only 35% would be utilized under the No Action Alternative. As discussed in Section 8.3.1.3, in cases of such disagreement, the approach that yielded the more conservative predictions was used as the basis for determining adverse impacts.

Based on the additional predicted seasonal and annual exceedances of one of both Bay Delta WQCP objectives for chloride, and the associated long-term water quality degradation, the potential exists for adverse effects on the municipal and industrial beneficial uses in the western Delta, particularly at the Antioch intake, through reduced opportunity for diversion of water with acceptable chloride levels.

303(d) Listed Water Bodies–Relative to No Action Alternative

With respect to the 303(d) listing for chloride, relative to the No Action Alternative, monthly average chloride concentrations near Tom Paine Slough for the 16-year period modeled would not be further degraded under Alternative 1A (Appendix 8G, Figure Cl-2); however, modeling results indicate that concentrations at source water channel locations for the Suisun Marsh would increase in some months during October through May compared to the No Action Alternative (Appendix 8G, Figures Cl-1, Cl-3 and Cl-4). Sensitivity analyses suggested that operation of the Salinity Control Gates and restoration area siting and design considerations could reduce these increases. However, the chloride concentration increases at certain locations could be substantial, depending on siting and design of restoration areas. Thus, these increased chloride levels in Suisun Marsh are considered to contribute to additional, measureable long-term degradation in Suisun Marsh that potentially would adversely affect the necessary actions to reduce chloride loading for any TMDL that is developed.

~~Therefore, additional, measurable long-term degradation would occur in Suisun Marsh that potentially would adversely affect the necessary actions to reduce chloride loading for any TMDL that is developed.~~

NEPA Effects: In summary, relative to the No Action Alternative, Alternative 1A would result in increased water quality degradation and frequency of exceedance of the 150 mg/L objective at Contra Costa Pumping Plant #1 and Antioch, the 250 mg/L municipal and industrial objective at interior and western Delta locations on a monthly average chloride basis, and could contribute measureable water quality degradation relative to the 303(d) impairment in Suisun Marsh. The predicted chloride increases constitute an adverse effect on water quality(see Mitigation Measure WQ-7 below; implementation of this measure along with a separate, non-environmental commitment relating to the potential increased chloride treatment costs would reduce these effects).Additionally, the predicted changes relative to the No Action Alternative indicate that implementation of CM1 and CM4 under Alternative 1A would contribute substantially to the adverse water quality effects (i.e., impacts are not wholly attributable to the effects of climate change/sea level rise).

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Chloride is not a constituent of concern in the Sacramento River watershed upstream of the Delta, thus river flow rate and reservoir storage reductions that would occur under the Alternative 1A, relative to Existing Conditions, would not be expected to result in a substantial adverse change in chloride levels. Additionally, relative to Existing Conditions, the Alternative 1A would not result in reductions in river flow rates (i.e., less dilution) or increased chloride loading such that there would be any substantial increase in chloride concentrations upstream of the Delta in the San Joaquin River watershed.

Relative to Existing Conditions, Alternative 1A would result in substantially increased chloride concentrations in the Delta such that frequency of exceedances of the 150 mg/L Bay-Delta WQCP objective would approximately double. Moreover, the frequency of exceedance of the 250 mg/L Bay-Delta WQCP objective would increase at Antioch (by 8%) and at Mallard Slough (by 2%) which could result in significant impacts on the municipal and industrial water supply beneficial use at these locations (see Mitigation Measure WQ-7 below; implementation of this measure along with a separate, non-environmental commitment relating to the potential increased chloride treatment costs would reduce these effects). Additionally, further long-term degradation would occur at Antioch, Mallard Slough, and Contra Costa Canal at Pumping Plant #1 locations when chloride concentrations would be near, or exceed, the objectives, thus increasing the risk of exceeding objectives. Relative to the Existing Conditions, the modeled increased chloride concentrations and degradation in the western Delta could further contribute, at measurable levels ~~(i.e., over a doubling of concentrations)~~ to the existing 303(d) listed impairment due to chloride in Suisun Marsh for the protection of fish and wildlife. However, based on sensitivity analyses conducted to date (see Appendix 8H Attachment 1), it is expected that implementation of WQ-7d will be able to reduce impacts on chloride in Suisun Marsh to a less than significant level.

Chloride concentrations would be reduced in water exported from the Delta to the CVP/SWP Export Service Areas, thus reflecting a potential improvement to chloride loading in the lower San Joaquin River.

Chloride is not a bioaccumulative constituent, thus any increased concentrations under Alternative 1A would not result in substantial chloride bioaccumulation impacts on aquatic life or humans. Alternative 1A maintenance would not result in any substantial changes in chloride concentration upstream of the Delta or in the SWP/CVP Export Service Areas. However, based on these findings, this impact would be significant due to increased chloride concentrations and degradation at western Delta locations and its impacts on municipal and industrial water supply and fish and wildlife beneficial uses.

~~While mitigation measures to reduce these water quality effects in affected water bodies to less than significant levels are not available~~ Implementation of Mitigation Measure WQ-7 along with a separate, non-environmental commitment relating to the potential increased costs associated with chloride-related changes would reduce these effects. Although it is not known whether implementation of WQ-7 will be able to feasibly reduce water quality degradation in the western Delta, implementation of Mitigation Measure WQ-7 is recommended to attempt to reduce the effect that increased chloride concentrations may have on Delta beneficial uses. However, because the effectiveness of this mitigation measure to result in feasible measures for reducing these water quality effects is uncertain, this impact is considered to remain significant and unavoidable. As mentioned above, it is expected that implementation of WQ-7d will be able to reduce impacts on chloride in Suisun Marsh to a less than significant level. ~~However, because the effectiveness of this mitigation measure to result in feasible measures for reducing water quality effects is uncertain, this impact is considered to remain significant and unavoidable.~~

In addition to and to supplement Mitigation Measure WQ-7, the BDCP proponents have incorporated into the BDCP, as set forth in EIR/EIS Appendix 3B, *Environmental Commitments*, a separate, non-environmental commitment to address the potential increased water treatment costs that could result from chloride concentration effects on municipal, industrial and agricultural water purveyor operations. Potential options for making use of this financial commitment include funding or providing other assistance towards acquiring alternative water supplies or towards modifying existing operations when chloride concentrations at a particular location reduce opportunities to operate existing water supply diversion facilities. Please refer to Appendix 3B, *Environmental Commitments*, for the full list of potential actions that could be taken pursuant to this commitment in order to reduce the water quality treatment costs associated with water quality effects relating to chloride, electrical conductivity, and bromide.

Mitigation Measure WQ-7: Conduct Additional Evaluation and Modeling of Increased Chloride Levels and Develop and Implement Phased Mitigation Actions

It is currently unknown whether the effects of increased chloride levels, and potential adverse effects on municipal and industrial water supply and fish and wildlife beneficial uses associated with CM1 operations (and hydrodynamic effects of tidal restoration under CM4), can be mitigated through modifications to initial operations and/or site-specific design of tidal restoration areas under CM4. Therefore, the proposed mitigation measures require a series of actions to identify and evaluate potentially feasible actions, to achieve reduced chloride levels in order to reduce or avoid impacts to beneficial uses.

Regarding exceedance of Bay Delta WQCP water quality objectives for chloride, staff from DWR and Reclamation shall continue to constantly monitor Delta water quality conditions and adjust operations of the SWP and CVP in real time as necessary to meet water quality objectives. These decisions take into account real-time conditions and are able to account for many factors that the best available models cannot simulate. DWR and Reclamation have a good history of compliance with water quality objectives (see section 8.3.1.4 and 8.3.1.7 for more detail). Considering these real-time actions, the good history of compliance with objectives, and the uncertainty inherent in the modeling approach (as discussed in section 8.3.1.1 and 8.3.1.3), it is likely that objective exceedance, should any be predicted to occur, could be avoided through real-time operation of the SWP and CVP.

Nevertheless, water quality degradation could occur that may not be addressed through real-time operations. The development and implementation of any mitigation actions shall be focused on those incremental effects attributable to implementation of Alternative 1A operations only. Development of mitigation actions for the incremental chloride effects attributable to climate change/sea level rise are not required because these changed conditions would occur with or without implementation of Alternative 1A.

Mitigation Measure WQ-7a: Conduct Additional Evaluation of Operational Ability to Reduce or Eliminate Water Quality Degradation in Western Delta Incorporating Site-Specific Restoration Areas and Updated Climate Change/Sea Level Rise Projections, if Available

The BDCP proponents will conduct additional evaluations and develop additional modeling (as necessary) to define the extent to which modified operations of the SWP and CVP could reduce or eliminate water quality degradation relative to the 250 mg/L Bay-Delta WQCP objective for chloride currently modeled to occur under Alternative 1A. The additional evaluations will be conducted to consider specifically the changes in Delta hydrodynamic conditions associated with tidal habitat restoration under CM4 once the specific restoration locations and timing of their construction are identified and designed. The evaluations will also consider up-to-date estimates of climate change and sea level rise, if and when such information is available. These evaluations will be conducted concurrently with Mitigation Measure WQ-7b. Together, findings from WQ-7a and WQ-7b will indicate whether sufficient flexibility to prevent or offset chloride increases is feasible under Alternative 1A.

Mitigation Measure WQ-7b: Site and Design Restoration Sites to Reduce or Eliminate Water Quality Degradation in the Western Delta

BDCP proponents shall consider effects of site-specific restoration areas proposed under CM4 on chloride concentrations in the western Delta. Design and siting of restoration areas shall attempt to reduce water quality degradation with respect to the 250 mg/L chloride objective in the western Delta to the extent possible without compromising proposed benefits of the restoration areas. These evaluations will be conducted concurrently with Mitigation Measure WQ-7a. Together, findings from WQ-7a and WQ-7b will indicate whether sufficient flexibility to prevent or offset chloride increases is feasible under Alternative 1A.

Mitigation Measure WQ-7c: Consult with Delta Water Purveyors to Identify Means to Avoid, Minimize, or Offset for Reduced Seasonal Availability of Water That Meets Applicable Water Quality Objectives

To determine the feasibility of reducing the effects of CM1/CM4 operations on increased chloride concentrations as shown in modeling estimates to occur to municipal and industrial water purveyors at the Antioch, Mallard Slough, and Contra Costa Canal at Pumping Plant #1 locations, the BDCP proponents will consult with the purveyors to identify any feasible operational means to either avoid, minimize, or offset for reduced seasonal availability of water that either meets applicable water quality objectives or that results in levels of degradation that do not substantially increase the risk of adversely affecting the municipal and industrial beneficial use. Any such action will be developed following, and in conjunction with, the completion of the evaluation and development of any potentially feasible actions described in Mitigation Measure WQ-7a and WQ-7b.

Mitigation Measure WQ-7d: Site and Design Restoration Sites and consult with CDFW/USFWS, and Suisun Marsh Stakeholders to Identify Potential Actions to Avoid or Reduce Chloride Concentration Increases in the Marsh

BDCP proponents shall consider effects of site-specific restoration areas proposed under CM4 on chloride concentrations in Suisun Marsh. Design and siting of restoration areas shall attempt to reduce potential effects to the extent possible without compromising proposed benefits of the restoration areas. BDCP proponents will also consult with CDFW/USFWS, and Suisun Marsh stakeholders, to identify potential actions to avoid or minimize the chloride increases in the marsh, with the goal of maintaining chloride at levels that would not further impair fish and wildlife beneficial uses in Suisun Marsh. Potential actions may include modifications of the existing Suisun Marsh Salinity Control Gates for effective salinity control and evaluation of the efficacy of additional physical salinity control facilities or operations for the marsh to reduce the effects of increased chloride levels. These actions are identical to the actions discussed in Mitigation Measure WQ-11b regarding levels of electrical conductivity in Suisun Marsh.

~~**Mitigation Measure WQ-7: Following Initial Operations of CM1, Conduct Additional Evaluation and Modeling of Chloride Levels to Determine Feasibility of Mitigation to Reduce Chloride Levels**~~

~~It is currently unknown whether the effects of increased chloride levels, and potential adverse effects on municipal and industrial water supply and fish and wildlife beneficial uses associated with CM1 operations (and hydrodynamic effects of tidal restoration under CM4), can be mitigated through modifications to initial operations.Specifically, it remains to be determined whether, or to what degree, the available and existing salinity response and countermeasure actions of SWP and CVP facilities, municipal water purveyors, or Suisun Marsh salinity control facilities would be capable of offsetting the actual level of changes in chloride that may occur from implementation of Alternative 1A. Therefore, the proposed mitigation measures require a series of actions to identify and evaluate potentially feasible actions,to achieve reduced chloride levels in order to reduce or avoid impacts to beneficial uses.~~

~~The development and implementation of any mitigation actions shall be focused on those incremental effects attributable to implementation of Alternative 1A operations only.Development of mitigation actions for the incremental chloride effects attributable to climate change/sea level rise are not required because these changed conditions would occur with or without implementation of Alternative 1A.~~

~~**Mitigation Measure WQ-7a: Conduct Additional Evaluation and Modeling of Increased Chloride Levels Following Initial Operations ofCM1**~~

~~Following commencement of initial operations of CM1, the BDCP proponentswill conduct additional evaluations described herein, and develop additional modeling (as necessary), to define the extent to which modified operations could reduce or eliminate the additional exceedances of the 250 mg/L Bay-Delta WQCP objective for chloride currently modeled to occur under Alternative 1A. The additional evaluations should also consider specifically the changes in Delta hydrodynamic conditions associated with tidal habitat restoration under CM4 (in particular the potential for increased chloride concentrations that could result from increased tidal exchange) once the specific restoration locations are identified and designed. If sufficient operational flexibility to offset chloride increases is not feasible under Alternative 1A~~

~~operations, achieving chloride reduction pursuant to this mitigation measure would not be feasible under this Alternative.~~

~~**Mitigation Measure WQ-7b: ConsultwithDelta Water Purveyors to Identify Means to Avoid, Minimize, or Offset for Reduced Seasonal Availability of Water That Meets Applicable Water Quality Objectives**~~

~~To determine the feasibility of reducing the effects of CM1/CM4 operations on increased chloride concentrations as shown in modeling estimates to occur to municipal and industrial water purveyors at the Antioch, Mallard Slough, and Contra Costa Canal at Pumping Plant #1 locations, the BDCP proponents will consult with the purveyors to identify any feasible operational means to either avoid, minimize, or offset for reduced seasonal availability of waterthat meets applicable water quality objectives and that results in levels of degradation that do not substantially increase the risk of adversely affecting the municipal and industrial beneficial use.Any such action will be developed following, and in conjunction with, the completion of the evaluation and development of anypotentially feasible actions described in Mitigation Measure WQ-7a.~~

~~**Mitigation Measure WQ-7c: Consult with CDFW/USFWS, and Suisun MarshStakeholders, to Identify Potential Actions to Avoid or Minimize ChlorideLevel Increases in the Marsh**~~

~~To determine the feasibility of reducing the effects of CM1/CM4 operations on increased chloride concentrations as shown in modeling estimates to occur in the Suisun Marsh, the BDCP proponents will consult with CDFW/USFWS, and Suisun Marsh stakeholders, to identify potential actions to avoid or minimize the chloride level increases in the marsh, with the goal of maintaining chloride at levels that would not further impair fish and wildlife beneficial uses in Suisun Marsh. Potential actions may include modifications of the existing Suisun Marsh Salinity Control Gates for effective salinity control and evaluation of the efficacy of additional physical salinity control facilities or operations for the marsh to reduce the effects of increased chloride levels. Based on the modeled conditions, the emphasis would be identification of potentially feasibleactions to reduce adverse chloride-related effects during the seasonal period of January through May. Any such action will be developed following, and in conjunction with, the completion of the evaluation and development of any feasible actions described in Mitigation Measure WQ-7a.~~

Impact WQ-9: Effects on Dissolved Oxygen Resulting from Facilities Operations and Maintenance (CM1)

CEQA Conclusion: Effects of CM1 on DO under Alternative 1A would be similar to those discussed for the No Action Alternative, and are summarized here, then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion under the No Action Alternative.

~~River flow rate and r~~Reservoir storage reductions that would occur under Alternative 1A, relative to Existing Conditions, would not be expected to result in a substantial adverse change in DO levels in the reservoirs, because oxygen sources (surface water aeration, aerated inflows, vertical mixing) would remain. Similarly, river flow rate reductions that would occur would not be expected to result in a substantial adverse change in DO levels in the ~~and~~ rivers upstream of the Delta, given that mean monthly flows would remain within the ranges historically seen under Existing Conditions and the affected river are large and turbulent. Any reduced DO saturation level that may be caused by increased water temperature would not be expected to cause DO levels to be outside of the range seen historically. Finally, amounts of oxygen demanding substances and salinity would not be expected to change sufficiently to affect DO levels.

It is expected there would be no substantial change in Delta DO levels in response to a shift in the Delta source water percentages under this alternative or substantial degradation of these water bodies, with regard to DO. DO levels would be affected by nutrient loading, which the state has begun to aggressively regulate the discharges of, and this loading would not be expected to lower DO levels relative to Existing Conditions based on historical DO levels. Further, the anticipated changes in salinity would have relatively minor effects on DO levels, and tidal exchange, which contribute to the reaeration of Delta waters would not be expected to change substantially.

There is not expected to be substantial, if even measurable, changes in DO levels in the SWP/CVP Export Service Areas waters under Alternative 1A, relative to Existing Conditions, because the biochemical oxygen demand of the exported water would not be expected to substantially differ from that under Existing Conditions (due to ever increasing water quality regulations), canal turbulence and exposure of the water to the atmosphere and the algal communities that exist within the canals would establish an equilibrium for DO levels within the canals. The same would occur in downstream reservoirs.

Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would result in significant impacts on any beneficial uses within affected water bodies. Because no substantial changes in DO levels are expected, long-term water quality degradation would not be expected to occur, and, thus, beneficial uses would not be adversely affected. Various Delta waterways are 303(d)-listed for low DO, but because no substantial decreases in DO levels would be expected, greater degradation and DO-related impairment of these areas would not be expected. This impact would be less than significant. No mitigation is required.

Impact WQ-11: Effects on Electrical Conductivity Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of ~~CM2-22~~CM2~~–through~~ CM~~22~~21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for ~~CM2-22~~CM2~~–through~~ CM~~22~~21. See section 8.3.1.3 for more information.

Relative to Existing Conditions, modeling indicates that Alternative 1A would result in an increase in the ~~fewer~~ number of days when Bay-Delta WQCP compliance locations ~~in the western, interior, and southern Delta~~ would exceed EC objectives or be out of compliance with the EC objectives at ~~, with the exception of~~the Sacramento River at Emmaton and San Joaquin River at Jersey Point (fish and wildlife objective) in the western Delta, the San Joaquin River at San Andreas Landing in the interior Delta, and Brandt Bridge in the southern Delta (Appendix 8H, *Electrical Conductivity,* Table EC-1).

The percent of days the Emmaton EC objective would be exceeded for the entire period modeled (1976–1991) would increase from 6% under Existing Conditions to ~~27~~31% under Alternative 1A. Further, the percent of days out of compliance at Emmaton would increase from 11% under Existing Conditions to ~~39~~45% under Alternative 1A.

The percent of days the San Andreas Landing EC objective would be exceeded would increase from 1% under Existing Conditions to ~~2~~3% under Alternative 1A. Further, the percent of days out of compliance with the EC objective would increase from 1% under Existing Conditions to ~~5~~6% under Alternative 1A. Sensitivity analyses were performed for Alternative 4 scenario H3, and indicated that many similar exceedances were modeling artifacts, and the small number of remaining exceedances were small in magnitude, lasted only a few days, and could be addressed with real time operations of the SWP and CVP (see Section 8.3.1.1 for a description of real time operations of the SWP and CVP). Due to similarities in the nature of the exceedances between alternatives, the findings from these analyses can be extended to this alternative as well.

At Jersey Point, relative to the fish and wildlife objective, the percent of days of EC objective exceedance and days out of compliance would increase from 0% under Existing Conditions to 3% under Alternative 1A, which represents a very small increase for this objective. Further discussion of EC increases relative to this objective can be found in Appendix 8H Attachment 2.

At Brandt Bridge, the increase in days of EC objective exceedance and days out of compliance would be <1%. Average EC levels at the western and southern Delta compliance locations, except at Emmaton in the western Delta, would decrease from 1–27% for the entire period modeled and 2–28% during the drought period modeled (1987–1991) (Appendix 8H, Table EC-12). At Emmaton, average EC would increase 16% for both the entire period modeled and the drought period modeled. Also, at the two interior Delta compliance locations, there would be increases in average EC: the S. Fork Mokelumne River at Terminous average EC would increase 4% for the entire period modeled and 3% during the drought period modeled; and San Joaquin River at San Andreas Landing average EC would increase 12% for the entire and drought periods modeled. On average, EC would increase at Emmaton during all months except October and November. Average EC would increase at San Andreas Landing during all months except November. Average EC in the S. Fork Mokelumne River at Terminous would increase during all months. Average EC at Jersey Point during the months of April–May, when the fish and wildlife objective applies in all but critical water year types, would increase ~~from~~ 15% for the entire period modeled (Appendix 8H, Table EC-12;~~)~~ further discussion of EC increases relative to this objective can be found in Appendix 8H Attachment 2). Of the Clean Water Act section 303(d) listed sections of the Delta–western, northwestern, and southern–the Sacramento River at Emmaton would have a modest increase in exceedance of the Bay-Delta WQCP EC objectives (2~~1~~5%) and the San Joaquin River at Brandt Bridge in the southern Delta would have a slight increase (<1%) in the exceedance of the Bay-Delta WQCP EC objectives (Appendix 8H, Table EC-1). Further, long-term average EC at Emmaton would increase by 16%, whereas the long-term average EC at ~~the San Joaquin River~~ Brandt Bridge would decrease by 2%, relative to Existing Conditions, for the entire period modeled (Appendix 8H, Table EC-12). Thus, Alternative 1A is not expected to contribute to additional impairment and adversely affect beneficial uses for section 303(d) listed southern Delta waterways, relative to Existing Conditions. However, the increase in incidence of exceedance of EC objectives and increases in long-term and drought period average EC at Emmaton in the western Delta, relative to Existing Conditions, has the potential to contribute to additional impairment and potentially adversely affect beneficial uses. The comparison to Existing Conditions reflects changes in EC due to both Alternative 1A operations (including north Delta intake capacity of 15,000 cfs and numerous other operational components of Scenario A) and climate change/sea level rise.

Relative to the No Action Alternative, the percent of days exceeding EC objectives and percent of days out of compliance would increase at: Sacramento River at Emmaton, San Joaquin River at Jersey Point, San Andreas Landing, Brandt Bridge, and Prisoners Point; and Old River near Middle River at Tracy Bridge (Appendix 8H, *Electrical Conductivity,* Table EC-1). The increase in percent of days exceeding the EC objective would be 2% or less and the increase in percent of days out of compliance would be ~~4~~5% or less, with the exception of Emmaton, which would have a 1~~5~~7% increase in percent of days exceeding the EC objective and ~~17~~20% increase in percent of days out of compliance. Regarding exceedances at Old River at Middle River and at Tracy Bridge, as noted in Section 8.1.3.7, SWP and CVP operations have relatively little influence on salinity levels at these locations, and the elevated salinity in south Delta channels is affected substantially by local salt contributions discharged into the San Joaquin River downstream of Vernalis. Thus, the modeling has limited ability to estimate salinity accurately in this region. Average EC would increase at some compliance locations for the entire period modeled: Sacramento River at Emmaton (15%), San Joaquin River at Jersey Point (3%), S. Fork Mokelumne River at Terminous (5%), San Joaquin River at San Andreas Landing (18%), and San Joaquin River at Prisoners Point (9%) (Appendix 8H, Table EC-12). For the drought period modeled, the locations with an average EC increase would be: Sacramento River at Emmaton (5%), S. Fork Mokelumne River at Terminous (4%), San Joaquin River at San Andreas Landing (13%), San Joaquin River at Brandt Bridge (1%), Old River at Tracy Bridge (1%), and San Joaquin River at Prisoners Point (4%) (Appendix 8H, Table EC-12). The western and southern Delta are CWA section 303(d) listed for elevated EC and the increased incidence of exceedance of EC objectives and EC degradation that could occur in the western Delta could make beneficial use impairment measurably worse. Since there would be very little change in EC levels in the southern Delta and there is not expected to be an increase in frequency of exceedances of objectives, this alternative is not expected to make beneficial use impairment measurably worse in the southern Delta. ~~Given that the western and southern Delta are Clean Water Act section 303(d) listed as impaired due to elevated EC, the increase in the incidence of exceedance of EC objectives and increases in long-term and drought period average EC at the western and southern Delta locations under Alternative 1A, relative to the No Action Alternative, has the potential to contribute to additional impairment and potentially adversely affect beneficial uses~~. The comparison to the No Action Alternative reflects changes in EC due only to Alternative 1A operations (including north Delta intake capacity of 15,000 cfs and numerous other operational components of Scenario A).

For Suisun Marsh, October–May is the period when Bay-Delta WQCP EC objectives for protection of fish and wildlife apply. Average EC for the entire period modeled would increase under Alternative 1A, relative to Existing Conditions, during the months of February through May by 0.1–0.8 mS/cm in the Sacramento River at Collinsville (Appendix 8H, Table EC-21). Long-term average EC would decrease relative to Existing Conditions in Montezuma Slough at National Steel during October–May (Appendix 8H, Table EC-22). The most substantial increase would occur near Beldon Landing, with long-term average EC levels increasing by 1.8–6.1 mS/cm, depending on the month, which would be a doubling or tripling of long-term average EC relative to Existing Conditions (Appendix 8H, Table EC-23). Sunrise Duck Club and Volanti Slough also would have long-term average EC increases during all months of 1.9–4.0 mS/cm (Appendix 8H, Tables EC-24 and EC-25). Modeling of this alternative assumed no operation of the Montezuma Slough Salinity Control Gates, but the project description assumes continued operation of the Salinity Control Gates, consistent with assumptions included in the No Action Alternative. A sensitivity analysis modeling run conducted for Alternative 4 scenario H3 with the gates operational consistent with the No Action Alternative resulted in substantially lower EC levels than indicated in the original Alternative 4 modeling results, but EC levels were still somewhat higher than EC levels under Existing Conditions and the No Action Alternative for several locations and months. Another modeling run with the gates operational and restoration areas removed resulted in EC levels nearly equivalent to Existing Conditions and the No Action Alternative, indicating that design and siting of restoration areas has notable bearing on EC levels at different locations within Suisun Marsh (see Appendix 8H Attachment 1 for more information on these sensitivity analyses). These analyses also indicate that increases are related primarily to the hydrodynamic effects of CM4, not operational components of CM1. Based on the sensitivity analyses, optimizing the design and siting of restoration areas may limit the magnitude of long-term EC increases to be on the order of 1 mS/cm or less. Due to similarities in the nature of the EC increases between alternatives, the findings from these analyses can be extended to this alternative as well.

The degree to which the long-term average EC increases in Suisun Marsh would cause exceedance of Bay-Delta WQCP objectives is unknown, because these objectives are expressed as a monthly average of daily high tide EC, which does not have to be met if it can be demonstrated “equivalent or better protection will be provided at the location” (State Water Resources Control Board 2006:14). The described long-term average EC increase may, or may not, contribute to adverse effects on beneficial uses, depending on how and when wetlands are flooded, soil leaching cycles, and how agricultural use of water is managed, and future actions taken with respect to the marsh. However, the EC increases at certain locations would could be substantial, depending on siting and design of restoration areas, and it is uncertain the degree to which current management plans for the Suisun Marsh would be able to address these substantially higher EC levels and protect beneficial uses. Thus, these increased EC levels in Suisun Marsh are considered to have a potentially adverse effect on marsh beneficial uses. Long-term average EC increases in Suisun Marsh under Alternative 1A relative to the No Action Alternative would be similar to the increases relative to Existing Conditions. Suisun Marsh is Clean Water Act section 303(d) listed as impaired due to elevated EC, and the potential increases in long-term average EC concentrations could contribute to additional impairment, because the increases would be double or triple that relative to Existing Conditions and the No Action Alternative.

NEPA Effects: In summary, the increased frequency of exceedance of EC objectives and increased long-term and drought period average EC levels that would occur at western and southern Delta compliance locations under Alternative 1A, relative to the No Action Alternative, would contribute to adverse effects on the agricultural beneficial uses. The increased frequency of exceedance of the EC objective for the San Joaquin River at Prisoners Point, and increased long-term period average EC levels between Jersey Point and Prisoners Point could contribute to adverse effects on fish and wildlife beneficial uses (specifically, indirect adverse effects on striped bass spawning), though there is a high degree of uncertainty associated with this impact. The western and southern Delta are CWA section 303(d) listed as impaired due to elevated EC, and the increase in incidence of exceedance of EC objectives and increases in long-term average and drought period average EC in the western portion of the Delta have the potential to contribute to additional beneficial use impairment. Given that the western and southern Delta are Clean Water Act section 303(d) listed as impaired due to elevated EC, the increase in the incidence of exceedance of EC objectives and increases in long-term and drought period average EC in the western and southern Delta under Alternative 1A has the potential to contribute to additional beneficial use impairment. The increases in long-term average

EC levels that ~~would~~ could occur in Suisun Marsh would further degrade existing EC levels and could contribute ~~additionally~~ to adverse effects on the fish and wildlife beneficial uses. Suisun Marsh is section 303(d) listed as impaired due to elevated EC, and the potential increases in long-term average EC levels could contribute to additional beneficial use impairment. The effects on EC in the western Delta, San Joaquin River at Prisoners Point, and in Suisun Marsh ~~These increases in EC~~ constitute an adverse effect on water quality. Mitigation Measure WQ-11 would be available to reduce these effects (implementation of this measure along with a separate, non-environmental commitment as set forth in EIR/EIS Appendix 3B, *Environmental Commitments*, relating to the potential EC-related changes would reduce these effects).

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

River flow rate and reservoir storage reductions that would occur under Alternative 1A, relative to Existing Conditions, would not be expected to result in a substantial adverse change in EC levels in the reservoirs and rivers upstream of the Delta, given that: changes in the quality of watershed runoff and reservoir inflows would not be expected to occur in the future; the state's aggressive regulation of point-source discharge effects on Delta salinity-elevating parameters and the expected further regulation as salt management plans are developed; the salt-related TMDLs adopted and being developed for the San Joaquin River; and the expected improvement in lower San Joaquin River average EC levels commensurate with the lower EC of the irrigation water deliveries from the Delta.

Relative to Existing Conditions, Alternative 1A would not result in any substantial increases in long-term average EC levels in the SWP/CVP Export Service Areas. There would be no exceedance of the EC objective at the Jones and Banks pumping plants. Average EC levels for the entire period modeled would decrease at both plants and, thus, this alternative would not contribute to additional beneficial use impairment related to elevated EC in the SWP/CVP Export Service Areas waters. Rather, this alternative would improve long-term EC levels in the SWP/CVP Export Service Areas, relative to Existing Conditions.

In the Plan Area, Alternative 1A would result in an increase in the frequency with which Bay-Delta WQCP EC objectives for agricultural beneficial use protection are exceeded in the ~~San Joaquin River at San Andreas Landing (12%; interior Delta) and~~ Sacramento River at Emmaton (2~~1~~5%; western Delta) for the entire period modeled (1976–1991). ~~Further, f~~For the entire and drought periods modeled, average EC levels would increase by 12% at San Andreas Landing and by 16% at Emmaton. In addition, there would be ~~an increase in the frequency with which the EC objective for fish and wildlife beneficial uses protection is exceeded in the San Joaquin River at Jersey Point, and an~~ an increase in the average EC at Jersey Point of 15% (for the entire period modeled) during the months of April–May, when the fish and wildlife objective applies. Because EC is not bioaccumulative, the increases in long-term average EC levels would not directly cause bioaccumulative problems in aquatic life or humans. The interior Delta is not Clean Water Act section 303(d) listed for elevated EC, however, the western Delta is. The increases in long-term and drought period average EC levels and increased frequency of exceedance of EC objectives that would occur ~~in the San Joaquin River at San Andreas Landing and~~ in the Sacramento River at Emmaton would potentially contribute to adverse effects on the agricultural beneficial uses in the ~~interior and~~

western Delta. The increased long-term period average EC levels between Jersey Point and Prisoners Point could contribute to adverse effects on fish and wildlife beneficial uses (specifically, indirect adverse effects on striped bass spawning), though there is a high degree of uncertainty associated with this impact. ~~The increases in long-term average EC levels and increased frequency of exceedance of the EC objective that would occur in the San Joaquin River at Jersey Point would potentially contribute to adverse effects on the fish and wildlife uses in the western Delta.~~ This impact is considered to be significant.

Further, relative to Existing Conditions, Alternative 1A ~~would~~ could result in substantial increases in long-term average EC during the months of October through May in Suisun Marsh~~, such that EC levels at would be up to double or triple that occurring under Existing Conditions~~. The increases in long-term average EC levels that would occur in Suisun Marsh would further degrade existing EC levels and could contribute additionally to adverse effects on the fish and wildlife beneficial uses. Because EC is not bioaccumulative, the increases in long-term average EC levels would not directly cause bioaccumulative problems in wildlife. Suisun Marsh is Clean Water Act section 303(d) listed for elevated EC and the increases in long-term average EC that would occur in the marsh could make beneficial use impairment measurably worse. This impact is considered to be significant. However, based on sensitivity analyses conducted to date (see Appendix 8H Attachment 1), it is expected that implementation of WQ-11d will be able to reduce impacts on EC in Suisun Marsh to a less than significant level.

Implementation of Mitigation Measure WQ-11 along with a separate, non-environmental commitment relating to the potential increased costs associated with EC-related changes would reduce these effects. Although it is not known whether implementation of WQ-11 will be able to feasibly reduce water quality degradation in the western Delta, implementation of Mitigation Measure WQ-11 is recommended to attempt to reduce the effect that increased EC may have on Delta beneficial uses. However, because the effectiveness of this mitigation measure to result in feasible measures for reducing these water quality effects is uncertain, this impact is considered to remain significant and unavoidable. As mentioned above, it is expected that implementation of WQ-11d will be able to reduce impacts on EC in Suisun Marsh to a less than significant level.

~~While mitigation measures to reduce these water quality effects in affected water bodies to less than significant levels are not available, implementation of Mitigation Measure WQ-11 is recommended to attempt to reduce the effect that increased EC concentrations may have on Delta beneficial uses. However,because the effectiveness of this mitigation measure to result in feasible measures for reducing water quality effects is uncertain, this impact is considered to remain significant and unavoidable.~~

In addition to and to supplement Mitigation Measure WQ-11, the BDCP proponents have incorporated into the BDCP, as set forth in EIR/EIS Appendix 3B, Environmental Commitments, a separate, non-environmental commitment to address the potential increased water treatment costs that could result from EC concentration effects on municipal, industrial and agricultural water purveyor operations. Potential options for making use of this financial commitment include funding or providing other assistance towards acquiring alternative water supplies or towards modifying existing operations when EC concentrations at a particular location reduce opportunities to operate existing water supply diversion facilities. Please refer to Appendix 3B, Environmental Commitments, for the full list of potential actions that could be taken pursuant to this commitment in order to reduce the water quality treatment costs associated with water quality effects relating to chloride, electrical conductivity, and bromide.

Mitigation Measure WQ-11: Avoid, Minimize, or Offset, as Feasible, Reduced Water Quality Conditions

~~It remains to be determined whether, or to what degree, the available and existing salinity response and countermeasure actions of SWP and CVP facilities, municipal water purveyors, or Suisun Marsh salinity control facilities would be capable of offsetting the actual level of changes in EC that may occur from implementation of Alternative 1A. Therefore,~~In order to ~~determine the feasibility of reducing~~reduce the effects of increased EC levels, and potential adverse effects on beneficial uses associated with CM1 operations (and hydrodynamic effects of tidal restoration under CM4), the proposed mitigation requires a series of phased actions to identify and evaluate ~~existing and possible~~ feasible actions, followed by development and implementation of the actions, if determined to be necessary. ~~The phased actions for reducing EC levels and associated adverse effects on agricultural water supply also could mitigate adverse effects on fish and wildlife life.~~ The emphasis and mitigation actions would be limited to those identified as necessary to avoid, reduce, or offset adverse EC effects at Delta compliance locations and the Suisun Marsh. The development and implementation of any mitigation actions shall be focused on those incremental effects attributable to implementation of Alternative 1A operations only. Development of mitigation actions for the incremental EC effects attributable to climate change/sea level rise are not required because these changed conditions would occur with or without implementation of Alternative 1A. The goal of specific actions would be to reduce/avoid additional exceedances of Delta EC objectives and reduce long-term average concentration increases to levels that would not adversely affect beneficial uses within the Delta and Suisun Marsh.

Mitigation Measure WQ-11a: Conduct Additional Evaluation of Operational Ability to Reduce or Eliminate Water Quality Degradation in Western Delta Incorporating Site-Specific Restoration Areas and Updated Climate Change/Sea Level Rise Projections, if Available

The BDCP proponents will conduct additional evaluations and develop additional modeling (as necessary) to define the extent to which modified operations of the SWP and CVP could reduce or eliminate water quality degradation in the western Delta currently modeled to occur under Alternative 1A. The additional evaluations will be conducted to consider specifically the changes in Delta hydrodynamic conditions associated with tidal habitat restoration under CM4 once the specific restoration locations and timing of their construction are identified and designed. The evaluations will also consider up-to-date estimates of climate change and sea level rise, if and when such information is available. These evaluations will be conducted concurrently with Mitigation Measure WQ-11b. Together, findings from WQ-11a and WQ-11b will indicate whether sufficient flexibility to prevent or offset EC increases is feasible under Alternative 1A. These actions are identical to the actions discussed in Mitigation Measure WQ-7a regarding levels of chloride in the western Delta.

Mitigation Measure WQ-11b: Site and Design Restoration Sites to Reduce or Eliminate Water Quality Degradation in the Western Delta

BDCP proponents shall consider effects of site-specific restoration areas proposed under CM4 on EC levels in the western Delta. Design and siting of restoration areas shall attempt to reduce water quality degradation in the western Delta to the extent possible without compromising proposed benefits of the restoration areas. These evaluations will be conducted concurrently with Mitigation Measure WQ-11a. Together, findings from WQ-11a and WQ-11b will indicate whether sufficient flexibility to prevent or offset EC increases is feasible under Alternative 1A. These actions are identical to the actions discussed in Mitigation Measure WQ-7b regarding levels of chloride in the western Delta.

Mitigation Measure WQ-~~11a~~11c: Design Restoration Sites to Reduce Effects on Compliance with the Fish and Wildlife EC Objective between Prisoners Point and Jersey Point, Evaluate Striped Bass Monitoring Data, and Consult with CDFW/USFWS/NMFS to Determine Whether Additional Actions are Warranted~~Conduct Additional Evaluation and Modeling of Increased ECLevels Following Initial Operations ofCM1~~

BDCP proponents shall consider effects of site-specific restoration areas proposed under CM4 on compliance with the fish and wildlife EC objective between Jersey Point and Prisoners point on the San Joaquin River. Design of restoration areas shall attempt to reduce potential effects to the extent possible without compromising proposed benefits of the restoration areas. Additionally, following commencement of initial operations of CM1, the BDCP proponents will evaluate ongoing monitoring of striped bass populations, and, specifically spawning in the San Joaquin River between Jersey Point and Prisoners Point, and will conduct such monitoring if it is not already being conducted by CDFW at that time. The BDCP proponents will consult with CDFW, USFWS, and NMFS to determine whether adaptive changes to Head of Old River Barrier operations and/or changes in North Delta vs. South Delta exports are warranted to avoid adverse impacts of salinity on striped bass spawning in the San Joaquin River. Because these actions may have adverse effects on other species, consultation is required, and the changes may not be warranted depending on conditions of striped bass populations and populations of other species at that time.

~~Following commencement of initial operations of CM1, the BDCP proponents will conduct additional evaluations described herein, and develop additional modeling (as necessary), to define the extent to which modified operations could reduce or eliminate the additional exceedances of the Bay-Delta WQCP objectives for EC currently modeled to occur under Alternative 1A. The additional evaluations should also consider specifically the changes in Delta hydrodynamic conditions associated with tidal habitat restoration under CM4 (in particular the potential for increased EC concentrations that could result from increased tidal exchange) once the specific restoration locations are identified and designed.If sufficient operational flexibility to offset EC increases is not feasible under Alternative 1A operations, achieving EC reduction pursuant to this mitigation measure would not be feasible under this Alternative.~~

Mitigation Measure WQ-~~11b~~11d: Site and Design Restoration Sites and consult with CDFW/USFWS, and Suisun Marsh Stakeholders to Identify Potential Actions to Avoid or Reduce EC Level Increases in the Marsh~~Consult withCDFW/USFWS, andSuisun MarshStakeholders, to Identify Potential Actions to Avoid or Minimize ECLevel Increases inthe Marsh~~

BDCP proponents shall consider effects of site-specific restoration areas proposed under CM4 on EC levels and compliance with the fish and wildlife EC objectives for Suisun Marsh. Design and siting of restoration areas shall attempt to reduce potential effects to the extent possible without compromising proposed benefits of the restoration areas. BDCP proponents will also consult with CDFW/USFWS, and Suisun Marsh stakeholders, to identify potential actions to avoid or minimize the EC increases in the marsh, with the goal of maintaining EC at levels that would not further impair fish and wildlife beneficial uses in Suisun Marsh. Potential actions may include modifications of the existing Suisun Marsh Salinity Control Gates for effective salinity control and evaluation of the efficacy of additional physical salinity control facilities or operations for the marsh to reduce the effects of increased EC levels. These actions are identical to the actions discussed in Mitigation Measure WQ-7c regarding levels of chloride in Suisun Marsh.~~To determine the feasibility of reducing the effects of CM1/CM4 operations on increased EC concentrations as shown in modeling estimates to occur in the Suisun Marsh, the BDCP proponents will consult with CDFW/USFWS, and Suisun Marsh stakeholders, to identify potential actions to avoid or minimize the EC increases in the marsh, with the goal of maintaining EC at levels that would not further impair fish and wildlife beneficial uses in Suisun Marsh. Potential actions may include modifications of the existing Suisun Marsh Salinity Control Gates for effective salinity control and evaluation of the efficacy of additional physical salinity control facilities or operations for the marsh to reduce the effects of increased EC levels. Based on the modeled conditions, the emphasis would be identification of potentially feasibleactions to reduce adverse EC-related effects. Any such action will be developed following, and in conjunction with, the completion of the evaluation and development of any feasible actions described in Mitigation Measure WQ-11a.~~

Impact WQ-13: Effects on Mercury Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of ~~CM2-22~~CM2–~~through CM22~~CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for ~~CM2-22~~CM2–~~through~~ CM~~22~~21. See section 8.3.1.3 for more information.

The water quality impacts of waterborne concentrations of mercury and methylmercury and fish tissue mercury concentrations were evaluated for 9 Delta locations. The analysis of percentage change in assimilative capacity of waterborne total mercury relative to the 25 ng/L ecological risk benchmark of Alternative 1A showed the greatest decrease to be 1% at Franks Tract and Old River relative to Existing Conditions, and 1.1% at Franks Tract relative to the No Action Alternative(Figures 8-53 and 8-54).These changes are not expected to result in adverse effects to beneficial uses. Similarly, changes in methylmercury concentration were very small. The greatest annual average methylmercury concentration for drought conditions was 0.167 ng/L for the San Joaquin River at Buckley Cove, which was slightly higher than Existing Conditions and the same as the No Action Alternative (Appendix 8I,*Mercury,* Table I-6).All modeled input concentrations exceeded the methylmercury TMDL guidance objective of 0.06 ng/L, therefore percentage change in assimilative capacity was not evaluated for methylmercury.

Fish tissue estimates show only small or no increases in exceedance quotients based on long-term annual average concentrations for mercury at the Delta locations. The greatest increase was at Mokelumne River (South Fork) at Staten Island (8% relative to Existing Conditions and 10% relative to the No Action Alternative) (Figure ~~8-55~~8-55a,b, Appendix 8I, *Mercury,* Table I-8b). Because these increases are relatively small, and it is not evident that substantive increases are expected at numerous locations throughout the Delta, these changes are expected to be within the uncertainty inherent in the modeling approach, and would likely not be measurable in the environment. See Appendix 8I for a discussion of the uncertainty associated with the fish tissue estimates.

Impact WQ-23: Effects on Phosphorus Concentrations Resulting from Facilities Operations and Maintenance (CM1)

As described under Impact WQ-29, facilities operations and maintenance is not expected to result in substantial changes in TSS and Turbidity under the project alternative relative to Existing Conditions in surface waters upstream of the Delta, in the Delta, and in the SWP/CVP Export Service Areas. Thus in these areas, long-term changes in the levels of suspended sediment-bound phosphorus are not expected. Additional factors that may effect phosphorus levels are discussed below.

Impact WQ-25: Effects on Selenium Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics~~,~~. To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of ~~CM2-22~~~~CM2 through CM22~~CM2–CM21 not attributable to hydrodynamics, ~~for example,~~such as additional loading of a constituent to the Delta, are discussed within the impact header for ~~CM2-22~~~~CM2 through CM22~~CM2–CM21. See ~~section~~ Section 8.3.1.3 for more information.

Selenium concentrations and threshold comparisons for each of the 11 modeled Delta assessment locations under Alternative 1A, relative to Existing Conditions and the No Action Alternative, are presented in Appendix 8M, *Selenium*, Table M-9a for water, Tables M-11 and M-21 for most biota (whole-body fish ~~(~~[excluding sturgeon~~)~~], bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets) throughout the Delta, and Tables M-30 through M-32 for sturgeon at the two western Delta locations. Figures 8-59a and 8-60a present graphical distributions of predicted selenium concentration changes (shown as changes in available assimilative capacity based on 1.3 µg/L) in water at each modeled assessment location for all years. Appendix 8M, Figure M-21 provides more detail in the form of monthly patterns of selenium concentrations in water during the modeling period. ~~Appendix 8M.~~

~~As presented in Section 8.3.3.1, selenium concentrations would be similar among Existing Conditions and the No Action Alternative;~~ Alternative 1A would result in little to no ~~small~~ changes in long-term average selenium concentrations in water at all modeled Delta assessment locations relative to Existing Conditions and the No Action Alternative (Appendix 8M, *Selenium*, Table M-~~10A~~9a). Long-term average concentrations at some interior and western Delta locations would increase by 0.01–0.02 µg/L for either the entire period modeled (1976–1991). These small ~~changes~~ increases in selenium concentrations in water ~~are reflected~~ would result in small ~~percent changes~~ reductions (~~10~~2% or less) in available assimilative capacity for selenium, relative to the ~~2~~1.3 µg/L ~~ecological risk benchmark~~USEPA draft water quality criterion (Figures 8-59a and 8-60a)~~ for all years~~. ~~Relative to Existing Conditions, Alternative 1A would result in the largest modeled increase in available assimilative capacity at Buckley Cove (5%) and the largest decrease at Contra Costa PP (2%) (Figure 8-59). Relative to the No Action Alternative, the largest modeled increase in available~~

~~assimilative capacity would be at Mokelumne River (South Fork) at Staten Island (Staten Island) (1%) and the largest decrease would be at Franks Tract (2%) (Figure 8-60). Although there are some small negative changes in selenium concentrations in water, the effect of Alternative 1A is generally minimal for the Delta locations. Furthermore, t~~The long-term average selenium concentrations in water ~~(Appendix 8M, Table M-11)~~ for Alternative 1A (range 0.~~21~~09–0.~~70~~38 μg/L) ~~are~~ would be similar to those for Existing Conditions (range 0.~~21~~09–0.~~76~~41 μg/L)~~,~~ and the No Action Alternative (range 0.~~21~~09–0.~~69~~38 μg/L), and all would be below the ~~ecological risk benchmark~~USEPA draft water quality criterion of ~~(2~~1.3 μg/L~~)~~ (Appendix 8M, Table 9a).

Relative to Existing Conditions and the No Action Alternative, Alternative 1A would result in very small changes (~~less than~~ 1% or less) in estimated selenium concentrations in most biota (whole-body fish, bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets) throughout the Delta, with little difference among locations (Figures 8-61a through 8-64b; Appendix 8M, *Selenium*, Table M-~~12~~ 21~~and addendumM.A, *Selenium in Sturgeon*, to Appendix 8M, Table M.A~~8M~~-2 in the sturgeon addendum to Appendix 8M~~). Level of Concern Exceedance Quotients (i.e., modeled tissue divided by Level of Concern benchmarks) for selenium concentrations in those biota for all years and for drought years are less than 1.0 (indicating low probability of adverse effects). Similarly, Advisory Tissue Level Exceedance Quotients for selenium concentrations in fish fillets for all years and drought years also are less than 1.0. Estimated selenium concentrations in sturgeon for the San Joaquin River at Antioch are predicted to increase by about 12 percent relative ~~Relative~~ to Existing Conditions and to the No Action Alternative in all years (from about 4.7 to 5.3 mg/kg ~~dry weight~~ ~~[~~dw~~]~~)~~,~~ and those for sturgeon in the Sacramento River at Mallard Island are predicted to increase by about 7 percent in all years (from about 4.4 to 4.7 mg/kg dw) (~~Figure 8-65;~~ Appendix 8M, Tables M-30 and M-31). Selenium concentrations in sturgeon during drought years are expected to increase by only 2 or 3 percent at those locations (Appendix 8M, Tables M-30 and M-31). Detection of small changes in whole-body sturgeon such as those estimated for the western Delta would require very large sample sizes because of the inherent variability in fish tissue selenium concentrations. Low Toxicity Threshold Exceedance Quotients for selenium concentrations in sturgeon in the western Delta would exceed 1.0 (indicating a higher probability for adverse effects) for drought years at both locations (as they do for Existing Conditions and the No Action Alternative; Figure 8-65), and would increase slightly, from 0.94 to 1.1, for all years in the San Joaquin River at Antioch ~~(where quotients increasees from 0.94 to 1.1)~~ (Appendix 8M, Table M-32).

The disparity between larger estimated changes for sturgeon and smaller changes for other biota ~~are~~is attributable largely to differences in modeling approaches, as described in Appendix 8M, *Selenium*. The model for most biota was calibrated to encompass the varying concentration-dependent uptake from waterborne selenium concentrations (expressed as the K_d, which is the ratio of selenium concentrations in particulates [as the lowest level of the food chain] relative to the waterborne concentration) that was exhibited in data for largemouth bass in 2000, 2005, and 2007 at various locations across the Delta. In contrast, the modeling for sturgeon could not be similarly calibrated at the two western Delta locations and used literature-derived uptake factors and trophic transfer factors for the estuary from Presser and Luoma (2013). As noted in the appendix, there was a significant negative log-log relationship of K_d to waterborne selenium concentration that reflected the greater bioaccumulation rates for bass at low waterborne selenium than at higher concentrations. (There was no difference in bass selenium concentrations in the Sacramento River at Rio Vista in comparison to the San Joaquin River at Vernalis in 2000, 2005, and 2007 [Foe 2010], despite a nearly 10-fold difference in waterborne selenium.) Thus, there is more confidence in the site-specific modeling based on the Delta-wide model that was calibrated for bass data than in the estimates for sturgeon based on "fixed" K_ds for all years and for drought years without regard to waterborne selenium concentration at the two locations in different time periods.

Increased water residence times could increase the bioaccumulation of selenium in biota, thereby potentially increasing fish tissue and bird egg concentrations of selenium (see residence time discussion in Appendix 8M, *Selenium*, and Presser and Luoma [2010b]). Thus, residence time was assessed for its relevance to selenium bioaccumulation. Table 60a (presented originally in Section 8.3.1.7 in the *Microcystis* subsection) shows the time for neutrally buoyant particles to move through the Delta (surrogate for flow and residence time). Although an increase in residence time throughout the Delta is expected under the No Action Alternative, relative to Existing Conditions (because of climate change and sea level rise), the change is fairly small in most areas of the Delta. Thus, the changes in residence times between Alternative 1A and the No Action Alternative are very similar to the changes in residence times between Alternative 1A and the Existing Conditions.

Relative to Existing Conditions and the No Action Alternative, increases in residence times for Alternative 1A would be greater in the East Delta than in other sub-regions. Relative to Existing Conditions, annual average residence times for Alternative 1A in the East Delta are expected to increase by more than 8 days (Table 60a). Relative to the No Action Alternative, annual average residence times for Alternative 1A in the Cache Slough are expected to increase by up to 10 days. Increases in residence times for other sub-regions would be smaller, especially as compared to Existing Conditions and the No Action Alternative (which are longer than those modeled for the East Delta). As mentioned above, these results incorporate hydrodynamic effects of both CM1 and CM2 and CM4, and the effects of CM1 cannot be distinguished from the effects of CM2 and CM4. However, it is expected that CM2 and CM4 are substantial drivers of the increased residence time.

Presser and Luoma (2010b) summarized and discussed selenium uptake in the Bay-Delta (including hydrologic conditions [e.g., Delta outflow and residence time for water], K_ds [the ratio of selenium concentrations in particulates, as the lowest level of the food chain, relative to the water-borne concentration], and associated tissue concentrations [especially in clams and their consumers, such as sturgeon]). When the Delta Outflow Index (daily average flow per month) decreased by five-fold (73,732 cubic feet per second [cfs] in June 1998 to 12, 251 cfs in October 1998), residence time doubled (from 11 to 22 days) and the calculated mean K_d also doubled (from 3,198 to 6,501). However, when daily average Delta outflow in November 1999 was only 6,951 cfs (i.e., about one-half that in October 1998) and residence time was 70 days, the calculated mean K_d (7,614) did not increase proportionally.

Models are not available to quantitatively estimate the level of changes in selenium bioaccumulation as related to residence time, but the effects of residence time are incorporated in the bioaccumulation modeling for selenium that was based on higher K_d values for drought years in comparison to wet, normal, or all years; see Appendix 8M, *Selenium*. If increases in fish tissue or bird egg selenium were to occur, the increases would likely be of concern only where fish tissues or bird eggs are already elevated in selenium to near or above thresholds of concern. That is, where biota concentrations are currently low and not approaching thresholds of concern (which, as discussed above, is the case throughout the Delta, except for sturgeon in the western Delta), changes in residence time alone would not be expected to cause them to then approach or exceed thresholds of concern. In consideration of this factor, although the Delta as a whole is a CWA Section 303(d)-listed water body for selenium, and although monitoring data of fish tissue or bird eggs in the Delta are sparse, the most likely area in which biota tissues would be at levels high enough that additional bioaccumulation due to increased residence time from restoration areas would be a concern is the western Delta and Suisun Bay for sturgeon, as discussed above. As shown in Table 60a, the overall increase in residence time estimated in the western Delta is 2 days relative to Existing Conditions, and 5 days relative to the No Action Alternative. Given the available information, these increases are small enough that they are not expected to substantially affect selenium bioaccumulation in the western Delta. Because CM2 and CM4 are expected to be substantial drivers of the increased residence times, further discussion is included in Impact WQ-26 below.

In summary, the largest increase of selenium concentrations in biota would be at Contra Costa PP for all years and for sturgeon at the two western Delta locations in all years, and the largest decrease would be at Buckley Cove for drought years. Relative to the No Action Alternative, the largest increase would be at Buckley Cove for drought years (except for bird eggs [assuming a fish diet] at Franks Tract for all years) and for sturgeon at the two western Delta locations in all years; the largest decrease would be at Staten Island for all years (except for bird eggs [assuming a fish diet] at Buckley Cove for drought years). Except for sturgeon in the western Delta, concentrations of selenium in whole-body fish and bird eggs (invertebrate and fish diets) would exceed only the lower benchmarks (4 and 6 mg/kg dry weight, respectively, indicating a low potential for effects), under drought conditions, at Buckley Cove for Existing Conditions and the No Action Alternative, and Alternative 1A (Figures 8-61 through 8-63). However, Exceedance Quotientsexceedance quotients for these exceedances of the lower benchmarks for Alternative 1A are between 1.0 and 1.5 (similar to Existing Conditions and the No Action Alternative), indicating a low risk to biota in the Delta and no substantial difference from Existing Conditions and the No Action Alternative. Selenium concentrations in fish fillets would not exceed the screening value for protection of human health (Figure 8-64). For sturgeon in the western Delta, whole-body selenium concentrations would increase from 12.3 mg/kg under Existing Conditions and the No Action Alternative to 13.1 mg/kg under Alternative 1A, a 7% increase (Table M.A8M-2 in the sturgeon addendum to Appendix 8M). Although all of these values exceed both the low and high toxicity benchmarks, it is unlikely that the modeled increases in whole-body selenium for sturgeon would be measurable in the environment (see also the discussion of results provided in the sturgeon addendum M.A to Appendix 8M).

Rrelative to Existing Conditions and the No Action Alternative, Alternative 1A would result in essentially no change in selenium concentrations throughout the Delta for most biota (lessapproximately than 1% or less), although increases in selenium concentrations are predicted for sturgeon in the western Delta. The Low Toxicity Threshold Exceedance Quotient for selenium concentrations in sturgeon for all years in the San Joaquin River at Antioch would increase from 0.94 for Existing Conditions and the No Action Alternative to 1.1 for Alternative 1A. Concentrations of selenium in sturgeon would exceed only the lower benchmark, indicating a low potential for adverse effects. The modeling of bioaccumulation for sturgeon is less calibrated to site-specific conditions than that for other biota, which was calibrated on a robust dataset for modeling of bioaccumulation in largemouth bass as a representative species for the Delta. Overall, Alternative 1A would not be expected to substantially increase the frequency with which applicable benchmarks would be exceeded in the Delta (there being only a small increase for sturgeon relative to the low benchmark and no exceedance of the high benchmark) or substantially degrade the quality of water in the Delta, with regard to selenium.

SWP/CVP Export Service Areas

As presented in Section 8.3.3.1, effects on selenium concentrations in water would vary little among Existing Conditions the and No Action Alternative, and Alternative 1A would result in only small (0.05–0.06 µg/L) changes decreases in long-term average selenium concentrations in water at the

~~two modeled Export Service Area assessment locations~~ Banks and Jones pumping plants, relative to Existing Conditions and the No Action Alternative, for the entire period modeled (Appendix 8M, Table M-~~10A~~9a). These ~~small changes~~ decreases in selenium concentrations in water ~~are reflected in small percent changes (10% or less) in available assimilative capacity for selenium (based on 2 µg/L ecological risk benchmark) for all years. Relative to Existing Conditions and the No Action Alternative, Alternative 1A~~ would result in ~~small~~ increases in available assimilative capacity for selenium at these pumping plants ~~Jones PP~~ (of 6–7%, relative to the 1.3 µg/L benchmark ~~and 7%, respectively) and at Banks PP (6% and 5%, respectively), and have a small positive effect on the Export Service Area locations~~ (Figures 8-59a and 8-60a). Furthermore, the ~~modeled~~ long-term average selenium concentrations in water ~~(Table 8.3-E-SeTable M-10A in Appendix 8M)~~ for Alternative 1A (range 0.~~37~~15–0.~~50~~2 µg/L) ~~are~~ would ~~similar to those for Existing Conditions (range 0.37–0.58 µg/L)and the No Action Alternative (range 0.37–0.59 µg/L), and all would~~ be well below the ~~ecological risk benchmark~~USEPA draft water quality criterion ~~(~~of ~~2~~1.3 µg/L~~)~~ (Table M-9a in Appendix 8M).

Relative to Existing Conditions and the No Action Alternative, Alternative 1A would result in very small changes (less than 1%) in estimated selenium concentrations in biota (whole-body fish, bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets) (Figures 8-61a through 8-64b; Appendix 8M, *Selenium,* Table M-~~12~~21) at ~~export service areas~~the Banks and Jones pumping plants. ~~Relative to Existing Conditions and the No Action Alternative, the largest increase of selenium concentrations in biota under Alternative 1A would be at Banks PP for drought years, and the largest decrease would be at Jones PP for all years (except for bird eggs [assuming a fish diet] at Jones PP for drought years). Relative to the No Action Alternative, the largest increase under Alternative 1A would be at Banks PP for drought years (except for bird eggs [assuming a fish diet] at Banks PP for all years), and the largest decrease would be at Jones PP for all years (except for bird eggs [assuming a fish diet] at Jones PP for drought years). However, c~~Concentrations in biota would not exceed any selenium benchmarks for Alternative 1A (Figures 8-61a through 8-64b).

~~Thus, relative to Existing Conditions and the No Action Alternative, Alternative 1A would result in minimal changes in selenium concentrations at the Export Service Area locations. Selenium concentrations in water and biota would generally decrease under Alternative 1A and would not exceed ecological benchmarks at either location, whereas the lower benchmark for bird eggs (fish diet) would be exceeded under Existing Conditions and the No Action Alternative at Jones PP for drought years. This small positive change in selenium concentrations under Alternative 1A would be expected to slightly decrease the frequency with which applicable benchmarks would be exceeded or slightly improve the quality of water at the Export Service Area locations, with regard to selenium.~~

NEPA Effects: Based on the discussion above, the effects on selenium (both as waterborne and as bioaccumulated in biota) from Alternative 1A are not considered to be adverse.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for selenium. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

There are no substantial point sources of selenium in watersheds upstream of the Delta, and no substantial nonpoint sources of selenium in the watersheds of the Sacramento River and the eastern tributaries. Nonpoint sources in the San Joaquin Valley that contribute selenium to the Delta will be controlled through a TMDL developed by the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the Grassland Bypass Project, and Basin Plan objectives (Central Valley Water Board [2010~~c~~d]~~)~~ and State Water Board [~~(~~2010~~d~~b, 2010~~e~~c]) that are expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta. Consequently, any modified reservoir operations and subsequent changes in river flows under Alternative 1A, relative to Existing Conditions, are expected to cause negligible changes in selenium concentrations in water. Any negligible changes in selenium concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies as related to selenium.

Relative to Existing Conditions, modeling estimates indicate that Alternative 1A would result in essentially no change in selenium concentrations in water or most biota throughout the Delta, with no exceedances of benchmarks for biological effects. The Low Toxicity Threshold Exceedance Quotient for selenium concentrations in sturgeon for all years in the San Joaquin River at Antioch would increase slightly, from 0.94 for Existing Conditions ~~and the No Action Alternative~~ to 1.1 for Alternative 1A. Concentrations of selenium in sturgeon would exceed only the lower benchmark, indicating a low potential for adverse effects. Overall, Alternative 1A would not be expected to substantially increase the frequency with which applicable benchmarks would be exceeded in the Delta (there being only a small ~~increase for sturgeon~~exceedance relative to the low benchmark for sturgeon and no exceedance of the high benchmark) or substantially degrade the quality of water in the Delta, with regard to selenium.~~.~~

~~This Assessment a~~Assessment of effects of selenium in the ~~SWP~~ SWP/~~and~~ CVP Export Service Areas is based on effects on selenium concentrations at the Banks and Jones pumping plants. Relative to Existing Conditions, Alternative 1A would ~~slightly decrease~~cause no ~~change~~increase in the frequency with which applicable benchmarks would be exceeded ~~(there would be none)~~, and ~~or~~ would slightly improve the quality ~~of water in~~ selenium concentrations of water in at the Banks and Jones pumping plants ~~locations~~.

Based on the above, selenium concentrations that would occur in water under Alternative 1A would not cause additional exceedances of applicable state or federal numeric or narrative water quality objectives/criteria, or other relevant water quality effects thresholds identified for this assessment (Appendix 8M~~,~~; Table 8-54), by frequency, magnitude, and geographic extent that would result in adverse effects to one or more beneficial uses within affected water bodies. In comparison to Existing Conditions, water quality conditions under this alternative would not increase levels of selenium by frequency, magnitude, and geographic extent such that the affected environment would be expected to have measurably higher body burdens of selenium in aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish) or humans consuming those organisms. Water quality conditions under this alternative with respect to selenium would not cause long-term degradation of water quality in the affected environment, and therefore would not result in use of available assimilative capacity such that exceedances of water quality objectives/criteria would be likely and would result in substantially increased risk for adverse effects to one or more beneficial uses. This alternative would not further degrade water quality by measurable levels, on a long-term basis, for selenium and, thus, cause the CWA Section 303(d)-listed impairment of beneficial use to be made discernibly worse. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-26: Effects on Selenium Concentrations Resulting from Implementation of CM2–~~CM22~~CM21

***NEPA Effects*:** In general, with the possible exception of changes in Delta hydrodynamics resulting from habitat restoration, CM2–CM~~1~~21 would not substantially increase selenium concentrations in the water bodies of the affected environment. Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, and thus such effects of these restoration measures were included in the assessment of CM1 facilities operations and maintenance (see Impact WQ-25).

As discussed in Impact WQ-25,~~However,~~ implementation of these conservation measures may increase water residence time within the restoration areas. Increased restoration area water residence times could ~~potentially~~ increase the bioaccumulation of selenium in biota, thereby potentially increasing fish tissue and bird egg concentrations of selenium (see residence time discussion in Appendix 8M, *Selenium*, and Presser and Luoma [2010b]).~~,~~ ~~but m~~ Models are not available to quantitatively estimate the level of changes in selenium bioaccumulation as related to residence time, but the effects of residence time are incorporated in the bioaccumulation modeling for selenium that was based on higher K_d values for drought years in comparison to wet, normal, or all years; see Appendix 8M, *Selenium*. If increases in fish tissue or bird egg selenium were to occur, the increases would likely be of concern only where fish tissues or bird eggs are already elevated in selenium to near or above thresholds of concern. That is, where biota concentrations are currently low and not approaching thresholds of concern (which, as discussed above, is the case throughout the Delta, except for sturgeon in the western Delta), changes in residence time alone would not be expected to cause them to then approach or exceed thresholds of concern. In consideration of this factor, although the Delta as a whole is a CWA Section 303(d)-listed water body for selenium, and although monitoring data of fish tissue or bird eggs in the Delta are sparse, the most likely area in which biota tissues would be at levels high enough that additional bioaccumulation due to increased residence time from restoration areas would be a concern is the western Delta and Suisun Bay for sturgeon, as discussed above. As shown in Table 60a, the overall increase in residence time estimated in the western Delta is 2 days relative to Existing Conditions, and 5 days relative to the No Action Alternative. Given the available information, these increases are small enough that they are not expected to substantially affect selenium bioaccumulation in the western Delta.~~Models are not available to quantitatively estimate the level of changes in residence time and the associated selenium bioavailability, but the effects of residence time are incorporated in the bioaccumulation modeling for selenium that was based on higher K_d values (the ratio of selenium concentrations in particulates [as the lowest level of the food chain] relative to the water-borne concentration) for drought years in comparison to wet, normal, or all years; see Appendix 8M, *Selenium*. If increases in fish tissue or bird egg selenium were to occur, the increases would likely be of concern only where fish tissues or bird eggs are already elevated in selenium to near or above thresholds of concern. That is, where biota concentrations are currently low and not approaching thresholds of concern, changes in residence time alone would not be expected to cause them to then approach or exceed thresholds of concern. In consideration of this factor, although the Delta as a whole is a CWA Section 303(d)-listed water body for selenium, and although monitoring data of fish tissue or bird eggs in the Delta are sparse, the most likely areas in which biota tissues would be at levels high enough that additional bioaccumulation due to increased residence time from restoration areas would be a concern are the western Delta and Suisun Bay, and the South Delta in areas that receive San Joaquin River water.~~

The western Delta and Suisun Bay receive elevated selenium loads from North San Francisco Bay (including San Pablo Bay, Carquinez Strait, and Suisun Bay) and from the San Joaquin River. The San Francisco Bay Water Board is conducting a TMDL project to address selenium toxicity in the North San Francisco Bay (North Bay), defined to include a portion of the Delta, Suisun Bay, Carquinez Strait, San Pablo Bay, and the Central Bay (State Water Resources Control Board 2011).The North Bay selenium TMDL will identify and characterize selenium sources to the North Bay and the processes that control the uptake of selenium by wildlife. The TMDL will quantify selenium loads, develop and assign waste load and load allocations among sources, and include an implementation plan designed to achieve the TMDL and protect beneficial uses. ~~Point sources of selenium in North San Francisco Bay (i.e., refineries) that contribute selenium to Suisun Bay are expected to be reduced through a TMDL under development by the San Francisco Bay Water Board (San Francisco Bay Water Board 2012) that is expected to result in decreasing discharges of selenium.~~ Nonpoint sources of selenium in the San Joaquin Valley that contribute selenium to the San Joaquin River, and thus the Delta and Suisun Bay, will be controlled through a TMDL developed by the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the Grassland Bypass Project, and Basin Plan objectives (Central Valley Water Board 2010~~c,~~ d; State Water Board 2010b and 2010c) that are expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta. ~~If selenium levels are not sufficiently reduced via these efforts, it is expected that the State Water Board and the San Francisco Bay and Central Valley Water Boards would initiate additional actions to further control sources of selenium(State Water Resources Control Board 2010b and 2010c).~~

The South Delta receives elevated selenium loads from the San Joaquin River~~.~~, and as Table 8-60a shows, residence times in this area are expected to increase on an annual average by 11 days relative to Existing Conditions, and 9 days relative to the No Action Alternative. However, as discussed in Impact WQ-25, biota concentrations in the South Delta are not approaching levels of concern. Furthermore, ~~I~~in contrast to Suisun Bay and possibly the western Delta in the future, the South Delta lacks the overbite clam (*Corbula* [*Potamocorbula*] *amurensis*), which is considered a key driver of selenium bioaccumulation in Suisun Bay, due to its high bioaccumulation of selenium and its role in the benthic food web that includes long-lived sturgeon. The South Delta does have *Corbicula fluminea*, another bivalve that bioaccumulates selenium, but ~~it is not as invasive as the overbite clam and thus likely makes up a smaller fraction of sturgeon diet~~to a lesser degree than the overbite clam (Lee et al. 2006). Also, as mentioned above, nonpoint sources of selenium in the San Joaquin Valley that contribute selenium to the Delta will be controlled through a TMDL developed by the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the Grassland Bypass Project, and Basin Plan objectives (Central Valley Water Board 2010~~c,~~ d; State Water Board 2010b and 2010c) that are expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta. Further, if selenium levels in the San Joaquin River are not sufficiently reduced via these efforts, it is expected that the State Water Board and Central Valley Water Board would initiate additional TMDLs to further control nonpoint sources of selenium. Given the available information, these increases are small enough that they are not expected to cause selenium concentrations in biota in the south Delta to approach or exceed thresholds of concern.

Wetland restoration areas will not be designed such that water flows in and does not flow out. Exchange of water between the restoration areas and existing Delta channels is an important design factor, since one goal of the restoration areas is to export food produced in these areas to the rest of the Delta (see BDCP Chapter 3, *Conservation Strategy*, Section 3.3, Biological Goals and Objectives). Thus, these areas can be thought of as "flow-through" systems. Consequently, although water residence times associated with BDCP restoration could increase, they are not expected to increase without bound~~.~~, and selenium concentrations in the water column would not continue to build up and be recycled in sediments and organisms as may be the case within a closed system.

However, because increases in bioavailable selenium in the habitat restoration areas are uncertain, proposed avoidance and minimization measures would require evaluating risks of selenium exposure at a project level for each restoration area, minimizing to the extent practicable potential risk of additional bioaccumulation, and monitoring selenium levels in fish and/or wildlife to establish whether, or to what extent, additional bioaccumulation is occurring. See Appendix 3B, *Environmental Commitments* for a description of the environmental commitment BDCP proponents are making with respect to Selenium Management; and Appendix 3.C. of the BDCP for additional detail on this avoidance and minimization measure (AMM27). Data generated as part of the avoidance and minimization measures will assist the State and Regional Water Boards in determining whether beneficial uses are being impacted by selenium, and thus will provide the data necessary to support regulatory actions (including additional TMDL development), should such actions be warranted.

Given the factors discussed in the assessment above, any increases in bioaccumulation rates from water-borne selenium that could occur in some areas as a result of increased water residence time would not be of sufficient magnitude and geographic extent that any portion of the Delta would be expected to have measurably higher body burdens of selenium in aquatic organisms and, therefore, would not substantially increase risk for adverse effects to beneficial uses. Furthermore, although the Delta is a 303(d)-listed water body for selenium, given the discussion in the assessment above, it is unlikely that restoration areas would result in measurable increases in selenium in fish tissues or bird eggs such that the beneficial use impairment would be made discernibly worse.

Because it is unlikely that substantial increases in selenium in fish tissues or bird eggs would occur such that effects on aquatic life beneficial uses would be anticipated, and because of the avoidance and minimization measures that are designed to further minimize and evaluate the risk of such increases, the effects of WQ-26 are considered not adverse.

CEQA Conclusion: There would be no substantial, long-term increase in selenium concentrations in water in the rivers and reservoirs upstream of the Delta, water in the Delta, or the waters exported to the CVP and SWP service areas due to implementation of CM2–~~CM22~~CM21 relative to Existing Conditions. Water-borne selenium concentrations under this alternative would not exceed applicable water quality objectives/criteria.

Given the factors discussed in the assessment above, any increases in bioaccumulation rates from water-borne selenium that could occur in some areas as a result of increased water residence times would not be of sufficient magnitude and geographic extent that any portion of the Delta would be expected to have measurably higher body burdens of selenium in aquatic organisms, and therefore would not substantially increase risk for adverse effects to beneficial uses. ~~CM2-22CM2 through CM22~~CM2–CM21 would not cause long-term degradation of water quality resulting in sufficient use of available assimilative capacity such that occasionally exceeding water quality objectives/criteria would be likely. Also, ~~CM2-22CM2 through CM22~~CM2–CM21 would not result in substantially increased risk for adverse effects to any beneficial uses. Furthermore, although the Delta is a 303(d)-listed water body for selenium, given the discussion in the assessment above, it is unlikely that restoration areas would result in measurable increases in selenium in fish tissues or bird eggs such that the beneficial use impairment would be made discernibly worse.

~~Since~~ Because it is unlikely that substantial increases in selenium in fish tissues or bird eggs would occur such that effects on aquatic life beneficial uses would be anticipated, and because of the avoidance and minimization measures that are designed to further minimize and evaluate the risk of such increases (see Appendix 3.C. of the BDCP for more detail on AMM27) also described as the Selenium Management environmental commitment(see Appendix 3B, *Environmental Commitments*), this impact is considered less than significant. No mitigation is required.

Impact WQ-32~~.~~: Effects on *Microcystis* Bloom Formation Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Impacts from *Microcystis* upstream of the Delta have only been documented in lakes such as Clear Lake, where eutrophic levels of nutrients give cyanobacteria a competitive advantage over other phytoplankton during the bloom season. Large reservoirs upstream of the Delta are typically characterized by low nutrient concentrations, where other phytoplankton outcompete cyanobacteria, including *Microcystis*. In the rivers and streams of the Sacramento River watershed, watersheds of the eastern tributaries (Cosumnes, Mokelumne, and Calaveras Rivers), and the San Joaquin River upstream of the Delta, under Existing Conditions and the No Action Alternative, bloom development is limited by high water velocity and low residence times. These conditions are not expected to change under Alternative 1A. Consequently, any modified reservoir operations under Alternative 1A are not expected to promote *Microcystis* production upstream of the Delta, relative to Existing Conditions and the No Action Alternative.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics. To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related changes of water residence times and its effects on *Microcystis* production (i.e., CM1). Other effects of CM2 through CM21 not attributable to hydrodynamics are discussed within the impact header for CM2 through CM21.

Under Alternative 1A, modeled residence times in the six Delta sub-regions during the *Microcystis* bloom season of June through September show varying levels of change, depending on sub-region and timeframe (**Table ~~Ms-~~18-60a**). Although an increase in residence time throughout the Delta is expected under the No Action Alternative, relative to Existing Conditions, because of climate change and sea level rise, the change is fairly small in most areas of the Delta. Thus, the changes in residence times between Alternative 1A and the No Action Alternative are very similar to the changes in residence times between Alternative 1A and the Existing Conditions. Below, residence times under Alternative 1A is compared to residence times under the No Action Alternative to remove the effect of climate change and sea level rise, thereby revealing the effect due to CM1 (i.e., operations) and the effect of the CM2 and CM4 restoration areas, which were accounted for in the modeling performed for CM1.

Water residence time in the North Delta and West Delta are projected to increase in both the summer and fall periods by 11 and 8 days, respectively, compared to the No Action Alternative. During the summer period, residence time for the Cache Slough, East Delta, and South Delta sub-regions are projected to increase by 25 ~~[this number differs from the BDCP writeup]~~, 14, and 6 days, respectively, compared to the No Action Alternative. During the fall period, residence time in these sub-regions is projected to decrease slightly. Water residence time in Suisun Marsh is projected to decrease 21 days in the summer and increase 20 days in the fall, relative to No Action Alternative.

The summer and fall period average residence times provide a general direction in which residence time may change under Alternative 1A compared to the No Action Alternative. The changes in residence time are driven by a number of factors accounted for in the modeling, including the hydrodynamic effects of restoration actions planned under CM2 and CM4, diversion of Sacramento River water at the proposed north Delta intake facility, as well as changes in net Delta outflows. Variability in local residence times is expected within any Delta sub-region because major portions of the Delta are comprised of complex networks of intertwining channels, shallow back water areas, and submerged islands. Siting and design of restoration areas has substantial influence on the magnitude of residence time increases that would occur under Alternative 1A. However, the expected residence time changes under Alternative 1A, compared to the No Action Alternative, are in a direction and of magnitude that could lead to an increase in the frequency, magnitude, and geographic extent of *Microcystis* blooms throughout the Delta.

The relationship between Delta water temperatures, climate change, and changes in water deliveries from upstream reservoirs are discussed in Appendix 29C. In short, ambient meteorological conditions are the primary driver of Delta water temperatures, meaning that climate warming and not water operations will determine future water temperatures in the Delta. Climate projections for the Central Valley, California discussed in Appendix 5A-D indicate substantial warming of ambient air temperatures with a median increase in annual temperature of about 1.1°C (2.0°F) by 2025 and 2.2°C (4.0°F) by 2060. The projected water temperature change ranges from 0.7 to 1.4°C (1.3 to 2.5°F) by 2025 and 1.6 to 2.7°C (2.9-4.9°F) by 2060. Increasing water temperatures could lead to earlier attainment of the water temperature threshold of 19°C required to initiate *Microcystis* bloom formation, and thus earlier occurrences of *Microcystis* blooms in the Delta, relative to Existing Conditions. Warmer water temperatures could also increase bloom duration and magnitude, relative to Existing Conditions. Elevated ambient water temperatures in the Delta, and thus an increase in *Microcystis* bloom duration and magnitude, are expected under Alternative 1A, relative to Existing Conditions, but these impacts are due entirely to climate change and not the project alternative. Because climate change is assumed under the No Action Alternative, potential water temperature-driven increases in *Microcystis* blooms in the Delta, relative to Existing Conditions, also would occur under the No Action Alternative. Therefore, no water temperature-driven increases in *Microcystis* blooms would occur in the Delta under Alternative 1A, relative to the No Action Alternative.

SWP/CVP Export Service Areas

The assessment of effects from *Microcystis* in the SWP/CVP Export Service Areas is based on the assessment of *Microcystis* production in source waters to Banks and Jones Pumping plants, and upon the effects of residence time and water temperature on the potential for *Microcystis* blooms to occur in the Export Service Area.

Under Alternative 1A, exports from Banks and Jones pumping plants will consist of a mixture of Sacramento River water diverted around the Delta, with water quality characteristic of both upstream Sacramento River water, and Sacramento and San Joaquin River water that has flowed through various portions of the North, South, and West Delta. Water diverted from the Sacramento River in the North Delta is expected to be unaffected by *Microcystis* and microcystins. However, the fraction of water flowing through the Delta that reaches the existing south Delta intakes is expected to be influenced by an increase in the frequency, magnitude, and geographic extent of *Microcystis* blooms discussed in the "Delta" section above. Therefore, relative to Existing Conditions and the No Action Alternative, the addition of Sacramento River water from the North Delta under Alternative 1A serves to dilute *Microcystis* and microcystins in water diverted from the South Delta with water that is not expected to contain them. Because the degree to which *Microcystis* blooms, and thus microcystins concentrations, will increase in source water from the South Delta is unknown, it cannot be determined whether Alternative 1A will result in increased or decreased levels of microcystins in the mixture of source waters exported from Banks and Jones pumping plants, relative to Existing Conditions and the No Action Alternative.

Microcystis blooms have not occurred in the Export Service Areas even though source waters to the SWP and CVP have been affected. Conditions in the Export Service Areas under Alternative 1A may become more conducive to *Microcystis* bloom formation, relative to Existing Conditions, because water temperatures will increase in the Export Service Areas due to the expected increase in ambient air temperatures resulting from climate change. Residence times in this area are not expected to substantially change under Alternative 1A, relative to Existing Conditions. Conditions in the Export Service Areas under Alternative 1A are not expected to become more conducive to *Microcystis* bloom formation, relative to the No Action Alternative, because neither water residence time nor water temperatures will increase in the Export Service Areas.

NEPA Effects: In summary, Alternative 1A operations and maintenance, relative to the No Action Alternative, would result in long-term increases in hydraulic residence time of various Delta sub-regions during the summer and fall Microcystis bloom period. During this period, the increased residence time could result in a concurrent increase in the frequency, magnitude, and geographic extent of Microcystis blooms, and thus microcystin levels, in affected areas of the Delta. As a result, Alternative 1A operation and maintenance activities would cause further degradation to water quality with respect to Microcystis in the Delta. Under Alternative 1A, relative to No Action Alternative, water exported to the SWP/CVP Export Service Area will be a mixture of Microcystis-affected source water from the south Delta intakes and unaffected source water from the Sacramento River, diverted at the north Delta intakes. It cannot be determined whether operations and maintenance under Alternative 1A will result in increased or decreased levels of Microcystis and microcystins in the mixture of source waters exported from Banks and Jones pumping plants. Mitigation Measure WQ-32a and WQ-32b are available to reduce the effects of degraded water quality in the Delta. Although there is considerable uncertainty regarding this impact, the effects on Microcystis from implementing CM1 is determined to be adverse.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Under Alternative 1A additional impacts from *Microcystis* in the reservoirs and watersheds upstream of the Delta are not expected, relative to Existing Conditions. Operations and maintenance occurring under Alternative 1A is not expected to change nutrient levels in upstream reservoirs or hydrodynamic conditions in upstream rivers and streams such that conditions would be more conductive to *Microcystis* production.

Relative to Existing Conditions, water temperatures and hydraulic residence times in the Delta are expected to increase under Alternative 1A, resulting in an increase in the frequency, magnitude and geographic extent of *Microcystis* blooms in the Delta. However, the degradation of water quality from *Microcystis* blooms due to the expected increases in Delta water temperatures is driven entirely by climate change, not effects of CM1. Increases in Delta residence times are expected throughout the Delta during the summer and fall bloom period, due in small part to climate change and sea level rise, but due more proportionately to CM1 and the hydrodynamic impacts of restoration included in CM2 and CM4. The precise change in local residence times and *Microcystis* production expected within any Delta sub-region is unknown because conditions will vary across the complex networks of intertwining channels, shallow back water areas, and submerged islands that compose the Delta. Nonetheless, Delta residence times are, in general, expected to increase due to Alternative 1A. Consequently, it is possible that increases in the frequency, magnitude, and geographic extent of *Microcystis* blooms in the Delta will occur due to the operations and maintenance of Alternative 1A and the hydrodynamic impacts of restoration (CM2 and CM4).

The assessment of effects of *Microcystis* on SWP/CVP Export Service Areas is based on the assessment of changes in *Microcystis* levels in export source waters, as well as the effects of temperature and residence time changes within the Export Service Areas on *Microcystis* production. Under Alternative 1A, relative to Existing Conditions, the potential for *Microcystis* to occur in the Export Service Area is expected to increase due to increasing water temperature, but this impact is driven entirely by climate change and not Alternative 1A. Water exported from the Delta to the Export Service Area is expected to be a mixture of *Microcystis*-affected source water from the south Delta intakes and unaffected source water from the Sacramento River. Because of this, it cannot be determined whether operations and maintenance under Alternative 1A, relative to existing conditions, will result in increased or decreased levels of *Microcystis* and microcystins in the mixture of source waters exported from Banks and Jones pumping plants.

Based on the above, this alternative would not be expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause significant impacts on any beneficial uses of waters in the affected environment. *Microcystis* and microcystins are not 303(d) listed within the affected environment and thus any increases that could occur in some areas would not make any existing *Microcystis* impairment measurably worse because no such impairments currently exist. Because *Microcystis* and microcystins are not bioaccumulative, increases that could occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. However, because it is possible that increases in the frequency, magnitude, and geographic extent of *Microcystis* blooms in the Delta will occur due to the operations and maintenance of Alternative 1A and the hydrodynamic impacts of restoration (CM2 and CM4), long-term water quality degradation may occur and, thus, significant impacts on beneficial uses could occur. Although there is considerable uncertainty regarding this impact, the effects on *Microcystis* from implementing CM1 is determined to be significant.

Implementation of Mitigation Measure WQ-32a and WQ-32b may reduce degradation of Delta water quality due to *Microcystis*. However, because the effectiveness of these mitigation measures to result in feasible measures for reducing water quality effects is uncertain, this impact is considered to remain significant and unavoidable.

Mitigation Measure WQ-32a: Design Restoration Sites to Reduce Potential for Increased *Microcystis* Blooms

It remains to be determined whether, or to what degree, *Microcystis* production will increase in Delta areas as a result of increased residence times associated with the implementation of the project alternative. Mitigation actions shall be focused on those incremental effects attributable to implementation of operations under the project alternative only. Development of mitigation actions for the incremental increase in *Microcystis* effects attributable to water temperature and residence time increases driven by climate change and sea level rise is not required because these changed conditions would occur with or without implementation of the project alternative. The goal of specific actions would be to reduce/avoid additional degradation of Delta water quality conditions with respect to occurrences of *Microcystis* blooms.

Additional evaluation will be conducted as part of the development of tidal habitat restoration areas to determine the feasibility of using site placement and design criteria to reduce or eliminate local conditions conducive to *Microcystis* production. Design criteria would be developed to provide guidelines for developing restoration areas to discourage *Microcystis* growth by maintaining adequate flushing, while maintaining the benefits of habitat restoration in terms of zooplankton production, fish food quality, and fish feeding success. For example, a target range of typical summer/fall hydraulic residence time that is long enough to promote phytoplankton growth, but not so long as to promote growth of *Microcystis*, could be used to aid restoration site design. However, currently there is not sufficient scientific certainty to evaluate whether or not longer residence times would result in greater *Microcystis* production, and also whether longer residence times might produce greater benefits to fish and other aquatic life than shorter residence times. This mitigation measure requires that residence time considerations be incorporated into restoration area site design for ~~CM 2~~CM2 and CM4 using best available science at the time of design. It is possible that through these efforts, increases in *Microcystis* under CM1 attributable to the project alternative, relative to Existing Conditions, could be mitigated. However, there may be instances where this design consideration may not be feasible, and thus, achieving *Microcystis* reduction pursuant to this mitigation measure would not be feasible.

Mitigation Measure WQ-32b: Investigate and Implement Operational Measures to Manage Water Residence Time

Because it is not known where, when, and to what extent *Microcystis* will be more abundant under CM1 than under Existing Conditions, specific mitigation measures cannot be described. However, this mitigation measure requires the project proponents to monitor for *Microcystis* abundance in the Delta and use appropriate statistical methods to determine whether increases in abundance are significant. This mitigation measure also requires that if *Microcystis* abundance increases, relative to Existing Conditions, the project proponents will investigate and evaluate measures that could be taken to reduce residence time in the affected areas of the Delta. Operational actions could include timing of temporary or operable barrier openings and closings, reservoir releases, and location of Delta exports (i.e., North Delta vs. South Delta pumping facilities). Depending on the location and severity of the increases, one or more of these actions may be feasible for reducing residence times. If so, these actions could mitigate increases in *Microcystis* under CM1 attributable to the project alternative, relative to Existing Conditions. However, it is possible that these actions would not be feasible because they would conflict with other project commitments, would cause their own environmental impacts, or would not be expected to reduce or mitigate increases in *Microcystis*. In this case, achieving *Microcystis* reduction pursuant to this mitigation measure would not be feasible.

Impact WQ-33~~.~~: Effects on *Microcystis* Bloom Formation Resulting from Other Conservation Measures (CM2–CM-21).

Implementation of CM3 and CM6~~-~~–CM21 is unlikely to ~~e~~affect ~~to~~ *Microcystis* abundance in the rivers and reservoirs upstream of the Delta, in the Delta region, or the waters exported to the CVP and SWP service areas. Implementation of CM5, Seasonally Inundated Floodplain Restoration, could result in increased local water temperatures in areas near restored seasonally inundated floodplains. However, floodplain inundation typically occurs during spring and winter months when *Microcystis* growth is limited in general by low water temperatures and by insufficient surface water irradiance, and water temperatures would not increase sufficiently due to floodplain inundation such that effects on *Microcystis* growth would occur. Therefore, implementation of CM5 is unlikely to affect *Microcystis* blooms in the project area. Implementation of CM13, Invasive Aquatic Vegetation Control, may increase turbidity and flow velocity, particularly in restored aquatic habitats, which could discourage *Microcystis* growth in these areas. To the extent that IAV removal would affect turbidity and water velocity, it is possible that IAV removal could, to some degree, help offset the increase in *Microcystis* production expected under Alternative 1A, relative to the No Action Alternative.

As discussed in detail in Impact WQ-32, development of restoration areas which will occur under CM2 and CM4 could possibly increase the frequency, magnitude, and geographic extent of *Microcystis* blooms due to the hydrodynamic impacts that are expected to increase water residence times throughout various areas of the Delta relative to Existing Conditions and the No Action Alternative. Additionally, restoration activities that create shallow backwater areas, due to implementation of CM2 and CM4, could result in local warmer water that may encourage *Microcystis* growth during the summer bloom forming season and result in further degradation of water quality. Mitigation to specifically address the effects of local increases in water temperatures on *Microcystis* in the vicinity of such restoration areas is not available. Regardless of elevated water temperatures, sufficient residence time is required for *Microcystis* bloom formation. Thus, the combined effect on *Microcystis* from increased local water temperatures and increased water residence times may be reduced by implementation of Mitigation Measure WQ-32a and WQ-32b. The effectiveness of these mitigation measures to result in feasible measures for reducing water quality effects is uncertain.

NEPA Effects: Although there is considerable uncertainty regarding this impact, the effects on *Microcystis* from implementing CM2-CM21 are determined to be adverse.

CEQA Conclusions: Based on the above, this alternative would not be expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause significant impacts on any beneficial uses of waters in the affected environment. Microcystis and microcystins are not 303(d) listed within the affected environment and thus any increases that could occur in some areas would not make any existing Microcystis impairment measurably worse because no such impairments currently exist. Because Microcystis and microcystins are not bioaccumulative, increases that could occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. Because restoration actions implemented under CM2 and CM4 will increase residence time throughout the Delta and create local areas of warmer water during the bloom season, it is possible that increases in the frequency, magnitude, and geographic extent of

Microcystis blooms, and thus long-term water quality degradation and significant impacts on beneficial uses, could occur. Although there is considerable uncertainty regarding this impact, the effects on Microcystis from implementing CM2–CM21 are determined to be significant.

Impact WQ-34: Effects on San Francisco Bay Water Quality Resulting from Facilities Operations and Maintenance (CM1) and Implementation of CM2–CM21

The effects analysis presented in the preceding impacts (Impact WQ-1 through WQ-33) concluded that Alternative 1A would have a less than significant impact/no adverse effect on the following constituents in the Delta:

- Boron
- Dissolved Oxygen
- Pathogens
- Pesticides
- Trace Metals
- Turbidity and TSS

Elevated concentrations of boron are of concern in drinking and agricultural water supplies. However, waters in the San Francisco Bay are not designated to support municipal water supply (MUN) and agricultural supply (AGR) beneficial uses. Changes in Delta dissolved oxygen, pathogens, pesticides, and turbidity and TSS are not anticipated to be of a frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of the Delta. Thus, changes in boron, dissolved oxygen, pathogens, pesticides, and turbidity and TSS in Delta outflow are not anticipated to be of a frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of the of San Francisco Bay.

The effects of Alternative 1A on bromide, chloride, and DOC, in the Delta were determined to be significant/adverse. Increases in bromide, chloride, and DOC concentrations are of concern in drinking water supplies; however, as described previously, the San Francisco Bay does not have a designated MUN use. Thus, changes in bromide, chloride, and DOC in Delta outflow would not adversely effect any beneficial uses of San Francisco Bay.

Elevated EC, as assessed for this alternative, is of concern for its effects on the agricultural beneficial use (AGR) and fish and wildlife beneficial uses. As discussed above, San Francisco Bay does not have an AGR beneficial use designation. Further, as discussed for the No Action Alternative, cAlso, as discussed for the No Action Alternative, adverse changes in Microcystis levels that could occur in the Delta would not cause adverse Microcystis blooms in San Francisco Bay, because Microcystis are intolerant of the Bay's high salinity and, thus not have not been detected downstream of Suisun Bay.

While effects of Alternative 1A on the nutrients ammonia, nitrate, and phosphorus were determined to be less than significant/not adverse, these constituents are addressed further below because the response of the seaward bays to changed nutrient concentrations/loading may differ from the response of the Delta. Selenium and mercury are discussed further, because they are bioaccumulative constituents where changes in load due to both changes in Delta concentrations and exports are of concern.

Nutrients: Ammonia, Nitrate, and Phosphorus

Total nitrogen loads in Delta outflow to Suisun and San Pablo Bays under Alternative 1A would be dominated almost entirely by nitrate, because planned upgrades to the SRWTP will result in >95% removal of ammonia in its effluent. Total nitrogen loads to Suisun and San Pablo Bays would decrease by 31%, relative to Existing Conditions, and increase by 1%, relative to the No Action Alternative (Appendix 8O, Table O-1), thus there would be little to no degradation of water quality with regard to total nitrogen. The change in nitrogen loading to Suisun and San Pablo Bays under Alternative 1A would not adversely impact primary productivity in these embayments because light limitation and grazing current limit algal production in these embayments. To the extent that algal growth increases in relation to a change in ammonia concentration, this would have net positive benefits, because current algal levels in these embayments are low. Nutrient levels and ratios are not considered a direct driver of *Microcystis* and cyanobacteria levels in the North Bay.

The phosphorus load exported from the Delta to Suisun and San Pablo Bays for Alternative 1A is estimated to decrease by 2% relative to Existing Conditions and 7% relative to the No Action Alternative (Appendix 8O, Table O-1)), thus there would be no degradation of water quality with regard to total phosphorus. The only postulated effect of changes in phosphorus loads to Suisun and San Pablo Bays is related to the influence of nutrient stoichiometry on primary productivity. However, there is uncertainty regarding the impact of nutrient ratios on phytoplankton community composition and abundance. Any effect on phytoplankton community composition would likely be small compared to the effects of grazing from introduced clams and zooplankton in the estuary (Senn and Novick 2014; Kimmerer and Thompson 2014). Therefore, the projected change in total nitrogen and phosphorus loading that would occur in Delta outflow to San Francisco Bay is not expected to result in adverse effects to beneficial uses or substantially degrade the water quality with regard to nutrients.

Mercury

The estimated long-term average mercury and methylmercury loads in Delta exports are shown in Appendix 8O, Table O-2. Loads of mercury and methylmercury from the Delta to San Francisco Bay are estimated to change relatively little due to changes in source water fractions and net Delta outflow that would occur under Alternative 1A. Mercury load to the Bay, relative to Existing Conditions, is estimated to be the same relative to Existing Conditions, and to decrease by 3 kg/yr (1%) relative to the No Action Alternative. Methylmercury load is estimated to decrease by 0.04 kg/yr (1%), relative to Existing Conditions, and by 0.13 kg/yr (4%) relative to the No Action Alternative. The estimated total mercury load to the Bay is 260 kg/yr, which would be less than the San Francisco Bay mercury TMDL WLA for the Delta of 330 kg/yr. The estimated changes in mercury and methylmercury loads would be within the overall uncertainty associated with the estimates of long-term average net Delta outflow and the long-term average mercury and methylmercury concentrations in Delta source waters. The estimated changes in mercury load under the alternative would also be substantially less than the considerable differences among estimates in the current mercury load to San Francisco Bay (SFBRWQCB 2006; David et al. 2009). Similar uncertainty is expected in the existing methylmercury load in net Delta exports, for which the best available current load estimate is based on approximately one year of monitoring data (Foe et al. 2008).

Given that the estimated incremental ~~decreases~~increases of mercury and methylmercury loading to San Francisco Bay would fall within the uncertainty of current mercury and methylmercury load estimates, the estimated changes in mercury and methylmerucy loads in Delta exports to San Francisco Bay due to Alternative 1A are not expected to result in adverse effects to beneficial uses or substantially degrade the water quality with regard to mercury, or make the existing CWA Section 303(d) impairment measurably worse.

Selenium

Changes in source water fraction and net Delta outflow under Alternative 1A, relative to Existing Conditions, are projected to cause the total selenium load to the North Bay to increase by 4% relative to Existing Conditions; relative to the No Action Alternative there would essentially be no change in load (Appendix 8O, Table O-3). Changes in long-term average selenium concentrations of the North Bay are assumed to be proportional to changes in North Bay selenium loads. Under Alternative 1A, the long-term average total selenium concentration of the North Bay is estimated to be 0.13µg/L and the dissolved selenium concentration is estimated to be 0.11 µg/L, which would be the same as Existing Conditions and the No Action Alternative (Appendix 8O, Table O-3). The dissolved selenium concentration would be below the target of 0.202 µg/L developed by Presser or Luoma (2013) to coincide with a white sturgeon whole-body fish tissue selenium concentration not greater than 8 mg/kg in the North Bay. The incremental increase in dissolved selenium concentrations in the North Bay, relative to Existing Conditions, would be negligible (0.00 µg/L) under this alternative. Thus, the estimated changes in selenium loads in Delta exports to San Francisco Bay due to Alternative 1A are not expected to result in adverse effects to beneficial uses or substantially degrade the water quality with regard to selenium, or make the existing CWA Section 303(d) impairment measurably worse.

NEPA Effects: Based on the discussion above, Alternative 1A, relative to the No Action Alternative, would not cause further degradation to water quality with respect to boron, bromide, chloride, dissolved oxygen, DOC, EC, mercury, pathogens, pesticides, selenium, nutrients (ammonia, nitrate, phosphorus), trace metals, or turbidity and TSS in the San Francisco Bay. Further, changes in these constituent concentrations in Delta outflow would not be expected to cause changes in Bay concentrations of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses. In summary, based on the discussion above, effects on the San Francisco Bay from implementation of CM1–CM21 are considered to be not adverse.

CEQA Conclusion: Based on the above, Alternative 1A would not be expected to cause long-term degradation of water quality in San Francisco Bay resulting in sufficient use of available assimilative capacity such that occasionally exceeding water quality objectives/criteria would be likely and would result in substantially increased risk for adverse effects to one or more beneficial uses. Further, based on the above, this alternative would not be expected to cause additional exceedance of applicable water quality objectives/criteria in the San Francisco Bay by frequency, magnitude, and geographic extent that would cause significant impacts on any beneficial uses of waters in the affected environment. Any changes in boron, bromide, chloride, and DOC in the San Francisco Bay would not adversely affect beneficial uses, because the uses most affected by changes in these parameters, MUN and AGR, are not beneficial uses of the Bay. Further, no substantial changes in dissolved oxygen, pathogens, pesticides, trace metals or turbidity or TSS are anticipated in the Delta, relative to Existing Conditions, therefore, no substantial changes these constituents levels in the Bay are anticipated. Changes in Delta salinity would not contribute to measurable changes in Bay salinity, as the change in Delta outflow would two to three orders of magnitude lower than (and thus minimal compared to) the Bay's tidal flow. Adverse changes in Microcystis levels that could occur in the Delta would not cause adverse Microcystis blooms in the Bay, because Microcystis are intolerant of the Bay's high salinity and, thus not have not been detected downstream of Suisun Bay. The 31% decrease in total nitrogen load and 2% decrease in phosphorus load, relative to Existing Conditions, are expected to have minimal effect on water quality degradation, primary productivity, or phytoplankton community composition. The estimated no change in mercury load (0 kg/yr; 0%) and decrease in methylmercury load (0.04 kg/yr; 1%), relative to Existing Conditions, is within the level of uncertainty in the mass load estimate and not expected to contribute to water quality degradation, make the CWA section 303(d) mercury impairment measurably worse or cause mercury/methylmercury to bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. The estimated increase in selenium load would be 4%, but estimated total and dissolved selenium concentrations under this alternative would be the same as Existing Conditions, and less than the target associated with white sturgeon whole-body fish tissue levels for the North Bay. Thus, the small increase in selenium load is not expected to contribute to water quality degradation, or make the CWA section 303(d) selenium impairment measurably worse or cause selenium to bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant.

Impact WQ-5: Effects on Bromide Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2-22CM2 through CM22CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for CM2-22CM2 through CM22CM2–CM21. See section 8.3.1.3 for more information.

Under Alternative 2A, the geographic extent of effects pertaining to long-term average bromide concentrations in the Delta would be similar to that previously described for Alternative 1A, although the magnitude of predicted long-term change and relative frequency of concentration threshold exceedances would be different. Using the mass-balance modeling approach for bromide (see Section 8.3.1.3), relative to Existing Conditions, modeled long-term average bromide concentrations would increase at Staten Island, Emmaton (during the drought period only), and Barker Slough, while modeled long-term average bromide concentrations would decrease at all other assessment locations(Appendix 8E, Bromide Table 6). Overall effects would be greatest at Barker Slough, where predicted long-term average bromide concentrations would increase from 51 μg/L to 63 μg/L (22% relative increase) for the modeled 16-year hydrologic period and would increase from 54 μg/L to 94 μg/L (75% relative increase) for the modeled drought period. At Barker Slough, the predicted 50 μg/L exceedance frequency would decrease from 49% under Existing Conditions to 38% under Alternative 2A, but would increase from 55% to 63% during the drought period. At Barker Slough, the predicted 100 μg/L exceedance frequency would increase from 0% under Existing Conditions to 17% under Alternative 2A, and would increase from 0% to 38% during the drought period. Relative increases in long-term average bromide concentrations at Staten Island would be of similar magnitude to that described for Barker Slough, although modeled 100 μg/L exceedance frequency increases would be much less considerable. At Staten Island, the predicted 100 μg/L exceedance frequency would increase from 1% under Existing Conditions to 4% under

Alternative 2A(0% to 2% during the drought period). Modeled long-term average concentration at Staten Island would be about 62 µg/L (about 63 µg/L in drought years). Changes in exceedance frequency of the 50 µg/L and 100 µg/L concentration thresholds, as well as relative change in long-term average concentration, at other assessment locations would be less substantial. The comparison to Existing Conditions reflects changes in bromide due to both Alternative 2A operations (including north Delta intake capacity of 15,000 cfs, Fall X2, and numerous other operational components of Scenario B) and climate change/sea level rise.

Due to the relatively small differences between modeled Existing Conditions and No Action baseline, changes in long-term average bromide concentrations and changes in exceedance frequencies relative to the No Action Alternative are generally of similar magnitude to those previously described for the existing condition comparison(Appendix 8E, *Bromide*, Table 6). Modeled long-term average bromide concentration increases would similarly be greatest at Barker Slough, where long-term average concentrations are predicted to increase by about 26% (about 75% in drought years) relative to the No Action Alternative. However, unlike the Existing Conditions comparison, long-term average bromide concentrations at Buckley Cove under Alternative 2Awould increase relative to the No Action Alternative, although the increases would be relatively small (≤4%). Unlike the comparison to Existing Conditions, the comparison to the No Action Alternative reflects bromide changes due only to operations.

At Barker Slough, modeled long-term average bromide concentrations for the two baseline conditions are very similar (Appendix 8E, *Bromide*, Table 6). Such similarity demonstrates that the modeled Alternative 2Achange in bromide is almost entirely due to Alternative 2A operations, and not climate change/sea level rise. Therefore, operations are the primary driver of effects on bromide at Barker Slough, regardless whether Alternative 2A is compared to Existing Conditions, or compared to the No Action Alternative.

Results of the modeling approach which used relationships between EC and chloride and between chloride and bromide (see Section 8.3.1.3) differed somewhat from what is presented above for the mass-balance approach (see Appendix 8E,*Bromide,* Table 7).For most locations, the frequency of exceedance of the 50 µg/L and 100 µg/L were similar. The greatest difference between the methods was predicted for Barker Slough. The increases in frequency of exceedance of the 100 µg/L threshold, relative to Existing Conditions and the No Action Alternative, were not as great using this alternative EC to chloride and chloride to bromide relationship modeling approach as compared to that presented above from the mass-balance modeling approach. However, there were still substantial increases, resulting in 10% exceedance over the modeled period under Alternative 2A, as compared to 1% under Existing Conditions and 2% under the No Action Alternative. For the drought period, exceedance frequency increased from 0% under Existing Conditions and the No Action Alternative, to 20% under Alternative 2A.Because the mass-balance approach predicts a greater level of impact at Barker Slough, determination of impacts was based on the mass-balance results.

The increase in long-term average bromide concentrations predicted at Barker Slough, principally the relative increase in 100 µg/L exceedance frequency, would result in a substantial change in source water quality for existing drinking water treatment plants drawing water from the North Bay Aqueduct. As discussed for Alternative 1A, drinking water treatment plants obtaining water via the North Bay Aqueduct utilize a variety of conventional and enhanced treatment technologies in order to achieve DBP drinking water criteria. While the implications of such a modeled change in bromide at Barker Slough are difficult to predict, the substantial modeled increases could lead to adverse changes in the formation of disinfection byproducts such that considerable treatment plant upgrades may be necessary in order to achieve equivalent levels of health protection. Because many of the other modeled locations already frequently exceed the 100 μg/L threshold under Existing Conditions and the No Action Alternative, these locations likely already require treatment plant technologies to achieve equivalent levels of health protection, and thus no additional treatment technologies would be triggered by the small increases in the frequency of exceeding the 100 μg/L threshold. Hence, no further impact on the drinking water beneficial use would be expected at these locations.

The seasonal intakes at Mallard Slough and City of Antioch are infrequently used due to water quality constraints related to sea water intrusion. On a long-term average basis, bromide at these locations is in excess of 3,000 μg/L, but during seasonal periods of high Delta outflow can be <300 μg/L. Based on modeling using the mass-balance approach, use of the seasonal intakes at Mallard Slough and City of Antioch under Alternative 2Awould experience a period average increase in bromide during the months when these intakes would most likely be utilized. For those wet and above normal water year types where mass balance modeling would predict water quality typically suitable for diversion, predicted long-term average bromide would increase from 103 μg/L to 165 μg/L(61% increase) at City of Antioch and would increase from 150 μg/L to 211 μg/L (41% increase) at Mallard Slough relative to Existing Conditions (Appendix 8E, *Bromide*, Table 23). Increases would be similar for the No Action Alternative comparison. Modeling results using the EC to chloride and chloride to bromide relationships show increases during these months, but the relative magnitude of the increases is much lower (Appendix 8E, *Bromide*, Table 24).Regardless of the differences in the data between the two modeling approaches, the decisions surrounding the use of these seasonal intakes is largely driven by acceptable water quality, and thus have historically been opportunistic. Opportunity to use these intakes would remain, and the predicted increases in bromide concentrations at the City of Antioch and Mallard Slough intake would not be expected to adversely affect MUN beneficial uses, or any other beneficial use, at these locations.

Important to the results presented above is the assumed habitat restoration footprint on both the temporal and spatial scales incorporated into the modeling. Modeling sensitivity analyses have indicated that habitat restoration (which are reflected in the modeling—see Section 8.3.1.3), not operations covered under CM1, are the driving factor in the modeled bromide increases. The timing, location, and specific design of habitat restoration will have effects on Delta hydrodynamics, and any deviations from modeled habitat restoration and implementation schedule will lead to different outcomes. Although habitat restoration near Barker Slough is an important factor contributing to modeled bromide concentrations at the North Bay Aqueduct, BDCP habitat restoration elsewhere in the Delta can also have large effects. Because of these uncertainties, and the possibility of adaptive management changes to BDCP restoration activities, including location, magnitude, and timing of restoration, the estimates are not predictive of the bromide levels that would actually occur in Barker Slough or elsewhere in the Delta.

Impact WQ-7: Effects on Chloride Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of ~~CM2-22~~~~CM2 through CM22~~CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for ~~CM2-22~~~~CM2 through CM22~~CM2–CM21. See section 8.3.1.3 for more information.

Relative to Existing Conditions, modeling predicts that Alternative 2A would result in similar or reduced long-term average chloride concentrations for the 16-year period modeled at most assessment locations, and, depending on modeling approach (see Section 8.3.1.3), and would result in increased concentrations at the North Bay Aqueduct at Barker Slough (i.e., ≤23%) and ~~San Joaquin River~~SF Mokelumne at Staten Island (i.e., ≤18%) (Appendix 8G, *Chloride*, Tables Cl-13 and ~~Table~~ Cl-14). Additionally, implementation of tidal habitat restoration under CM4 would increase the tidal exchange volume in the Delta, and thus may contribute to increased chloride concentrations in the Bay source water as a result of increased salinity intrusion. More discussion of this phenomenon is included in Section 8.3.1.3. Consequently, while uncertain, the magnitude of chloride increases may be greater than indicated herein and would affect the western Delta assessment locations the most which are influenced to the greatest extent by the Bay source water. The comparison to Existing Conditions reflects changes in chloride due to both Alternative 2A operations (including north Delta intake capacity of 15,000 cfs, Fall X2, and numerous other operational components of Scenario B) and climate change/sea level rise.

Relative to the No Action Alternative conditions, the mass balance analysis of modeling results indicated that Alternative 2A would result in similar or reduced long-term average chloride concentrations for the 16-year period modeled at nine of the assessment locations and increased concentrations at the SF Mokelumne River at Staten Island (up to 26%), San Joaquin River at Buckley Cove (up to 3%), and the North Bay Aqueduct at Barker Slough (up to 21%) (Appendix 8G, Table Cl-13). The comparison to the No Action Alternative reflects chloride changes due only to operations.

The following outlines the modeled chloride changes relative to the applicable objectives and beneficial uses of Delta waters.

Municipal Beneficial Uses–Relative to Existing Conditions

Estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3) were used to evaluate the 150 mg/L Bay-Delta WQCP objective for municipal and industrial beneficial uses on a basis of the percent of years the chloride objective is exceeded for the modeled 16-year period. The objective is exceeded if chloride concentrations exceed 150 mg/L for a specified number of days in a given water year at both the Antioch and Contra Costa Pumping Plant #1 locations. For Alternative 2A, the modeled frequency of objective exceedance would approximately ~~triple~~ double from ~~6~~7% of years under Existing Conditions, to ~~19~~13% of years under Alternative 2A (Appendix 8G, Table Cl-64). The increase was due to a single year, 1990, which was only one day short of the required number of days <150 mg/L. Given the uncertainty in the chloride modeling approach, it is likely that real time operations of the SWP and CVP could achieve compliance with this objective (see Section 8.3.1.1 for a discussion of chloride compliance modeling uncertainties and a description of real time operations of the SWP and CVP).

Similarly, estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3) were also used to evaluate the 250 mg/L Bay-Delta WQCP objective for chloride at Contra Costa Pumping Plant #1 where daily average objectives apply. The basis for the evaluation was the predicted number of days the objective was exceeded for the modeled 16-

year period. For Alternative 2A, the modeled frequency of objective exceedance would decrease by approximately one half, from 6% of modeled days under Existing Conditions, to 3% of modeled days under Alternative 2A (Appendix 8G, Table Cl-63).

Given the limitations inherent to estimating future chloride concentrations (see Section 8.3.1.3), estimation of chloride concentrations through both amass balance approach and an EC-chloride relationship approach was used to evaluate the 250 mg/L Bay-Delta WQCP objectives in terms of both frequency of exceedance and use of assimilative capacity. When utilizing the mass balance approach to model monthly average chloride concentrations for the 16-year period, the predicted frequency of exceeding the 250 mg/L objective would decrease at the Contra Costa Canal at Pumping Plant #1 (Appendix 8G, *Chloride,* Table Cl-15). The frequency of exceedances would increase for the 16-year period modeled at the San Joaquin River at Antioch (i.e., from 66% under Existing Conditions to 70%) and Sacramento River at Mallard Island (i.e., from 85% under Existing Conditions to 88%) (Appendix 8G, Table Cl-15), and would cause further degradation at Antioch in March and April (i.e., maximum reduction of 54% of available assimilative capacity for the 16-year period modeled, and 100% reduction, or elimination of assimilative capacity, during the drought period modeled) (Appendix 8G, Table Cl-17).

In comparison, when utilizing the chloride-EC relationship to model monthly average chloride concentrations for the 16-year period, trends in frequency of exceedance and use of assimilative capacity would be similar to that discussed when utilizing the mass balance modeling approach (Appendix 8G, *Chloride,* Tables Cl-16 and ~~Table~~ Cl-18).However, as with Alternative 1A the modeling approach utilizing the chloride-EC relationships predicted changes of lesser magnitude, where predictions of change utilizing the mass balance approach were generally of greater magnitude, and thus more conservative. As discussed in Section 8.3.1.3, in cases of such disagreement, the approach that yielded the more conservative predictions was used as the basis for determining adverse impacts.

Based on the additional predicted seasonal and annual exceedances of ~~one or both~~the 250 mg/L Bay Delta WQCP objective~~s~~ for chloride, and the magnitude of associated long-term average water quality degradation in the western Delta, the potential exists for substantial adverse effects on the municipal and industrial beneficial uses through reduced opportunity for diversion of water of acceptable chloride levels.

303(d) Listed Water Bodies–Relative to Existing Conditions

With respect to the 303(d) listing for chloride in Tom Paine Slough, the monthly average chloride concentrations for the 16-year period modeled at Old River at Tracy Road would generally be similar compared to Existing Conditions, and thus, would not be further degraded on a long-term basis (Appendix 8G, Figure Cl-2). With respect to Suisun Marsh, the monthly average chloride concentrations for the 16-year period modeled would generally increase compared to Existing Conditions in some months during October through May at the Sacramento River at Collinsville (Appendix 8G, Figure Cl-3) and Mallard Island (Appendix 8G, Figure Cl-1), and would increase substantially at Montezuma Slough at Beldon's Landing (i.e., over a doubling of concentration in December through February) (Appendix 8G, Figure Cl-4). ~~,~~However, modeling of Alternative 2A assumed no operation of the Montezuma Slough Salinity Control Gates, but the project description assumes continued operation of the Salinity Control Gates, consistent with assumptions included in the No Action Alternative. A sensitivity analysis modeling run conducted for Alternative 4 with the gates operational consistent with the No Action Alternative resulted in substantially lower EC levels than indicated in the original Alternative 4 modeling results for Suisun Marsh, but EC levels were still somewhat higher than EC levels under Existing Conditions for several locations and months. Although chloride was not specifically modeled in these sensitivity analyses, it is expected that chloride concentrations would be nearly proportional to EC levels in Suisun Marsh. Another modeling run with the gates operational and restoration areas removed resulted in EC levels nearly equivalent to Existing Conditions, indicating that design and siting of restoration areas has notable bearing on EC levels at different locations within Suisun Marsh (see Appendix 8H Attachment 1 for more information on these sensitivity analyses). These analyses also indicate that increases in salinity are related primarily to the hydrodynamic effects of CM4, not operational components of CM1. Based on the sensitivity analyses, optimizing the design and siting of restoration areas may limit the magnitude of long-term chloride increases in the Marsh. However, the chloride concentration increases at certain locations could be substantial, depending on siting and design of restoration areas. Thus, these increased chloride levels in Suisun Marsh are considered to contribute to additional, measureable long-term degradation that potentially would adversely affect the necessary actions to reduce chloride loading for any TMDL that is developed.

~~thereby contributing to additional, measureable long-term degradation that potentially would adversely affect the necessary actions to reduce chloride loading for any TMDL that is developed.~~

Municipal Beneficial Uses–Relative to No Action Alternative

Similar to the assessment conducted for Existing Conditions, estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3) were used to evaluate the 150 mg/L Bay-Delta WQCP objective for municipal and industrial beneficial uses. For Alternative 2A, the modeled frequency of objective exceedance would increase from ~~6~~0% under the No Action Alternative to ~~19~~13% of years under Alternative 2A (Appendix 8G, Table Cl-64). The increase was due to two years, 1977 and 1990, which were only eight and one day(s) short of the required number of days <150 mg/L, respectively. Given the uncertainty in the chloride modeling approach, it is likely that real time operations of the SWP and CVP could achieve compliance with this objective (see Section 8.3.1.1 for a discussion of chloride compliance modeling uncertainties and a description of real time operations of the SWP and CVP).

Similarly, estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3) were also used to evaluate the 250 mg/L Bay-Delta WQCP objective for chloride at Contra Costa Pumping Plant #1 where daily average objectives apply. For Alternative 2A, the modeled frequency of objective exceedance would decrease from 5% of modeled days under the No Action Alternative to 3% of modeled days under Alternative 2A (Appendix 8G, Table Cl-63).

Similar to Existing Conditions, a comparative assessment of modeling approaches was utilized to evaluate the 250 mg/L Bay-Delta WQCP objectives in terms of both frequency of exceedance and use of assimilative capacity on a monthly average basis. When utilizing the mass balance approach to model monthly average chloride concentrations for the 16-year period, the exceedance frequency would be predicted to decrease slightly at the San Joaquin River at Antioch (i.e., from 73% for the No Action Alternative to 70%), decrease slightly at the Contra Costa Canal at Pumping Plant #1 (i.e., from 14% to 12%), and increase slightly at the Sacramento River at Mallard Island (i.e., from 86% to 88%) (Appendix 8G, Table Cl-15).The available assimilative capacity would be reduced at the Antioch location compared to the No Action Alternative (i.e., reduction of 25% in April, and 100% in April [i.e., eliminated] during the drought period modeled) (Appendix 8G, Table Cl-17).Available assimilative capacity also would be reduced at the Contra Costa Canal at Pumping Plant #1 by up to

17% and 12% in September and October of the 16-year modeled period, respectively, and up to 100% in the drought period) (Appendix 8G, Table Cl-17), reflecting substantial degradation at these locations during months when average concentrations would be near, or exceed, the objective.

In comparison, when utilizing the chloride-EC relationship to model monthly average chloride concentrations for the 16-year period, trends in frequency of exceedance and use of assimilative capacity would be similar to that discussed when utilizing the mass balance modeling approach (Appendix 8G, Table Cl-16 and Table Cl 18).However, as with Alternative 1A the modeling approach utilizing the chloride-EC relationships predicted changes of lesser magnitude, where predictions of change utilizing the mass balance approach were generally of greater magnitude, and thus more conservative. As discussed in Section 8.3.1.3, in cases of such disagreement, the approach that yielded the more conservative predictions was used as the basis for determining adverse impacts.

Based on the additional seasonal and annual exceedances of the ~~municipal objectives~~250 mg/L objective as well as the magnitude of long-term average water quality degradation with respect to chloride at interior and western Delta locations, the potential exists for substantial adverse effects to the municipal and industrial beneficial uses through reduced opportunity for diversion of water with acceptable chloride levels.

303(d) Listed Water Bodies–Relative to No Action Alternative

With respect to the 303(d) listing for chloride, Alternative ~~1A~~2A would generally result in similar changes to those discussed for the comparison to Existing Conditions. Monthly average chloride concentrations at Tom Paine Slough would not be further degraded on a long-term basis (Appendix 8G, Figure Cl-2). Monthly average chloride concentrations at source water channel locations for the Suisun Marsh (Appendix 8G, Figures Cl-1, Cl-3 and Cl-4) would increase substantially in some months during October through May compared to the No Action Alternative conditions. Sensitivity analyses suggested that operation of the Salinity Control Gates and restoration area siting and design considerations could reduce these increases. However, the chloride concentration increases at certain locations could be substantial, depending on siting and design of restoration areas. Thus, these increased chloride levels in Suisun Marsh are considered to contribute to additional, measureable long-term degradation in Suisun Marsh that potentially would adversely affect the necessary actions to reduce chloride loading for any TMDL that is developed.

~~Therefore, additional, measureable long-term degradation would occur in Suisun Marsh that potentially would adversely affect the necessary actions to reduce chloride loading for any TMDL that is developed.~~

NEPA Effects: In summary, relative to the No Action Alternative conditions, Alternative 2A is not expected to result in substantially increased frequency of exceedance of the 150 mg/L municipal and industrial objective at Contra Costa Pumping Plant #1 and Antioch locations. ~~would result in increased water quality degradation and frequency of exceedance of the 150 mg/L municipal and industrial objective at Contra Costa Pumping Plant #1 and Antioch locations.T~~The frequency of exceedances of the 250 mg/L municipal and industrial objective at interior and western Delta locations would generally decrease, however, further water quality degradation would occur. Measureable water quality degradation also ~~would~~ could occur relative to the 303(d) impairment in Suisun Marsh. The predicted chloride increases constitute an adverse effect on water quality(see Mitigation Measure WQ-7 below; implementation of this measure along with a separate, non-environmental commitment relating to the potential increased chloride treatment costs would reduce these effects).Additionally, the predicted changes relative to the No Action Alternative conditions indicate that in addition to the effects of climate change/sea level rise, implementation of CM1 and CM4 under Alternative 2A would contribute substantially to the adverse water quality effects.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Impact WQ-9: Effects on Dissolved Oxygen Resulting from Facilities Operations and Maintenance (CM1)

NEPA Effects: Effects of CM1 on DO under Alternative 2A are the same as those discussed for Alternative 1A and are considered to not be adverse.

CEQA Conclusion: Effects of CM1 on DO under Alternative 2Awould be similar to those discussed for Alternative 1A, and are summarized here, then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion under Alternative 1A.

~~River flow rate and r~~Reservoir storage reductions that would occur under Alternative 2A, relative to Existing Conditions, would not be expected to result in a substantial adverse change in DO levels in the reservoirs, because oxygen sources (surface water aeration, aerated inflows, vertical mixing) would remain. Similarly, river flow rate reductions that would occur would not be expected to result in a substantial adverse change in DO levels in the ~~and~~ rivers upstream of the Delta, given that mean monthly flows would remain within the ranges historically seen under Existing Conditions and the affected river are large and turbulent. Any reduced DO saturation level that may be caused by increased water temperature would not be expected to cause DO levels to be outside of the range seen historically. Finally, amounts of oxygen demanding substances and salinity would not be expected to change sufficiently to affect DO levels.

It is expected there would be no substantial change in Delta DO levels in response to a shift in the Delta source water percentages under this alternative or substantial degradation of these water bodies, with regard to DO. DO levels would be affected by nutrient loading, which the state has begun to aggressively regulate the discharges of, and this loading would not be expected to lower DO levels relative to Existing Conditions based on historical DO levels. Further, the anticipated changes in salinity would have relatively minor effects on DO levels, and tidal exchange, which contribute to the reaeration of Delta waters would not be expected to change substantially.

There is not expected to be substantial, if even measurable, changes in DO levels in the SWP/CVP Export Service Areas waters under Alternative 2A, relative to Existing Conditions, because the biochemical oxygen demand of the exported water would not be expected to substantially differ from that under Existing Conditions (due to ever increasing water quality regulations), canal turbulence and exposure of the water to the atmosphere and the algal communities that exist within the canals would establish an equilibrium for DO levels within the canals. The same would occur in downstream reservoirs.

Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would result in significant impacts on any beneficial uses within affected water bodies. Because no substantial changes in DO levels are expected, long-term water quality degradation would not be expected to occur, and, thus, beneficial uses would not be adversely affected. Various Delta waterways are 303(d)-listed for low DO, but because no substantial decreases in DO levels would be expected, greater degradation and DO-related impairment of these areas would not be expected. This impact would be less than significant. No mitigation is required.

Impact WQ-11: Effects on Electrical Conductivity Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative, EC levels (highs, lows, typical conditions) in the Sacramento River and its tributaries, the eastside tributaries, their associated reservoirs, and the San Joaquin River upstream of the Delta under Alternative 2A are not expected to be outside the ranges occurring under Existing Conditions or would occur under the No Action Alternative. Any minor changes in EC levels that could occur under Alternative 2A in water bodies upstream of the Delta would not be of sufficient magnitude, frequency and geographic extent that would cause adverse effects on beneficial uses or substantially degrade water quality with regard to EC.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of ~~CM2-22~~CM2 ~~through CM22~~CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for ~~CM2-22~~CM2 ~~through CM22~~CM2–CM21. See section 8.3.1.3 for more information.

Relative to Existing Conditions, modeling indicates that Alternative 2A would result in an increase in the number of days the Bay-Delta WQCP EC objectives would be exceeded in the Sacramento River at Emmaton, San Joaquin River at San Andreas Landing, Jersey Point (fish and wildlife objective), and Prisoners Point, and Old River near Middle River and at Tracy Bridge (Appendix 8H, *Electrical Conductivity*, Table EC-2).

The percent of days the Emmaton EC objective would be exceeded for the entire period modeled (1976–1991) would increase from 6% under Existing Conditions to 2~~3~~6% under Alternative 2A, and the percent of days out of compliance would increase from 11% under Existing Conditions to ~~35~~40% under Alternative 2A.

The percent of days the San Andreas Landing EC objective would be exceeded would increase from 1% under Existing Conditions to ~~4~~5% under Alternative 2A, and the percent of days out of compliance with the EC objective would increase from 1% under Existing Conditions to ~~6~~8% under Alternative 2A. Sensitivity analyses were performed for Alternative 4 scenario H3, and indicated that many similar exceedances were modeling artifacts, and the small number of remaining exceedances were small in magnitude, lasted only a few days, and could be addressed with real time operations of the SWP and CVP (see Section 8.3.1.1 for a description of real time operations of the

SWP and CVP). Due to similarities in the nature of the exceedances between alternatives, the findings from these analyses can be extended to this alternative as well.

The percent of days the Prisoners Point EC objective would be exceeded for the entire period modeled would increase from 6% under Existing Conditions to 25% under Alternative 2A, and the percent of days out of compliance with the EC objective would increase from 10% under Existing Conditions to 2~~7~~9% under Alternative 2A. At Jersey Point, relative to the fish and wildlife objective, the percent of days the EC objective would be exceeded for the entire period modeled would increase from 0% under Existing Conditions to 1% under Alternative 2A, and the percent of days out of compliance with the EC objective would increase from 0% under Existing Conditions to 2% under Alternative 2A. Sensitivity analyses conducted for Alternative 4 scenario H3 indicated that removing all tidal restoration areas would reduce the number of exceedances, but there would still be substantially more exceedances than under Existing Conditions or the No Action Alternative. Results of the sensitivity analyses indicate that the exceedances are partially a function of the operations of the alternative itself, perhaps due to Head of Old River Barrier assumptions and south Delta export differences (see Appendix 8H Attachment 1 for more discussion of these sensitivity analyses). Due to similarities in the nature of the exceedances between alternatives, the findings from these analyses can be extended to this alternative as well. Appendix ~~X~~8H Attachment 2 contains a more detailed assessment of the likelihood of these exceedances impacting aquatic life beneficial uses. Specifically, Appendix 8H Attachment 2 discusses whether these exceedances might have indirect effects on striped bass spawning in the Delta, and concludes that the high level of uncertainty precludes making a definitive determination.

The increase in percent of days exceeding the EC objectives and days out of compliance at the Old River locations would be 2% at Tracy Bridge and less than 1% at Middle River. Sensitivity analyses performed for Alternative 4 scenario H3 indicated that many of these exceedances are modeling artifacts, and modeling barrier installation assumptions consistent with historical dry year practices of installing barriers earlier in the year could resolve these additional exceedances (see Appendix 8H Attachment 1 for a discussion of these sensitivity analyses). Due to similarities in the nature of the exceedances between alternatives, the findings from these analyses can be extended to this alternative as well. Furthermore, as noted in Section 8.1.3.7, SWP and CVP operations have relatively little influence on salinity levels at these locations, and the elevated salinity in south Delta channels is affected substantially by local salt contributions discharged into the San Joaquin River downstream of Vernalis. Thus, the modeling has limited ability to estimate salinity accurately in this region.

Average EC levels at the western and southern Delta compliance locations would decrease from 0–37% for the entire period modeled. During the drought period modeled (1987~~-~~–1991), average EC would decrease by 0–32%, at western and southern Delta locations, except Emmaton would have an increase in average EC of 9% (Appendix 8H, Table EC-13). At the two interior Delta locations, there would be increases in average EC: the S. Fork Mokelumne River at Terminous average EC would increase 5% for the entire period modeled and 4% during the drought period modeled; and San Joaquin River at San Andreas Landing average EC would increase 1% for the entire period modeled and 10% during the drought period modeled. On average, EC would increase at San Andreas Landing from February through September. Average EC in the S. Fork Mokelumne River at Terminous would increase during all months. Average EC at Jersey Point during the months of April–May, when the fish and wildlife objective applies in all but critical water year types, would increase from 15–16% for the entire period modeled (Appendix 8H, Table EC-13). The comparison to Existing Conditions reflects changes in EC due to both Alternative 2A operations (including north

Delta intake capacity of 15,000 cfs, Fall X2, and numerous other operational components of Scenario B) and climate change/sea level rise.

Relative to the No Action Alternative, the percent of days exceeding EC objectives and percent of days out of compliance would increase at: Sacramento River at Emmaton, San Joaquin River at Jersey Point, San Andreas Landing, and Prisoners Point; and Old River near Middle River and at Tracy Bridge (Appendix 8H, *Electrical Conductivity,* Table EC-2). The increase in percent of days exceeding the EC objective would be 24% at Prisoners Point and 12~~1~~% or less at the remaining locations. The increase in percent of days out of compliance would be 28~~6~~% at Prisoners Point and 1~~3~~5% or less at the remaining locations. For the entire period modeled, average EC levels would increase at all Delta compliance locations relative to the No Action Alternative, except in~~ Three Mile Slough near the Sacramento River,~~ the Sacramento River at Emmaton, and the San Joaquin River at Jersey Point. The average EC increase would be 6% or less (Appendix 8H, Table EC-13). Similarly, during the drought period modeled, average EC would increase at all locations, except ~~Three Mile Slough, ~~Emmaton~~,~~ and Jersey Point. The greatest average EC increase during the drought period modeled would occur in the San Joaquin River at San Andreas Landing (10%); the increase at the other locations would be 1–7% (Appendix 8H, Table EC-13). The comparison to the No Action Alternative reflects changes in EC due only to Alternative 2A operations (including north Delta intake capacity of 15,000 cfs, Fall X2, and numerous other operational components of Scenario B).

For Suisun Marsh, October–May is the period when Bay-Delta WQCP EC objectives for protection of fish and wildlife apply. Average EC would increase for the entire period modeled under Alternative 2A, relative to Existing Conditions, during the months of March through May by 0.3–0.6 mS/cm in the Sacramento River at Collinsville (Appendix 8H, Table EC-21). Long-term average EC would decrease relative to Existing Conditions in Montezuma Slough at National Steel during October–May (Appendix 8H, Table EC-22). The most substantial increase would occur near Beldon Landing, with long-term average EC levels increasing by 1.6–4.6 mS/cm, depending on the month, at least doubling during some months the long-term average EC relative to Existing Conditions (Appendix 8H, Table EC-23). Sunrise Duck Club and Volanti Slough also would have long-term average EC increases during all months of 0.5–2.4 mS/cm (Appendix 8H, Tables EC-24 and EC-25). Modeling of this alternative assumed no operation of the Montezuma Slough Salinity Control Gates, but the project description assumes continued operation of the Salinity Control Gates, consistent with assumptions included in the No Action Alternative. A sensitivity analysis modeling run conducted for Alternative 4 scenario H3 with the gates operational consistent with the No Action Alternative resulted in substantially lower EC levels than indicated in the original Alternative 4 modeling results, but EC levels were still somewhat higher than EC levels under Existing Conditions and the No Action Alternative for several locations and months. Another modeling run with the gates operational and restoration areas removed resulted in EC levels nearly equivalent to Existing Conditions and the No Action Alternative, indicating that design and siting of restoration areas has notable bearing on EC levels at different locations within Suisun Marsh (see Appendix 8H Attachment 1 for more information on these sensitivity analyses). These analyses also indicate that increases are related primarily to the hydrodynamic effects of CM4, not operational components of CM1. Based on the sensitivity analyses, optimizing the design and siting of restoration areas may limit the magnitude of long-term EC increases to be on the order of 1 mS/cm or less. Due to similarities in the nature of the EC increases between alternatives, the findings from these analyses can be extended to this alternative as well.

The degree to which the long-term average EC increases in Suisun Marsh would cause exceedance of Bay-Delta WQCP objectives is unknown, because these objectives are expressed as a monthly average of daily high tide EC, which does not have to be met if it can be demonstrated "equivalent or better protection will be provided at the location" (State Water Resources Control Board 2006:14). The ~~described~~ long-term average EC increase may, or may not, contribute to adverse effects on beneficial uses, depending on how and when wetlands are flooded, soil leaching cycles, and how agricultural use of water is managed, and future actions taken with respect to the marsh. However, the EC increases at certain locations ~~would~~ could be substantial, depending on siting and design of restoration areas, and it is uncertain the degree to which current management plans for the Suisun Marsh would be able to address these substantially higher EC levels and protect beneficial uses. Thus, these increased EC levels in Suisun Marsh are considered to have a potentially adverse effect on marsh beneficial uses. Long-term average EC increases in Suisun Marsh under Alternative 2A relative to the No Action Alternative would be similar to the increases relative to Existing Conditions.

Given that the western and southern Delta are Clean Water Act section 303(d) listed as impaired due to elevated EC, the increase in the incidence of exceedance of EC objectives under Alternative 2A, relative to Existing Conditions and the No Action Alternative, has the potential to contribute to additional impairment and potentially adversely affect beneficial uses. Suisun Marsh is CWA section 303(d) listed as impaired due to elevated EC, and the potential increases in long-term average EC concentrations could contribute to additional impairment.~~, because the increases would be double that relative to Existing Conditions and the No Action Alternative.~~

SWP/CVP Export Service Areas

At the Banks and Jones pumping plants, Alternative 2A would result in no exceedances of the Bay-Delta WQCP's 1,000 μmhos/cm EC objective for the entire period modeled (Appendix 8H, Table EC-10). Thus, there would be no adverse effect on the beneficial uses in the SWP/CVP Export Service Areas using water pumped at this location under the Alternative 2A.

At the Banks pumping plant, relative to Existing Conditions, average EC levels under Alternative 2A would decrease 28% for the entire period modeled and 22% during the drought period modeled. Relative to the No Action Alternative, average EC levels would decrease by 22% for the entire period modeled and 17% during the drought period modeled. (Appendix 8H, Table EC-13)

At the Jones pumping plant, relative to Existing Conditions, average EC levels under Alternative 2A would decrease 28% for the entire period modeled and 23% during the drought period modeled. Relative to the No Action Alternative, average EC levels would decrease by 24% for the entire period modeled and 20% during the drought period modeled. (Appendix 8H, Table EC-13)

Based on the decreases in long-term average EC levels that would occur at the Banks and Jones pumping plants, Alternative 2A would not cause degradation of water quality with respect to EC in the SWP/CVP Export Service Areas; rather, Alternative 2A would improve long-term average EC conditions in the SWP/CVP Export Service Areas.

Commensurate with the EC decrease in exported waters, an improvement in lower San Joaquin River average EC levels would be expected since EC in the lower San Joaquin River is, in part, related to irrigation water deliveries from the Delta. While the magnitude of this expected lower San Joaquin River improvement in EC is difficult to predict, the relative decrease in overall loading of EC-elevating constituents to the Export Service Areas would likely alleviate or lessen any expected increase in EC at Vernalis related to decreased annual average San Joaquin River flows (see EC impact discussion under the No Action Alternative).

The export area of the Delta is listed on the state's CWA Section 303(d) list as impaired due to elevated EC. Alternative 2A would result in lower average EC levels relative to Existing Conditions and the No Action Alternative and, thus, would not contribute to additional beneficial use impairment related to elevated EC in the SWP/CVP Export Service Areas waters.

NEPA Effects: In summary, the increased frequency of exceedance of EC objectives and increased long-term and drought period average EC levels that would occur at western, interior, and southern Delta compliance locations under Alternative 2A, relative to the No Action Alternative, would contribute to adverse effects on the agricultural beneficial uses. The increased long-term period average EC levels between Jersey Point and Prisoners Point could contribute to adverse effects on fish and wildlife beneficial uses (specifically, indirect adverse effects on striped bass spawning), though there is a high degree of uncertainty associated with this impact. The western and southern Delta are CWA section 303(d) listed as impaired due to elevated EC, and the increase in incidence of exceedance of EC objectives and increases in long-term average and drought period average EC in the western portion of the Delta have the potential to contribute to additional beneficial use impairment. In addition, the increased frequency of exceedance of the San Joaquin River at Prisoners Point EC objective and long-term and drought period average EC could contribute to adverse effects on fish and wildlife beneficial uses. Given that the western and southern Delta are Clean Water Act section 303(d) listed as impaired due to elevated EC, the increase in the incidence of exceedance of EC objectives and long-term average and drought period average EC in this portion of the Delta has the potential to contribute to additional beneficial use impairment.The increases in long-term average EC levels that would could occur in Suisun Marsh would further degrade existing EC levels and could contribute additional to adverse effects on the fish and wildlife beneficial uses. Suisun Marsh is section 303(d) listed as impaired due to elevated EC, and the potential increases in long-term average EC levels could contribute to additional beneficial use impairment. The effects on EC in the western Delta, San Joaquin River at Prisoners Point, and in Suisun Marsh These increases in EC constitute an adverse effect on water quality. Mitigation Measure WQ-11 would be available to reduce these effects (implementation of this measure along with a separate, non-environmental commitment as set forth in EIR/EIS Appendix 3B, *Environmental Commitments*, relating to the potential EC-related changes would reduce these effects).

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

River flow rate and reservoir storage reductions that would occur under Alternative 2A, relative to Existing Conditions, would not be expected to result in a substantial adverse change in EC levels in the reservoirs and rivers upstream of the Delta, given that: changes in the quality of watershed runoff and reservoir inflows would not be expected to occur in the future; the state's aggressive regulation of point-source discharge effects on Delta salinity-elevating parameters and the expected further regulation as salt management plans are developed; the salt-related TMDLs adopted and being developed for the San Joaquin River; and the expected improvement in lower San Joaquin River average EC levels commensurate with the lower EC of the irrigation water deliveries from the Delta.

Relative to Existing Conditions, Alternative 2A would not result in any substantial increases in long-term average EC levels in the SWP/CVP Export Service Areas. There would be no exceedance of the

EC objective at the Jones and Banks pumping plants. Average EC levels for the entire period modeled would decrease at both plants and, thus, this alternative would not contribute to additional beneficial use impairment related to elevated EC in the SWP/CVP Export Service Areas waters. Rather, this alternative would improve long-term EC levels in the SWP/CVP Export Service Areas, relative to Existing Conditions.

In the Plan Area, Alternative 2A would result in an increase in the frequency with which Bay-Delta WQCP EC objectives are exceeded for the entire period modeled (1976–1991): in the Sacramento River at Emmaton (agricultural objective;~~17~~20% increase), in the San Joaquin River at ~~San Andreas Landing (agricultural objective; 34% increase), and~~ Prisoners Point (fish and wildlife objective; 19% increase), ~~both~~ in the interior Delta~~; and in Old River near Middle River and at Tracy Bridge (agricultural objectives; up to 2% increase), both in the southern Delta~~. Average EC levels at San Andreas Landing would increase by 1% during for the entire period modeled and 10% during the drought period modeled. The increases in long-term and drought period average EC levels and increased frequency of exceedance of EC objectives that would occur ~~in the San Joaquin River at San Andreas Landing, and the increased exceedance of EC objectives~~ in the Sacramento River at Emmaton would potentially contribute to adverse effects on the agricultural beneficial uses in the ~~interior and~~ western Delta. The increased long-term period average EC levels between Jersey Point and Prisoners Point could contribute to adverse effects on fish and wildlife beneficial uses (specifically, indirect adverse effects on striped bass spawning), though there is a high degree of uncertainty associated with this impact. ~~Further, the increased frequency of exceedance of the fish and wildlife objective at Prisoners Point could contribute to adverse effects on aquatic life.~~ Because EC is not bioaccumulative, the increases in long-term average EC levels would not directly cause bioaccumulative problems in aquatic life or humans. The western and southern Delta are Clean Water Act section 303(d) listed for elevated EC and the increased frequency of exceedance of EC objectives that would occur in ~~these portions of the~~in the western Delta could make beneficial use impairment measurably worse. This impact is considered to be significant.

Further, relative to Existing Conditions, Alternative 2A ~~would~~ could result in substantial increases in long-term average EC during the months of October through May in Suisun Marsh~~, such that EC levels would be double that relative to Existing Conditions~~. The increases in long-term average EC levels that would occur in Suisun Marsh could further degrade existing EC levels and thus contribute additionally to adverse effects on the fish and wildlife beneficial uses. Because EC is not bioaccumulative, the increases in long-term average EC levels would not directly cause bioaccumulative problems in fish and wildlife. Suisun Marsh is Clean Water Act section 303(d) listed for elevated EC and the increases in long-term average EC that would occur in the marsh could make beneficial use impairment measurably worse. This impact is considered to be significant.

Implementation of Mitigation Measure WQ-11 along with a separate, non-environmental commitment relating to the potential increased costs associated with EC-related changes would reduce these effects. While mitigation measures to reduce these water quality effects in affected water bodies to less than significant levels are not available, implementation of Mitigation Measure WQ-11 is recommended to attempt to reduce the effect that increased EC concentrations may have on Delta beneficial uses. However, because the effectiveness of this mitigation measure to result in feasible measures for reducing water quality effects is uncertain, this impact is considered to remain significant and unavoidable. Please see Mitigation Measure WQ-11 under Impact WQ-11 in the discussion of Alternative 1A.

In addition to and to supplement Mitigation Measure WQ-11, the BDCP proponents have incorporated into the BDCP, as set forth in EIR/EIS Appendix 3B, *Environmental Commitments*, a separate, non-environmental commitment to address the potential increased water treatment costs that could result from EC concentration effects on municipal, industrial and agricultural water purveyor operations. Potential options for making use of this financial commitment include funding or providing other assistance towards acquiring alternative water supplies or towards modifying existing operations when EC concentrations at a particular location reduce opportunities to operate existing water supply diversion facilities. Please refer to Appendix 3B, *Environmental Commitments*, for the full list of potential actions that could be taken pursuant to this commitment in order to reduce the water quality treatment costs associated with water quality effects relating to chloride, electrical conductivity, and bromide.

Impact WQ-13: Effects on Mercury Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Under Alternative 2A, the magnitude and timing of reservoir releases and river flows upstream of the Delta in the Sacramento River watershed and east-side tributaries would be altered, relative to Existing Conditions and the No Action Alternative.

The Sacramento River at Freeport and San Joaquin River at Vernalis (as summarized for water quality average concentrations in Tables 8-48 and 8-49) were examined for flow/concentration relationships for mercury and methylmercury. No significant, predictive regression relationships were discovered for mercury or methylmercury, except for total mercury with flow at Freeport (monthly or annual)(Appendix 8I,Mercury, Figures I-10 through I-13~~, Appendix 8I~~).Such a positive relationship between total mercury and flow is to be expected based on the association of mercury with suspended sediment and the mobilization of sediments during storm flows. However, the changes in flow in the Sacramento River under Alternative 2A relative to Existing Conditions and the No Action Alternative are not of the magnitude of storm flows, in which substantial sediment-associated mercury is mobilized. Therefore mercury loading should not be substantially different due to changes in flow. In addition, even though it may be flow-affected, total mercury concentrations remain well below criteria at upstream locations. Any negligible changes in mercury concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies as related to mercury. Both waterborne methylmercury concentrations and largemouth bass fillet mercury concentrations are expected to remain above guidance levels at upstream of Delta locations, but will not change substantially relative to Existing Conditions or the No Action Alternative due to changes in flows under Alternative 2A.

The upstream of Delta areas in the north will benefit from the implementation of the Cache Creek, Sulfur Creek, Harley Gulch, and Clear Lake Mercury TMDLs and the American River methylmercury TMDL. These projects will target specific sources of mercury and methylation upstream of the Delta and could result in net improvement to Delta mercury loading in the future. The implementation of these projects could help to ensure that upstream of Delta environments will not be substantially degraded for water quality with respect to mercury or methylmercury.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2-22CM2 through CM22CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for CM2-22CM2 through CM22CM2–CM21. See section 8.3.1.3 for more information.

The water quality impacts of waterborne concentrations of mercury and methylmercury and fish tissue mercury concentrations were evaluated for 9 Delta locations. The analysis of percentage change in assimilative capacity of waterborne total mercury of Alternative 2A relative to the 25 ng/L ecological risk benchmark showed the greatest decrease to be 2.2% for Old River at Rock Slough as compared to Existing Conditions, and 2.1% for Old River at Rock Slough as compared to the No Action Alternative (Figures 8-53 and 8-54).These changes are not expected to result in adverse effects to beneficial uses. Similarly, changes in methylmercury concentration are expected to be very small. The greatest annual average methylmercury concentration for drought conditions was 0.163 ng/L for the San Joaquin River at Buckley Cove, which was slightly higher than Existing Conditions (0.161 ng/L) and slightly lower than the No Action Alternative (0.167 ng/L)(Appendix 8I, Table I-6).All modeled input concentrations exceeded the methylmercury TMDL guidance objective of 0.06 ng/L, therefore percentage change in assimilative capacity was not evaluated for methylmercury.

Fish tissue estimates show only small or no increases in exceedance quotients based on long-term annual average concentrations for mercury at the Delta locations. The greatest increase in exceedance quotients was 13% at Old River at Rock Slough relative to Existing Conditions, and 11 - 12% at the Mokelumne River (South Fork) at Staten Island, Franks Tract, and Old River at Rock Slough relative to the No Action Alternative (Figure 8-558-55a,b; Appendix 8I, Table I-9b). Because these increases are relatively small, and it is not evident that substantive increases are expected at numerous locations throughout the Delta, these changes are expected to be within the uncertainty inherent in the modeling approach, and would likely not be measurable in the environment. See Appendix 8I for a discussion of the uncertainty associated with the fish tissue estimates.

SWP/CVP Export Service Areas

The analysis of mercury and methylmercury in the SWP/CVP Export Service Areas was based on concentrations estimated at the Banks and Jones pumping plants. Both waterborne total and methylmercury concentrations for Alternative 2A are projected to be lower than Existing Conditions and the No Action Alternative at the Jones and Banks pumping plants (Appendix 8I, Figures I-2 and I-3).Therefore, mercury shows increased assimilative capacity at these locations (Figures 8-53 and 8-54).

The largest improvements in bass tissue mercury concentrations and exceedance quotients for Alternative 2A, relative to Existing Conditions and the No Action Alternative at any location within the Delta are expected for the export pump locations (specifically, at Jones Pumping plant, 14% improvement relative to Existing Conditions, 17% relative to the No Action Alternative) (Figure 8-558-55a,b, Appendix 8I, Table I-9b).

NEPA Effects: Based on the above discussion, the effects of mercury and methylmercury in comparison of Alternative 2A to the No Action Alternative (as waterborne and bioaccumulated forms) are not considered to be adverse.

***CEQA Conclusion*:** Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Under Alternative 2A, greater water demands and climate change would alter the magnitude and timing of reservoir releases and river flows upstream of the Delta in the Sacramento River watershed and east-side tributaries, relative to Existing Conditions. Concentrations of mercury and methylmercury upstream of the Delta will not be substantially different relative to Existing Conditions due to the lack of important relationships between mercury/methylmercury concentrations and flow for the major rivers.

Methylmercury concentrations exceed criteria at all locations in the Delta and no assimilative capacity exists. However, monthly average waterborne concentrations of total and methylmercury, over the period of record, are very similar to Existing Conditions. Similarly, estimates of fish tissue mercury concentrations show almost no differences would occur among sites for Alternative 2A as compared to Existing Conditions for Delta sites.

Assessment of effects of mercury in the SWP and CVP Export Service Areas were based on effects on mercury concentrations and fish tissue mercury concentrations at the Banks and Jones pumping plants. The Banks and Jones pumping plants are expected to show increased assimilative capacity for waterborne mercury and decreased fish tissue concentrations of mercury for Alternative 2A as compared to Existing Conditions.

As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because mercury concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Because any increases in mercury or methylmercury concentrations are not likely to be measurable, changes in mercury concentrations or fish tissue mercury concentrations would not make any existing mercury-related impairment measurably worse. In comparison to Existing Conditions, Alternative 2A would not increase levels of mercury by frequency, magnitude, and geographic extent such that the affected environment would be expected to have measurably higher body burdens of mercury in aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish) or humans consuming those organisms. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-25: Effects on Selenium Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics., To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2-22CM2 through CM22CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for CM2-22CM2 through CM22CM2–CM21. See section 8.3.1.3 for more information.

Selenium concentrations and threshold comparisons for each of the 11 modeled Delta assessment locations under Alternative 2A, relative to Existing Conditions and the No Action Alternative, are presented in Appendix 8M, *Selenium*, Table M-9a for water, Tables M-12 and M-22 for most biota (whole-body fish ([excluding sturgeon)], bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets) throughout the Delta, and Tables M-30 through M-32 for sturgeon at the two western Delta locations. Figures 8-59a and 8-60a present graphical distributions of predicted selenium concentration changes (shown as changes in available assimilative capacity based on 1.3 µg/L) in water at each modeled assessment location for all years. Appendix 8M, Figure M-21 provides more detail in the form of monthly patterns of selenium concentrations in water during the modeling period. Appendix 8M.

Alternative 2A would result in small changes in average selenium concentrations in water at all modeled Delta assessment locations relative to Existing Conditions and the No Action Alternative (Appendix 8M, *Selenium*, Table M-10A9a). Long-term average concentrations at some interior and western Delta locations would increase by 0.01–0.04 µg/L for the entire period modeled (1976–1991). These small changes increases in selenium concentrations in water are reflected in would result in small percent changes reductions (104% or less) in available assimilative capacity for selenium, relative to the 21.3 µg/L ecological risk benchmarkUSEPA draft water quality criterion (Figures 8-59a and 8-60a) for all years. Relative to Existing Conditions, Alternative 2A would result in the largest modeled increase in available assimilative capacity at Buckley Cove (1%) and the largest decrease at Contra Costa PP (4%) (Figure 8-59). Relative to the No Action Alternative, the largest modeled increase would be at Staten Island (1%) and the largest decrease would be at Buckley Cove (4%) (Figure 8-60). Although some small negative changes (less than 5%) in selenium concentrations in water are expected, the effect of Alternative 2A would generally be minimal for the Delta locations. Furthermore, tThe long-term average selenium concentrations in water (Appendix 8M, Table M-10A) for Alternative 2A (range 0.2209–0.7440 µg/L) would be very similar to those for Existing Conditions (range 0.2109–0.4761 µg/L) and the No Action Alternative (range 0.2109–0.6938 µg/L), and all would be below the ecological risk benchmarkUSEPA draft water quality criterion of (21.3 µg/L) (Appendix 8M, Table M-9a).

Relative to Existing Conditions and the No Action Alternative, Alternative 2A would result in very small changes (less than 1%) in estimated selenium concentrations in most biota (whole-body fish, bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets) throughout the Delta, with little difference among locations (Figures 8-61a through 8-64b; Appendix 8M, *Selenium*, Table M-22Appendix 8M, Table M-13 and Addendum M.A, *Selenium in Sturgeon*, to Appendix 8M, Table M.A8M-2 in the sturgeon addendum to Appendix 8M). Level of Concern Exceedance Quotients (i.e., modeled tissue divided by Level of Concern benchmarks) for selenium concentrations in those biota for all years and for drought years are less than 1.0 (indicating low probability of adverse effects). Similarly, Advisory Tissue Level Exceedance Quotients for selenium concentrations in fish fillets for all years and drought years also are less than 1.0. Estimated selenium concentrations in sturgeon for the San Joaquin River at Antioch are predicted to increase by about 19 percent relative to Existing Conditions and to the No Action Alternative in all years (from about 4.7 to 5.6 mg/kg dw), and those for sturgeon in the Sacramento River at Mallard Island are predicted to increase by about 11 percent in all years (from about 4.4 to 4.9 mg/kg dw) (Appendix 8M, Figure 8-65; Tables M-30 and M-31).

Selenium concentrations in sturgeon during drought years are expected to increase by only 4 to 8 percent at those locations. Detection of small changes in whole-body sturgeon such as those estimated for the western Delta would require very large sample sizes because of the inherent variability in fish tissue selenium concentrations. Low Toxicity Threshold Exceedance Quotients for selenium concentrations in sturgeon in the western Delta would be 1.5 (indicating a higher probability for adverse effects) for drought years at both locations (similar to Existing Conditions and the No Action Alternative; Figure 8-65) and would increase slightly, from 0.94 to 1.1, for all years in the San Joaquin River at Antioch (Appendix 8M, Table M-32). ~~Relative to Existing Conditions, the largest increase of selenium concentrations in biota would be at Contra Costa PP for all years and for the sturgeon at the San Joaquin River at Antioch in all years, and the largest decrease would be at Buckley Cove for drought years. Relative to the No Action Alternative, the largest increase would be at Buckley Cove for drought years (except for bird eggs [assuming a fish diet] at Old River at Rock Slough [hereafter Rock Slough] for all years) and for the sturgeon at the San Joaquin River at Antioch in all years; the largest decrease would be at Staten Island for drought years. Except for sturgeon in the western Delta, concentrations of selenium in whole-body fish and bird eggs (invertebrate and fish diets) would exceed only the lower benchmarks (4 and 6 mg/kg dry weight, respectively, indicating a low potential for effects), under drought conditions, at Buckley Cove for Existing Conditions, the No Action Alternative, and Alternative 2A (Figures 8-61 through 8-63). However, Exceedance Quotients~~~~exceedance quotients~~ ~~for these exceedances of the lower benchmarks are between 1.0 and 1.5, indicating a low risk to biota in the Delta and no substantial difference from Existing Conditions and the No Action Alternative. Selenium concentrations in fish fillets would not exceed the screening value for protection of human health (Figure 8-64). For sturgeon in the western Delta, whole-body selenium concentrations would increase from 12.3 mg/kg under Existing Conditions and the No Action Alternative to 13.5 mg/kg under Alternative 2A, a 10% increase (~~~~Table 8M-2 in the sturgeon addendum to Appendix 8M~~~~Table M.A-2). Although all of these values exceed both the low and high toxicity benchmarks, it is unlikely that the modeled increases in whole-body selenium for sturgeon would be measurable in the environment (see also the discussion of results provided in Addendum~~ ~~the sturgeon addendum~~ ~~M.A~~~~, *Selenium in Sturgeon*,~~~~to Appendix 8M).~~

The disparity between larger estimated changes for sturgeon and smaller changes for other biota ~~are~~is attributable largely to differences in modeling approaches, as described in Appendix 8M, *Selenium*. The model for most biota was calibrated to encompass the varying concentration-dependent uptake from waterborne selenium concentrations (expressed as the K_d, which is the ratio of selenium concentrations in particulates [as the lowest level of the food chain] relative to the waterborne concentration) that was exhibited in data for largemouth bass in 2000, 2005, and 2007 at various locations across the Delta. In contrast, the modeling for sturgeon could not be similarly calibrated at the two western Delta locations and used literature-derived uptake factors and trophic transfer factors for the estuary from Presser and Luoma (2013). As noted in the appendix, there was a significant negative log-log relationship of K_d to waterborne selenium concentration that reflected the greater bioaccumulation rates for bass at low waterborne selenium than at higher concentrations. (There was no difference in bass selenium concentrations in the Sacramento River at Rio Vista in comparison to the San Joaquin River at Vernalis in 2000, 2005, and 2007 [Foe 2010], despite a nearly 10-fold difference in waterborne selenium.) Thus, there is more confidence in the site-specific modeling based on the Delta-wide model that was calibrated for bass data than in the estimates for sturgeon based on "fixed" K_ds for all years and for drought years without regard to waterborne selenium concentration at the two locations in different time periods.

Increased water residence times could increase the bioaccumulation of selenium in biota, thereby potentially increasing fish tissue and bird egg concentrations of selenium (see residence time discussion in Appendix 8M, *Selenium*, and Presser and Luoma [2010b]). Thus, residence time was assessed for its relevance to selenium bioaccumulation. Table 60a (presented originally in Section 8.3.1.7 in the *Microcystis* subsection) shows the time for neutrally buoyant particles to move through the Delta (surrogate for flow and residence time). Although an increase in residence time throughout the Delta is expected under the No Action Alternative, relative to Existing Conditions (because of climate change and sea level rise), the change is fairly small in most areas of the Delta. Thus, the changes in residence times between Alternative 2A and the No Action Alternative are very similar to the changes in residence times between Alternative 2A and the Existing Conditions.

Relative to Existing Conditions and the No Action Alternative, increases in residence times for Alternative 2A would be greater in the East Delta and South Delta than in other sub-regions. Relative to Existing Conditions, annual average residence times for Alternative 2A in the East Delta are expected to increase by more than 16 days (Table 60a). Relative to the No Action Alternative, annual average residence times for Alternative 2A in the East Delta are expected to increase by less than 10 days. Increases in residence times for other sub-regions would be smaller, especially as compared to Existing Conditions and the No Action Alternative (which are longer than those modeled for the South Delta). As mentioned above, these results incorporate hydrodynamic effects of both CM1 and CM2 and CM4, and the effects of CM1 cannot be distinguished from the effects of CM2 and CM4. However, it is expected that CM2 and CM4 are substantial drivers of the increased residence time.

Presser and Luoma (2010b) summarized and discussed selenium uptake in the Bay-Delta (including hydrologic conditions [e.g., Delta outflow and residence time for water], K_ds [the ratio of selenium concentrations in particulates, as the lowest level of the food chain, relative to the water-borne concentration], and associated tissue concentrations [especially in clams and their consumers, such as sturgeon]). When the Delta Outflow Index (daily average flow per month) decreased by five-fold (73,732 cubic feet per second [cfs] in June 1998 to 12, 251 cfs in October 1998), residence time doubled (from 11 to 22 days) and the calculated mean K_d also doubled (from 3,198 to 6,501). However, when daily average Delta outflow in November 1999 was only 6,951 cfs (i.e., about one-half that in October 1998) and residence time was 70 days, the calculated mean Kd (7,614) did not increase proportionally.

Models are not available to quantitatively estimate the level of changes in selenium bioaccumulation as related to residence time, but the effects of residence time are incorporated in the bioaccumulation modeling for selenium that was based on higher Kd values for drought years in comparison to wet, normal, or all years; see Appendix 8M, Selenium. If increases in fish tissue or bird egg selenium were to occur, the increases would likely be of concern only where fish tissues or bird eggs are already elevated in selenium to near or above thresholds of concern. That is, where biota concentrations are currently low and not approaching thresholds of concern (which, as discussed above, is the case throughout the Delta, except for sturgeon in the western Delta), changes in residence time alone would not be expected to cause them to then approach or exceed thresholds of concern. In consideration of this factor, although the Delta as a whole is a CWA Section 303(d)-listed water body for selenium, and although monitoring data of fish tissue or bird eggs in the Delta are sparse, the most likely area in which biota tissues would be at levels high enough that additional bioaccumulation due to increased residence time from restoration areas would be a concern is the western Delta and Suisun Bay for sturgeon, as discussed above. As shown in Table 60a, the overall increase in residence time estimated in the western Delta is 5 days relative to Existing Conditions, and 3 days relative to the No Action Alternative. Given the available information, these increases are small enough that they are not expected to substantially affect selenium bioaccumulation in the western Delta. Because CM2 and CM4 are expected to be substantial drivers of the increased residence times, further discussion is included in Impact WQ-26 below.

In summary, ~~R~~relative to Existing Conditions and the No Action Alternative, Alternative 2A would result in essentially no change in selenium concentrations throughout the Delta for most biota (~~less~~approximately ~~than~~ 1% or less), although increases in selenium concentrations are predicted for sturgeon in the western Delta. ~~The Low Toxicity Threshold Exceedance Quotient for selenium concentrations in sturgeon for all years in the San Joaquin River at Antioch would increase from 0.94 for Existing Conditions and the No Action Alternative to 1.1 for Alternative 2A.~~ Concentrations of selenium in sturgeon would exceed only the lower benchmark, indicating a low potential for effects. The modeling of bioaccumulation for sturgeon is less calibrated to site-specific conditions than that for other biota, which was calibrated on a robust dataset for modeling of bioaccumulation in largemouth bass as a representative species for the Delta. Overall, Alternative 2A would not be expected to substantially increase the frequency with which applicable benchmarks would be exceeded in the Delta (there being only a small increase for sturgeon relative to the low benchmark and no exceedance of the high benchmark) or substantially degrade the quality of water in the Delta, with regard to selenium.

SWP/CVP Export Service Areas

Alternative 2A would result in small (0.06–0.09 µg/L) ~~changes~~ decreases in long-term average selenium concentrations in water at ~~both modeled Export Service Area assessment locations~~ the Banks and Jones pumping plants relative to Existing Conditions and the No Action Alternative, for the entire period modeled (Appendix 8M, *Selenium*, Table M-~~10A~~9a). These ~~small changes~~ decreases in long-term average selenium concentrations in water ~~are reflected~~ would result in ~~small percent changes~~ increases ~~(10% or less)~~ in available assimilative capacity for selenium at these pumping plants of 6–9%, relative to the 1.3 µg/L ~~ecological risk benchmark~~USEPA draft water quality criterion (Figures 8-59a and 8-60a)~~(based on 2 µg/L ecological risk benchmark) for all years~~. ~~Relative to Existing Conditionsand the No Action Alternative, Alternative 2A would result in modeled increases in assimilative capacity at Jones PP (9% and 10%, respectively) and at Banks PP (5%) (Figures 8-59 and 8-60), and generally would have a small positive effect on the Export Service Area locations.~~ Furthermore, the ~~ranges of modeled~~ long-term average selenium concentrations in water ~~(Appendix 8M, Table M-10A)~~ for Alternative 2A (range 0.~~37~~15–0.~~45~~19 µg/L) ~~are~~ would ~~similar to those for Existing Conditions (range 0.37–0.58 µg/L) and the No Action Alternative (range 0.37–0.59 µg/L), and would~~ be well below the ~~ecological risk benchmark~~USEPA draft water quality criterion of ~~(2~~1.3 µg/L~~)~~ (Appendix 8M, Table M-9a).

Relative to Existing Conditions and the No Action Alternative, Alternative 2A would result in very small~~minimal~~ changes (less than 1%) in estimated selenium concentrations in biota (whole-body fish, bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets) (Figures 8-61a through 8-64b; Appendix 8M, *Selenium*, Table M-~~13~~22) at ~~export service areas~~Banks and Jones pumping plants. ~~The largest increase of selenium concentrations in biota would be at Banks PP for drought years, and the largest decrease would be at Jones PP for all years (except for bird eggs [assuming a fish diet] at Jones PP for drought years).~~ Concentrations ~~of selenium~~ in biota would not exceed any selenium benchmarks for Alternative 2A (Figures 8-61a through 8-64b).

~~Thus, relative to Existing Conditions and the No Action Alternative, Alternative 2A would result in minimal changes in selenium concentrations at the Export Service Area locations. Selenium~~

~~concentrations in water and biota would generally decrease for Alternative 2A and would not exceed ecological benchmarks at either location. Compared to Existing Conditions and the No Action Alternative at Jones PP under drought conditions, there would be a small positive change in selenium concentrations under Alternative 2A in that it would be expected to slightly decrease the frequency with which applicable benchmarks would be exceeded or slightly improve the quality of water at the Export Service Area locations, with regard to selenium.~~

NEPA Effects: Based on the discussion above, the effects on selenium (both as waterborne and as bioaccumulated in biota) from Alternative 2A are not considered to be adverse.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for selenium. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

There are no substantial point sources of selenium in watersheds upstream of the Delta, and no substantial nonpoint sources of selenium in the watersheds of the Sacramento River and the eastern tributaries. Nonpoint sources in the San Joaquin Valley that contribute selenium to the Delta will be controlled through a TMDL developed by the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the Grassland Bypass Project, and Basin Plan objectives (Central Valley Water Board [~~(~~2010~~c~~d]) and State Water Board [~~(~~2010~~d~~b, 2010~~e~~c]) that are expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta. Consequently, any modified reservoir operations and subsequent changes in river flows under Alternative 2A, relative to Existing Conditions, are expected to cause negligible changes in selenium concentrations in water. Any negligible changes in selenium concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies as related to selenium.

Relative to Existing Conditions, modeling estimates indicate that Alternative 2A would result in essentially no change in selenium concentrations in water or most biota throughout the Delta,~~.~~

with no exceedances of benchmarks for biological effects. The Low Toxicity Threshold Exceedance Quotient for selenium concentrations in sturgeon for all years in the San Joaquin River at Antioch would increase slightly, from 0.94 for Existing Conditions ~~and the No Action Alternative~~ to 1.1 for Alternative 2A. Concentrations of selenium in sturgeon would exceed only the lower benchmark, indicating a low potential for effects. Overall, Alternative ~~1~~2A would not be expected to substantially increase the frequency with which applicable benchmarks would be exceeded in the Delta (there being only a ~~modest~~small exceedance relative to the low benchmark for sturgeon and no exceedance of the high benchmark) or substantially degrade the quality of water in the Delta, with regard to selenium.

~~Assessment This a~~Assessment of effects of selenium in the SWP/~~ and~~ CVP Export Service Areas is based on effects on selenium concentrations at the Banks and Jones pumping plants. Relative to Existing Conditions, Alternative 2A would ~~slightly decrease~~ cause no increase in the frequency with which applicable benchmarks would be exceeded, ~~or~~and would slightly improve the quality of water in selenium concentrations at the Banks and Jones pumping plants~~ locations~~.

Based on the above, selenium concentrations that would occur in water under Alternative 2A would not cause additional exceedances of applicable state or federal numeric or narrative water quality objectives/criteria, or other relevant water quality effects thresholds identified for this assessment (Table ~~M-10A~~8-54), by frequency, magnitude, and geographic extent that would result in adverse effects to one or more beneficial uses within affected water bodies. In comparison to Existing Conditions, water quality conditions under this alternative would not increase levels of selenium by frequency, magnitude, and geographic extent such that the affected environment would be expected to have measurably higher body burdens of selenium in aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish) or humans consuming those organisms. Water quality conditions under this alternative with respect to selenium would not cause long-term degradation of water quality in the affected environment, and therefore would not result in use of available assimilative capacity such that exceedances of water quality objectives/criteria would be likely and would result in substantially increased risk for adverse effects to one or more beneficial uses. This alternative would not further degrade water quality by measurable levels, on a long-term basis, for selenium and, thus, cause the CWA Section 303(d)-listed impairment of beneficial use to be made discernibly worse. This alternative is considered to be less than significant. No mitigation is required.

Impact WQ-26: Effects on Selenium Concentrations Resulting from Implementation ofCM2–~~CM22~~CM21

NEPA Effects**:** Effects of CM2–CM21 on selenium under Alternative 2A are the same as those discussed for Alternative 1A and are considered not to be adverse.

CEQA Conclusion**:** CM2–CM21 proposed under Alternative 2A would be similar to those proposed under Alternative 1A. As such, effects on selenium resulting from the implementation of CM2–CM21 would be similar to that previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

~~***NEPA Effects*****:** In general, with the possible exception of changes in Delta hydrodynamics resulting from habitat restoration, CM2–CM11 would not substantially increase selenium concentrations in the water bodies of the affected environment. Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, and thus such effects of these restoration measures were included in the assessment of CM1 facilities operations and maintenance (see Impact WQ-25).~~

~~However, i~~Implementation ~~of these conservation measures may increase water residence time within the restoration areas. Increased restoration area water residence times could potentially increase the bioaccumulation of selenium in biota, thereby potentially increasing fish tissue and bird egg concentrations of selenium., but m~~Models ~~are not available to quantitatively estimate the level of changes in residence time and the associated selenium bioavailability, but the effects of residence time are incorporated in the bioaccumulation modeling for selenium that was based on higher K_d values (the ratio of selenium concentrations in particulates [as the lowest level of the food chain] relative to the water-borne concentration) for drought years in comparison to wet, normal, or all years; see Appendix 8M, *Selenium*. If increases in fish tissue or bird egg selenium were to occur, the increases would likely be of concern only where fish tissues or bird eggs are already elevated in selenium to near or above thresholds of concern. That is, where biota concentrations are currently low and not approaching thresholds of concern, changes in residence time alone would not be expected to cause them to then approach or exceed thresholds of concern. In consideration of this~~

~~factor, although the Delta as a whole is a 303(d)-listed water body for selenium, and although monitoring data of fish tissue or bird eggs in the Delta are sparse, the most likely areas in which biota tissues would be at levels high enough that additional bioaccumulation due to increased residence time from restoration areas would be a concern are the western Delta and Suisun Bay, and the South Delta in areas that receive San Joaquin River water.~~

~~The western Delta and Suisun Bay receive elevated selenium loads from North San Francisco Bay (including San Pablo Bay, Carquinez Strait, and Suisun Bay) and from the San Joaquin River. Point sources of selenium in North San Francisco Bay (i.e., refineries) that contribute selenium to Suisun Bay are expected to be reduced through a TMDL under development by the San Francisco Bay Water Board (San Francisco Bay Water Board 2012) that is expected to result in decreasing discharges of selenium. Nonpoint sources of selenium in the San Joaquin Valley that contribute selenium to the San Joaquin River, and thus the Delta and Suisun Bay, will be controlled through a TMDL developed by the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the Grassland Bypass Project, and Basin Plan objectives (Central Valley Water Board 2010c, d) that are expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta. If selenium levels are not sufficiently reduced via these efforts, it is expected that the State Water Board and the San Francisco Bay and Central Valley Water Boards would initiate additional actions to further control sources of selenium.~~

~~The South Delta receives elevated selenium loads from the San Joaquin River. In contrast to Suisun Bay and possibly the western Delta in the future, the South Delta lacks the overbite clam (*Corbula* [*Potamocorbula*] *amurensis*), which is considered a key driver of selenium bioaccumulation in Suisun Bay, due to its high bioaccumulation of selenium and its role in the benthic food web that includes long-lived sturgeon. The South Delta does have *Corbicula fluminea*, another bivalve that bioaccumulates selenium, but it is not as invasive as the overbite clam and thus likely makes up a smaller fraction of sturgeon diet. Also, as mentioned above, nonpoint sources of selenium in the San Joaquin Valley that contribute selenium to the Delta will be controlled through a TMDL developed by the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the Grassland Bypass Project, and Basin Plan objectives (Central Valley Water Board 2010c, d) that are expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta. Further, if selenium levels in the San Joaquin River are not sufficiently reduced via these efforts, it is expected that the State Water Board and Central Valley Water Board would initiate additional TMDLs to further control nonpoint sources of selenium.~~

~~Wetland restoration areas will not be designed such that water flows in and does not flow out. Exchange of water between the restoration areas and existing Delta channels is an important design factor, since one goal of the restoration areas is to export food produced in these areas to the rest of the Delta (see BDCP Chapter 3, *Conservation Strategy*, Section 3.3, Biological Goals and Objectives). Thus, these areas can be thought of as "flow-through" systems. Consequently, although water residence times associated with BDCP restoration could increase, they are not expected toincrease without bound. and selenium concentrations in the water column would not continue to build up and be recycled in sediments and organisms as may be the case within a closed system.~~

~~However, because increases in bioavailable selenium in the habitat restoration areas are uncertain, proposed avoidance and minimization measureswould require evaluating risks of selenium exposure at a project level for each restoration area, minimizing to the extent practicable potential risk of additional bioaccumulation, and monitoring selenium levels in fish and/or wildlife to establish whether, or to what extent, additional bioaccumulation is occurring. See Appendix 3B,~~

Environmental Commitments for a description of the environmental commitment BDCP proponents are making with respect to Selenium Management; and Appendix 3.C. of the BDCP for additionaldetail on this avoidance and minimization measure (AMM27). Data generated as part of the avoidance and minimization measures will assist the State and Regional Water Boards in determining whether beneficial uses are being impacted by selenium, and thus will provide the data necessary to support regulatory actions (including additional TMDL development), should such actions be warranted.

Given the factors discussed in the assessment above, any increases in bioaccumulation rates from water-borne selenium that could occur in some areas as a result of increased water residence time would not be of sufficient magnitude and geographic extent that any portion of the Delta would be expected to have measurably higher body burdens of selenium in aquatic organisms and, therefore, would not substantially increase risk for adverse effects to beneficial uses. Furthermore, although the Delta is a 303(d)-listed water body for selenium, given the discussion in the assessment above, it is unlikely that restoration areas would result in measurable increases in selenium in fish tissues or bird eggs such that the beneficial use impairment would be made discernibly worse.

Because it is unlikely that substantial increases in selenium in fish tissues or bird eggs would occur such that effects on aquatic life beneficial uses would be anticipated, and because of the avoidance and minimization measures that are designed to further minimize and evaluate the risk of such increases, the effects of WQ-26 are considered not adverse.

***CEQA Conclusion*:** There would be no substantial, long-term increase in selenium concentrations in water in the rivers and reservoirs upstream of the Delta, water in the Delta, or the waters exported to the CVP and SWP service areas due to implementation of CM2–CM22CM21 relative to Existing Conditions. Waterborne selenium concentrations under this alternative would not exceed applicable water quality objectives/criteria.

Given the factors discussed in the assessment above, any increases in bioaccumulation rates from water-borne selenium that could occur in some areas as a result of increased water residence times would not be of sufficient magnitude and geographic extent that any portion of the Delta would be expected to have measurably higher body burdens of selenium in aquatic organisms, and therefore would not substantially increase risk for adverse effects to beneficial uses. CM2-22CM2 through CM22CM2–CM21 would not cause long-term degradation of water quality resulting in sufficient use of available assimilative capacity such that occasionally exceeding water quality objectives/criteria would be likely. Also, CM2-22CM2 through CM22CM2–CM21 would not result in substantially increased risk for adverse effects to any beneficial uses. Furthermore, although the Delta is a 303(d)-listed water body for selenium, given the discussion in the assessment above, it is unlikely that restoration areas would result in measurable increases in selenium in fish tissues or bird eggs such that the beneficial use impairment would be made discernibly worse.

Since Because it is unlikely that substantial increases in selenium in fish tissues or bird eggs would occur such that effects on aquatic life beneficial uses would be anticipated, and because of the avoidance and minimization measures that are designed to further minimize and evaluate the risk of such increases (see Appendix 3.C. of the BDCP for more detail on AMM27) as well as the Selenium Management environmental commitment (see Appendix 3B, *Environmental Commitments*), this impact is considered less than significant. No mitigation is required.***Upstream of the Delta***

Impact WQ-32.: Effects on *Microcystis* Bloom Formation Resulting from Facilities Operations and Maintenance (CM1)

Effects of facilities and operations (CM1) on Microcystis abundance, and thus microcystins concentrations, in water bodies of the affected environment under Alternative 2A would be very similar (i.e., nearly the same) to those discussed for Alternative 1A. This is because factors that affect Microcystis abundance in waters upstream of the Delta, in the Delta, and in the SWP/CVP Export Services Areas under Alternative 1A would similarly change under Alternative 2A, relative to Existing Conditions and the No Action Alternative. For the Delta in particular, there are differences in the direction and magnitude of water residence time changes during the Microcystis bloom period among the six Delta sub-regions under Alternative 2A compared to Alternative 1A, relative to Existing Conditions and No Action Alternative. However, under Alternative 2A, relative to Existing Conditions and No Action Alternative, water residence times during the Microcystis bloom period in various Delta sub-regions are expected to increase to a degree that could, similar to Alternative 1A, lead to an increase in the frequency, magnitude, and geographic extent of Microcystis blooms throughout the Delta.

Similar to Alternative 1A, elevated ambient water temperatures relative to Existing Conditions would occur in the Delta under Alternative 2A, which could lead to earlier occurrences of Microcystis blooms in the Delta, and increase the overall duration and magnitude of blooms. However, the degradation of water quality from Microcystis blooms due to the expected increases in Delta water temperatures is driven entirely by climate change, not effects of CM1. While Microcystis blooms have not occurred in the Export Service Areas, conditions in the Export Service Areas under Alternative 2A may become more conducive to Microcystis bloom formation, relative to Existing Conditions, because water temperatures will increase in the Export Service Areas due to the expected increase in ambient air temperatures resulting from climate change.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Under Alternative 2A, additional impacts from *Microcystis* in the reservoirs and watersheds upstream of the Delta are not expected, relative to Existing Conditions. Operations and maintenance occurring under Alternative 2A is not expected to change nutrient levels in upstream reservoirs or hydrodynamic conditions in upstream rivers and streams such that conditions would be more conductive to *Microcystis* production.

Relative to Existing Conditions, water temperatures and hydraulic residence times in the Delta are expected to increase under Alternative 2A, resulting in an increase in the frequency, magnitude and geographic extent of *Microcystis* blooms in the Delta. However, the degradation of water quality from *Microcystis* blooms due to the expected increases in Delta water temperatures is driven entirely by climate change, not effects of CM1. Increases in Delta residence times are expected throughout the Delta during the summer and fall bloom period, due in small part to climate change and sea level rise, but due more proportionately to CM1 and the hydrodynamic impacts of restoration included in CM2 and CM4. The precise change in local residence times and *Microcystis* production expected within any Delta sub-region is unknown because conditions will vary across the complex networks of intertwining channels, shallow back water areas, and submerged islands that compose the Delta. Nonetheless, Delta residence times are, in general, expected to increase due to Alternative 2A. Consequently, it is possible that increases in the frequency, magnitude, and geographic extent of *Microcystis* blooms in the Delta will occur due to the operations and maintenance of Alternative 2A and the hydrodynamic impacts of restoration (CM2 and CM4).

The assessment of effects of *Microcystis* on SWP/CVP Export Service Areas is based on the assessment of changes in *Microcystis* levels in export source waters, as well as the effects of temperature and residence time changes within the Export Service Areas on *Microcystis* production. Under Alternative 2A, relative to Existing Conditions, the potential for *Microcystis* to occur in the Export Service Area is expected to increase due to increasing water temperature, but this impact is driven entirely by climate change and not Alternative 2A. Water exported from the Delta to the Export Service Area is expected to be a mixture of *Microcystis*-affected source water from the south Delta intakes and unaffected source water from the Sacramento River. Because of this, it cannot be determined whether operations and maintenance under Alternative 2A, relative to existing conditions, will result in increased or decreased levels of *Microcystis* and microcystins in the mixture of source waters exported from Banks and Jones pumping plants.

Based on the above, this alternative would not be expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause significant impacts on any beneficial uses of waters in the affected environment. *Microcystis* and microcystins are not 303(d) listed within the affected environment and thus any increases that could occur in some areas would not make any existing *Microcystis* impairment measurably worse because no such impairments currently exist. Because *Microcystis* and microcystins are not bioaccumulative, increases that could occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. However, because it is possible that increases in the frequency, magnitude, and geographic extent of *Microcystis* blooms in the Delta will occur due to the operations and maintenance of Alternative 2A and the hydrodynamic impacts of restoration (CM2 and CM4), long-term water quality degradation may occur and, thus, significant impacts on beneficial uses could occur. Although there is considerable uncertainty regarding this impact, the effects on *Microcystis* from implementing CM1 is determined to be significant.

Implementation of Mitigation Measure WQ-32a and WQ-32b may reduce degradation of Delta water quality due to *Microcystis*. However, because the effectiveness of these mitigation measures to result in feasible measures for reducing water quality effects is uncertain, this impact is considered to remain significant and unavoidable.

Mitigation Measure WQ-32a: Design Restoration Sites to Reduce Potential for Increased *Microcystis* Blooms

Please see Mitigation Measure WQ-32a under Impact WQ-32 in the discussion of Alternative 1A.

Mitigation Measure WQ-32b: Investigate and Implement Operational Measures to Manage Water Residence Time

Please see Mitigation Measure WQ-32b under Impact WQ-32 in the discussion of Alternative 1A.

Impact WQ-33. Effects on *Microcystis* Bloom Formation Resulting from Other Conservation Measures (CM2-–CM21)

The effects of CM2–CM21 on *Microcystis* under Alternative ~~9~~2A are the same as those discussed for Alternative 1A. In summary, potential environmental effects related to CM2 and CM4 could result in an increase in the frequency, magnitude, and geographic extent of *Microcystis* blooms in the Delta, relative to Existing Conditions and the No Action Alternative, as a result of increased residence times for Delta waters from implementing CM2 and CM4 restoration areas. -Because the hydrodynamic effects associated with implementing CM2 and CM4 were incorporated into the modeling used to assess CM1, a detailed assessment of the effects of implementing CM2 and CM4 on *Microcystis* blooms in the Delta via their~~e~~ effects on Delta water residence time is provided under CM1 (above). The effects of ~~CM 2~~CM2 and ~~CM 4~~CM4 on *Microcystis* may be reduced by implementation of Mitigation Measures WQ-32A and WQ-32b. The effectiveness of these mitigation measures to result in feasible measures for reducing water quality effects is uncertain. Conservation Measures 3 (CM3) and CM5-CM21 would not result in an increase in the frequency, magnitude, and geographic extent of *Microcystis* blooms in the Delta.

NEPA Effects: Effects of CM2–CM21on Microcystis under Alternative 2A are the same as those discussed for Alternative 1A and are considered to be adverse.

CEQA Conclusion: Based on the above, this alternative would not be expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause significant impacts on any beneficial uses of waters in the affected environment. Microcystis and microcystins are not 303(d) listed within the affected environment and thus any increases that could occur in some areas would not make any existing Microcystis impairment measurably worse because no such impairments currently exist. Because Microcystis and microcystins are not bioaccumulative, increases that could occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. Because restoration actions implemented under CM2 and CM4 will increase residence time throughout the Delta and create local areas of warmer water during the bloom season, it is possible that increases in the frequency, magnitude, and geographic extent of Microcystis blooms, and thus long-term water quality degradation and significant impacts on beneficial uses, could occur. Although there is considerable uncertainty regarding this impact, the effects on Microcystis from implementing CM2–CM21 are determined to be significant.

Impact WQ-34: Effects on San Francisco Bay Water Quality Resulting from Facilities Operations and Maintenance (CM1) and Implementation of CM2–CM21

The effects analysis presented in the preceding impacts (Impact WQ-1 through WQ-33) concluded that Alternative 2A would have a less than significant impact/no adverse effect on the following constituents in the Delta:

- Boron
- Dissolved Oxygen
- Pathogens
- Pesticides
- Trace Metals
- Turbidity and TSS

Elevated concentrations of boron are of concern in drinking and agricultural water supplies. However, waters in the San Francisco Bay are not designated to support municipal water supply (MUN) and agricultural supply (AGR) beneficial uses. Changes in Delta dissolved oxygen, pathogens, pesticides, and turbidity and TSS are not anticipated to be of a frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of the Delta. Thus, changes in boron, dissolved oxygen, pathogens, pesticides, and turbidity and TSS in Delta outflow are not anticipated to be of a frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of the of San Francisco Bay.

The effects of Alternative 2A on bromide, chloride, and DOC, in the Delta were determined to be significant/adverse. Increases in bromide, chloride, and DOC concentrations are of concern in drinking water supplies; however, as described previously, the San Francisco Bay does not have a designated MUN use. Thus, changes in bromide, chloride, and DOC in Delta outflow would not adversely effect any beneficial uses of San Francisco Bay.

Elevated EC, as assessed for this alternative, is of concern for its effects on the agricultural beneficial use (AGR) and fish and wildlife beneficial uses. As discussed above, San Francisco Bay does not have an AGR beneficial use designation. Further, as discussed for the No Action Alternative, cwhich would be the primaryAlso, as discussed for the No Action Alternative, adverse changes in Microcystis levels that could occur in the Delta would not cause adverse Microcystis blooms in San Francisco Bay, because Microcystis are intolerant of the Bay's high salinity and, thus not have not been detected downstream of Suisun Bay.

While effects of Alternative 2A on the nutrients ammonia, nitrate, and phosphorus were determined to be less than significant/not adverse, these constituents are addressed further below because the response of the seaward bays to changed nutrient concentrations/loading may differ from the response of the Delta. Selenium and mercury are discussed further, because they are bioaccumulative constituents where changes in load due to both changes in Delta concentrations and exports are of concern.

Nutrients: Ammonia, Nitrate, and Phosphorus

Total nitrogen loads in Delta outflow to Suisun and San Pablo Bays under Alternative 2A would be dominated almost entirely by nitrate, because planned upgrades to the SRWTP will result in >95% removal of ammonia in its effluent. Total nitrogen loads to Suisun and San Pablo Bays would decrease by 26%, relative to Existing Conditions, and increase by 9%, relative to the No Action Alternative (Appendix 8O, Table O-1). The change in nitrogen loading to Suisun and San Pablo Bays under Alternative 2A would not adversely impact primary productivity in these embayments because light limitation and grazing current limit algal production in these embayments. To the extent that algal growth increases in relation to a change in ammonia concentration, this would have net positive benefits, because current algal levels in these embayments are low. Nutrient levels and ratios are not considered a direct driver of *Microcystis* and cyanobacteria levels in the North Bay.

The phosphorus load exported from the Delta to Suisun and San Pablo Bays for Alternative 2A is estimated to increase slightly (by 1%) relative to Existing Conditions and decrease by 4% relative to the No Action Alternative (Appendix 8O, Table O-1)). The only postulated effect of changes in phosphorus loads to Suisun and San Pablo Bays is related to the influence of nutrient stoichiometry on primary productivity. However, there is uncertainty regarding the impact of nutrient ratios on phytoplankton community composition and abundance. Any effect on phytoplankton community composition would likely be small compared to the effects of grazing from introduced clams and zooplankton in the estuary (Senn and Novick 2014; Kimmerer and Thompson 2014). Therefore, the projected change in total nitrogen and phosphorus loading that would occur in Delta outflow to San Francisco Bay is not expected to result in degradation of water quality with regard to nutrients that would result in adverse effects to beneficial uses.

Mercury

The estimated long-term average mercury and methylmercury loads in Delta exports are shown in Appendix 8O, Table O-2. Loads of mercury and methylmercury from the Delta to San Francisco Bay are estimated to change relatively little due to changes in source water fractions and net Delta outflow that would occur under Alternative 2A. Mercury load to the Bay, relative to Existing Conditions, is estimated to be the same relative to Existing Conditions, and to decrease by 2 kg/yr (1%) relative to the No Action Alternative. Methylmercury load is estimated to increase by 0.07 kg/yr (2%), relative to Existing Conditions, and decrease by 0.02 kg/yr (1%) relative to the No Action Alternative. The estimated total mercury load to the Bay is 261 kg/yr, which would be less than the San Francisco Bay mercury TMDL WLA for the Delta of 330 kg/yr. The estimated changes in mercury and methylmercury loads would be within the overall uncertainty associated with the estimates of long-term average net Delta outflow and the long-term average mercury and methylmercury concentrations in Delta source waters. The estimated changes in mercury load under the alternative would also be substantially less than the considerable differences among estimates in the current mercury load to San Francisco Bay (SFBRWQCB 2006; David et al. 2009). Similar uncertainty is expected in the existing methylmercury load in net Delta exports, for which the best available current load estimate is based on approximately one year of monitoring data (Foe et al. 2008).

Given that the estimated incremental ~~decreases~~increases of mercury and methylmercury loading to San Francisco Bay would fall within the uncertainty of current mercury and methylmercury load estimates, the estimated changes in mercury and methylmerucy loads in Delta exports to San Francisco Bay due to Alternative 2A are not expected to result in adverse effects to beneficial uses or substantially degrade the water quality with regard to mercury, or make the existing CWA Section 303(d) impairment measurably worse.

Selenium

Changes in source water fraction and net Delta outflow under Alternative 2A, relative to Existing Conditions, are projected to cause the total selenium load to the North Bay to increase by 8%, relative to Existing Conditions, and 5%, relative to the No Action Alternative (Appendix 8O, Table O-3). Changes in long-term average selenium concentrations of the North Bay are assumed to be proportional to changes in North Bay selenium loads. Under Alternative 2A, the long-term average total selenium concentration of the North Bay is estimated to be 0.14μg/L and the dissolved selenium concentration is estimated to be 0.12 μg/L, which would be a 0.01 μg/L increase relative to Existing Conditions and the No Action Alternative (Appendix 8O, Table O-3). The dissolved selenium concentration would be below the target of 0.202 μg/L developed by Presser or Luoma (2013) to coincide with a white sturgeon whole-body fish tissue selenium concentration not greater than 8 mg/kg in the North Bay. The incremental increase in dissolved selenium concentrations in the North Bay, relative to Existing Conditions, would be negligible (0.01 μg/L) under this alternative. Thus, the estimated changes in selenium loads in Delta exports to San Francisco Bay due to Alternative 2A are not expected to result in adverse effects to beneficial uses or substantially degrade the water quality with regard to selenium, or make the existing CWA Section 303(d) impairment measurably worse.

NEPA Effects: Based on the discussion above, Alternative 2A, relative to the No Action Alternative, would not cause further degradation to water quality with respect to boron, bromide, chloride, dissolved oxygen, DOC, EC, mercury, pathogens, pesticides, selenium, nutrients (ammonia, nitrate, phosphorus), trace metals, or turbidity and TSS in the San Francisco Bay. Further, changes in these constituent concentrations in Delta outflow would not be expected to cause changes in Bay concentrations of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses. In summary, based on the discussion above, effects on the San Francisco Bay from implementation of CM1–CM21 are considered to be not adverse.

CEQA Conclusion: Based on the above, Alternative 2A would not be expected to cause long-term degradation of water quality in San Francisco Bay resulting in sufficient use of available assimilative capacity such that occasionally exceeding water quality objectives/criteria would be likely and would result in substantially increased risk for adverse effects to one or more beneficial uses. Further, based on the above, this alternative would not be expected to cause additional exceedance of applicable water quality objectives/criteria in the San Francisco Bay by frequency, magnitude, and geographic extent that would cause significant impacts on any beneficial uses of waters in the affected environment. Any changes in boron, bromide, chloride, and DOC in the San Francisco Bay would not adversely affect beneficial uses, because the uses most affected by changes in these parameters, MUN and AGR, are not beneficial uses of the Bay. Further, no substantial changes in dissolved oxygen, pathogens, pesticides, trace metals or turbidity or TSS are anticipated in the Delta, relative to Existing Conditions, therefore, no substantial changes these constituents levels in the Bay are anticipated. Changes in Delta salinity would not contribute to measurable changes in Bay salinity, as the change in Delta outflow would two to three orders of magnitude lower than (and thus minimal compared to) the Bay's tidal flow. Adverse changes in Microcystis levels that could occur in the Delta would not cause adverse Microcystis blooms in the Bay, because Microcystis are intolerant of the Bay's high salinity and, thus not have not been detected downstream of Suisun Bay. The 26% decrease in total nitrogen load and 1% increase in phosphorus load, relative to Existing Conditions, are expected to have minimal effect on water quality degradation, primary productivity, or phytoplankton community composition. The estimated no change in mercury load (0 kg/yr; 0%) and increase in methylmercury load (0.07 kg/yr; 2%), relative to Existing Conditions, is within the level of uncertainty in the mass load estimate and not expected to contribute to water quality degradation, make the CWA section 303(d) mercury impairment measurably worse or cause mercury/methylmercury to bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. The estimated increase in selenium load would be 8%, but estimated total and dissolved selenium concentrations under this alternative would be nearly the same as Existing Conditions, and less than the target associated with white sturgeon whole-body fish tissue levels for the North Bay. Thus, the small increase in selenium load is not expected to contribute to water quality degradation, or make the CWA section 303(d) selenium impairment measurably worse or cause selenium to bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant.

8.3.2.8 Alternative 3—Dual Conveyance with Tunnel and Intakes 1 and 2 (6,000 cfs; Operational Scenario A)

Impact WQ-5: Effects on Bromide Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of ~~CM2-22~~~~CM2 through CM22~~CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for ~~CM2-22~~~~CM2 through CM22~~CM2–CM21. See section 8.3.1.3 for more information.

Under Alternative 3, the geographic extent of effects pertaining to long-term average bromide concentrations in the Delta would be similar to that previously described for Alternative 1A, although the magnitude of predicted long-term change and relative frequency of concentration threshold exceedances would be different. Using the mass-balance modeling approach for bromide (see Section 8.3.1.3), relative to Existing Conditions, modeled long-term average bromide concentrations would increase at Staten Island, Emmaton, and Barker Slough, while modeled long-term average bromide concentrations would generally decrease at other assessment locations (Appendix 8E, *Bromide*, Table 8). Overall effects would be greatest at Barker Slough, where predicted long-term average bromide concentrations would increase from 51 μg/L to 69 μg/L (34% relative increase) for the modeled 16-year hydrologic period and would increase from 54 μg/L to 99 μg/L (85% relative increase) for the modeled drought period. At Barker Slough, the predicted 50 μg/L exceedance frequency would decrease slightly from 49% under Existing Conditions to 48% under Alternative 3, but would increase from 55% to 77% during the drought period. At Barker Slough, the predicted 100 μg/L exceedance frequency would increase from 0% under Existing Conditions to 22% under Alternative 3, and would increase from 0% to 47% during the drought period. In contrast, increases in bromide at Staten Island would result in a 50 μg/L bromide threshold exceedance increase from 47% under Existing Conditions to 71% under Alternative 3(52% to 73% during the modeled drought period). However, unlike Barker Slough, modeling shows that long-term average bromide concentration at Staten Island would exceed the 100 μg/L assessment threshold concentration 1% under Existing Conditions and 3% under Alternative 3(0% to 2% during the modeled drought period). The long-term average bromide concentrations would be 60 μg/L (62 μg/L for the modeled drought period) at Staten Island under Alternative 3. Changes in exceedance frequency of the 50 μg/L and 100 μg/L concentration thresholds, as well as relative change in long-term average concentration, at other assessment locations would be less substantial. This comparison to Existing Conditions reflects changes in bromide due to both Alternative 3 operations (including north Delta intake capacity of 6,000 cfs and numerous other operational components of Scenario A) and climate change/sea level rise.

In comparison, Alternative3 relative to the No Action Alternative would result in predicted increases in long-term average bromide concentrations at all locations with the exception of the Banks and Jones pumping plants(Appendix 8E, *Bromide*, Table 8). These increases would continue to be greatest at Barker Slough, where long-term average concentrations are predicted to increase by about 38% (about 85% in drought years) relative to the No Action Alternative. Increases in long-term average bromide concentrations would be less than 29% at the remaining assessment locations. Due to the relatively small differences between modeled Existing Conditions and No Action baselines, changes in the frequency with which concentration thresholds of 50 µg/L and 100 µg/L are exceeded are of similar magnitude to the previously described existing condition comparison. Unlike the comparison to Existing Conditions, this comparison to the No Action Alternative reflects changes in bromide due only to Alternative 3 operations.

At Barker Slough, modeled long-term average bromide concentrations for the two baseline conditions are very similar(Appendix 8E, *Bromide*, Table 8). Such similarity demonstrates that the modeled Alternative 3 change in bromide is almost entirely due to Alternative 3 operations, and not climate change/sea level rise. Therefore, operations are the primary driver of effects on bromide at Barker Slough, regardless whether Alternative 3 is compared to Existing Conditions, or compared to the No Action Alternative.

Results of the modeling approach which used relationships between EC and chloride and between chloride and bromide (see Section 8.3.1.3) differed somewhat from what is presented above for the mass-balance approach (see Appendix 8E, Table 9).For most locations, the frequency of exceedance of the 50 µg/L and 100 µg/L were similar. The greatest difference between the methods was predicted for Barker Slough. The increases in frequency of exceedance of the 100 µg/L threshold, relative to Existing Conditions and the No Action Alternative, were not as great using this alternative EC to chloride and chloride to bromide relationship modeling approach as compared to that presented above from the mass-balance modeling approach. However, there were still substantial increases, resulting in 9% exceedance over the modeled period under Alternative 3, as compared to 1% under Existing Conditions and 2% under the No Action Alternative. For the drought period, exceedance frequency increased from 0% under Existing Conditions and the No Action Alternative, to 18% under Alternative 3.Because the mass-balance approach predicts a greater level of impact at Barker Slough, determination of impacts was based on the mass-balance results.

The increase in long-term average bromide concentrations predicted at Barker Slough, principally the relative increase in 100 µg/L exceedance frequency, would result in a substantial change in source water quality for existing drinking water treatment plants drawing water from the North Bay Aqueduct. As discussed for Alternative 1A, drinking water treatment plants obtaining water via the North Bay Aqueduct utilize a variety of conventional and enhanced treatment technologies in order to achieve DBP drinking water criteria. While the implications of such a modeled change in bromide at Barker Slough are difficult to predict, the substantial modeled increases could lead to adverse changes in the formation of disinfection byproducts such that considerable treatment plant upgrades may be necessary in order to achieve equivalent levels of health protection. Because many of the other modeled locations already frequently exceed the 100 µg/L threshold under Existing Conditions and the No Action Alternative, these locations likely already require treatment plant technologies to achieve equivalent levels of health protection, and thus no additional treatment technologies would be triggered by the small increases in the frequency of exceeding the 100 µg/L threshold. Hence, no further impact on the drinking water beneficial use would be expected at these locations.

The seasonal intakes at Mallard Slough and City of Antioch are infrequently used due to water quality constraints related to sea water intrusion. On a long-term average basis, bromide at these locations is in excess of 3,000 µg/L, but during seasonal periods of high Delta outflow can be <300 µg/L. Based on modeling using the mass-balance approach, use of the seasonal intakes at Mallard Slough and City of Antioch under Alternative 3would experience a period average increase in bromide during the months when these intakes would most likely be utilized. For those wet and above normal water year types where mass balance modeling would predict water quality typically suitable for diversion, predicted long-term average bromide would increase from 103 μg/L to 149 μg/L (45% increase) at City of Antioch and would increase from 150 μg/L to 201 μg/L (34% increase) at Mallard Slough relative to Existing Conditions (Appendix 8E, *Bromide*, Table 23). Increases would be similar for the No Action Alternative comparison. Modeling results using the EC to chloride and chloride to bromide relationships show increases during these months, but the relative magnitude of the increases is much lower (Appendix 8E, *Bromide*, Table 24).Regardless of the differences in the data between the two modeling approaches, the decisions surrounding the use of these seasonal intakes is largely driven by acceptable water quality, and thus have historically been opportunistic. Opportunity to use these intakes would remain, and the predicted increases in bromide concentrations at the City of Antioch and Mallard Slough intake would not be expected to adversely affect MUN beneficial uses, or any other beneficial use, at these locations.

Important to the results presented above is the assumed habitat restoration footprint on both the temporal and spatial scales incorporated into the modeling. Modeling sensitivity analyses have indicated that habitat restoration (which are reflected in the modeling—see Section 8.3.1.3), not operations covered under CM1, are the driving factor in the modeled bromide increases. The timing, location, and specific design of habitat restoration will have effects on Delta hydrodynamics, and any deviations from modeled habitat restoration and implementation schedule will lead to different outcomes. Although habitat restoration near Barker Slough is an important factor contributing to modeled bromide concentrations at the North Bay Aqueduct, BDCP habitat restoration elsewhere in the Delta can also have large effects. Because of these uncertainties, and the possibility of adaptive management changes to BDCP restoration activities, including location, magnitude, and timing of restoration, the estimates are not predictive of the bromide levels that would actually occur in Barker Slough or elsewhere in the Delta.

Impact WQ-7: Effects on Chloride Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Delta

303(d) Listed Water Bodies–Relative to Existing Conditions

With respect to the 303(d) listing for chloride in Tom Paine Slough, the monthly average chloride concentrations for the 16-year period modeled at Old River at Tracy Road would generally be similar compared to Existing Conditions, and thus, would not be further degraded on a long-term basis (Appendix 8G, Figure Cl-2). With respect to Suisun Marsh, the monthly average chloride concentrations for the 16-year period modeled would increase compared to Existing Conditions in some months during October through May at the Sacramento River at Collinsville (Appendix 8G, Figure Cl-3), Mallard Island (Appendix 8G, Figure Cl-1), and increase substantially at Montezuma Slough at Beldon's Landing (i.e., up to a tripling of concentration in December through February) (Appendix 8G, Figure Cl-4). However, modeling of Alternative 3 assumed no operation of the Montezuma Slough Salinity Control Gates, but the project description assumes continued operation of the Salinity Control Gates, consistent with assumptions included in the No Action Alternative. A sensitivity analysis modeling run conducted for Alternative 4 with the gates operational consistent with the No Action Alternative resulted in substantially lower EC levels than indicated in the original Alternative 4 modeling results for Suisun Marsh, but EC levels were still somewhat higher than EC levels under Existing Conditions for several locations and months. Although chloride was not specifically modeled in these sensitivity analyses, it is expected that chloride concentrations would be nearly proportional to EC levels in Suisun Marsh. Another modeling run with the gates operational and restoration areas removed resulted in EC levels nearly equivalent to Existing Conditions, indicating that design and siting of restoration areas has notable bearing on EC levels at different locations within Suisun Marsh (see Appendix 8H Attachment 1 for more information on these sensitivity analyses). These analyses also indicate that increases in salinity are related primarily to the hydrodynamic effects of CM4, not operational components of CM1. Based on the sensitivity analyses, optimizing the design and siting of restoration areas may limit the magnitude of long-term chloride increases in the Marsh. However, the chloride concentration increases at certain locations could be substantial, depending on siting and design of restoration areas. Thus, these increased chloride levels in Suisun Marsh are considered to contribute to additional, measureable long-term degradation that potentially would adversely affect the necessary actions to reduce chloride loading for any TMDL that is developed.

~~thereby contributing to additional, measureable long-term degradation that potentially would adversely affect the necessary actions to reduce chloride loading for any TMDL that is developed.~~

Municipal Beneficial Uses–Relative to No Action Alternative

303(d) Listed Water Bodies–Relative to No Action Alternative

With respect to the 303(d) listing for chloride, Alternative 3 would generally result in similar changes to those discussed for the comparison to Existing Conditions. Monthly average chloride concentrations at Tom Paine Slough would not be further degraded on a long-term basis (Appendix 8G, Figure Cl-2). Monthly average chloride concentrations at source water channel locations for the Suisun Marsh (Appendix 8G, Figures Cl-1, Cl-3 and Cl-4) would increase substantially in some months during October through May compared to the No Action Alternative conditions but sensitivity analyses suggest that operation of the Salinity Control Gates and restoration area siting and design considerations could reduce these increases. However, the chloride concentration increases at certain locations could be substantial, depending on siting and design of restoration areas. Thus, these increased chloride levels in Suisun Marsh are considered to contribute to~~.~~ ~~Therefore~~, additional, measureable long-term degradation would occur in Suisun Marsh that potentially would adversely affect the necessary actions to reduce chloride loading for any TMDL that is developed.

Impact WQ-9: Effects on Dissolved Oxygen Resulting from Facilities Operations and Maintenance (CM1)

***NEPA Effects*: ** Effects of CM1 on DO under Alternative 3 are the same as those discussed for Alternative 1A and are considered to not be adverse.

CEQA Conclusion: Effects of CM1 on DO under Alternative 3would be similar to those discussed for Alternative 1A, and are summarized here, then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion under Alternative 1A.

~~River flow rate and r~~Reservoir storage reductions that would occur under Alternative 3, relative to Existing Conditions, would not be expected to result in a substantial adverse change in DO levels in the reservoirs, because oxygen sources (surface water aeration, aerated inflows, vertical mixing) would remain. Similarly, river flow rate reductions that would occur would not be expected to result in a substantial adverse change in DO levels in the ~~and~~ rivers upstream of the Delta, given that mean monthly flows would remain within the ranges historically seen under Existing Conditions and the affected river are large and turbulent. Any reduced DO saturation level that may be caused by increased water temperature would not be expected to cause DO levels to be outside of the range seen historically. Finally, amounts of oxygen demanding substances and salinity would not be expected to change sufficiently to affect DO levels.

It is expected there would be no substantial change in Delta DO levels in response to a shift in the Delta source water percentages under this alternative or substantial degradation of these water bodies, with regard to DO. DO levels would be affected by nutrient loading, which the state has begun to aggressively regulate the discharges of, and this loading would not be expected to lower DO levels relative to Existing Conditions based on historical DO levels. Further, the anticipated changes in salinity would have relatively minor effects on DO levels, and tidal exchange, which contribute to the reaeration of Delta waters would not be expected to change substantially.

There is not expected to be substantial, if even measurable, changes in DO levels in the SWP/CVP Export Service Areas waters under Alternative 3, relative to Existing Conditions, because the biochemical oxygen demand of the exported water would not be expected to substantially differ from that under Existing Conditions (due to ever increasing water quality regulations), canal turbulence and exposure of the water to the atmosphere and the algal communities that exist within the canals would establish an equilibrium for DO levels within the canals. The same would occur in downstream reservoirs.

Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would result in significant impacts on any beneficial uses within affected water bodies. Because no substantial changes in DO levels are expected, long-term water quality degradation would not be expected to occur, and, thus, beneficial uses would not be adversely affected. Various Delta waterways are 303(d)-listed for low DO, but because no substantial decreases in DO levels would be expected, greater degradation and DO-related impairment of these areas would not be expected. This impact would be less than significant. No mitigation is required.

Impact WQ-11: Effects on Electrical Conductivity Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of ~~CM2-22~~CM2 ~~through CM22~~CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for ~~CM2-22~~CM2 ~~through CM22~~CM2–CM21. See section 8.3.1.3 for more information.

Relative to Existing Conditions, modeling indicates that Alternative 3 would result in an increase in the ~~fewer~~ number of days when Bay-Delta WQCP compliance locations ~~in the western, interior, and southern Delta~~ would exceed EC objectives or be out of compliance with the EC objectives at~~, with the exception of~~ the Sacramento River at Emmaton and San Joaquin River at Jersey Point (fish and wildlife objective) in the western Delta and San Joaquin River at San Andreas Landing in the interior Delta (Appendix 8H, Table EC-3).

The percent of days the Emmaton EC objective would be exceeded for the entire period modeled (1976–1991) would increase from 6% under Existing Conditions to ~~27~~30% under Alternative 3, and the days out of compliance with the EC objective would increase from 11% under Existing Conditions to ~~39~~44% under Alternative 3.

The percent of days the San Andreas Landing EC objective would be exceeded would increase from 1% under Existing Conditions to ~~2~~4% under Alternative 3. Further, the percent of days out of compliance with the EC objective would increase from 1% under Existing Conditions to ~~4~~6% under Alternative 3. Sensitivity analyses were performed for Alternative 4 scenario H3, and indicated that many similar exceedances were modeling artifacts, and the small number of remaining exceedances were small in magnitude, lasted only a few days, and could be addressed with real time operations of the SWP and CVP (see Section 8.3.1.1 for a description of real time operations of the SWP and CVP). Due to similarities in the nature of the exceedances between alternatives, the findings from these analyses can be extended to this alternative as well.

At Jersey Point, relative to the fish and wildlife objective,- the percent of days of EC objective exceedance and days out of compliance would increase from 0% under Existing Conditions to 3% under Alternative 3, which represents a very small increase for this objective. Further discussion of EC increases relative to this objective can be found in Appendix 8H Attachment 2.

Average EC levels at the western and southern Delta compliance locations, except at Emmaton in the western Delta, would decrease from 1–28% for the entire period modeled and 2–30% during the drought period modeled (1987–1991) (Appendix 8H, Table EC-14). At Emmaton, average EC would increase by 14% for the entire period modeled and 12% for the drought period modeled. At the two interior Delta locations, there would be increases in average EC: the S. Fork Mokelumne River at Terminous average EC would increase 4% for the entire period modeled and 3% during the drought period modeled; and San Joaquin River at San Andreas Landing average EC would increase 12% for the entire period modeled and 13% during the drought period modeled. On average, EC would increase at Emmaton during December and March through September. Average EC would increase at San Andreas Landing during all months except November. Average EC in the S. Fork Mokelumne River at Terminous would increase during all months. Average EC at Jersey Point during the months of April–May, when the fish and wildlife objective applies in all but critical water year types, would increase from 14–17% for the entire period modeled (Appendix 8H, Table EC-14; further discussion of EC increases relative to this objective can be found in Appendix 8H Attachment 2). Of the Clean Water Act section 303(d) listed sections of the Delta–western, northwestern, and southern–the western portion of the Delta at Emmaton would have an increased frequency of exceedance of EC objectives (Appendix 8H, Table EC-~~1~~3) and increased average EC. Thus, Alternative 3 could contribute to additional impairment and adversely affect beneficial uses for section 303(d) listed Delta waterways, relative to Existing Conditions. These EC changes are similar to that described for Alternative 1A. The comparison to Existing Conditions reflects changes in EC due to both Alternative 3 operations (including north Delta intake capacity of 6,000 cfs and numerous other operational components of Scenario A) and climate change/sea level rise.

Relative to the No Action Alternative, the percent of days exceeding EC objectives and percent of days out of compliance would increase at: Sacramento River at Emmaton, San Joaquin River at Jersey Point, San Andreas Landing, and Prisoners Point; and Old River near Middle River; and Old

River at Tracy Bridge (Appendix 8H, Table EC-3). The increase in percent of days exceeding the EC objective would be ~~1~~3% or less and the increase in percent of days out of compliance would be ~~3~~5% or less, with the exception of Emmaton, which would have a 1~~5~~6% increase in days exceeding the EC objective and a 1~~7~~9% increase in days out of compliance. Regarding exceedances at Old River at Middle River and at Tracy Bridge, as noted in Section 8.1.3.7, SWP and CVP operations have relatively little influence on salinity levels at these locations, and the elevated salinity in south Delta channels is affected substantially by local salt contributions discharged into the San Joaquin River downstream of Vernalis. Thus, the modeling has limited ability to estimate salinity accurately in this region. Average EC would increase at some compliance locations for the entire period modeled: Sacramento River at Emmaton (13%), San Joaquin River at Jersey Point (2%), S. Fork Mokelumne River at Terminous (4%),San Joaquin River at San Andreas Landing (18%), and San Joaquin River at Prisoners Point (9%) (Appendix 8H, Table EC-14). For the drought period modeled, the locations with an average EC increase, relative to the No Action Alternative, would be: Sacramento River at Emmaton (1%), S. Fork Mokelumne River at Terminous (4%), San Joaquin River at San Andreas Landing (13%), San Joaquin River at Brandt Bridge (1%), Old River at Tracy Bridge (1%), and San Joaquin River at Prisoners Point (5%) (Appendix 8H, Table EC-14). The western and southern Delta are CWA section 303(d) listed for elevated EC and the increased incidence of exceedance of EC objectives and EC degradation that could occur in the western Delta could make beneficial use impairment measurably worse. Since there would be very little change in EC levels in the southern Delta and there is not expected to be an increase in frequency of exceedances of objectives, this alternative is not expected to make beneficial use impairment measurably worse in the southern Delta. ~~Given that the western and southern Delta are Clean Water Act section 303(d) listed as impaired due to elevated EC, the increase in the incidence of exceedance of EC objectives and increases in long-term and drought period average EC at the western and southern Delta locations under Alternative 3, relative to the No Action Alternative, has the potential to contribute to additional impairment and potentially adversely affect beneficial uses.~~ These EC changes are similar to that described for Alternative 1A. The comparison to the No Action Alternative reflects changes in EC due only to Alternative 3 operations (including north Delta intake capacity of 6,000 cfs and numerous other operational components of Scenario A).

For Suisun Marsh, October–May is the period when Bay-Delta WQCP EC objectives for protection of fish and wildlife apply. Long-term average EC would increase under Alternative 3, relative to Existing Conditions, during the months of March through May by 0.3–0.9 mS/cm in the Sacramento River at Collinsville (Appendix 8H, Table EC-21). Long-term average EC would decrease relative to Existing Conditions in Montezuma Slough at National Steel during October–May (Appendix 8H, Table EC-22). The most substantial increase would occur near Beldon Landing, with long-term average EC levels increasing by 1.8–6.1 mS/cm, depending on the month, which would be a doubling or tripling of long-term average EC relative to Existing Conditions (Appendix 8H, Table EC-23). Sunrise Duck Club and Volanti Slough also would have long-term average EC increases during all months of 1.7–4.0 mS/cm (Appendix 8H, Tables EC-24 and EC-25). Modeling of this alternative assumed no operation of the Montezuma Slough Salinity Control Gates, but the project description assumes continued operation of the Salinity Control Gates, consistent with assumptions included in the No Action Alternative. A sensitivity analysis modeling run conducted for Alternative 4 scenario H3 with the gates operational consistent with the No Action Alternative resulted in substantially lower EC levels than indicated in the original Alternative 4 modeling results, but EC levels were still somewhat higher than EC levels under Existing Conditions and the No Action Alternative for several locations and months. Another modeling run with the gates operational and restoration areas removed resulted in EC levels nearly equivalent to Existing Conditions and the No Action

Alternative, indicating that design and siting of restoration areas has notable bearing on EC levels at different locations within Suisun Marsh (see Appendix 8H Attachment 1 for more information on these sensitivity analyses). These analyses also indicate that increases are related primarily to the hydrodynamic effects of CM4, not operational components of CM1. Based on the sensitivity analyses, optimizing the design and siting of restoration areas may limit the magnitude of long-term EC increases to be on the order of 1 mS/cm or less. Due to similarities in the nature of the EC increases between alternatives, the findings from these analyses can be extended to this alternative as well.

The degree to which the long-term average EC increases in Suisun Marsh would cause exceedance of Bay-Delta WQCP objectives is unknown, because these objectives are expressed as a monthly average of daily high tide EC, which does not have to be met if it can be demonstrated “equivalent or better protection will be provided at the location” (State Water Resources Control Board 2006:14). The ~~described~~ long-term average EC increase may, or may not, contribute to adverse effects on beneficial uses, depending on how and when wetlands are flooded, soil leaching cycles, and how agricultural use of water is managed, and future actions taken with respect to the marsh. However, the EC increases at certain locations ~~would~~ could be substantial, depending on siting and design of restoration areas, and it is uncertain the degree to which current management plans for the Suisun Marsh would be able to address these substantially higher EC levels and protect beneficial uses. Thus, these increased EC levels in Suisun Marsh are considered to have a potentially adverse effect on marsh beneficial uses. Long-term average EC increases in Suisun Marsh under Alternative 3 relative to the No Action Alternative would be similar to the increases relative to Existing Conditions. Suisun Marsh is section 303(d) listed as impaired due to elevated EC, and the potential increases in long-term average EC concentrations could contribute to additional impairment~~, because the increases would be double or triple that relative to Existing Conditions and the No Action Alternative~~. These EC changes are similar to that described for Alternative 1A.

NEPA Effects: In summary, the increased frequency of exceedance of EC objectives and increased long-term and drought period average EC levels that would occur at western ~~and southern~~ Delta compliance locations under Alternative 3, relative to the No Action Alternative, would contribute to adverse effects on the agricultural beneficial uses. The increased long-term period average EC levels between Jersey Point and Prisoners Point could contribute to adverse effects on fish and wildlife beneficial uses (specifically, indirect adverse effects on striped bass spawning), though there is a high degree of uncertainty associated with this impact. The western and southern Delta are CWA section 303(d) listed as impaired due to elevated EC, and the increase in incidence of exceedance of EC objectives and increases in long-term average and drought period average EC in the western portion of the Delta have the potential to contribute to additional beneficial use impairment. ~~The increased frequency of exceedance of the EC objective for the San Joaquin River at Prisoners Point, and increased long-term period average EC levels that would occur in April–May at this location under Alternative 3, relative to the No Action Alternative,could contribute to adverse effects on fish and wildlife beneficial uses. Given that the western and southern Delta areClean Water Act section 303(d) listed as impaired due to elevated EC, the increase in the incidence of exceedance of EC objectives and increases in long-term and drought period average EC in the southern Delta under Alternative 3 has the potential to contribute to additional beneficial use impairment.~~ The increases in long-term average EC levels that ~~would~~ could occur in Suisun Marsh would further degrade existing EC levels and could contribute ~~additionally~~ to adverse effects on the fish and wildlife beneficial uses. Suisun Marsh is section 303(d) listed as impaired due to elevated EC, and the potential increases in long-term average EC levels could contribute to additional beneficial use impairment. The effects on EC in the western Delta, San Joaquin River at Prisoners Point, and in

Suisun Marsh ~~These increases in EC~~ constitute an adverse effect on water quality. Mitigation Measure WQ-11 would be available to reduce these effects (implementation of this measure along with a separate, non-environmental commitment as set forth in EIR/EIS Appendix 3B, *Environmental Commitments*, relating to the potential EC-related changes would reduce these effects).

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

River flow rate and reservoir storage reductions that would occur under Alternative 3, relative to Existing Conditions, would not be expected to result in a substantial adverse change in EC levels in the reservoirs and rivers upstream of the Delta, given that: changes in the quality of watershed runoff and reservoir inflows would not be expected to occur in the future; the state's aggressive regulation of point-source discharge effects on Delta salinity-elevating parameters and the expected further regulation as salt management plans are developed; the salt-related TMDLs adopted and being developed for the San Joaquin River; and the expected improvement in lower San Joaquin River average EC levels commensurate with the lower EC of the irrigation water deliveries from the Delta.

Relative to Existing Conditions, Alternative 3 would not result in any substantial increases in long-term average EC levels in the SWP/CVP Export Service Areas. There would be no exceedance of the EC objective at the Jones and Banks pumping plants. Average EC levels for the entire period modeled would decrease at both plants and, thus, this alternative would not contribute to additional beneficial use impairment related to elevated EC in the SWP/CVP Export Service Areas waters. Rather, this alternative would improve long-term EC levels in the SWP/CVP Export Service Areas, relative to Existing Conditions.

In the Plan Area, Alternative 3 would result in an increase in the frequency with which Bay-Delta WQCP EC objectives for agricultural beneficial use protection are exceeded in the Sacramento River at Emmaton (2~~1~~4%; western Delta) ~~and San Joaquin River at San Andreas Landing (31%; interior Delta)~~ for the entire period modeled (1976–1991). Further, average EC levels at Emmaton would increase by 14% for the entire period modeled and 12% during the drought period modeled. Average EC levels at San Andreas Landing would increase by 12% for the entire period modeled and 13% during the drought period modeled. . In addition, there would be an increase in ~~the frequency with which the EC objective for fish and wildlife beneficial uses protection is exceeded in the San Joaquin River at Jersey Point (3%; western Delta), and an increase in~~ the average EC of 14–17% at Jersey Point (for the entire period modeled) during the months of April–May, when the fish and wildlife objective applies. Because EC is not bioaccumulative, the increases in long-term average EC levels would not directly cause bioaccumulative problems in aquatic life or humans. The interior Delta is not Clean Water Act section 303(d) listed for elevated EC; however, the western Delta is. The increases in long-term and drought period average EC levels and increased frequency of exceedance of EC objectives that would occur in the Sacramento River at Emmaton ~~and San Joaquin River at San Andreas Landing~~ would potentially contribute to adverse effects on the agricultural beneficial uses in the ~~interior~~ western Delta. The increased long-term period average EC levels between Jersey Point and Prisoners Point could contribute to adverse effects on fish and wildlife beneficial uses (specifically, indirect adverse effects on striped bass spawning), though there is a high degree of uncertainty associated with this impact. The increases in long-term average EC levels and increased frequency of exceedance of the EC objective that would occur in the San Joaquin River at Jersey Point would potentially contribute to adverse effects on the fish and wildlife uses in the western Delta. This impact is considered to be significant.

Further, relative to Existing Conditions, Alternative 3 would could result in substantial increases in long-term average EC during the months of October through May in Suisun Marsh, such that EC levels would be double or triple that occurring under Existing Conditions. The increases in long-term average EC levels that would occur in Suisun Marsh could further degrade existing EC levels and thus contribute additionally to adverse effects on the fish and wildlife beneficial uses. Because EC is not bioaccumulative, the increases in long-term average EC levels would not directly cause bioaccumulative problems in wildlife. Suisun Marsh is Clean Water Act section 303(d) listed for elevated EC and the increases in long-term average EC that would occur in the marsh could make beneficial use impairment measurably worse. This impact is considered to be significant.

Implementation of Mitigation Measure WQ-11 along with a separate, non-environmental commitment relating to the potential increased costs associated with EC-related changes would reduce these effects. While mitigation measures to reduce these water quality effects in affected water bodies to less than significant levels are not available, implementation of Mitigation Measure WQ-11 is recommended to attempt to reduce the effect that increased EC concentrations may have on Delta beneficial uses. However, because the effectiveness of this mitigation measure to result in feasible measures for reducing water quality effects is uncertain, this impact is considered to remain significant and unavoidable. Please see Mitigation Measure WQ-11 under Impact WQ-11 in the discussion of Alternative 1A.

In addition to and to supplement Mitigation Measure WQ-11, the BDCP proponents have incorporated into the BDCP, as set forth in EIR/EIS Appendix 3B, Environmental Commitments, a separate, non-environmental commitment to address the potential increased water treatment costs that could result from EC concentration effects on municipal, industrial and agricultural water purveyor operations. Potential options for making use of this financial commitment include funding or providing other assistance towards acquiring alternative water supplies or towards modifying existing operations when EC concentrations at a particular location reduce opportunities to operate existing water supply diversion facilities. Please refer to Appendix 3B, Environmental Commitments, for the full list of potential actions that could be taken pursuant to this commitment in order to reduce the water quality treatment costs associated with water quality effects relating to chloride, electrical conductivity, and bromide.

Impact WQ-13: Effects on Mercury Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2-22CM2 through CM22CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for CM2-22CM2 through CM22CM2–CM21. See section 8.3.1.3 for more information.

The water quality impacts of waterborne concentrations of mercury and methylmercury and fish tissue mercury concentrations were evaluated for 9 Delta locations. The analysis of percentage change in assimilative capacity of waterborne total mercury of Alternative 3relative to the 25 ng/L ecological risk benchmark as compared to Existing Conditions showed the greatest decrease to be 0.7% for Franks Tract, Old River at Rock Slough, and Contra Costa Pumping Plant, and 0.8% for the Mokelumne River (South Fork) at Staten Island and Franks Tract relative to the No Action Alternative (Figures 8-53 and 8-54).These changes are not expected to result in adverse effects to beneficial uses. Similarly, changes in methylmercury concentration are expected to be very small. The greatest annual average methylmercury concentration for drought conditions was 0.167 ng/L for the San Joaquin River at Buckley Cove which was slightly higher than Existing Conditions (0.161 ng/L), and the same as the No Action Alternative (Appendix 8I, Table I-6) (Appendix 8I, Figure I-3).All modeled input concentrations exceeded the methylmercury TMDL guidance objective of 0.06 ng/L, therefore percentage change in assimilative capacity was not evaluated for methylmercury.

Fish tissue showed small increases in exceedance quotients based on long-term annual average concentrations for mercury at the Delta locations. There was a 6% increase at the Mokelumne River (South Fork) at Staten Island, the San Joaquin River at Buckley Cove, Franks Tract, and Old River at Rock Slough relative to Existing Conditions, and a 8% increase at the Mokelumne River (South Fork) at Staten Island relative to the No Action Alternative (Figure 8-55a,b, Appendix 8I, Table I-10b). All water export locations except Contra Costa Pumping Plant #1 showed improved bass tissue mercury estimates (Figure 8-55a,b, Appendix 8I, Table I-10a,b). Because these increases are relatively small, and it is not evident that substantive increases are expected at numerous locations throughout the Delta, these changes are expected to be within the uncertainty inherent in the modeling approach, and would likely not be measurable in the environment. See Appendix 8I for a discussion of the uncertainty associated with the fish tissue estimates.

Impact WQ-25: Effects on Selenium Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics,. To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2-22CM2 through CM22CM2–CM21 not attributable to hydrodynamics, for example,such as additional loading of a constituent to the Delta, are discussed within the impact header for CM2-22CM2 through CM22CM2–CM21. See section Section 8.3.1.3 for more information.

Selenium concentrations and threshold comparisons for each of the 11 modeled Delta assessment locations under Alternative 3, relative to Existing Conditions and the No Action Alternative, are presented in Appendix 8M, *Selenium*, Table M-9a for water, Tables M-13 and M-23 for most biota (whole-body fish ([excluding sturgeon)], bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets) throughout the Delta, and Tables M-30 through M-32 for sturgeon at the two western Delta locations. Figures 8-59a and 8-60a present graphical distributions of predicted selenium concentration changes (shown as changes in available assimilative capacity based on 1.3 µg/L) in water at each modeled assessment location for all years. Appendix 8M, Figure M-21 provides more detail in the form of monthly patterns of selenium concentrations in water during the modeling period. Appendix 8M.

Alternative 3 would result in small changes in average selenium concentrations in water at all modeled Delta assessment locations relative to Existing Conditions and the No Action Alternative (Appendix 8M, *Selenium,* Table M-9a). Long-term average concentrations at some interior and western Delta locations would increase by 0.01 µg/L for the entire period modeled (1976–1991). These small increases in selenium concentrations in water would result in small reductions (1% or less) in available assimilative capacity for selenium, relative to the 1.3 µg/L ~~ecological risk benchmark~~USEPA draft water quality criterion (Figures 8-59a and 8-60a). The long-term average selenium concentrations in water ~~(Appendix 8M, Table M-9a)~~ for Alternative 3 (range 0.09–0.38 µg/L) would be similar to those for Existing Conditions (range 0.09–0.41 µg/L) and the No Action Alternative (range 0.09–0.38 µg/L), and all would be below the ~~ecological risk benchmark~~USEPA draft water quality criterion ~~(~~ of 1.3~~2~~ µg/L (Appendix 8M, Table M-9a).

Relative to Existing Conditions and the No Action Alternative, Alternative 3 would result in ~~minimal~~ very small changes (less than 1%) in estimated selenium concentrations in most biota (whole-body fish, bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets) throughout the Delta, with little difference among locations (Figures 8-61a through 8-64b; Appendix 8M, *Selenium,* Table M-~~14~~ 23 ~~andTable 8M-2 in the sturgeon addendum to Appendix 8M.Addendum M.A, *Selenium in Sturgeon,* to Appendix 8M, Table M.A-2~~). Level of Concern Exceedance Quotients (i.e., modeled tissue divided by Level of Concern benchmarks) for selenium concentrations in those biota for all years and for drought years are less than 1.0 (indicating low probability of adverse effects). Similarly, Advisory Tissue Level Exceedance Quotients for selenium concentrations in fish fillets for all years and drought years also are less than 1.0. Estimated selenium concentrations in sturgeon for the San Joaquin River at Antioch are predicted to increase by about 7 percent relative~~Relative~~ to Existing Conditions and to the No Action Alternative in all years (from about 4.7 to 5.0 mg/kg dry weight [dw]), and those for sturgeon in the Sacramento River at Mallard Island are predicted to increase by about 4 percent in all years (from about 4.4 to 4.6 mg/kg dw) (~~Figure 8-65;~~ Appendix 8M, Tables M-30 and M-31). Selenium concentrations in sturgeon during drought years are expected to increase by only 2 or 3 percent at those locations (Appendix 8M, Tables M-30 and M-31). Detection of small changes in whole-body sturgeon such as those estimated for the western Delta would require very large sample sizes because of the inherent variability in fish tissue selenium concentrations. Low Toxicity Threshold Exceedance Quotients for selenium concentrations in sturgeon in the western Delta would exceed 1.0 (indicating a higher probability for adverse effects) for drought years at both locations (as they do for Existing Conditions and the No Action Alternative; Figure 8-65); however, for the entire period modeled, the quotient would not be exceeded at either location (Appendix 8M, Table M-32).

The disparity between larger estimated changes for sturgeon and smaller changes for other biota ~~are~~is attributable largely to differences in modeling approaches, as described in Appendix 8M, *Selenium*. The model for most biota was calibrated to encompass the varying concentration-dependent uptake from waterborne selenium concentrations (expressed as the K_d, which is the ratio of selenium concentrations in particulates [as the lowest level of the food chain] relative to the waterborne concentration) that was exhibited in data for largemouth bass in 2000, 2005, and 2007 at various locations across the Delta. In contrast, the modeling for sturgeon could not be similarly calibrated at the two western Delta locations and used literature-derived uptake factors and trophic transfer factors for the estuary from Presser and Luoma (2013). As noted in the appendix, there was a significant negative log-log relationship of K_d to waterborne selenium concentration that reflected the greater bioaccumulation rates for bass at low waterborne selenium than at higher concentrations. (There was no difference in bass selenium concentrations in the Sacramento River at Rio Vista in comparison to the San Joaquin River at Vernalis in 2000, 2005, and 2007 [Foe 2010], despite a nearly 10-fold difference in waterborne selenium.) Thus, there is more confidence in the site-specific modeling based on the Delta-wide model that was calibrated for bass data than in the estimates for sturgeon based on "fixed" K_ds for all years and for drought years without regard to waterborne selenium concentration at the two locations in different time periods.

Increased water residence times could increase the bioaccumulation of selenium in biota, thereby potentially increasing fish tissue and bird egg concentrations of selenium (see residence time discussion in Appendix 8M, *Selenium*, and Presser and Luoma [2010b]). Thus, residence time was assessed for its relevance to selenium bioaccumulation. Table 60a (presented originally in Section 8.3.1.7 in the *Microcystis* subsection) shows the time for neutrally buoyant particles to move through the Delta (surrogate for flow and residence time). Although an increase in residence time throughout the Delta is expected under the No Action Alternative, relative to Existing Conditions (because of climate change and sea level rise), the change is fairly small in most areas of the Delta. Thus, the changes in residence times between Alternative 3 and the No Action Alternative are very similar to the changes in residence times between Alternative 3 and the Existing Conditions.

Relative to Existing Conditions and the No Action Alternative, increases in residence times for Alternative 3 would be greater in the East Delta than in other sub-regions. Relative to Existing Conditions, annual average residence times for Alternative 3 in the East Delta are expected to increase by more than 15 days (Table 60a). Relative to the No Action Alternative, annual average residence times for Alternative 3 in the East Delta are expected to increase by less than 9 days. Increases in residence times for other sub-regions would be smaller, especially as compared to Existing Conditions and the No Action Alternative (which are longer than those modeled for the South Delta). As mentioned above, these results incorporate hydrodynamic effects of both CM1 and CM2 and CM4, and the effects of CM1 cannot be distinguished from the effects of CM2 and CM4. However, it is expected that CM2 and CM4 are substantial drivers of the increased residence time.

Presser and Luoma (2010b) summarized and discussed selenium uptake in the Bay-Delta (including hydrologic conditions [e.g., Delta outflow and residence time for water], K_ds [the ratio of selenium concentrations in particulates, as the lowest level of the food chain, relative to the water-borne concentration], and associated tissue concentrations [especially in clams and their consumers, such as sturgeon]). When the Delta Outflow Index (daily average flow per month) decreased by five-fold (73,732 cubic feet per second [cfs] in June 1998 to 12, 251 cfs in October 1998), residence time doubled (from 11 to 22 days) and the calculated mean K_d also doubled (from 3,198 to 6,501). However, when daily average Delta outflow in November 1999 was only 6,951 cfs (i.e., about one-half that in October 1998) and residence time was 70 days, the calculated mean K_d (7,614) did not increase proportionally.

Models are not available to quantitatively estimate the level of changes in selenium bioaccumulation as related to residence time, but the effects of residence time are incorporated in the bioaccumulation modeling for selenium that was based on higher K_d values for drought years in comparison to wet, normal, or all years; see Appendix 8M, *Selenium*. If increases in fish tissue or bird egg selenium were to occur, the increases would likely be of concern only where fish tissues or bird eggs are already elevated in selenium to near or above thresholds of concern. That is, where biota concentrations are currently low and not approaching thresholds of concern (which, as discussed above, is the case throughout the Delta, except for sturgeon in the western Delta), changes in residence time alone would not be expected to cause them to then approach or exceed thresholds of concern. In consideration of this factor, although the Delta as a whole is a CWA Section 303(d)-listed water body for selenium, and although monitoring data of fish tissue or bird eggs in the Delta are sparse, the most likely area in which biota tissues would be at levels high enough that additional bioaccumulation due to increased residence time from restoration areas would be a concern is the western Delta and Suisun Bay for sturgeon, as discussed above. As shown in Table 60a, the overall increase in residence time estimated in the western Delta is 6 days relative to Existing Conditions, and 4 days relative to the No Action Alternative. Given the available information, these increases are small enough that they are not expected to substantially affect selenium bioaccumulation in the western Delta. Because CM2 and CM4 are expected to be substantial drivers of the increased residence times, further discussion is included in Impact WQ-26 below.

, the largest increase of selenium concentrations in biota would be at Barker Slough PP for drought years (except for bird eggs [assuming a fish diet] at Barker Slough for all years) and for sturgeon at the San Joaquin River at Antioch in all years, and the largest decrease would be at Buckley Cove for drought years. Relative to the No Action Alternative, the largest increase also would be at Barker Slough PP for drought years (except for bird eggs [assuming a fish diet] at Barker Slough for all years) and the largest decrease would be at Staten Island for drought years (except for bird eggs [assuming a fish diet] at Buckley Cove for drought years). Except for sturgeon in the western Delta, concentrations of selenium in whole-body fish and bird eggs (invertebrate and fish diets) would exceed only the lower benchmarks (4 and 6 mg/kg dry weight, respectively, indicating a low potential for effects), under drought conditions, at Buckley Cove for Alternative 3 (as it would for Existing Conditions and the No Action Alternative) (Figures 8-61 through 8-63). Exceedance QuotientsExceedance quotients for all these exceedances of the lower benchmarks are between 1.0 and 1.5, indicating a low risk to biota in the Delta and no substantial difference from Existing Conditions and the No Action Alternative. Selenium concentrations in fish fillets would not exceed the screening value for protection of human health (Figure 8-64). For sturgeon in the western Delta, whole-body selenium concentrations would increase from 12.3 mg/kg under Existing Conditions and the No Action Alternative to 12.7 mg/kg under Alternative 3, a 3% increase (Table 8M-2 in the sturgeon addendum to Appendix 8M.Table M.A-2). Although all of these values exceed both the low and high toxicity benchmarks, it is unlikely that the modeled increases in whole-body selenium for sturgeon would be measurable in the environment (see also the discussion of results provided in the sturgeon addendum M.A, *Selenium in Sturgeon*, to Appendix 8M).

In summary, relative to Existing Conditions and the No Action Alternative, Alternative 3 would result in essentially no change in selenium concentrations throughout the Delta for most biota (less than 1%), although increases in selenium concentrations are predicted for sturgeon in the western Delta. Concentrations of selenium in sturgeon would exceed only the lower benchmark, indicating a low potential for effects. The modeling of bioaccumulation for sturgeon is less calibrated to site-specific conditions than that for other biota, which was calibrated on a robust dataset for modeling of bioaccumulation in largemouth bass as a representative species for the Delta. Overall, Alternative 3 would not be expected to substantially increase the frequency with which applicable benchmarks would be exceeded in the Delta (there being only a small increase for sturgeon relative to the low benchmark and no exceedance of the high benchmark) or substantially degrade the quality of water in the Delta, with regard to selenium.

SWP/CVP Export Service Areas

Alternative 3 would result in small (0.04 µg/L) decreases in long-term average selenium concentrations in water at the Banks and Jones pumping plants, relative to Existing Conditions and the No Action Alternative, for the entire period modeled (Appendix 8M, *Selenium*, Table M-9a). These decreases in long-term average selenium concentrations in water would result in increases in available assimilative capacity for selenium at these pumping plants of 4%, relative to the 1.3 µg/L ~~ecological risk benchmark~~USEPA draft water quality criterion (Figures 8-59a and 8-60a). Furthermore, the modeled selenium concentrations in water for Alternative 3 (range 0.17–0.24 µg/L) would be below the ~~ecological risk benchmark~~USEPA draft water quality criterion of 1.3 µg/L (Appendix 8M, Table M-9a).

Relative to Existing Conditions and the No Action Alternative, Alternative 3 would result in very small changes (less than 1%) in estimated selenium concentrations in biota (whole-body fish, bird eggs [invertebrate diet], and fish fillets) (Figures 8-61a through 8-64b; Appendix 8M, *Selenium*, Table M-~~14~~23) at Banks and Jones pumping plants. ~~Relative to Existing Conditions the largest increase of selenium concentrations in biota would be at Banks PP for drought years (except for bird eggs (assuming a fish diet) at Banks PP for all years), and the largest decrease would be at Jones PP for all years (except for bird eggs [assuming a fish diet] at Jones PP for drought years). Relative to the No Action Alternative, the largest increase of selenium in biota would be at Banks PP for drought years (except for bird eggs (assuming a fish diet) at Banks PP for all years), and the largest decrease would be at Jones PP for drought years. Furthermore, c~~Concentrations in biota would not exceed any selenium benchmarks for Alternative 3 (Figures 8-61a through 8-64b).

~~Thus, relative to Existing Conditions and the No Action Alternative, Alternative 3 would result in minimal changes in selenium concentrations throughout at Export Service Area locations. Selenium concentrations in water and biota generally would decrease for Alternative 3 and would not exceed ecological benchmarks at any location, whereas the lower benchmark for bird eggs (fish diet) would be exceeded under Existing Conditions and the No Action Alternativeat Jones PP under drought conditions. This small positive change in selenium concentrations under Alternative 3 would be expected to slightly decrease the frequency with which applicable benchmarks would be exceeded or slightly improve the quality of water in at Export Service Area locations, with regard to selenium.~~

NEPA Effects: Based on the discussion above, the effects on selenium (both as waterborne and as bioaccumulated in biota) from Alternative 3 are not considered to be adverse.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for selenium. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

There are no substantial point sources of selenium in watersheds upstream of the Delta, and no substantial nonpoint sources of selenium in the watersheds of the Sacramento River and the eastern tributaries. Nonpoint sources in the San Joaquin Valley that contribute selenium to the Delta will be controlled through a TMDL developed by the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the Grassland Bypass Project, and Basin Plan objectives (Central Valley Water Board [2010~~c~~d]~~)~~ and State Water Board ~~(~~[2010~~d~~b, 2010~~e~~c]) that are expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta. Consequently, any modified reservoir operations and subsequent changes in river flows under Alternative 3, relative to Existing Conditions, are expected to cause negligible changes in selenium concentrations in water. Any negligible changes in selenium concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies as related to selenium.

Relative to Existing Conditions, modeling estimates indicate that Alternative 3 would result in essentially no change in selenium concentrations in water or most biota throughout the Delta, with no exceedances of benchmarks for biological effects. The Low Toxicity Threshold Exceedance Quotient for selenium concentrations in sturgeon for all years in the San Joaquin River at Antioch would increase slightly, from 0.94 for Existing Conditions ~~and the No Action Alternative~~ to 1.0 for Alternative 3. Concentrations of selenium in sturgeon would exceed only the lower benchmark during the drought period modeled, indicating a low potential for effects. Overall, Alternative 3 would not be expected to substantially increase the frequency with which applicable benchmarks would be exceeded in the Delta (there being only a small exceedance for sturgeon relative to the low benchmark for sturgeon during the drought period and no exceedance of the high benchmark) or substantially degrade the quality of water in the Delta, with regard to selenium.

AAssessment of effects of selenium in the SWP/CVP Export Service Areas is based on effects on selenium concentrations at the Banks and Jones pumping plants. Relative to Existing Conditions, Alternative 3 would ~~slightly decrease~~ cause no increase in ~~slightly decrease~~ the frequency with which applicable benchmarks would be exceeded and would slightly improve the quality of water in selenium concentrations at the Banks and Jones pumping plants.

Based on the above, selenium concentrations that would occur in water under Alternative 3 would not cause additional exceedances of applicable state or federal numeric or narrative water quality objectives/criteria, or other relevant water quality effects thresholds identified for this assessment (Table 8-54), by frequency, magnitude, and geographic extent that would result in adverse effects to one or more beneficial uses within affected water bodies. In comparison to Existing Conditions, water quality conditions under this alternative would not increase levels of selenium by frequency, magnitude, and geographic extent such that the affected environment would be expected to have measurably higher body burdens of selenium in aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish) or humans consuming those organisms. Water quality conditions under this alternative with respect to selenium would not cause long-term degradation of water quality in the affected environment, and therefore would not result in use of available assimilative capacity such that exceedances of water quality objectives/criteria would be likely and would result in substantially increased risk for adverse effects to one or more beneficial uses. This alternative would not further degrade water quality by measurable levels, on a long-term basis, for selenium and, thus, cause the CWA Section 303(d)-listed impairment of beneficial use to be made discernibly worse. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-26: Effects on Selenium Concentrations Resulting from Implementation ofCM2–~~CM22~~CM21

***NEPA Effects*: Effects of CM2–CM21 on selenium under Alternative 3 are the same as those discussed for Alternative 1A and are considered not to be adverse.**

***CEQA Conclusion*:** CM2–CM21 proposed under Alternative 3 would be similar to those proposed under Alternative 1A. As such, effects on selenium resulting from the implementation of CM2–CM21 would be similar to that previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

NEPA Effects: In general, with the possible exception of changes in Delta hydrodynamics resulting from habitat restoration, CM2–CM11 would not substantially increase selenium concentrations in the water bodies of the affected environment. Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, and thus such effects of these restoration measures were included in the assessment of CM1 facilities operations and maintenance (see Impact WQ-25).

However, iImplementation of these conservation measures may increase water residence time within the restoration areas. Increased restoration area water residence times could potentially increase the bioaccumulation of selenium in biota, therebypotentially increasing fish tissue and bird egg concentrations of selenium, but m. Models are not available to quantitatively estimate the level of changes in residence time and the associated selenium bioavailability, but the effects of residence time are incorporated in the bioaccumulation modeling for selenium that was based on higher K_d values (the ratio of selenium concentrations in particulates [as the lowest level of the food chain] relative to the water-borne concentration) for drought years in comparison to wet, normal, or all years; see Appendix 8M, *Selenium*. If increases in fish tissue or bird egg selenium were to occur, the increases would likely be of concern only where fish tissues or bird eggs are already elevated in selenium to near or above thresholds of concern. That is, where biota concentrations are currently low and not approaching thresholds of concern, changes in residence time alone would not be expected to cause them to then approach or exceed thresholds of concern. In consideration of this factor, although the Delta as a whole is a 303(d)-listed water body for selenium, and although monitoring data of fish tissue or bird eggs in the Delta are sparse, the most likely areas in which biota tissues would be at levels high enough that additional bioaccumulation due to increased residence time from restoration areas would be a concern are the western Delta and Suisun Bay, and the South Delta in areas that receive San Joaquin River water.

The western Delta and Suisun Bay receive elevated selenium loads from North San Francisco Bay (including San Pablo Bay, Carquinez Strait, and Suisun Bay) and from the San Joaquin River. Point sources of selenium in North San Francisco Bay (i.e., refineries) that contribute selenium to Suisun Bay are expected to be reduced through a TMDL under development by the San Francisco Bay Water Board (San Francisco Bay Water Board 2012) that is expected to result in decreasing discharges of selenium. Nonpoint sources of selenium in the San Joaquin Valley that contribute selenium to the San Joaquin River, and thus the Delta and Suisun Bay, will be controlled through a TMDL developed by the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the Grassland Bypass Project, and Basin Plan objectives (Central Valley Water Board 2010c, d) that are expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta. If selenium levels are not sufficiently reduced via these efforts, it is expected that the State Water Board and the San Francisco Bay and Central Valley Water Boards would initiate additional actions to further control sources of selenium.

The South Delta receives elevated selenium loads from the San Joaquin River. In contrast to Suisun Bay and possibly the western Delta in the future, the South Delta lacks the overbite clam (*Corbula* [*Potamocorbula*] *amurensis*), which is considered a key driver of selenium bioaccumulation in Suisun Bay, due to its high bioaccumulation of selenium and its role in the benthic food web that includes long-lived sturgeon. The South Delta does have *Corbicula fluminea*, another bivalve that bioaccumulates selenium, but it is not as invasive as the overbite clam and thus likely makes up a smaller fraction of sturgeon diet. Also, as mentioned above, nonpoint sources of selenium in the San Joaquin Valley that contribute selenium to the Delta will be controlled through a TMDL developed by the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the

Grassland Bypass Project, and Basin Plan objectives (Central Valley Water Board 2010c, d) that are expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta. Further, if selenium levels in the San Joaquin River are not sufficiently reduced via these efforts, it is expected that the State Water Board and Central Valley Water Board would initiate additional TMDLs to further control nonpoint sources of selenium.

Wetland restoration areas will not be designed such that water flows in and does not flow out. Exchange of water between the restoration areas and existing Delta channels is an important design factor, since one goal of the restoration areas is to export food produced in these areas to the rest of the Delta (see BDCP Chapter 3, *Conservation Strategy*, Section 3.3, Biological Goals and Objectives). Thus, these areas can be thought of as "flow-through" systems. Consequently, althoughwater residence times associated with BDCP restoration could increase, they are not expected toincrease without bound. and selenium concentrations in the water column would not continue to build up and be recycled in sediments and organisms as may be the case within a closed system.

However, because increases in bioavailable selenium in the habitat restoration areas are uncertain, proposed avoidance and minimization measureswould require evaluating risks of selenium exposure at a project level for each restoration area, minimizing to the extent practicable potential risk of additional bioaccumulation, and monitoring selenium levels in fish and/or wildlife to establish whether, or to what extent, additional bioaccumulation is occurring. See Appendix 3B, *Environmental Commitments* for a description of the environmental commitment BDCP proponents are making with respect to Selenium Management; and Appendix 3.C. of the BDCP for additionaldetail on this avoidance and minimization measure (AMM27). Data generated as part of the avoidance and minimization measures will assist the State and Regional Water Boards in determining whether beneficial uses are being impacted by selenium, and thus will provide the data necessary to support regulatory actions (including additional TMDL development), should such actions be warranted.

Given the factors discussed in the assessment above, any increases in bioaccumulation rates from water-borne selenium that could occur in some areas as a result of increased water residence time would not be of sufficient magnitude and geographic extent that any portion of the Delta would be expected to have measurably higher body burdens of selenium in aquatic organisms and, therefore, would not substantially increase risk for adverse effects to beneficial uses. Furthermore, although the Delta is a 303(d)-listed water body for selenium, given the discussion in the assessment above, it is unlikely that restoration areas would result in measurable increases in selenium in fish tissues or bird eggs such that the beneficial use impairment would be made discernibly worse.

Because it is unlikely that substantial increases in selenium in fish tissues or bird eggs would occur such that effects on aquatic life beneficial uses would be anticipated, and because of the avoidance and minimization measures that are designed to further minimize and evaluate the risk of such increases, the effects of WQ-26 are considered not adverse.

CEQA Conclusion: There would be no substantial, long-term increase in selenium concentrations in water in the rivers and reservoirs upstream of the Delta, water in the Delta, or the waters exported to the CVP and SWP service areas due to implementation of CM2–CM22CM21 relative to Existing Conditions. Waterborne selenium concentrations under this alternative would not exceed applicable water quality objectives/criteria.

Given the factors discussed in the assessment above, any increases in bioaccumulation rates from water-borne selenium that could occur in some areas as a result of increased water residence times would not be of sufficient magnitude and geographic extent that any portion of the Delta would be expected to have measurably higher body burdens of selenium in aquatic organisms, and therefore would not substantially increase risk for adverse effects to beneficial uses. CM2-22CM2 through CM22CM2–CM21 would not cause long-term degradation of water quality resulting in sufficient use of available assimilative capacity such that occasionally exceeding water quality objectives/criteria would be likely. Also, CM2-22CM2 through CM22CM2–CM21 would not result in substantially increased risk for adverse effects to any beneficial uses. Furthermore, although the Delta is a 303(d)-listed water body for selenium, given the discussion in the assessment above, it is unlikely that restoration areas would result in measurable increases in selenium in fish tissues or bird eggs such that the beneficial use impairment would be made discernibly worse.

Since Because it is unlikely that substantial increases in selenium in fish tissues or bird eggs would occur such that effects on aquatic life beneficial uses would be anticipated, and because of the avoidance and minimization measures that are designed to further minimize and evaluate the risk of such increases (see Appendix 3.C. of the BDCP for more detail on AMM27) as well as the Selenium Management environmental commitment (see Appendix 3B, *Environmental Commitments*), this impact is considered less than significant. No mitigation is required.

Impact WQ-32. Effects on *Microcystis* Bloom Formation Resulting from Facilities Operations and Maintenance (CM1)

Effects of facilities and operations (CM1) on *Microcystis* abundance, and thus microcystins concentrations, in water bodies of the affected environment under Alternative 3 would be very similar (i.e., nearly the same) to those discussed for Alternative 1A. This is because factors that affect *Microcystis* abundance in waters upstream of the Delta, in the Delta, and in the SWP/CVP Export Services Areas under Alternative 1A would similarly change under Alternative 3, relative to Existing Conditions and the No Action Alternative. For the Delta in particular, there are differences in the direction and magnitude of water residence time changes during the *Microcystis* bloom period among the six Delta sub-regions under Alternative 3 compared to Alternative 1A, relative to Existing Conditions and No Action Alternative. However, under Alternative 3, relative to Existing Conditions and No Action Alternative, water residence times during the *Microcystis* bloom period in various Delta sub-regions are expected to increase to a degree that could, similar to Alternative 1A, lead to an increase in the frequency, magnitude, and geographic extent of *Microcystis* blooms throughout the Delta.

Similar to Alternative 1A, elevated ambient water temperatures relative to Existing Conditions would occur in the Delta under Alternative 3, which could lead to earlier occurrences of *Microcystis* blooms in the Delta, and increase the overall duration and magnitude of blooms. However, the degradation of water quality from *Microcystis* blooms due to the expected increases in Delta water temperatures is driven entirely by climate change, not effects of CM1. While *Microcystis* blooms have not occurred in the Export Service Areas, conditions in the Export Service Areas under Alternative 3 may become more conducive to *Microcystis* bloom formation, relative to Existing Conditions, because water temperatures will increase in the Export Service Areas due to the expected increase in ambient air temperatures resulting from climate change.

NEPA Effects: Effects of water facilities and operations (CM1) on Microcystis in water bodies of the affected environment under Alternative 3 would be very similar to (i.e., nearly the same) to those discussed for Alternative 1A. In summary, Alternative 3 operations and maintenance, relative to the No Action Alternative, would result in long-term increases in hydraulic residence time of various

Delta sub-regions during the summer and fall Microcystis bloom period. During this period, the increased residence time could result in a concurrent increase in the frequency, magnitude, and geographic extent of Microcystis blooms, and thus microcystin levels, in affected areas of the Delta. As a result, Alternative 3 operation and maintenance activities would cause further degradation to water quality with respect to Microcystis in the Delta. Under Alternative 3, relative to No Action Alternative, water exported to the SWP/CVP Export Service Area will be a mixture of Microcystis-affected source water from the south Delta intakes and unaffected source water from the Sacramento River, diverted at the north Delta intakes. It cannot be determined whether operations and maintenance under Alternative 3 will result in increased or decreased levels of Microcystis and microcystins in the mixture of source waters exported from Banks and Jones pumping plants. Mitigation Measure WQ-32a and WQ-32b are available to reduce the effects of degraded water quality in the Delta. Although there is considerable uncertainty regarding this impact, the effects on Microcystis from implementing CM1 is determined to be adverse.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Under Alternative 3, additional impacts from *Microcystis* in the reservoirs and watersheds upstream of the Delta are not expected, relative to Existing Conditions. Operations and maintenance occurring under Alternative 3 is not expected to change nutrient levels in upstream reservoirs or hydrodynamic conditions in upstream rivers and streams such that conditions would be more conductive to *Microcystis* production.

Relative to Existing Conditions, water temperatures and hydraulic residence times in the Delta are expected to increase under Alternative 3, resulting in an increase in the frequency, magnitude and geographic extent of *Microcystis* blooms in the Delta. However, the degradation of water quality from *Microcystis* blooms due to the expected increases in Delta water temperatures is driven entirely by climate change, not effects of CM1. Increases in Delta residence times are expected throughout the Delta during the summer and fall bloom period, due in small part to climate change and sea level rise, but due more proportionately to CM1 and the hydrodynamic impacts of restoration included in CM2 and CM4. The precise change in local residence times and *Microcystis* production expected within any Delta sub-region is unknown because conditions will vary across the complex networks of intertwining channels, shallow back water areas, and submerged islands that compose the Delta. Nonetheless, Delta residence times are, in general, expected to increase due to Alternative 3. Consequently, it is possible that increases in the frequency, magnitude, and geographic extent of *Microcystis* blooms in the Delta will occur due to the operations and maintenance of Alternative 3 and the hydrodynamic impacts of restoration (CM2 and CM4).

The assessment of effects of *Microcystis* on SWP/CVP Export Service Areas is based on the assessment of changes in *Microcystis* levels in export source waters, as well as the effects of temperature and residence time changes within the Export Service Areas on *Microcystis* production. Under Alternative 3, relative to Existing Conditions, the potential for *Microcystis* to occur in the Export Service Area is expected to increase due to increasing water temperature, but this impact is driven entirely by climate change and not Alternative 3. Water exported from the Delta to the Export Service Area is expected to be a mixture of *Microcystis*-affected source water from the south Delta intakes and unaffected source water from the Sacramento River. Because of this, it cannot be determined whether operations and maintenance under Alternative 3, relative to existing conditions, will result in increased or decreased levels of *Microcystis* and microcystins in the mixture of source waters exported from Banks and Jones pumping plants.

Based on the above, this alternative would not be expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause significant impacts on any beneficial uses of waters in the affected environment. *Microcystis* and microcystins are not 303(d) listed within the affected environment and thus any increases that could occur in some areas would not make any existing *Microcystis* impairment measurably worse because no such impairments currently exist. Because *Microcystis* and microcystins are not bioaccumulative, increases that could occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. However, because it is possible that increases in the frequency, magnitude, and geographic extent of *Microcystis* blooms in the Delta will occur due to the operations and maintenance of Alternative 3 and the hydrodynamic impacts of restoration (CM2 and CM4), long-term water quality degradation may occur and, thus, significant impacts on beneficial uses could occur. Although there is considerable uncertainty regarding this impact, the effects on *Microcystis* from implementing CM1 is determined to be significant.

Implementation of Mitigation Measure WQ-32a and WQ-32b may reduce degradation of Delta water quality due to *Microcystis*. However, because the effectiveness of these mitigation measures to result in feasible measures for reducing water quality effects is uncertain, this impact is considered to remain significant and unavoidable.

Mitigation Measure WQ-32a: Design Restoration Sites to Reduce Potential for Increased *Microcystis* Blooms

Please see Mitigation Measure WQ-32a under Impact WQ-32 in the discussion of Alternative 1A.

Mitigation Measure WQ-32b: Investigate and Implement Operational Measures to Manage Water Residence Time

Please see Mitigation Measure WQ-32b under Impact WQ-32 in the discussion of Alternative 1A.

Impact WQ-33. Effects on *Microcystis* Bloom Formation Resulting from Other Conservation Measures (CM2-–CM21).

The effects of CM2–CM21 on *Microcystis* under Alternative ~~9~~3 are the same as those discussed for Alternative 1A. In summary, potential environmental effects related to CM2 and CM4 could result in an increase in the frequency, magnitude, and geographic extent of *Microcystis* blooms in the Delta, relative to Existing Conditions and the No Action Alternative, as a result of increased residence times for Delta waters from implementing CM2 and CM4 restoration areas. -Because the hydrodynamic effects associated with implementing CM2 and CM4 were incorporated into the modeling used to assess CM1, a detailed assessment of the effects of implementing CM2 and CM4 on *Microcystis* blooms in the Delta via their~~e~~ effects on Delta water residence time is provided under CM1 (above). The effects of ~~CM 2~~CM2 and ~~CM 4~~CM4 on *Microcystis* may be reduced by implementation of Mitigation Measures WQ-32A and WQ-32b. The effectiveness of these mitigation measures to result in feasible measures for reducing water quality effects is uncertain. Conservation Measures 3 (CM3) and CM5-CM21 would not result in an increase in the frequency, magnitude, and geographic extent of *Microcystis* blooms in the Delta.

NEPA Effects: Effects of CM2–CM21on Microcystis under Alternative 3 are the same as those discussed for Alternative 1A and are considered to be adverse.

CEQA Conclusion: Based on the above, this alternative would not be expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause significant impacts on any beneficial uses of waters in the affected environment. Microcystis and microcystins are not 303(d) listed within the affected environment and thus any increases that could occur in some areas would not make any existing Microcystis impairment measurably worse because no such impairments currently exist. Because Microcystis and microcystins are not bioaccumulative, increases that could occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. Because restoration actions implemented under CM2 and CM4 will increase residence time throughout the Delta and create local areas of warmer water during the bloom season, it is possible that increases in the frequency, magnitude, and geographic extent of Microcystis blooms, and thus long-term water quality degradation and significant impacts on beneficial uses, could occur. Although there is considerable uncertainty regarding this impact, the effects on Microcystis from implementing CM2–CM21 are determined to be significant.

Impact WQ-34: Effects on San Francisco Bay Water Quality Resulting from Facilities Operations and Maintenance (CM1) and Implementation of CM2–CM21

The effects analysis presented in the preceding impacts (Impact WQ-1 through WQ-33) concluded that Alternative 3 would have a less than significant impact/no adverse effect on the following constituents in the Delta:

- Boron
- Dissolved Oxygen
- Pathogens
- Pesticides
- Trace Metals
- Turbidity and TSS

Elevated concentrations of boron are of concern in drinking and agricultural water supplies. However, waters in the San Francisco Bay are not designated to support municipal water supply (MUN) and agricultural supply (AGR) beneficial uses. Changes in Delta dissolved oxygen, pathogens, pesticides, and turbidity and TSS are not anticipated to be of a frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of the Delta. Thus, changes in boron, dissolved oxygen, pathogens, pesticides, and turbidity and TSS in Delta outflow are not anticipated to be of a frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of the of San Francisco Bay.

The effects of Alternative 3 on bromide, chloride, and DOC, in the Delta were determined to be significant/adverse. Increases in bromide, chloride, and DOC concentrations are of concern in drinking water supplies; however, as described previously, the San Francisco Bay does not have a designated MUN use. Thus, changes in bromide, chloride, and DOC in Delta outflow would not adversely effect any beneficial uses of San Francisco Bay.

Elevated EC, as assessed for this alternative, is of concern for its effects on the agricultural beneficial use (AGR) and fish and wildlife beneficial uses. As discussed above, San Francisco Bay does not have an AGR beneficial use designation. Further, as discussed for the No Action Alternative, changes in Delta salinity would not contribute to measurable changes in Bay salinity, as the change in Delta outflow, which would be the primary driver of salinity changes, would two to three orders of magnitude lower than (and thus minimal compared to) the Bay's tidal flow.

Also, as discussed for the No Action Alternative, adverse changes in Microcystis levels that could occur in the Delta would not cause adverse Microcystis blooms in San Francisco Bay, because Microcystis are intolerant of the Bay's high salinity and, thus not have not been detected downstream of Suisun Bay.

While effects of Alternative 3 on the nutrients ammonia, nitrate, and phosphorus were determined to be less than significant/not adverse, these constituents are addressed further below because the response of the seaward bays to changed nutrient concentrations/loading may differ from the response of the Delta. Selenium and mercury are discussed further, because they are bioaccumulative constituents where changes in load due to both changes in Delta concentrations and exports are of concern.

Nutrients: Ammonia, Nitrate, and Phosphorus

Total nitrogen loads in Delta outflow to Suisun and San Pablo Bays under Alternative 3 would be dominated almost entirely by nitrate, because planned upgrades to the SRWTP will result in >95% removal of ammonia in its effluent. Total nitrogen loads to Suisun and San Pablo Bays would decrease by 33%, relative to Existing Conditions, and decrease by 9%, relative to the No Action Alternative (Appendix 8O, Table O-1). The change in nitrogen loading to Suisun and San Pablo Bays under Alternative 3 would not adversely impact primary productivity in these embayments because light limitation and grazing current limit algal production in these embayments. To the extent that algal growth increases in relation to a change in ammonia concentration, this would have net positive benefits, because current algal levels in these embayments are low. Nutrient levels and ratios are not considered a direct driver of *Microcystis* and cyanobacteria levels in the North Bay.

The phosphorus load exported from the Delta to Suisun and San Pablo Bays for Alternative 3 is estimated to decrease by 1%, relative to Existing Conditions and by 6% relative to the No Action Alternative (Appendix 8O, Table O-1)). The only postulated effect of changes in phosphorus loads to Suisun and San Pablo Bays is related to the influence of nutrient stoichiometry on primary productivity. However, there is uncertainty regarding the impact of nutrient ratios on phytoplankton community composition and abundance. Any effect on phytoplankton community composition would likely be small compared to the effects of grazing from introduced clams and zooplankton in the estuary (Senn and Novick 2014; Kimmerer and Thompson 2014). Therefore, the projected change in total nitrogen and phosphorus loading that would occur in Delta outflow to San Francisco Bay is not expected to result in degradation of water quality with regard to nutrients that would result in adverse effects to beneficial uses.

Mercury

The estimated long-term average mercury and methylmercury loads in Delta exports are shown in Appendix 8O, Table O-2. Loads of mercury and methylmercury from the Delta to San Francisco Bay are estimated to change relatively little due to changes in source water fractions and net Delta outflow that would occur under Alternative 3. Mercury load to the Bay, relative to Existing

Conditions, is estimated to decrease by 2 kg/yr (1%), relative to Existing Conditions, and to decrease by 5 kg/yr (2%), relative to the No Action Alternative. Methylmercury load is estimated to decrease by 0.04 kg/yr (1%), relative to Existing Conditions, and by 0.13 kg/yr (4%) relative to the No Action Alternative. The estimated total mercury load to the Bay is 258 kg/yr, which would be less than the San Francisco Bay mercury TMDL WLA for the Delta of 330 kg/yr. The estimated changes in mercury and methylmercury loads would be within the overall uncertainty associated with the estimates of long-term average net Delta outflow and the long-term average mercury and methylmercury concentrations in Delta source waters. The estimated changes in mercury load under the alternative would also be substantially less than the considerable differences among estimates in the current mercury load to San Francisco Bay (SFBRWQCB 2006; David et al. 2009). Similar uncertainty is expected in the existing methylmercury load in net Delta exports, for which the best available current load estimate is based on approximately one year of monitoring data (Foe et al. 2008).

Given that the estimated incremental ~~decreases~~increases of mercury and methylmercury loading to San Francisco Bay would fall within the uncertainty of current mercury and methylmercury load estimates, the estimated changes in mercury and methylmerucy loads in Delta exports to San Francisco Bay due to Alternative 3 are not expected to result in adverse effects to beneficial uses or substantially degrade the water quality with regard to mercury, or make the existing CWA Section 303(d) impairment measurably worse.

Selenium

Changes in source water fraction and net Delta outflow under Alternative 3, relative to Existing Conditions, are projected to cause the total selenium load to the North Bay to increase by 1%, relative to Existing Conditions, and decrease by 2%, relative to the No Action Alternative (Appendix 8O, Table O-3). Changes in long-term average selenium concentrations of the North Bay are assumed to be proportional to changes in North Bay selenium loads. Under Alternative 3, the long-term average total selenium concentration of the North Bay is estimated to be 0.13µg/L and the dissolved selenium concentration is estimated to be 0.11 µg/L, which would be the same as Existing Conditions and the No Action Alternative (Appendix 8O, Table O-3). The dissolved selenium concentration would be below the target of 0.202 µg/L developed by Presser or Luoma (2013) to coincide with a white sturgeon whole-body fish tissue selenium concentration not greater than 8 mg/kg in the North Bay. The incremental increase in dissolved selenium concentrations in the North Bay, relative to Existing Conditions, would be negligible (0.00 µg/L) under this alternative. Thus, the estimated changes in selenium loads in Delta exports to San Francisco Bay due to Alternative 3 are not expected to result in adverse effects to beneficial uses or substantially degrade the water quality with regard to selenium, or make the existing CWA Section 303(d) impairment measurably worse.

NEPA Effects: Based on the discussion above, Alternative 3, relative to the No Action Alternative, would not cause further degradation to water quality with respect to boron, bromide, chloride, dissolved oxygen, DOC, EC, mercury, pathogens, pesticides, selenium, nutrients (ammonia, nitrate, phosphorus), trace metals, or turbidity and TSS in the San Francisco Bay. Further, changes in these constituent concentrations in Delta outflow would not be expected to cause changes in Bay concentrations of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses. In summary, based on the discussion above, effects on the San Francisco Bay from implementation of CM1–CM21 are considered to be not adverse.

CEQA Conclusion: Based on the above, Alternative 3 would not be expected to cause long-term degradation of water quality in San Francisco Bay resulting in sufficient use of available assimilative capacity such that occasionally exceeding water quality objectives/criteria would be likely and would result in substantially increased risk for adverse effects to one or more beneficial uses. Further, based on the above, this alternative would not be expected to cause additional exceedance of applicable water quality objectives/criteria in the San Francisco Bay by frequency, magnitude, and geographic extent that would cause significant impacts on any beneficial uses of waters in the affected environment. Any changes in boron, bromide, chloride, and DOC in the San Francisco Bay would not adversely affect beneficial uses, because the uses most affected by changes in these parameters, MUN and AGR, are not beneficial uses of the Bay. Further, no substantial changes in dissolved oxygen, pathogens, pesticides, trace metals or turbidity or TSS are anticipated in the Delta, relative to Existing Conditions, therefore, no substantial changes these constituents levels in the Bay are anticipated. Changes in Delta salinity would not contribute to measurable changes in Bay salinity, as the change in Delta outflow would two to three orders of magnitude lower than (and thus minimal compared to) the Bay's tidal flow. Adverse changes in Microcystis levels that could occur in the Delta would not cause adverse Microcystis blooms in the Bay, because Microcystis are intolerant of the Bay's high salinity and, thus not have not been detected downstream of Suisun Bay. The 33% decrease in total nitrogen load and 1% decrease in phosphorus load, relative to Existing Conditions, are expected to have minimal effect on water quality degradation, primary productivity, or phytoplankton community composition. The estimated reduction in mercury load (2 kg/yr; 1%) and methylmercury load (0.04 kg/yr; 1%), relative to Existing Conditions, is within the level of uncertainty in the mass load estimate and not expected to contribute to water quality degradation, make the CWA section 303(d) mercury impairment measurably worse or cause mercury/methylmercury to bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. The estimated increase in selenium load would be 1%, but estimated total and dissolved selenium concentrations under this alternative would be the same as Existing Conditions, and less than the target associated with white sturgeon whole-body fish tissue levels for the North Bay. Thus, the small increase in selenium load is not expected to contribute to water quality degradation, or make the CWA section 303(d) selenium impairment measurably worse or cause selenium to bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant.

8.3.3.9 Alternative 4—Dual Conveyance with Modified Pipeline/Tunnel and Intakes 2, 3, and 5 (9,000 cfs; Operational Scenario H)

Alternative 4 would comprise physical/structural components similar to those under Alternative 1A, however, there are notable differences. Alternative 4 would convey up to 9,000 cfs of water from the north Delta to the south Delta and that Alternative 4 would include an operable barrier at the head of Old River. Diverted water would be conveyed through pipelines/tunnels from three screened intakes (i.e., Intakes 2, 3 and 5) located on the east bank of the Sacramento River between Clarksburg and Courtland. Alternative 4 would include a 245 acre intermediate forebay at Glannvale Tract. Clifton Court Forebay would be dredged and expanded by approximately 690 acres to the southeast of the existing forebay. Water supply and conveyance operations would follow the guidelines described as Scenario H1, H2, H3, or H4, which variously include or exclude implementation of fall X2 and/or enhanced spring outflow. ~~Conservation Measures 2–22~~CM2–CM21 would be implemented under this alternative, and would be the same as those under Alternative 1A. See Chapter 3, *Description of Alternatives,* Section 3.5.9, for additional details on Alternative 4.

Effects of the Alternative on Delta Hydrodynamics

Under the No Action Alternative and Alternatives 1–9, the following two primary factors can substantially affect water quality within the Delta:

- Within the south, west, and interior Delta, a decrease in the percentage of Sacramento River-sourced water and a concurrent increase in San Joaquin River-sourced water can increase the concentrations of numerous constituents (e.g., boron, bromide, chloride, electrical conductivity, nitrate, organic carbon, some pesticides, selenium). This source water replacement is caused by decreased exports of San Joaquin River water (due to increased Sacramento River water exports), or effects of climate change on timing of flows in the rivers. Changes in channel flows also can affect water residence time and many related physical, chemical, and biological variables.
- Particularly in the west Delta, sea water intrusion as a result of sea level rise or decreased Delta outflow can increase the concentration of salts (bromide, chloride) and levels of electrical conductivity. Conversely, increased Delta outflow (e.g., as a result of Fall X2 operations in wet and above normal water years) will decrease levels of these constituents, particularly in the west Delta.

Under Alternative 4, over the long term, average annual delta exports are anticipated to range from an increase of 112 TAF under scenario H1 to a decrease by 730 TAF under scenario H4 relative to Existing Conditions, and an increase by 815 TAF under scenario H1 to a decrease of 27 TAF under scenario H4 relative to the No Action Alternative. Since, over the long-term, between 47 (scenario H1) and 49% (scenario H4) of the exported water will be from the new north Delta intakes, average monthly diversions at the south Delta intakes would be decreased because of the shift in diversions to the north Delta intakes (see Chapter 5, Water Supply, for more information).The result of this is increased San Joaquin River water influence throughout the south, west, and interior Delta, and a corresponding decrease in Sacramento River water influence. This can be seen, for example, in Appendix 8D, ALT 4, H3–Old River at Rock Slough for ALL years (1976–1991), which shows increased San Joaquin River (SJR) percentage and decreased Sacramento River (SAC) percentage under the alternative, relative to Existing Conditions and the No Action Alternative.

Under Alternative 4, long-term average annual Delta outflow is anticipated to range from a decrease of 114 TAF under scenario H1 to an increase 744 TAF under scenario H4 relative to Existing Conditions, due to both changes in operations (including north Delta intake capacity of 9,000 cfs, Fall X2, and numerous other operational components of scenarios H1 through H4) and climate change/sea level rise (see Chapter 5, Water Supply, for more information).Long-term average annual Delta outflow is anticipated to decrease under Alternative 4 by between 864 (scenario H1) and 5 TAF (scenario H4) relative to the No Action Alternative, due only to changes in operations. The result of this is increased sea water intrusion in the west Delta. The increase in sea water intrusion (represented by an increase in San Francisco Bay (BAY) percentage) can be seen, for example, in Appendix 8D, ALT 4, H3–Sacramento River at Mallard Island for ALL years (1976–1991).

Impact WQ-1: Effects on Ammonia Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Substantial point sources of ammonia-N do not exist upstream of the SRWTP in the Sacramento River watershed, in the watersheds of the eastern tributaries (Cosumnes, Mokelumne, and Calaveras Rivers), or upstream of the Delta in the San Joaquin River watershed. Nonpoint sources of ammonia-N within the watersheds are also relatively low, thus resulting in generally low ammonia-N concentrations in the reservoirs and rivers of the watersheds. Consequently, any modified reservoir operations and subsequent changes in river flows under Alternative 4 (including the different operational components of Scenarios H1–H4) would have negligible, if any, effect on ammonia concentrations in the rivers and reservoirs upstream of the Delta relative to Existing Conditions and the No Action Alternative. Any negligible increases in ammonia-N concentrations that could occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regard to ammonia.

Delta

As summarized in Table 8-40, it is assumed that SRWTP effluent ammonia concentrations would be substantially lower under Alternative 4 than under Existing Conditions, and would be the same as would occur under the No Action Alternative. Relative to Existing Conditions, ammonia-N concentrations downstream of the SRWTP would be substantially lower under Alternative 4 (including the different operational components of Scenarios H1–H4) because it is assumed that SRWTP upgrades would be in place, and thus that the average monthly effluent ammonia-N concentration would not exceed 1.5 mg/L-N in April through October or 2.4 mg/L-N in November through March. Consequently, a substantial decrease in Sacramento River ammonia-N concentrations is expected to decrease ammonia concentrations for all areas of the Delta that are influenced by Sacramento River water. Concentrations of ammonia-N at locations not influenced notably by Sacramento River water will change little relative to Existing Conditions, due to the similarity in SJR and BAY concentrations and the lack of expected changes in either of these concentrations. Thus, Alternative 4 would not result in substantial increases in ammonia concentrations in the Plan Area, relative to Existing Conditions.

Because the SRWTP discharge ammonia concentrations are assumed to be the same under Alternative 4 as would occur under the No Action Alternative, the primary mechanism that could potentially increase ammonia concentrations in the Delta under Alternative 4, relative to the No

Action Alternative, is decreased flows in the Sacramento River, which would lower dilution available to the SRWTP discharge. This change would be attributable only to operations of Alternative 4, since the same assumptions regarding water demands, climate change, and sea level rise are included in both Alternative 1A and the No Action Alternative.

To address this possibility, a simple mixing calculation was performed to assess concentrations of ammonia downstream of the SRWTP discharge (i.e., downstream of Freeport) under Alternative 4 and the No Action Alternative. Monthly average CALSIM II flows at Freeport and the upstream ammonia concentration (0.04 mg/L-N; Central Valley Water Board 2010a:5) were used, together with the SRWTP permitted average dry weather flow (181 mgd) and seasonal ammonia concentration (1.5 mg/L-N in Apr-Oct, 2.4 mg/L-N in Nov-Mar), to estimate the average change in ammonia concentrations downstream of the SRWTP. Table 8-67 shows monthly average and long term annual average predicted concentrations under the two scenarios.

As Table 8-67 shows, average monthly ammonia-N concentrations in the Sacramento River downstream of Freeport (upon full mixing of the SRWTP discharge with river water) under the four different operational scenarios of Alternative 4 and under the No Action Alternative are expected to be similar (Table 8-67). In comparison to the No Action Alternative, minor increases in monthly average ammonia-N concentrations would occur during February, July through September, and during November for all operational scenarios (H1 through H4). Under operational scenario H2 and H4, minor increases in ammonia-N concentrations also would occur in the months of January and March. In the month of December, average ammonia-N concentrations would increase slightly for scenario H4. Minor decreases in ammonia-N concentrations are expected for all scenarios (H1 through H4) in May and June, while minor decreases would also occur in October under scenario H1.

A minor increase in the annual average concentration would occur under the different operational components of scenarios H1 through H4 of Alternative 4, compared to the No Action Alternative. Moreover, the estimated concentrations downstream of Freeport under Alternative 4 would be similar to existing source water concentrations for the San Francisco Bay and San Joaquin River. Consequently, changes in source water fraction anticipated under Alternative 4, relative to the No Action Alternative, are not expected to substantially increase ammonia concentrations at any Delta locations.

Any negligible increases in ammonia-N concentrations that could occur at certain locations in the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to ammonia.

Table 8-67. Estimated Ammonia-N (mg-L as N) Concentrations in the Sacramento River Downstream of the Sacramento Regional Wastewater Treatment Plant for the No Action Alternative and Alternative 4 Operational Scenarios H1, H2, H3, and H4

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual Average
No Action Alternative	0.074	0.084	0.069	0.060	0.057	0.060	0.058	0.064	0.067	0.060	0.067	0.064	0.065
Scenario H1	0.073	0.090	0.068	0.060	0.058	0.060	0.058	0.063	0.062	0.062	0.070	0.076	0.067
Scenario H2	0.074	0.088	0.069	0.061	0.058	0.061	0.058	0.063	0.062	0.062	0.070	0.065	0.066
Scenario H3	0.074	0.090	0.069	0.060	0.058	0.060	0.057	0.062	0.066	0.064	0.071	0.075	0.067
Scenario H4	0.074	0.088	0.070	0.061	0.058	0.061	0.057	0.062	0.066	0.064	0.071	0.065	0.066

SWP/CVP Export Service Areas

The assessment of effects on ammonia in the SWP and CVP Export Service Area is based on assessment of ammonia-N concentrations at Banks and Jones pumping plants. The dominant source waters influencing the Banks and Jones pumping plants are the Sacramento and San Joaquin Rivers (see Appendix 8D). As discussed above for the Plan Area, for areas of the Delta that are influenced by Sacramento River water, including Banks and Jones pumping plants, ammonia-N concentrations are expected to decrease under Alternative 4, relative to Existing Conditions (in association with less diversion of water influenced by the SRWTP). This decrease in ammonia-N concentrations for water exported via the south Delta pumps is not expected to result in an adverse effect on beneficial uses or substantially degrade water quality of exported water, with regards to ammonia.

Furthermore, as discussed above for the Plan Area, for all areas of the Delta, including Banks and Jones pumping plants, ammonia-N concentrations are not expected to be substantially different under the four different operational scenarios of Alternative 4, relative to No Action Alternative. Any negligible increases in ammonia-N concentrations that could occur at Banks and Jones pumping plants would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to ammonia.

NEPA Effects: In summary, based on the discussion above, effects on ammonia from implementation of CM1 are considered to be not adverse.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Ammonia-N concentrations are generally low in the reservoirs and rivers of the watersheds, owing to the lack of substantial point and nonpoint sources of ammonia-N upstream of the SRWTP in the Sacramento River watershed, in the watersheds of the eastern tributaries (Cosumnes, Mokelumne, and Calaveras Rivers), or upstream of the Delta in the San Joaquin River watershed. Consequently, any modified reservoir operations and subsequent changes in river flows under Alternative 4, relative to Existing Conditions, are expected to have negligible, if any, effects on reservoir and river ammonia-N concentrations upstream of Freeport in the Sacramento River watershed and upstream of the Delta in the San Joaquin River watershed.

Ammonia-N concentrations in the Sacramento River downstream of the SRWTP would be substantially lower under Alternative 4 (regardless of operational scenario), relative to Existing Conditions, due to upgrades to the SRWTP that are assumed to be in place, and thus, ammonia concentrations for all areas of the Delta that are influenced by Sacramento River water are expected to decrease. At locations which are not influenced notably by Sacramento River water, concentrations are expected to remain relatively unchanged compared to Existing Conditions, due to the similarity in SJR and BAY concentrations and the lack of expected changes in either of these concentrations.

The assessment of effects on ammonia in the SWP/CVP Export Service Areas is based on assessment of ammonia-N concentrations at Banks and Jones pumping plants. As discussed above for the Plan Area, for areas of the Delta that are influenced by Sacramento River water, including Banks and Jones pumping plants, ammonia-N concentrations are expected to decrease under Alternative 4, relative to Existing Conditions.

Based on the above, there would be no substantial, long-term increase in ammonia-N concentrations in the rivers and reservoirs upstream of the Delta, in the Plan Area, or the waters exported to the CVP and SWP service areas under Alternative 4 relative to Existing Conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because ammonia concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects on beneficial uses would occur. Ammonia is not 303(d) listed within the affected environment and thus any minor increases that could occur in some areas would not make any existing ammonia-related impairment measurably worse because no such impairments currently exist. Because ammonia-N is not bioaccumulative, minor increases that could occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-2: Effects on Ammonia Concentrations Resulting from Implementation ofCM2–~~CM22~~CM21

NEPA Effects: Some habitat restoration activities would occur on lands in the Delta formerly used for irrigated agriculture. Although this may decrease ammonia loading to the Delta from agriculture, increased biota in those areas as a result of restored habitat may increase ammonia loading originating from flora and fauna. Ammonia loaded from organisms is expected to be converted rapidly to nitrate by established microbial communities. Thus, these land use changes would not be expected to substantially increase ammonia concentrations in the Delta. In general, with the exception of changes in Delta hydrodynamics resulting from habitat restoration, CM2–CM11 would not substantially increase ammonia concentrations in the water bodies of the affected environment. Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, and thus such effects of these restoration measures were included in the assessment of CM1 facilities operations and maintenance (see Impact WQ-1). Additionally, implementation of CM12–~~CM22~~CM21 would not be expected to substantially alter ammonia concentrations in the affected environment.

The effects of ammonia from implementation of CM2–22CM2 through CM22CM2–CM21 are considered to be not adverse.

***CEQA Conclusion*:** There would be no substantial, long-term increase in ammonia-N concentrations in the rivers and reservoirs upstream of the Delta, in the Plan Area, or the waters exported to the CVP and SWP service areas due to implementation of CM2–CM22CM21 relative to Existing Conditions. As such, implementation of these conservations measures would not be expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause significant impacts on any beneficial uses of waters in the affected environment. Because ammonia concentrations would not be expected to increase substantially from implementation of these conservation measures, no long-term water quality degradation would be expected to occur and, thus, no significant impact on beneficial uses would occur. Ammonia is not 303(d) listed within the affected environment and thus any minor increases that could occur in some areas would not make any existing ammonia-related impairment measurably worse because no such impairments currently exist. Because ammonia-N is not bioaccumulative, minor increases that could occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered less than significant. No mitigation is required.

Impact WQ-3: Effects on Boron Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Under Alternative 4 Scenarios H1–H4, there would be no expected change to the sources of boron in the Sacramento and east-side tributary watersheds, and resultant changes in flows from altered system-wide operations would have negligible, if any, effects on the concentration of boron in the rivers and reservoirs of these watersheds. The modeled long-term annual average lower San Joaquin River flow at Vernalis would decrease by an estimated 6%, relative to Existing Conditions (in association with the different operational components of Scenarios H1–H4 for Alternative 4, climate change, and increased water demands) and would remain virtually the same relative to the No Action Alternative considering only changes due only to the different operational components of Scenarios H1–H4 under Alternative 4. The reduced flow would result in possible increases in long-term average boron concentrations of up to about 3% relative to the Existing Conditions, which would be nearly identical under each of the H1–H4 scenarios (Appendix 8F, Table Bo-24). The increased boron concentrations would not increase the frequency of exceedances of any applicable objectives or criteria and would not be expected to cause further degradation at measurable levels in the lower San Joaquin River, and thus would not cause the existing impairment there to be discernibly worse. Consequently, Alternative 4 would not be expected to cause exceedance of boron objectives/criteria or substantially degrade water quality with respect to boron, and thus would not adversely affect any beneficial uses of the Sacramento River, the east-side tributaries, associated reservoirs upstream of the Delta, or the San Joaquin River.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of

~~CM2-22~~~~CM2 through CM22~~CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for ~~CM2-22~~~~CM2 through CM22~~CM2–CM21. See section 8.3.1.3 for more information.

The effects relative to Existing Conditions and the No Action Alternative are discussed together because the direction and magnitude of predicted change are so similar. Relative to Existing Conditions, the following changes reflect the range of effects that would result from the four potential outcomes under the Alternative 4 H1–H4 Scenarios. There would be generally similar increased long-term average boron concentrations for the 16-year period modeled at interior Delta locations (by as much as 8% at the SF Mokelumne River at Staten Island for all H1–H4 Scenarios, from 12% for H1 to 15% for H4 at Franks Tract, and from 11% for H1 to 18% for H4 at Old River at Rock Slough) (Appendix 8F, Tables Bo-12A~~/ and~~through Bo-12D). The comparisons to Existing Conditions reflects changes due to the different operational components of Scenarios H1–H4 for Alternative 4 and climate change/sea level rise. Comparison to the No Action Alternative reflects changes due only to the different operational components of Scenarios H1–H4 for Alternative 4.

Implementation of tidal habitat restoration under CM4 also may contribute to increased boron concentrations at western Delta assessment locations (more discussion of this phenomenon is included in Section 8.3.1.3), and thus would not be anticipated to substantially affect agricultural diversions which occur primarily at interior Delta locations. The long-term annual average and monthly average boron concentrations, for either the 16-year period or drought period modeled, would never exceed the 2,000 µg/L human health advisory objective (i.e., for children) or 500 µg/L agricultural objective at any of the eleven Delta assessment locations, which represents no change from the Existing Conditions and No Action Alternative (Appendix 8F, Table Bo-3B). Additionally, relative to the Existing Conditions, reductions in long-term average assimilative capacity would be small with respect to the 500 µg/L agricultural objective at interior Delta locations and reductions would be similar for all of the Alternative 4 H1–H4 Scenarios (i.e., range of maximum monthly reductions of 12% (H1) to 13% (H4) at Franks Tract and up to 13% (H1) to 18% (H4) at Old River at Rock Slough (Appendix 8F, Tables Bo-13A~~/~~ through 13D), and the reductions in assimilative capacity relative to the No Action Alternative also would be comparable. However, because the absolute boron concentrations would still be well below the lowest 500 µg/L objective for the protection of the agricultural beneficial use under Alternative 4, the levels of boron degradation would not be of sufficient magnitude to substantially increase the risk of exceeding objectives or cause adverse effects to municipal and agricultural water supply beneficial uses, or any other beneficial uses, in the Delta (Appendix 8F, Figure Bo-3).

SWP/CVP Export Service Areas

Under all of the Alternative 4 H1–H4 Scenarios, long-term average boron concentrations would decrease at the Banks Pumping Plant (ranging from as much as 21% [H1]) to a9% [H2]) and at Jones Pumping Plant (ranging from 23% [H4] to 19% [H1]) relative to Existing Conditions, and the reductions would be similar compared to No Action Alternative (Appendix 8F, Tables Bo-12A~~/~~ through 12D) as a result of export of a greater proportion of low-boron Sacramento River water. Commensurate with the decrease in exported boron concentrations, boron concentrations in the lower San Joaquin River may be reduced and would likely alleviate or lessen any expected increase in boron concentrations at Vernalis associated with flow reductions (see discussion of Upstream of the Delta), as well as locations in the Delta receiving a large fraction of San Joaquin River water. Reduced export boron concentrations also may contribute to reducing the existing 303(d) impairment in the lower San Joaquin River and associated TMDL actions for reducing boron loading.

Maintenance of SWP and CVP facilities under Alternative 4 would not be expected to create new sources of boron or contribute towards a substantial change in existing sources of boron in the affected environment. Maintenance activities would not be expected to cause any substantial increases in boron concentrations or degradation with respect to boron such that objectives would be exceeded more frequently, or any beneficial uses would be adversely affected anywhere in the affected environment.

NEPA Effects: In summary, relative to the No Action Alternative conditions, Alternative 4 would result in relatively small increases in long-term average boron concentrations in the Delta and not appreciably change boron levels in the lower San Joaquin River. However, the predicted changes would not be expected to cause exceedances of applicable objectives or further measurable water quality degradation, and thus would not constitute an adverse effect on water quality.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Boron is not a constituent of concern in the Sacramento River watershed upstream of the Delta, thus river flow rate and reservoir storage reductions that would occur under the Alternative 4, relative to Existing Conditions, would not be expected to result in a substantial adverse change in boron levels. Additionally, relative to Existing Conditions, Alternative 4 would not result in reductions in river flow rates (i.e., less dilution) or increased boron loading such that there would be any substantial increases in boron concentration upstream of the Delta in the San Joaquin River watershed.

Small increased boron levels predicted for interior and western Delta locations in response (i.e., up to 15% increase) to a shift in the Delta source water percentages and tidal habitat restoration under this alternative would not be expected to cause exceedances of objectives, or substantial degradation of these water bodies. Alternative 4 maintenance also would not result in any substantial increases in boron concentrations in the affected environment. Boron concentrations would be reduced in water exported from the Delta to the CVP/SWP Export Service Areas, thus reflecting a potential improvement to boron loading in the lower San Joaquin River.

Boron is not a bioaccumulative constituent, thus any increased concentrations under Alternative 4would not result in adverse boron bioaccumulation effects to aquatic life or humans. Relative to Existing Conditions, Alternative 4 would not result in substantially increased boron concentrations such that frequency of exceedances of municipal and agricultural water supply objectives would increase. The levels of boron degradation that may occur under Alternative 4 would not be of sufficient magnitude to cause substantially increased risk for adverse effects to municipal or agricultural beneficial uses within the affected environment. Long-term average boron concentrations would decrease in Delta water exports to the SWP and CVP service area, which may contribute to reducing the existing 303(d) impairment of agricultural beneficial uses in the lower San Joaquin River. Based on these findings, this impact is determined to be less than significant. No mitigation is required.

Impact WQ-4: Effects on Boron Concentrations Resulting from Implementation ofCM2–~~CM22~~CM21

***NEPA Effects*: The implementation of the other conservation measures (i.e., CM2–~~CM22~~CM21), of which most do not involve land disturbance, present no new direct sources of boron to the affected environment, including areas Upstream of the Delta, within the Plan Area, and the SWP/CVP Export Service Area, nor would they affect channel flows or Delta hydrodynamic conditions. As noted above, the potential effects of implementation of tidal habitat restoration (i.e., CM4) on Delta hydrodynamic conditions is addressed above in the discussion of Impact WQ-3. The potential channel flow effects of CM2 for actions in the Yolo Bypass also were accounted for in the CALSIM II and DSM2 modeling, and thus were addressed in the discussion for Impact WQ-3. Habitat restoration activities in the Delta (i.e., CM4–CM10~~–10~~), including restored tidal wetlands, floodplain, and related channel margin and off-channel habitats, while involving increased land and water interaction within these habitats, would not be anticipated to contribute boron which is primarily associated with source water inflows to the Delta (i.e., San Joaquin River, agricultural drainage, and Bay source water). Moreover, some habitat restoration conservation measures (CM4–CM10) would occur on lands within the Delta currently used for irrigated agriculture, thus replacing agricultural land uses with restored habitats. The potential reduction in irrigated lands within the Delta may result in reduced discharges of agricultural field drainage with elevated boron concentrations, which would be considered an improvement compared to the No Action Alternative. CM3 and CM11 provide the mechanism, guidance, and planning for the land acquisition and thus would not, themselves, affect boron levels in the Delta. CM12–~~CM22~~CM21 involve actions that target reduction in other stressors at the species level involving actions such as methylmercury reduction management (CM12), improving DO in the Stockton Deep Water Ship Channel (CM14), and urban stormwater treatment (CM19). None of the CM12–~~CM22~~CM21 actions would contribute to substantially increasing boron levels in the Delta. Consequently, as they pertain to boron, implementation of CM2–~~CM22~~CM21 would not be expected to adversely affect any of the beneficial uses of the affected environment.

The impact on boron of implementing CM2–~~CM22~~CM21 is determined to be not adverse.

CEQA Conclusion: Implementation of the CM2–~~CM22~~CM21 for Alternative 4 would not present new or substantially changed sources of boron to the affected environment upstream of the Delta, within Delta, or in the SWP and CVP service area. As such, the their implementation would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or other criteria would be exceeded in water bodies of the affected environment located upstream of the Delta, within the Delta, or in the SWP and CVP Service Area or substantially degrade the quality of these water bodies, with regard to boron. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-5: Effects on Bromide Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Under Alternative 4, regardless of operational scenario (i.e., Scenarios H1–H4),there would be no expected change to the sources of bromide in the Sacramento and eastside tributary watersheds. Bromide loading in these watersheds would remain unchanged and resultant changes in flows from altered system-wide operations under Alternative 4 would have negligible, if any, effects on the concentration of bromide in the rivers and reservoirs of these watersheds. Consequently, no individual operational scenario of Alternative 4 would be expected to adversely affect the MUN beneficial use, or any other beneficial uses, of the Sacramento River, the eastside tributaries, or their associated reservoirs upstream of the Delta.

Under the four operational scenarios of Alternative 4, modeling indicates that long-term annual average flows on the San Joaquin River would decrease by 6% relative to Existing Conditions and would remain virtually the same relative to the No Action Alternative (Appendix 5A). These similar decreases in flow, regardless of operational scenario, would result in possible increases in long-term average bromide concentrations of about 3%, relative to Existing Conditions and less than <1% relative to the No Action Alternative (Appendix 8E, *Bromide*, Table 22). The small predicted increases in lower San Joaquin River bromide levels that could occur under Scenarios H1–H4 of Alternative 4, relative to existing and No Action Alternative conditions, would not be expected to adversely affect the MUN beneficial use, or any other beneficial uses, of the lower San Joaquin River.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of ~~CM2-22~~~~CM2 through CM22~~CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for ~~CM2-22~~~~CM2 through CM22~~CM2–CM21. See section 8.3.1.3 for more information.

Under operational scenarios H1–H4 of Alternative 4, the geographic extent of effects pertaining to long-term average bromide concentrations in the Delta would be similar to that previously described for Alternative 1A, although the magnitude of predicted long-term change and relative frequency of concentration threshold exceedances would be different. Using the mass-balance modeling approach for bromide (see Section 8.3.1.3), relative to Existing Conditions, Scenario H1–H4 modeled long-term average bromide concentrations would increase at Staten Island, Emmaton, and Barker Slough, while Scenario H1–H4 modeled long-term average bromide concentrations would decrease at the other assessment locations (Appendix 8E, *Bromide*, Table 10). Overall effects would be greatest at Barker Slough, with the smallest model predicted increases occurring under Scenario H3, and the largest model predicted increases occurring under Scenario H2.Under Scenario H3, predicted long-term average bromide concentrations would increase from 51 µg/L to 62 µg/L (21% relative increase) for the modeled 16-year hydrologic period and would increase from 54 µg/L to 92 µg/L (72% relative increase) for the modeled drought period. Under Scenario H2, predicted long-term average bromide concentrations would increase from 51 µg/L to 72 µg/L (40% relative increase) for the modeled 16-year hydrologic period and would increase from 54 µg/L to 106 µg/L (98% relative increase) for the modeled drought period. At Barker Slough, changes in exceedance frequency would follow a similar pattern, with the greatest increase in exceedance frequency occurring under Scenario H2.Under Scenario H2, the predicted 50 µg/L exceedance frequency would increase from 49% under Existing Conditions to 56% under Alternative 4, and would increase from 55% to 83% during the drought period. Similarly at Barker Slough, the predicted 100 µg/L exceedance frequency would increase from 0% under Existing Conditions to 20% under Scenario H2, and would increase from 0% to 47% during the drought period. In contrast, increases in bromide at Staten Island would result in a 50 µg/L bromide threshold exceedance increase from 47% under Existing Conditions to 76% under Scenario H2(52% to 83% during the modeled drought period). However, unlike Barker Slough, modeling shows that long-term average bromide concentration at Staten Island would exceed the 100 µg/L assessment threshold concentration 1% under Existing Conditions and 3% under all operational scenarios(0% to 2% during the modeled drought period for all operational scenarios). The highest long-term average bromide concentrations would occur under Scenario H2, and would be 76 µg/L (83 µg/L for the modeled drought period) at Staten Island. Changes in exceedance frequency of the 50 µg/L and 100 µg/L concentration thresholds, as well as relative change in long-term average concentration, at other assessment locations would be less substantial for all operational scenarios. This comparison to Existing Conditions reflects changes in bromide due to both Alternative 4 operations (including north Delta intake capacity of 9,000 cfs and the different operational components of Scenarios H1–H4) and climate change/sea level rise.

Due to the relatively small differences between modeled Existing Conditions and No Action baseline, changes in long-term average bromide concentrations and changes in exceedance frequencies relative to the No Action Alternative are generally of similar magnitude to those previously described for the existing condition comparison (Appendix 8E, *Bromide*, Table 10). Relative to the No Action Alternative, modeled long-term average bromide concentration increases would similarly be greatest at Barker Slough under Scenario H2, where long-term average concentrations are predicted to increase by 44% (97% for the modeled drought period). However, unlike the Existing Conditions comparison, under the No Action Alternative long-term average bromide concentrations at Buckley Cove would increase for all operational scenarios, although the increases would be relatively small (≤4%). Unlike the comparison to Existing Conditions, this comparison to the No Action Alternative reflects changes in bromide due only to the different operational components of Scenarios H1–H4 of Alternative 4.

At Barker Slough, modeled long-term average bromide concentrations for the two baseline conditions are very similar (Appendix 8E, *Bromide*, Tables 10 and 11). Such similarity demonstrates that the modeled Alternative 4 change in bromide is almost entirely due to Alternative 4 operations, and not climate change/sea level rise, regardless of the specific different operational components of Scenarios H1–H4. Therefore, operations are the primary driver of effects on bromide at Barker Slough, regardless of whether and particular operational scenario of Alternative 4 is compared to Existing Conditions, or compared to the No Action Alternative.

Results of the modeling approach which used relationships between EC and chloride and between chloride and bromide (see Section 8.3.1.3) differed somewhat from what is presented above for the mass-balance approach (see Appendix 8E, Table 11).For most locations, the frequency of exceedance of the 50 µg/L and 100 µg/L were similar. The greatest difference between the methods was predicted for Barker Slough. Under all of the operational scenarios, the increases in frequency of exceedance of the 100 µg/L threshold, relative to Existing Conditions and the No Action Alternative, were not as great using this alternative EC to chloride and chloride to bromide relationship modeling approach as compared to that presented above from the mass-balance modeling approach. Model predicted increases under Scenario H2 were still the greatest, and increases under the other operational scenarios were still substantial. At Barker Slough, the predicted 100 µg/L exceedance frequency for the 16-year hydrologic period would increase from 1% under Existing Conditions and 2% under the No Action Alternative to as much as 11% under the Scenario H2.For the modeled drought period, the predicted 100 µg/L exceedance frequency would increase from 0% under Existing Conditions and the No Action Alternative to as much as 25% under Scenario H2.Because the mass-balance approach predicts a greater level of impact at Barker Slough, determination of impacts was based on the mass-balance results.

Although Scenario H2 would result in the greatest relative increase in long-term average bromide concentrations and greatest relative increase in exceedance frequency at Barker Slough, the difference between operational scenarios is very small. Regardless of particular Alternative 4 operational scenario, the increase in long-term average bromide concentrations predicted at Barker Slough, principally the relative increase in 100 μg/L exceedance frequency, would result in a substantial change in source water quality for existing drinking water treatment plants drawing water from the North Bay Aqueduct. As discussed for Alternative 1A, drinking water treatment plants obtaining water via the North Bay Aqueduct utilize a variety of conventional and enhanced treatment technologies in order to achieve DBP drinking water criteria. While the implications of such a modeled change in bromide at Barker Slough are difficult to predict, the substantial modeled increases could lead to adverse changes in the formation of disinfection byproducts such that considerable treatment plant upgrades may be necessary in order to achieve equivalent levels of health protection. Because many of the other modeled locations already frequently exceed the 100 μg/L threshold under Existing Conditions and the No Action Alternative, these locations likely already require treatment plant technologies to achieve equivalent levels of health protection, and thus no additional treatment technologies would be triggered by the small increases in the frequency of exceeding the 100 μg/L threshold. Hence, no further impact on the drinking water beneficial use would be expected at these locations.

The seasonal intakes at Mallard Slough and City of Antioch are infrequently used due to water quality constraints related to sea water intrusion. On a long-term average basis, bromide at these locations is in excess of 3,000 μg/L, but during seasonal periods of high Delta outflow can be <300 μg/L. Based on modeling using the mass-balance approach, use of the seasonal intakes at Mallard Slough and City of Antioch under Scenarios H1–H4 of Alternative 4 would experience a period average increase in bromide during the months when these intakes would most likely be utilized. For those wet and above normal water year types where mass balance modeling would predict water quality typically suitable for diversion, change would be greatest for Scenario H1 and H3, where predicted long-term average bromide concentrations would increase from 103 μg/L to 155 μg/L (51% increase) at City of Antioch and would increase from 150 μg/L to 201 μg/L (41% increase) at Mallard Slough relative to Existing Conditions(Appendix 8E, *Bromide*, Table 23). Under Scenarios H2 and H4, predicted increases would also occur, but would be somewhat less, with approximate 40% increases at the City of Antioch and approximate 34% increases at Mallard Slough. Increases would be similar for the No Action Alternative comparison, with slightly lower relative increases at City of Antioch (i.e., 33–44% depending on operational scenario), and slightly higher relative increases at Mallard Slough (i.e., 36–47% depending on operational scenario). Modeling results using the EC to chloride and chloride to bromide relationships show increases during these months, but the relative magnitude of the increases is much lower (Appendix 8E, *Bromide*, Table 24).Regardless of the differences in the data between the two modeling approaches, the decisions surrounding the use of these seasonal intakes is largely driven by acceptable water quality, and thus have historically been opportunistic. Opportunity to use these intakes would remain, and the predicted increases in bromide concentrations at the City of Antioch and Mallard Slough intake would not be expected to adversely affect MUN beneficial uses, or any other beneficial use, at these locations.

Important to the results presented above is the assumed habitat restoration footprint on both the temporal and spatial scales incorporated into the modeling. Modeling sensitivity analyses have indicated that habitat restoration (which is reflected in the modeling—see Section 8.3.1.3), not operations covered under CM1, are the driving factor in the modeled bromide increases. The timing, location, and specific design of habitat restoration will have effects on Delta hydrodynamics, and any deviations from modeled habitat restoration and implementation schedule will lead to different outcomes. Although habitat restoration near Barker Slough is an important factor contributing to modeled bromide concentrations at the North Bay Aqueduct, BDCP habitat restoration elsewhere in the Delta can also have large effects. Because of these uncertainties, and the possibility of adaptive management changes to BDCP restoration activities, including location, magnitude, and timing of restoration, the estimates are not predictive of the bromide levels that would actually occur in Barker Slough or elsewhere in the Delta.

SWP/CVP Export Service Areas

Under the various operational scenarios of Alternative 4, improvement in long-term average bromide concentrations would occur at the Banks and Jones pumping plants, with the largest improvement predicted to occur under Scenario H4 and the smallest improvement predicted to occur under Scenario H1. Under Scenario H4, long-term average bromide concentrations for the modeled 16-year hydrologic period at Banks and Jones pumping plants would decrease by as much as 46% relative to Existing Conditions and 38% relative to the No Action Alternative. Relative change in long-term average bromide concentration under Scenario H4 would be less during drought conditions (≤36%), but would still represent considerable improvement (Appendix 8E, *Bromide*, Table 10). Decreased long-term average bromide concentrations under the other operational scenarios would also be predicted, but would be slightly less. Under Scenario H1, long-term average bromide concentrations for the modeled 16-year hydrologic period at Banks and Jones pumping plants would decrease by as much as 37% relative to Existing Conditions and 28% relative to the No Action Alternative. Relative change in long-term average bromide concentration under Scenario H1 would be less during drought conditions (≤28%) (Appendix 8E, *Bromide*, Table 10). As a result, and regardless of operational scenario, less frequent bromide concentration exceedances of the 50 μg/L and 100 μg/L assessment thresholds would be predicted and an overall improvement in Export Service Areas water quality would be experienced respective to bromide. Commensurate with the decrease in exported bromide, an improvement in lower San Joaquin River bromide would also be observed since bromide in the lower San Joaquin River is principally related to irrigation water deliveries from the Delta. While the magnitude of this expected lower San Joaquin River improvement in bromide is difficult to predict, the relative decrease in overall loading of bromide to the Export Service Areas would likely alleviate or lessen any expected increase in bromide concentrations at Vernalis (see discussion of Upstream of the Delta) as well as locations in the Delta receiving a large fraction of San Joaquin River water, such as much of the south Delta.

The discussion above is based on results of the mass-balance modeling approach. Results of the modeling approach which used relationships between EC and chloride and between chloride and bromide (see Section 8.3.1.3) were consistent with the discussion above, and assessment of bromide using these data results in the same conclusions as are presented above for the mass-balance approach (see Appendix 8E, Table 11).

Similar to the discussion pertaining to the No Action Alternative, maintenance of SWP and CVP facilities under Scenarios H1–H4 of Alternative 4 would not be expected to create new sources of bromide or contribute towards a substantial change in existing sources of bromide in the affected environment. Maintenance activities would not be expected to cause any substantial change in bromide such that MUN beneficial uses, or any other beneficial use, would be adversely affected anywhere in the affected environment.

NEPA Effects: In summary, the operations and maintenance activities under Scenarios H1–H4 of Alternative 4, relative to the No Action Alternative, would result in small increases (i.e., <1%) in long-term average bromide concentrations at Vernalis related to relatively small declines in long-term average flow on the San Joaquin River. However, the operations and maintenance activities under Scenarios H1–H4 of Alternative 4 would cause substantial degradation to water quality with respect to bromide at Barker Slough, source of the North Bay Aqueduct. This substantial degradation would be predicted to occur regardless of operational scenario, but would be greatest under Scenario H2. Resultant substantial change in long-term average bromide at Barker Slough could necessitate changes in water treatment plant operations or require treatment plant upgrades in order to maintain DBP compliance, and thus would constitute an adverse effect on water quality. Mitigation Measure WQ-5 is available to reduce these effects(implementation of this measure along with a separate, non-environmental commitment as set forth in EIR/EIS Appendix 3B, *Environmental Commitments*, relating to the potential increased treatment costs associated with bromide-related changes would reduce these effects).

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Under operational Scenarios H1–H4 of Alternative 4there would be no expected change to the sources of bromide in the Sacramento and eastside tributary watersheds. Bromide loading in these watersheds would remain unchanged and resultant changes in flows from altered system-wide operations under any operational scenario of Alternative 4would have negligible, if any, effects on the concentration of bromide in the rivers and reservoirs of these watersheds. However, south of the Delta, the San Joaquin River is a substantial source of bromide, primarily due to the use of irrigation water imported from the southern Delta. Concentrations of bromide at Vernalis are inversely correlated to net river flow. Under all operational scenarios of Alternative 4, long-term average flows at Vernalis would decrease only slightly, resulting in less than substantial predicted increases in long-term average bromide of about 3% relative to Existing Conditions.

Relative to Existing Conditions, all operational scenarios of Alternative 4would result in small decreases in long-term average bromide concentration at most Delta assessment locations, with principal exceptions being the North Bay Aqueduct at Barker Slough, Staten Island, and Emmaton on the Sacramento River. Overall effects would be greatest at Barker Slough, where substantial increases in long-term average bromide concentrations under all operational scenarios would be predicted, but would be greatest for Scenario H2. While the predicted increase in long-term average bromide concentrations at Barker Slough would be greatest for Scenario H2, the relative increases regardless of particular operational scenario would result in a substantial change in source water quality to existing drinking water treatment plants drawing water from the North Bay Aqueduct. These modeled increases in bromide at Barker Slough could lead to adverse changes in the formation of disinfection byproducts at drinking water treatment plants such that considerable water treatment plant upgrades could be necessary in order to achieve equivalent levels of drinking water health protection.

The assessment of effects on bromide in the SWP/CVP Export Service Areas is based on assessment of changes in bromide concentrations at Banks and Jones pumping plants. Under all of the operational scenarios of Alternative 4, substantial improvement would occur at the Banks and Jones pumping plants, where long-term average bromide concentrations are predicted to decrease by as much as 44% relative to Existing Conditions. As a result, an overall improvement in bromide-related water quality would be predicted in the SWP/CVP Export Service Areas.

Based on the above, the operations and maintenance activities under Scenarios H1–H4 of Alternative 4would not result in any substantial change in long-term average bromide concentration upstream of the Delta. Furthermore, under all of the operational scenarios of Alternative 4, water exported from the Delta to the SWP/CVP service area would be substantially improved relative to bromide. Bromide is not bioaccumulative, therefore change in long-term average bromide concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Additionally, bromide is not a constituent related to any 303(d) listings. The operations and maintenance activities under Scenarios H1–H4 of Alternative 4 would not cause substantial long-term degradation to water quality respective to bromide with the exception of water quality at Barker Slough, source of the North Bay Aqueduct. At Barker Slough, modeled long-term annual average concentrations of bromide would increase by as much as 40%, and 98% during the modeled drought period. For the modeled 16-year hydrologic period the frequency of predicted bromide concentrations exceeding 100 μg/L would increase from 0% under Existing Conditions to as much as 20% under Alternative 4, while for the modeled drought period, the frequency would increase from 0% to as much as 47%. The substantial changes in long-term average bromide predicted for Barker Slough under all operational scenarios of Alternative 4could necessitate changes in treatment plant operation or require treatment plant upgrades in order to maintain DBP compliance. The model predicted change at Barker Slough is substantial and, therefore, would represent a substantially increased risk for adverse effects on existing MUN beneficial uses should treatment upgrades not be undertaken. The impact is considered significant.

Implementation of Mitigation Measure WQ-5 along with a separate, non-environmental commitment relating to the potential increased treatment costs associated with bromide-related changes would reduce these effects. While mitigation measures to reduce these water quality effects in affected water bodies to less than significant levels are not available, implementation of Mitigation Measure WQ-5 is recommended to attempt to reduce the effect that increased bromide concentrations may have on Delta beneficial uses. However, because the effectiveness of this mitigation measure to result in feasible measures for reducing water quality effects is uncertain, this impact is considered to remain significant and unavoidable.

In addition to and to supplement Mitigation Measure WQ-5, the BDCP proponents have incorporated into the BDCP, as set forth in EIR/EIS Appendix 3B, *Environmental Commitments*, a separate, non-environmental commitment to address the potential increased water treatment costs that could result from bromide-related concentration effects on municipal water purveyor operations. Potential options for making use of this financial commitment include funding or providing other assistance towards implementation of the North Bay Aqueduct AIP, acquiring alternative water supplies, or other actions to indirectly reduce the effects of elevated bromide and DOC in existing water supply diversion facilities. Please refer to Appendix 3B, *Environmental Commitments*, for the full list of potential actions that could be taken pursuant to this commitment in order to reduce the water quality treatment costs associated with water quality effects relating to chloride, electrical conductivity, and bromide.

Mitigation Measure WQ-5: Avoid, Minimize, or Offset, as Feasible, Adverse Water Quality Conditions; Site and Design Restoration Sites to Reduce Bromide Increases in Barker Slough

It remains to be determined whether, or to what degree, the available and existing salinity response and countermeasure actions of SWP and CVP facilities or municipal water purveyors would be capable of offsetting the actual level of changes in bromide that may occur from implementation of Alternative 4. Therefore, in order to determine the feasibility of reducing the effects of increased bromide levels, and potential adverse effects on beneficial uses associated with CM1 operations (and hydrodynamic effects of tidal restoration under CM4), the proposed mitigation requires a series of phased actions to identify and evaluate existing and possible feasible actions, followed by development and implementation of the actions, if determined to be necessary. The development and implementation of any mitigation actions shall be focused on those incremental effects attributable to implementation of Alternative 4 operations only. Development of mitigation actions for the incremental bromide effects attributable to climate change/sea level rise are not required because these changed conditions would occur with or without implementation of Alternative 4.The goal of specific actions would be to reduce/avoid additional degradation of Barker Slough water quality conditions with respect to the CALFED bromide goal.

BDCP proponents shall consider effects of site-specific restoration areas proposed under CM4 on bromide concentrations in Barker Slough. Design and siting of restoration areas shall attempt to reduce potential effects to the extent possible without compromising proposed benefits of the restoration areas. It is anticipated that these efforts will be able to reduce the level of projected increase, though it is unknown whether it would be able to completely eliminate any increases.

Additionally, ~~F~~following commencement of initial operations of CM1, the BDCP proponents will conduct additional evaluations described herein, and develop additional modeling (as necessary), to define the extent to which modified operations could reduce or eliminate the increased bromide concentrations currently modeled to occur under Alternative 4. The additional evaluations should also consider specifically the changes in Delta hydrodynamic conditions associated with tidal habitat restoration under CM4 (in particular the potential for increased bromide concentrations that could result from increased tidal exchange) once the specific restoration locations are identified and designed. The evaluations will also consider up-to-date estimates of climate change and sea level rise, if and when such information is available. If sufficient operational flexibility to offset bromide increases is not practicable/feasible under Alternative 4 operations, and/or siting and design of restoration areas cannot feasibly reduce bromide increases to a less than significant level without compromising the benefits of the proposed areas, achieving bromide reduction pursuant to this mitigation measure would not be feasible under this alternative.

Impact WQ-6: Effects on Bromide Concentrations Resulting from Implementation ofCM2–~~CM22~~CM21

NEPA Effects: CM12–~~CM22~~CM21 would present no new sources of bromide to the affected environment, including areas Upstream of the Delta, within the Plan Area, and the SWP/CVP Export Service Areas. As they pertain to bromide, implementation of these conservation measures would not be expected to adversely affect MUN beneficial use, or any other beneficial uses, of the affected environment.

With exception to habitat restoration areas that would effectively alter Delta hydrodynamics, habitat restoration and the various land-disturbing conservation measures proposed for Alternative 4 would not present new or substantially changed sources of bromide to the study area. Modeling scenarios included assumptions regarding how certain habitat restoration activities would affect Delta hydrodynamics (CM2 and CM4), and thus such hydrodynamic effects of these restoration measures were included in the assessment of CM1 facilities operations and maintenance (see Impact WQ-1).

Some habitat restoration activities would occur on lands in the Delta formerly used for irrigated agriculture. Such replacement or substitution of land use activity would not be expected to result in new or increased sources of bromide to the Delta. Implementation of CM2–CM11 would not be expected to adversely affect MUN beneficial use, or any other beneficial uses, within the affected environment.

In summary, implementation of CM2–~~CM22~~CM21 under Alternative 4, relative to the No Action Alternative, would have negligible, if any, effects on bromide concentrations. The effects on bromide from implementing CM2–~~CM22~~CM21 are determined to not be adverse.

CEQA Conclusion: Implementation of CM2–~~CM22~~CM21 under Alternative 4 would not present new or substantially changed sources of bromide to the study area. Some conservation measures may replace or substitute for existing irrigated agriculture in the Delta. This replacement or substitution would not be expected to substantially increase or present new sources of bromide. Implementation of CM2–~~CM22~~CM21 would have negligible, if any, effects on bromide concentrations throughout the affected environment, would not cause exceedance of applicable state or federal numeric or narrative water quality objectives/criteria because none exist for bromide, and would not cause changes in bromide concentrations that would result in significant impacts on any beneficial uses within affected water bodies. Implementation of CM2–~~CM22~~CM21 would not cause significant long-term water quality degradation such that there would be greater risk of significant impacts on beneficial uses, would not cause greater bioaccumulation of bromide, and would not further impair any beneficial uses due to bromide concentrations because no uses are currently impaired due to bromide levels. This impact is therefore considered less than significant. No mitigation is required.

Impact WQ-7: Effects on Chloride Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Under Alternative 4, Scenarios H1–H4, there would be no expected change to the sources of chloride in the Sacramento and eastside tributary watersheds. Chloride loading in these watersheds would remain unchanged and resultant changes in flows from altered system-wide operations would have negligible, if any, effects on the concentration of chloride in the rivers and reservoirs of these watersheds. The modeled long-term annual average flows on the lower San Joaquin River at Vernalis would decrease slightly compared to Existing Conditions (in association with the different operational components of Scenarios H1–H4 for Alternative 4, climate change, and increased water demands) and be similar compared to the No Action Alternative (considering only changes due only to the different operational components of Scenarios H1–H4 under Alternative 4). The reduced flow would result in possible increases in long-term average chloride concentrations of about 2%, relative to the Existing Conditions, which would be nearly identical under each of the H1–H4 scenarios, and no change relative to No Action Alternative (Appendix 8G, Table Cl-62). Consequently, the Alternative 4 H1–H4 Scenarios would not be expected to cause exceedances of chloride objectives/criteria or substantially degrade water quality with respect to chloride, and thus would not adversely affect any beneficial uses of the Sacramento River, the eastside tributaries, associated reservoirs upstream of the Delta, or the San Joaquin River.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of ~~CM2-22~~~~CM2 through CM22~~CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for ~~CM2-22~~~~CM2 through CM22~~CM2–CM21. See section 8.3.1.3 for more information.

Relative to Existing Conditions, modeling predicts that the Alternative 4H1–H4 Scenarios would result in similar or reduced long-term average chloride concentrations for the 16-year period modeled at most of the assessment locations. The mass-balance modeling results indicate similar, but slightly larger increases in chloride concentrations compared to estimates generated using EC-chloride relationships and DSM2 EC output(see Section 8.3.1.3).Increased long-term average chloride concentrations would occur at the North Bay Aqueduct at Barker Slough (i.e., range from up to 33% [H2] to 16% [H3]) and ~~San Joaquin~~ SF Mokelumne River at Staten Island (i.e., similar increase of 22–23% for all H1–H4 Scenarios) (Appendix 8G, *Chloride*, Tables Cl-25A~~/~~ through 25D [mass balance model results] and Tables Cl-26A~~/~~ through 26D[EC-chloride relationship results]).Changes in long-term average concentrations in the western Sacramento River at Emmaton would range from an increase for Scenarios H1 and H2 (14 to 16%) to no measureable change for Scenarios H3 and H4 (i.e., -1%).Long-term average chloride concentration would decrease at other assessment locations, with the largest reductions occurring under Scenarios H3 and H4 (i.e., up to -24% at Franks Tract) and less reduction under Scenarios H1 and H2 (i.e., up to -12% at Franks Tract).Additionally, implementation of tidal habitat restoration under CM4 would increase the tidal exchange volume in the Delta, and thus may contribute to increased chloride concentrations in the Bay source water as a result of increased salinity intrusion. More discussion of this phenomenon is included in Section 8.3.1.3. Consequently, while uncertain, the magnitude of chloride increases may be greater than indicated herein and would affect the western Delta assessment locations the most which are influenced to the greatest extent by the Bay source water. This comparison to Existing Conditions reflects changes in chloride due to both the different operational components of Scenarios H1–H4 for Alternative 4 and climate change/sea level rise.

Relative to the No Action Alternative conditions, the mass balance analysis of modeling results indicated that the Alternative 4 Scenarios H1–H4 would result in similar increases in long-term average chloride concentrations for the 16-year period as described above compared to Existing Conditions: SF Mokelumne River at Staten Island (i.e., up to 25 to 27% for all H1–H4 Scenarios), North Bay Aqueduct at Barker Slough (i.e., range of 20% [H3] up to 37% [H2]), and for the Sacramento River at Emmaton (i.e., ranging from an increase for Scenarios H1-H2 of up to 17% to reduction under Scenarios H3-H4 [-1%]) (Appendix 8G, Table Cl-25A~~/~~ through 25D [mass balance model results] and Tables Cl-26A~~/~~ through 26D [EC-chloride relationship results]). Relative to the No Action Alternative, the long-term average chloride concentrations based on EC to chloride relationships indicate that most of the other interior and western Delta assessment locations under Scenarios H1 and H2 would exhibit similar increases ranging from up to 3% at San Joaquin River at Buckley Cove to 9% at the Sacramento River at Mallard Island. The comparison to the No Action Alternative reflects chloride changes due only to the different operational components of Scenarios H1–H4 for Alternative 4.

The following outlines the modeled chloride changes relative to the applicable objectives and beneficial uses of Delta waters.

Municipal Beneficial Uses–Relative to Existing Conditions

Estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3) were used to evaluate the 150 mg/L Bay-Delta WQCP objective for municipal and industrial beneficial uses on a basis of the percent of years the chloride objective is exceeded for the modeled 16-year period. The objective is exceeded if chloride concentrations exceed 150 mg/L for a specified number of days in a given water year at both the Antioch and Contra Costa Pumping Plant #1 locations. For the Alternative 4 Scenarios H1–H4, the modeled frequency of objective exceedance would ~~approximately double~~be unchanged relative to Existing Conditions at the Contra Costa Pumping Plant #1 at~~from~~ 7~~6~~% ~~of years under Existing Conditions, to 13% of years under all of the Alternative 4 scenarios~~ (Appendix 8G, Table Cl-64).

Similarly, estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3) were also used to evaluate the 250 mg/L Bay-Delta WQCP objective for chloride at Contra Costa Pumping Plant #1 where daily average objectives apply. The basis for the evaluation was the predicted number of days the objective was exceeded for the modeled 16-year period. For Alternative 4, the modeled frequency of objective exceedance would decrease similarly for the H1–H4 Scenarios by approximately one half, from 6% of modeled days under Existing Conditions, to 3–4% of modeled days under the Alternative 4 operational scenarios (Appendix 8G, Table Cl-63).

Given the limitations inherent to estimating future chloride concentrations (see Section 8.3.1.3), estimation of chloride concentrations through both a mass balance approach and an EC-chloride relationship approach was used to evaluate the 250 mg/L Bay-Delta WQCP objectives in terms of both frequency of exceedance and use of assimilative capacity. When utilizing the mass balance approach to model monthly average chloride concentrations for the 16-year period, the predicted frequency of exceeding the 250 mg/L objective would decrease at the Contra Costa Canal at Pumping Plant #1 from an exceedance frequency of 24% under Existing Conditions to a range of 18% (for H1) to 12–13% (for H3 and H4) (Appendix 8G, Table Cl-27 and Figure Cl-5).However, the frequency of exceedances would increase slightly for the 16-year period modeled at the San Joaquin River at Antioch (i.e., from 66% under Existing Conditions to 68% to 70% for the H1–H4 Scenarios) and Sacramento River at Mallard Island (i.e., from 85% under Existing Conditions to 86% to 88% for the H1–H4 Scenarios) (Appendix 8G, Table Cl-27).). Although these changes are within the uncertainty of the modeling approach, ~~T~~the mass balance results also indicate that the increased concentrations would reduce assimilative capacity with respect to the 250 mg/L objective, thus causing further degradation at Antioch in March and April, with similar maximum reductions under H1 and H3 of up to54% to maximum reductions of up to 42% for H3 and H4for the 16-year period modeled, and 100% reduction, or elimination of assimilative capacity, for all of the H1–H4 Scenarios during the drought period modeled) (Appendix 8G, Tables Cl-29~~A/2~~A through 29D and Figure Cl-5).Assimilative capacity at the Contra Costa Canal at Pumping Plant #1 also would be similarly reduced in September and October under the H1 and H2 scenarios (i.e., up to 100%, or elimination) when chloride concentrations would be near, or exceed, the objectives, thus increasing the risk of exceeding objectives (Appendix 8G, Figure Cl-5), but would not be substantially reduced under the H3 or H4 scenarios.

In comparison, when utilizing the chloride-EC relationship to model monthly average chloride concentrations for the 16-year period, trends in frequency of exceedance and use of assimilative capacity would be similar to that discussed when utilizing the mass balance modeling approach (Appendix 8G, *Chloride,* Table Cl-28 and Tables Cl-30~~A/3~~A through 30D).However, as with Alternative 1A the modeling approach utilizing the chloride-EC relationships predicted changes of lesser magnitude, where predictions of change utilizing the mass balance approach were generally of greater magnitude, and thus more conservative. As discussed in Section 8.3.1.3, in cases of such disagreement, the approach that yielded the more conservative predictions was used as the basis for determining adverse impacts.

Based on the ~~additional predicted annual and seasonal exceedances of one or both Bay Delta WQCP objectives for chloride,and the associated~~long-term average water quality degradation in the western Delta, the potential exists for substantial adverse effects under all of the Alternative 4H1–H4 Scenarios on the municipal and industrial beneficial uses through reduced opportunity for diversion of water with acceptable chloride levels.

303(d) Listed Water Bodies–Relative to Existing Conditions

With respect to the 303(d) listing for chloride in Tom Paine Slough, the monthly average chloride concentrations for the 16-year period modeled at Old River at Tracy Road would generally be similar under all of the Alternative 4H1–H4 Scenarios compared to Existing Conditions, and thus, would not be further degraded on a long-term basis (Appendix 8G, Figure Cl-6). With respect to Suisun Marsh, the monthly average chloride concentrations for the 16-year period modeled would generally increase under all of the Alternative 4 H1–H4 Scenarios compared to Existing Conditions in the months of March through May at the Sacramento River at Collinsville (Appendix 8G, Figure Cl-7), Mallard Island (Appendix 8G, Figure Cl-5), and increase substantially at Montezuma Slough at Beldon's Landing (i.e., over a doubling of concentration in December through February) (Appendix 8G, Figure Cl-8). However, modeling ~~data for~~ of Alternative 4 assumed no operation of the Montezuma Slough Salinity Control Gates, but the project description assumes continued operation of the Salinity Control Gates, consistent with assumptions included in the No Action Alternative. A sensitivity analysis modeling run conducted for Alternative 4 with the gates operational consistent with the No Action Alternative resulted in substantially lower EC levels than indicated in the original Alternative 4 modeling results for Suisun Marsh, but EC levels ~~was~~ were still somewhat higher than EC levels under Existing Conditions ~~and~~ for several locations and months. Although chloride was not specifically modeled ~~using~~ in these sensitivity analyses, it is expected that chloride concentrations would be nearly proportional to EC levels in Suisun ~~m~~Marsh. Another modeling run with the gates operational and ~~removing~~ restoration areas removed resulted in EC levels nearly equivalent to Existing Conditions, indicating that design and siting of restoration areas has notable bearing on EC levels at different locations within Suisun Marsh (see Appendix 8H Attachment 1 for more information on these sensitivity analyses). These analyses also indicate that increases in salinity are related primarily to the hydrodynamic effects of CM4, not operational components of CM1. Based on the sensitivity analyses, optimizing the ~~Although chloride was not specifically modeled using these sensitivity analyses, it is expected that chloride would be nearly proportional to EC in Suisun marsh. It is believed that d~~design and siting of restoration areas ~~can~~ may ~~be~~

~~optimized to the degree that~~ limit the magnitude of long-term chloride increases in the Marsh~~, if any, would be relatively small.~~, However, the chloride concentration increases at certain locations could be substantial, depending on siting and design of restoration areas. Thus, these increased chloride levels in Suisun Marsh are considered to ~~potentially~~ ~~thereby contributing~~ contribute to additional, measureable long-term degradation that potentially would adversely affect the necessary actions to reduce chloride loading for any TMDL that is developed.

Municipal Beneficial Uses–Relative to No Action Alternative

Similar to the assessment conducted for Existing Conditions, estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3) were used to evaluate the 150 mg/L Bay-Delta WQCP objective for municipal and industrial beneficial uses. For Alternative 4, the modeled frequency of objective exceedance would increase at the Contra Costa Pumping Plant #1 from ~~6~~0% under the No Action Alternative to ~~13~~7% of years under all of the Alternative 4 H1–H4 Scenarios (Appendix 8G, Table Cl-64). The increase was due to a single year, 1977, which fell just short of the required number of days (i.e., was within 10 days minimum number of required days < 150 mg/L). Given the uncertainty in the chloride modeling approach, it is likely that real time operations of the SWP and CVP could achieve compliance with this objective (see Section 8.3.1.1 for a discussion of chloride compliance modeling uncertainties and a description of real time operations of the SWP and CVP).

Similarly, estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3) were also used to evaluate the 250 mg/L Bay-Delta WQCP objective for chloride at Contra Costa Pumping Plant #1 where daily average objectives apply. For Alternative 4, the modeled frequency of objective exceedance would decrease minimally under all the H1–H4 Scenarios, from 5% of modeled days under the No Action Alternative to 4–3% of modeled days under the Alternative 4 scenarios (Appendix 8G, Table Cl-64).

Similar to Existing Conditions, a comparative assessment of modeling approaches was utilized to evaluate the 250 mg/L Bay-Delta WQCP objectives in terms of both frequency of exceedance and use of assimilative capacity on a monthly average basis. When utilizing the mass balance approach to model monthly average chloride concentrations for the 16-year period, a small increase in exceedance frequency would be predicted at the Sacramento River at Mallard Island (i.e., from 86% for the No Action Alternative to a slight 2% increase [up to88%] for H1and H3), with no change in exceedances under H2 or H4 (Appendix 8G, Table Cl-27). The frequency of exceedances would decrease slightly at the San Joaquin River at Antioch (i.e., from 73% for the No Action Alternative to a range of 68% [H2 and H4] to 70% [H1]), and the frequency of exceedances at the Contra Costa Canal at Pumping Plant #1 would depend on the scenario from 14% under the No Action Alternative increasing by 2–4% for H1 and H2 (i.e., up to 18%) and decreasing at H3 and H4 [to 12%]~~)(~~) (Appendix 8G, Table Cl-27). Although these changes are within the uncertainty of the modeling approach, ~~S~~substantial reductions in available assimilative capacity compared to the No Action Alternative condition would occur at Antioch under H1 and H3 (i.e., 24% in April) and no substantial reduction under H2/H4 for the 16-year period modeled, and up to 100% in April [i.e., eliminated] for the drought period for all H1–H4 scenarios). Assimilative capacity also would be reduced substantially at the Contra Costa Canal at Pumping Plant #1 at similar levels for H1 and H2 in August through November (i.e., up to 100% elimination in October) to only in August and September under H3 and H4 (i.e., up to 29%) for the 16-year period modeled, with 100% elimination in at least one month under all of the H1–H4 scenarios for the drought period) (Appendix 8G, Tables Cl-29~~A/2~~A through 29D), reflecting substantial degradation during months when average concentrations would be near, or exceed, the objective.

In comparison, when utilizing the chloride-EC relationship to model monthly average chloride concentrations for the 16-year period, trends in frequency of exceedance and use of assimilative capacity would be similar to that discussed when utilizing the mass balance modeling approach (Appendix 8G, Tables Cl-30~~A/3~~A through 30D).However, as with Alternative 1A, the modeling approach utilizing the chloride-EC relationships predicted changes of lesser magnitude, where predictions of change utilizing the mass balance approach were generally of greater magnitude, and thus more conservative. As discussed in Section 8.3.1.3, in cases of such disagreement, the approach that yielded the more conservative predictions was used as the basis for determining adverse impacts.

Based on the ~~additional predicted annual and seasonal exceedances of one or both Bay Delta WQCP objectives for chloride, and theassociated~~long-term average water quality degradation in the western Delta, the potential exists for substantial adverse effects under all of the Alternative 4H1–H4 Scenarios on the municipal and industrial beneficial uses through reduced opportunity for diversion of water with acceptable chloride levels.

303(d) Listed Water Bodies–Relative to No Action Alternative

With respect to the 303(d) listing for chloride, Alternative 4 would generally result in similar changes for all of the Alternative 4 H1–H4 Scenarios to those discussed for the comparison to Existing Conditions. Monthly average chloride concentrations at Tom Paine Slough would not be further degraded on a long-term basis (Appendix 8G, Figure Cl-6). Modeling results indicate~~d~~ that ~~M~~monthly average chloride concentrations at source water channel locations for the Suisun Marsh (Appendix 8G, Figures Cl-5, Cl-7 and Cl-8) would increase substantially in some months during October through May compared to the No Action Alternative conditions, but sensitivity analyses suggest~~ed~~ that operation of the Salinity Control Gates and restoration area siting and design considerations could reduce these increases. However, the chloride concentration increases at certain locations could be substantial, depending on siting and design of restoration areas. Thus, these increased chloride levels in Suisun Marsh are considered to ~~Therefore,~~ contribute to additional, measureable long-term degradation ~~would occur~~ in Suisun Marsh that potentially would adversely affect the necessary actions to reduce chloride loading for any TMDL that is developed.

SWP/CVP Export Service Areas

Under the Alternative 4H1–H4 Scenarios, long-term average chloride concentrations based on the mass balance analysis of modeling results for the 16-year period modeled at the Banks and Jones pumping plants would decrease compared to Existing Conditions. Reductions at Banks would be slightly larger than at Jones, ranging from 37% (H1) to 45% (H4) (Appendix 8G, *Chloride*, Table Cl-25~~A/2~~A through 25D).Compared to No Action Alternative, the pattern of reductions would be similar with Banks ranging from 32% (H1) to 38% (H4). The modeled frequency of exceedances of applicable water quality objectives/criteria would decrease relative to Existing Conditions and No Action Alternative, for both the 16-year period and the drought period modeled (Appendix 8G, *Chloride*, Table Cl-27). Consequently, water exported into the SWP/CVP service area would generally be of similar or better quality with regards to chloride relative to Existing Conditions and the No Action Alternative conditions.

Results of the modeling approach which used relationships between EC and chloride (see Section 8.3.1.3) were consistent with the discussion above, and assessment of chloride using these data results in the same conclusions as are presented above for the mass-balance approach (Appendix 8G, Tables Cl-26~~A/2~~A through 26D [for concentration changes] and Table Cl-28 [for frequency of exceedances]).

Commensurate with the reduced chloride concentrations in water exported to the service area, reduced chloride loading in the lower San Joaquin River would be anticipated which would likely alleviate or lessen any expected increase in chloride at Vernalis related to decreased annual average San Joaquin River flows (see discussion of Upstream of the Delta).

Maintenance of SWP and CVP facilities would not be expected to create new sources of chloride or contribute towards a substantial change in existing sources of chloride in the affected environment. Maintenance activities would not be expected to cause any substantial change in chloride such that any long-term water quality degradation would occur, thus, beneficial uses would not be adversely affected anywhere in the affected environment.

***NEPA Effects*:** In summary, relative to the No Action Alternative conditions, the Alternative 4H1-H4 Scenarios are not expected to result in substantial additional exceedances of the 150 mg/L or 250 mg/L water quality objectives. ~~a~~All of the Alternative 4H1–H4 Scenarios would result in increased water quality degradation ~~and frequency of exceedance of the 150 mg/L objective at Contra Costa Pumping Plant #1 and Antioch, increased water quality degradation~~ with respect to the 250 mg/L municipal and industrial objective at ~~interior and~~ western Delta locations on a monthly average basis, and could contribute measureable water quality degradation relative to the 303(d) impairment in Suisun Marsh (see Mitigation Measure WQ-7 below; implementation of this measure along with a separate, non-environmental commitment relating to the potential increased chloride treatment costs would reduce these effects).The predicted chloride increases constitute an adverse effect on water quality. Additionally, the predicted changes relative to the No Action Alternative conditions indicate that in addition to the effects of climate change/sea level rise, implementation of CM1 and CM4 under the Alternative 4 H1–H4 Scenarios would contribute substantially to the adverse water quality effects.

***CEQA Conclusion*:** Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Chloride is not a constituent of concern in the Sacramento River watershed upstream of the Delta, thus river flow rate and reservoir storage reductions that would occur under any of the Alternative 4H1–H4 Scenarios, relative to Existing Conditions, would not be expected to result in a substantial adverse change in chloride levels. Additionally, relative to Existing Conditions, the Alternative 4 H1–H4 Scenarios would not result in reductions in river flow rates (i.e., less dilution) or increased chloride loading such that there would be any substantial increase in chloride concentrations upstream of the Delta in the San Joaquin River watershed.

Relative to Existing Conditions, ~~all of~~ the Alternative 4H1–H4 Scenarios would ~~result in substantially increased chloride concentrations in the Delta such that~~not increase the frequency of exceeding the 150 mg/L Bay-Delta WQCP objective. ~~would approximately double~~. ~~Moreover, t~~Modeling results indicate~~d~~ that the frequency of exceedance of the 250 mg/L Bay-Delta WQCP objective would increase at the San Joaquin River at Antioch and at Mallard Slough (ranging by up to 2 to 4% for the H1–H4 Scenarios), but these frequencies are expected to be within the uncertainty present in the chloride modeling procedure. Substantial long-term degradation ~~also~~ may occur at Antioch under all of the H1–H4 Scenarios, and at the Contra Costa Canal at Pumping Plant #1 under the H1-H2 Scenarios, that may result in adverse effects on the municipal and industrial water supply beneficial use (see Mitigation Measure WQ-7 below; implementation of this measure along with a separate, non-environmental commitment relating to the potential increased chloride treatment costs would reduce these effects). Relative to the Existing Conditions, the modeled increased chloride concentrations and degradation in the western Delta under all of the H1–H4 Scenarios could further contribute, at measurable levels ~~(i.e., over a doubling of concentration)~~, to the existing 303(d) listed impairment due to chloride in Suisun Marsh for the protection of fish and wildlife.

Chloride concentrations would be reduced under all of the H1–H4 Scenarios in water exported from the Delta to the CVP/SWP Export Service Areas, thus reflecting a potential improvement to chloride loading in the lower San Joaquin River.

Chloride is not a bioaccumulative constituent, thus any increased concentrations under the Alternative 4H1–H4 Scenarios would not result in substantial chloride bioaccumulation impacts on aquatic life or humans. Alternative 4 maintenance would not result in any substantial changes in chloride concentration upstream of the Delta or in the SWP/CVP Export Service Areas. However, based on these findings, this impact is determined to be significant due to increased chloride concentrations and degradation at western Delta locations and its potential effects on municipal and industrial water supply and fish and wildlife beneficial uses.

Implementation of Mitigation Measure WQ-7 along with a separate, non-environmental commitment relating to the potential increased costs associated with chloride-related changes would reduce these effects. Although it is not known whether implementation of WQ-7 will be able to feasibly reduce water quality degradation in the western Delta, implementation of Mitigation Measure WQ-7 is recommended to attempt to reduce the effect that increased chloride concentrations may have on Delta beneficial uses. However, because the effectiveness of this mitigation measure to result in feasible measures for reducing these water quality effects is uncertain, this impact is considered to remain significant and unavoidable. Based on sensitivity analyses conducted to date (see Appendix 8H Attachment 1), it is expected that implementation of WQ-7d will be able to reduce impacts on chloride in Suisun Marsh to a less than significant level.

~~While mitigation measures to reduce these water quality effects in affected water bodies to less than significant levels are not available, implementation of Mitigation Measure WQ-7 is recommended to attempt to reduce the effect that increased chloride concentrations may have on Delta beneficial uses.However,because the effectiveness of this mitigation measure to result in feasible measures for reducing water quality effects is uncertain, this impact is considered to remain significant and unavoidable.~~

In addition to and to supplement Mitigation Measure WQ-7, the BDCP proponents have incorporated into the BDCP, as set forth in EIR/EIS Appendix 3B, *Environmental Commitments*, a separate, non-environmental commitment to address the potential increased water treatment costs that could result from chloride concentration effects on municipal, industrial and agricultural water purveyor operations. Potential options for making use of this financial commitment include funding or providing other assistance towards acquiring alternative water supplies or towards modifying existing operations when chloride concentrations at a particular location reduce opportunities to operate existing water supply diversion facilities. Please refer to Appendix 3B, *Environmental Commitments*, for the full list of potential actions that could be taken pursuant to this commitment in order to reduce the water quality treatment costs associated with water quality effects relating to chloride, electrical conductivity, and bromide.

Mitigation Measure WQ-7: Conduct Additional Evaluation and Modeling of Increased Chloride Levels and Develop and Implement Phased Mitigation Actions

It is currently unknown whether the effects of increased chloride levels, and potential adverse effects on municipal and industrial water supply and fish and wildlife beneficial uses associated with CM1 operations (and hydrodynamic effects of tidal restoration under CM4), can be mitigated through modifications to initial operations and/or site-specific design of tidal restoration areas under CM4. Specifically, it remains to be determined whether, or to what degree, the available and existing salinity response and countermeasure actions of SWP and CVP facilities, municipal water purveyors, or Suisun Marsh salinity control facilities would be capable of offsetting the actual level of changes in chloride that may occur from implementation of Alternative 4. Therefore, the proposed mitigation measures require a series of actions to identify and evaluate potentially feasible actions, to achieve reduced chloride levels in order to reduce or avoid impacts to beneficial uses.

Regarding exceedance of Bay Delta WQCP water quality objectives for chloride, staff from DWR and Reclamation shall continue to constantly monitor Delta water quality conditions and adjust operations of the SWP and CVP in real time as necessary to meet water quality objectives. These decisions take into account real-time conditions and are able to account for many factors that the best available models cannot simulate. DWR and Reclamation have a good history of compliance with water quality objectives (see section 8.3.1.4 and 8.3.1.7 for more detail). Considering these real-time actions, the good history of compliance with objectives, and the uncertainty inherent in the modeling approach (as discussed in section 8.3.1.1 and 8.3.1.3), it is likely that objective exceedance, should any be predicted to occur, could be avoided through real-time operation of the SWP and CVP.

Nevertheless, water quality degradation could occur that may not be addressed through real-time operations. The development and implementation of any mitigation actions shall be focused on those incremental effects attributable to implementation of Alternative 4 operations only. Development of mitigation actions for the incremental chloride effects attributable to climate change/sea level rise are not required because these changed conditions would occur with or without implementation of Alternative 4.

Mitigation Measure WQ-7a: Conduct Additional Evaluation and Modeling of Increased Chloride Levels Following Initial Operations of CM1of Operational Ability to Reduce or Eliminate Water Quality Degradation in Western Delta Incorporating Site-Specific Restoration Areas and Updated Climate Change/Sea Level Rise Projections, if Available

Following commencement of initial operations of CM1, tThe BDCP proponents will conduct additional evaluations described herein, and develop additional modeling (as necessary), to define the extent to which modified operations of the SWP and CVP could reduce or eliminate the additional exceedances ofwater quality degradation relative to the 250 mg/L Bay-Delta WQCP objective for chloride currently modeled to occur under Alternative 4. The additional evaluations should will be conducted to also consider specifically the changes in Delta hydrodynamic conditions associated with tidal habitat restoration under CM4 ~~(in particular the potential for increased chloride concentrations that could result from increased tidal exchange)~~ once the specific restoration locations and timing of their construction are identified and designed. The evaluations will also consider up-to-date estimates of climate change and sea level rise, if and when such information is available. These evaluations will be conducted concurrently with Mitigation Measure WQ-7b. Together, findings from WQ-7a and WQ-7b will indicate ~~If~~whether sufficient ~~operational~~ flexibility to prevent or offset chloride increases is ~~not~~ feasible under Alternative 4~~ operations,.~~ ~~achieving chloride reduction pursuant to this mitigation measure would not be feasible under this alternative.~~

Mitigation Measure WQ-7b: Site and Design Restoration Sites to Reduce or Eliminate Water Quality Degradation in the Western Delta

BDCP proponents shall consider effects of site-specific restoration areas proposed under CM4 on chloride concentrations in the western Delta. Design and siting of restoration areas shall attempt to reduce water quality degradation with respect to the 250 mg/L chloride objective in the western Delta to the extent possible without compromising proposed benefits of the restoration areas. These evaluations will be conducted concurrently with Mitigation Measure WQ-7a. Together, findings from WQ-7a and WQ-7b will indicate whether sufficient flexibility to prevent or offset chloride increases is feasible under Alternative 4.

Mitigation Measure WQ-~~7b~~7c: Consult with Delta Water Purveyors to Identify Means to Avoid, Minimize, or Offset for Reduced Seasonal Availability of Water That Meets Applicable Water Quality Objectives

To determine the feasibility of reducing the effects of CM1/CM4 operations on increased chloride concentrations as shown in modeling estimates to occur to municipal and industrial water purveyors at the Antioch, Mallard Slough, and Contra Costa Canal at Pumping Plant #1 locations, the BDCP proponents will consult with the purveyors to identify any feasible operational means to either avoid, minimize, or offset for reduced seasonal availability of water that either meets applicable water quality objectives or ~~and~~ that results in levels of degradation that do not substantially increase the risk of adversely affecting the municipal and industrial beneficial use. Any such action will be developed following, and in conjunction with, the completion of the evaluation and development of any potentially feasible actions described in Mitigation Measure WQ-7a and WQ-7b.

Mitigation Measure WQ-~~7c~~7d: Site and Design Restoration Sites and consult with CDFW/USFWS, and Suisun Marsh Stakeholders to Identify Potential Actions to Avoid or Reduce Chloride ~~Level~~Concentration Increases in the Marsh

BDCP proponents shall consider effects of site-specific restoration areas proposed under CM4 on chloride ~~levels~~concentrations in Suisun Marsh. Design and siting of restoration areas shall attempt to reduce potential effects to the extent possible without compromising proposed benefits of the restoration areas. BDCP proponents will also consult with CDFW/USFWS, and Suisun Marsh stakeholders, to identify potential actions to avoid or minimize the chloride increases in the marsh, with the goal of maintaining chloride at levels that would not further impair fish and wildlife beneficial uses in Suisun Marsh. Potential actions may include modifications of the existing Suisun Marsh Salinity Control Gates for effective salinity control and evaluation of the efficacy of additional physical salinity control facilities or operations for the marsh to reduce the effects of increased chloride levels. These actions are identical to the actions discussed in Mitigation Measure WQ-11b regarding levels of electrical conductivity in Suisun Marsh.~~Consult with DFW/USFWS, and Suisun MarshStakeholders, to Identify Potential Actions to Avoid or Minimize Chloride Level Increases in the Marsh~~

~~To determine the feasibility of reducing the effects of CM1/CM4 operations on increased chloride concentrations as shown in modeling estimates to occur in the Suisun Marsh, the BDCP proponents will consult with DFW/USFWS, and Suisun Marsh stakeholders, to identify potential actions to avoid or minimize the chloride level increases in the marsh, with the goal of maintaining chloride at levels that would not further impair fish and wildlife beneficial uses in Suisun Marsh. Potential actions may include modifications of the existing Suisun Marsh Salinity Control Gates for effective salinity control and evaluation of the efficacy of additional physical salinity control facilities or operations for the marsh to reduce the effects of increased chloride levels. Based on the modeled conditions, the emphasis would be identification of potentially feasible actions to reduce adverse chloride-related effects during the seasonal period of January through May. Any such action will be developed following, and in conjunction with, the completion of the evaluation and development of any feasible actions described in Mitigation Measure WQ-7a.~~

Impact WQ-8: Effects on Chloride Concentrations Resulting from Implementation ofCM2–~~CM22~~CM21

NEPA Effects: The implementation of the other conservation measures (i.e., CM2–~~CM22~~CM21), of which most do not involve land disturbance, present no new direct sources of chloride to the affected environment, including areas Upstream of the Delta, within the Plan Area, and the SWP/CVP Export Service Area, nor would they affect channel flows or Delta hydrodynamic conditions. As noted above, the potential effects of implementation of tidal habitat restoration (i.e., CM4) on Delta hydrodynamic conditions is addressed above in the discussion of Impact WQ-8. The potential channel flow effects of CM2 for actions in the Yolo Bypass also were accounted for in the CALSIM II and DSM2 modeling, and thus were addressed in the discussion for Impact WQ-8. CM3 and CM11 provide the mechanism, guidance, and planning for the land acquisition and thus would not, themselves, affect chloride levels in the Delta. CM12–~~CM22~~CM21 involve actions that target reduction in other stressors at the species level involving actions such as methylmercury reduction management (CM12), improving DO in the Stockton Deep Water Ship Channel (CM14), and urban stormwater treatment (CM19). None of CM12–~~CM22~~CM21 would contribute to substantially increasing chloride levels in the Delta. Consequently, as they pertain to chloride, implementation of CM2–~~CM22~~CM21 would not be expected to adversely affect any of the beneficial uses of the affected environment. Moreover, some habitat restoration conservation measures (CM4–CM10) would occur on lands within the Delta currently used for irrigated agriculture, thus replacing agricultural land uses with restored tidal wetlands, floodplain, and related channel margin and off-channel habitats. The potential reduction in irrigated lands within the Delta may result in reduced discharges of agricultural field drainage with elevated chloride concentrations, which would be considered an improvement compared to the No Action Alternative.

In summary, based on the discussion above, the effects on chloride from implementing CM2-~~CM22~~CM21 are considered to be not adverse.

CEQA Conclusion: Implementation of the CM2–~~CM22~~CM21 for Alternative 4 would not present new or substantially changed sources of chloride to the affected environment upstream of the Delta, within Delta, or in the SWP/CVP service area. Replacement of irrigated agricultural land uses in the Delta with habitat restoration conservation measures may result in some reduction in discharge of agricultural field drainage with elevated chloride concentrations, thus resulting in improved water quality conditions. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-9: Effects on Dissolved Oxygen Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

DO levels in the reservoirs and rivers are primarily affected by water temperature, flow velocity, turbulence, amounts of oxygen demanding substances present (e.g., ammonia, organics), and rates of photosynthesis (which is influenced by nutrient levels), respiration, and decomposition. Water temperature and salinity affect the maximum DO saturation level (i.e., the highest amount of oxygen the water can dissolve). Flow velocity affects the turbulence and re-aeration of the water (i.e., the rate at which oxygen from the atmosphere can be dissolved in water). High nutrient content can support aquatic plant and algae growth, which in turn generates oxygen through photosynthesis and consumes oxygen through respiration and decomposition.

A reservoir can exhibit seasonal changes in the DO profile from the water surface to the sediments that is affected by its degree of thermal stratification, where oxygenated inflows enter and mix with the reservoir, its level of productivity that contributes DO through photosynthesis and consumes DO through respiration and decomposition, as well as the prevailing winds that cause mixing within the reservoir. Water temperature also is a factor in that it affects the level (between the surface and the bottom) at which oxygenated river inflows enter the reservoir, the DO saturation level, and photosynthesis and respiration rates. Cold inflows tend to move deep into the reservoir due to the lower density of cold water, whereas warm water inflows tend to mix with the surface waters, particularly when the reservoir is thermally stratified. Under Alternative 4, the primary factor that would change relative to Existing Conditions is that end-of-September carryover storage may be lower in some years (see Chapter 5, *Water Supply*, Section 5.3.3.9), which would affect the temperature profile of the reservoirs at the end of summer. Nevertheless, the reservoirs would continue to thermally stratify seasonally, as they do under Existing Conditions. Given the size of the reservoirs—Lake Oroville, Trinity Lake, Shasta Lake, and Folsom Lake—and their significant surface area, inflows and wind fetch that would still contribute to oxygenating these water bodies, the lower carryover storage that could occur in some years under Alternative 4 is not expected to cause DO depletions or substantial changes in DO that would adversely affect the beneficial uses of these water bodies.

The four operational scenarios of Alternative 4 would alter the magnitude and timing of water releases from reservoirs upstream of the Delta relative to Existing Conditions and the No Action Alternative, which would consequently alter downstream river flows. There would be some increases and decreases in the mean monthly river flows, depending on month and year. Mean monthly flows would remain within the range historically seen under Existing Conditions and the No Action Alternative. Moreover, these are large, turbulent rivers with flow velocities typically in the range of 0.5 fps to 2.0 fps or higher. Consequently, flow changes that would occur under any operational scenario of Alternative 4 would not be expected to have substantial effects on river DO levels; likely, the changes would be immeasurable. This is because sufficient turbulence and interaction of river water with the atmosphere would continue to occur under this alternative to maintain water saturation levels (due to these factors) at levels similar to that of Existing Conditions and the No Action Alternative.

The changes in the magnitude and timing of water releases from reservoirs upstream of the Delta, relative to Existing Conditions and the No Action Alternative, could affect downstream river temperatures, depending on month and year. Water temperature affects the maximum DO saturation level; as temperature increases, the DO saturation level decreases. When holding constant for barometric pressure (e.g., 760 mm mercury), the DO saturation level ranges from 7.5 mg/L at 30°C (86°F) to 11 mg/L at 10°C(50°F) (Tchobanoglous and Schroeder 1987:735). As described in the affected environment section, DO in the Sacramento River at Keswick, Feather River at Oroville, and lower American River ranged from 7.3 to 15.6 mg/L, 7.4 to 12.5 mg/L, and 6.5 to 13.0 mg/L, respectively. Thus, these rivers are well oxygenated and experience periods of supersaturation (i.e., when DO level exceeds the saturation concentration). Because these are large, turbulent rivers, any reduced DO saturation level that would be caused by an increase in temperature under any operational scenario of Alternative 4 would not be expected to cause DO levels to be outside of the range seen historically. This is because sufficient turbulence and interaction of river water with the atmosphere would continue to occur under this alternative to maintain saturation levels.

Amounts of oxygen demanding substances present (e.g., ammonia, organics) in the reservoirs and rivers upstream of the Delta, rates of photosynthesis (which is influenced by nutrient levels/loading), and respiration and decomposition of aquatic life is not expected to change sufficiently under Alternative 4 to substantially alter DO levels relative to Existing Conditions or the No Action Alternative. Any minor reductions in DO levels that may occur under this alternative would not be expected to be of sufficient frequency, magnitude and geographic extent to adversely affect beneficial uses, or substantially degrade the quality of these water bodies, with regard to DO.

An effect on salinity (expressed as EC) would not be expected in the rivers and reservoirs upstream of the Delta. Thus, these parameters would not be expected to measurably change DO levels under any of the operational scenarios of Alternative 4, relative to Existing Conditions or the No Action Alternative.

Delta

Similar to the reservoirs and rivers upstream of the Delta, DO levels in the Delta are primarily affected by water temperature, salinity, Delta channel flow velocities, nutrients (i.e., phosphorus and nitrogen) and aquatic organisms (i.e., photosynthesis, respiration, and decomposition). Sediment oxygen demand of organic material deposited in the low velocity channels also affects Plan Area DO levels.

Under all operational scenarios of Alternative 4, minor DO level changes could occur due to nutrient loading to the Delta relative to Existing Conditions and the No Action Alternative (see WQ-1, WQ-15, WQ-23). The state has begun to aggressively regulate point-source discharge effects on Delta nutrients, and is expected to further regulate nutrients upstream of and in the Delta in the future. Although population increased in the affected environment between 1983 and 2001, average monthly DO levels during this period of record show no trend in decline in the presence of presumed increases in anthropogenic sources of nutrients (see Table 8-11~~4.4-15 in the ES/AE section~~). Based on these considerations, excessive nutrients that would cause low DO levels would not be expected to occur under any operational scenario of Alternative 4.

Various areas of the Delta could experience salinity increases due to change in quantity of Delta inflows (see WQ-11) For a 5 ppt salinity increase at 68°Fahrenheit, the saturation level of oxygen dissolved in the water is reduced by only about 0.25 mg/L. Thus, increased salinity under Alternative 4 would generally have relatively minor effects on Delta DO levels where salinity is increased on the order of 5 ppt or less.

The relative degree of tidal exchange of flows and turbulence, which contributes to exposure of Delta waters to the atmosphere for reaeration, would not be expected to substantially change relative to Existing Conditions or the No Action Alternative, such that these factors would reduce Delta DO levels below objectives or levels that protect beneficial uses.

As discussed in the section on DO in section 8.3.1.7 Effects of climate change on air and Delta water temperatures are discussed in Appendix 29C. In general, waters of the Delta would be expected to warm less than 5 degrees F under Alternative 4, relative to Existing Conditions, due to climate change, which translates into a < 0.5 mg/L decrease in DO saturation. Thus, increased temperature under Alternative 4 would generally have relatively minor effects on Delta DO levels, relative to Existing Conditions.

Some waterways in the eastern, southern, and western Delta are listed on the state's Clean Water Act section 303(d) list as impaired due to low oxygen levels. A TMDL for the Deep Water Ship channel in the eastern Delta has been approved and identifies the factors contributing to low DO in the Deep Water Ship Channel as oxygen demanding substances from upstream sources, Deep Water Ship Channel geometry, and reduced flow through the Deep Water Ship Channel (Central Valley Water Board 2005:28). The TMDL takes a phased approach to allow more time to gather additional informational on sources and linkages to the DO impairment, while at the same time moving forward on making improvements to DO conditions. One component of the TMDL implementation activities is an aeration device demonstration project.

In the Deep Water Ship Channel, low DO events have historically occurred in May-October, and typically in drier years and when flows in the San Joaquin River at Stockton are less than 1000 cfs (Central Valley Regional Water Quality Control Board 2014, ICF International 2010). Concerns have been raised that flows on the San Joaquin River at Stockton may increase, causing the location of the minimum DO point to shift downstream.

Figure 8-65 shows a box-and-whisker plot of the monthly average flows in the San Joaquin River at Stockton for the months of May-October for Dry and Critical water year types. The figure shows that while flows do change somewhat, they are generally within the range of flows seen under Existing Conditions. Reports indicate that the aeration facility performs adequately under the range of flows from 250-1000 cfs (ICF International 2010). Based on the above, the expected changes in flows in the San Joaquin River at Stockton are not expected to substantially move the point of minimum DO, and therefore the aeration facility will likely still be located appropriately to keep DO levels above basin plan objectives.

Overall, assuming continued operation of the aerators, the alternative is not expected to have a substantial impact on DO in the Deep Water Ship Channel. It is expected that under Alternative 4 that DO levels in the Deep Water Ship Channel would remain similar to those under Existing Conditions and the No Action Alternative or improve as the TMDL-required studies are completed and actions are implemented to improve DO levels. DO levels in other Clean Water Act section 303(d)-listed waterways would not be expected to change relative to Existing Conditions or the No

Action Alternative, as the circulation of flows, tidal flow exchange, and re-aeration would continue to occur.

SWP/CVP Export Service Areas

The primary factor that would affect DO in the conveyance channels and ultimately the receiving reservoirs in the SWP/CVP Export Service Areas would be changes in the levels of nutrients and oxygen-demanding substances and DO levels in the exported water. For reasons provided above, the Delta waters exported to the SWP/CVP Export Service Areas would not be expected to be substantially lower in DO compared to Existing Conditions or the No Action Alternative. Exported water could potentially be warmer and have higher salinity relative to Existing Conditions and the No Action Alternative. Nevertheless, because the biochemical oxygen demand of the exported water would not be expected to substantially differ from that under Existing Conditions or the No Action Alternative (due to ever increasing water quality regulations), canal turbulence and exposure of the water to the atmosphere and the algal communities that exist within the canals would establish an equilibrium for DO levels within the canals. The same would occur in downstream reservoirs. Consequently, substantial adverse effects on DO levels in the SWP/CVP Export Service Areas would not be expected to occur.

NEPA Effects: The effects on dissolved oxygen from implementing any operational scenario of Alternative 4 is determined to not be adverse.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

~~River flow rate and r~~Reservoir storage reductions that would occur under any operational scenario of Alternative 4, relative to Existing Conditions, would not be expected to result in a substantial adverse change in DO levels in the reservoirs, because oxygen sources (surface water aeration, aerated inflows, vertical mixing) would remain. Similarly, river flow rate reductions that would occur would not be expected to result in a substantial adverse change in DO levels in the ~~and~~ rivers upstream of the Delta, given that mean monthly flows would remain within the ranges historically seen under Existing Conditions and the affected river are large and turbulent. Any reduced DO saturation level that may be caused by increased water temperature would not be expected to cause DO levels to be outside of the range seen historically. Finally, amounts of oxygen demanding substances and salinity would not be expected to change sufficiently to affect DO levels.

It is expected there would be no substantial change in Delta DO levels in response to a shift in the Delta source water percentages under this alternative or substantial degradation of these water bodies, with regard to DO. DO levels would be affected by nutrient loading, which the state has begun to aggressively regulate the discharges of, and this loading would not be expected to lower DO levels relative to Existing Conditions based on historical DO levels. Further, the anticipated changes in salinity would have relatively minor effects on DO levels, and tidal exchange, which contribute to the reaeration of Delta waters would not be expected to change substantially.

There is not expected to be substantial, if even measurable, changes in DO levels in the SWP/CVP Export Service Areas waters under any operational scenario of Alternative 4, relative to Existing Conditions, because the biochemical oxygen demand of the exported water would not be expected to substantially differ from that under Existing Conditions (due to ever increasing water quality regulations), canal turbulence and exposure of the water to the atmosphere and the algal communities that exist within the canals would establish an equilibrium for DO levels within the canals. The same would occur in downstream reservoirs.

Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would result in significant impacts on any beneficial uses within affected water bodies. Because no substantial changes in DO levels are expected, long-term water quality degradation would not be expected to occur, and, thus, beneficial uses would not be adversely affected. Various Delta waterways are 303(d)-listed for low DO, but because no substantial decreases in DO levels would be expected, greater degradation and DO-related impairment of these areas would not be expected. This impact would be less than significant. No mitigation is required.

Impact WQ-10: Effects on Dissolved Oxygen Resulting from Implementation ofCM2–~~CM22~~CM21

NEPA Effects**:** CM2–~~CM22~~CM21 would not be expected to contribute to adverse DO levels in the Delta. The increased habitat provided by CM2–CM11 could contribute to an increased biochemical or sediment demand, through contribution of organic carbon and plants decaying. However, similar habitat exists currently in the Delta and is not identified as contributing to adverse DO conditions. Although additional DOC loading to the Delta may occur (see impact WQ-18), only a fraction of the DOC is available to microorganisms that would consume oxygen as part of the decay and mineralization process. Since decreases in dissolved organic carbon are not typically observed in Delta waterways due to these processes, any increase in DOC is unlikely to contribute to adverse DO levels in the Delta. CM14, an oxygen aeration facility in the Stockton Deep Water Ship Channel to meet TMDL objectives established by the Central Valley Water Board, would maintain DO levels above those that impair fish species when covered species are present. CM19, which would fund projects to contribute to reducing pollutant discharges in stormwater, would be expected to reduce biochemical oxygen demand load and, thus, would not adversely affect DO levels. The remaining conservation measures would not be expected to affect DO levels because they are actions that do not affect the presence of oxygen-demanding substances.

The effects on dissolved oxygen from implementing CM2–~~CM22~~CM21 is determined to not be adverse.

CEQA Conclusion**:** It is expected that DO levels in the Upstream of the Delta Region, in the Plan Area, or in the SWP/CVP Export Service Areas following implementation of CM2–~~CM22~~CM21 under Alternative 4 would not be substantially different from existing DO conditions. Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would result in significant impacts on any beneficial uses within affected water bodies. Because no substantial changes in DO levels would be expected, long-term water quality degradation would not be expected, and, thus, beneficial uses would not be adversely affected. Various Delta waterways are 303(d)-listed for low DO, but because no substantial decreases in DO levels would be expected, greater degradation and impairment of these areas would not be expected. Implementation of CM14 would have a net beneficial effect on DO conditions in the Stockton Deep Water Ship Channel. This impact would be less than significant. No mitigation is required.

Impact WQ-11: Effects on Electrical Conductivity Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Alternative 4, Scenarios H1–H4, would alter the magnitude and timing of water releases from reservoirs upstream of the Delta relative to Existing Conditions and the No Action Alternative. With respect to EC, an increase or decrease in river flow alone is not of concern. Measureable changes in the quality of the watershed runoff and reservoir inflows would not be expected to occur in the future; therefore, the EC levels in these reservoirs would not be expected to change relative to Existing Conditions or the No Action Alternative. There could be increased discharges of EC-elevating parameters in the future in water bodies upstream of the Delta as a result of urban growth and increased runoff and wastewater discharges. The state has begun to aggressively regulate point-source discharge effects on Delta salinity-elevating parameters, capping dischargers at existing levels, and is expected to further regulate EC and related parameters upstream of and within the Delta in the future as salt management plans are developed. Based on these considerations, EC levels (highs, lows, typical conditions) in the Sacramento River and its tributaries, the eastside tributaries, or their associated reservoirs upstream of the Delta would not be expected to be outside the ranges occurring under Existing Conditions or the No Action Alternative.

The effects on lower San Joaquin River EC would be somewhat different. Elevated EC in the San Joaquin River can be sourced to agricultural use of irrigation water imported from the southern Delta and applied on soils high in salts. This accumulation of salts is a primary contributor of elevated EC on the lower San Joaquin River. Tributary flows generally provide dilution of the high EC agricultural drainage waters. Depending on operational scenario, long-term average flows at Vernalis would decrease about 6% (as a result of climate change and increased water demands) relative to Existing Conditions, and would increase about 0.1% relative to the No Action Alternative(Appendix 5A). These decreases in flow, alone, would correspond to a possible increase in long-term average EC levels. The level of EC increase cannot be readily quantified but, based on estimated increase in bromide and chloride concentrations, to which EC is correlated, would be relatively small and on the order of about 3% relative to Existing Conditions, and less than 0.1% relative to the No Action Alternative. However, with the implementation of the adopted TMDL for the San Joaquin River at Vernalis and the ongoing development of the TMDL for the San Joaquin River upstream of Vernalis and its implementation, it is expected that long-term EC levels will improve. Based on these considerations, substantial changes in EC levels in the San Joaquin River relative to Existing Conditions or the No Action Alternative would not be expected of sufficient magnitude and geographic extent that would result in adverse effects on any beneficial uses, or substantially degrade the quality of these water bodies, with regard to EC.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics. To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of ~~CM2-22CM2 through CM22~~CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for ~~CM2-22CM2 through CM22~~CM2–CM21. See section 8.3.1.3 for more information.

Relative to Existing Conditions, modeling indicates that Alternative 4, Scenarios H1–H4, would result in an increase in the number of days the Bay-Delta WQCP EC objectives would be exceeded in the Sacramento River at Emmaton, San Joaquin River at San Andreas Landing, Jersey Point, and Prisoners Point, and Old River near Middle River and at Tracy Bridge (Appendix 8H, Table EC-4).

The percent of days the Emmaton EC objective would be exceeded for the entire period modeled (1976–1991) would increase from 6% under Existing Conditions to 2~~3~~7–2~~5~~9%, depending on the operations scenario, and the percent of days out of compliance would increase from 11% under Existing Conditions to ~~35~~40–~~38~~43%, depending on the operations scenario. Although these results are for modeling that was originally performed for Alternative 4 assuming the Emmaton compliance point shifted to Threemile Slough, Alternative 4 now does not include a change in compliance point from Emmaton to Threemile Slough. Sensitivity analyses were performed that modeled Alternative 4 scenario H3 with ~~compliance at~~ Emmaton as the compliance point. Assuming the compliance location at Emmaton instead of Threemile Slough in the CALSIM II modeling decreased exceedances at Emmaton from 28% to 15% under Alternative 4, operations scenario H3 (see Appendix ~~XX~~8H Attachment 1 for more discussion of these sensitivity analyses), which ~~is~~ would still be greater than Existing Conditions. Table 2 of Appendix 8H Attachment 1 indicates that most of these exceedances are a result of modeling artifacts, but some exceedances are due to dead pool conditions that occurred in 1977, 1981, and 1990 ~~occurred~~ under Alternative 4 and not under Existing Conditions. As discussed in Chapter 5, *Water Supply*, Section 5.3.1, *Methods for Analysis*, under extreme hydrologic and operational conditions where there is not enough water supply to meet all requirements, CALSIM II uses a series of operating rules to reach a solution that ~~are~~ is a simplified version of the very complex decision processes that SWP and CVP operators would use in actual extreme conditions. Thus, it is unlikely that the Emmaton objective would actually be violated due to dead pool conditions. However, these results indicate that water supply ~~and water quality conditions~~ could be either under greater stress or under stress earlier in the year, and ~~salinity~~ EC levels at Emmaton and in the western Delta may increase as a result, leading to EC ~~water quality~~ degradation and increased possibility of ~~impacts~~ adverse effects to agricultural beneficial uses.

The percent of days the San Andreas Landing EC objective would be exceeded would increase from 1% to 3–~~4~~6%, depending on the operations scenario. The percent of days out of compliance with the EC objective for San Andreas Landing would increase from 1% to 5–~~7~~9%, depending on the operations scenario. Sensitivity analyses performed indicated that ~~removing monthly-daily patterning reduced the~~ many ~~number~~ of these exceedances ~~under all scenarios~~ are modeling artifacts, and the small number of remaining exceedances were small in magnitude, lasted only a few days, and could be addressed with real time operations of the SWP and CVP (see Section 8.3.1.1 for a description of real time operations of the SWP and CVP).

The percent of days the Prisoners Point EC objective would be exceeded for the entire period modeled would increase from 6% to 2~~0~~1–31% and the percent of days out of compliance with the EC objective would increase from 10% to 2~~2~~5–3~~1~~3%, depending on the operations scenario. At Jersey Point, the percent of days the EC fish and wildlife objective would be exceeded for the entire period modeled would increase from 0% to 0–2%, and the percent of days out of compliance with the EC objective would increase from 0% to 0–2%, depending on operations scenario. Sensitivity analyses conducted indicate that removing all tidal restoration areas would reduce the number of exceedances, but there would still be substantially more exceedances than under Existing Conditions or the No Action Alternative. Results of the sensitivity analyses indicate that the exceedances are partially a function of the operations of the ~~A~~alternative itself, perhaps due to Head of Old River Barrier assumptions and ~~S~~south Delta ~~E~~export differences (see Appendix ~~XX~~8H

Attachment 1 for more discussion of these sensitivity analyses). Appendix X8H Attachment 2 contains a more detailed assessment of the likelihood of these exceedances impacting aquatic life beneficial uses. Specifically, Appendix ~~X~~8H Attachment 2 discusses whether these exceedances might have indirect effects on striped bass spawning in the Delta, and concludes that the high level of uncertainty precludes making a definitive determination.

The increase in percent of days exceeding the EC objectives and days out of compliance at the Old River locations would be 1–2% at Tracy Bridge and less than 1% at Middle River for all operations scenarios. Sensitivity analyses performed indicated that ~~removing monthly-daily patterning~~many of these exceedances are modeling artifacts, and modeling barrier installation assumptions consistent with historical dry year practices of installing barriers earlier in the year could resolve these additional exceedances (see Appendix ~~XX~~8H Attachment 1 for a discussion of these sensitivity analyses). Furthermore, as noted in Section 8.1.3.7, SWP and CVP operations have relatively little influence on salinity levels at these locations, and the elevated salinity in south Delta channels is affected substantially by local salt contributions discharged into the San Joaquin River downstream of Vernalis. Thus, the modeling has limited ability to estimate salinity accurately in this region.

Average EC levels at the western and southern Delta compliance locations would decrease, except at Emmaton, from 1–36% for the entire period modeled and 2–33% during the drought period modeled (1987–1991) (Appendix 8H, Tables EC-15A through EC-15D). At Emmaton, there would be an increase in average EC under all operational scenarios, though the increase would be less for scenarios H3 and H4 (0% for entire period; 8% for drought period) than for scenarios H1 and H2 (13–14% for entire period; 12–13% for drought period). There would be increases in average EC at two interior Delta locations under all operational scenarios: the S. Fork Mokelumne River at Terminous average EC would increase 5% for the entire period modeled and 4% during the drought period modeled; and San Joaquin River at San Andreas Landing average EC would increase 0–9% for the entire period modeled and 7–13% during the drought period modeled. In addition, under Scenarios H1 and H2, there would be slight increase (<1–2%) in drought period average EC in the San Joaquin River at Prisoners Point. On average, EC would increase at San Andreas Landing from March through September under all operations scenarios; Scenarios H1, H2, and H4 also would increase EC at this location in February and Scenarios H1 and H2 would increase EC in October. Average EC in the S. Fork Mokelumne River at Terminous would increase during all months. Average EC at Jersey Point during the months of April–May, when the fish and wildlife objective applies in all but critical water year types, would increase from 14–15% for the entire period modeled (Appendix 8H, Tables EC-15A through EC-15D). The comparison to Existing Conditions reflects changes in EC due to both Alternative 4 operations (including north Delta intake capacity of 9,000 cfs and numerous other operational components of Scenarios H1–H4) and climate change/sea level rise.

Relative to the No Action Alternative, the percent of days exceeding EC objectives and percent of days out of compliance would increase at: Sacramento River at Emmaton, San Joaquin River at Jersey Point, San Andreas Landing, and Prisoners Point; and Old River near Middle River and at Tracy Bridge (Appendix 8H, Table EC-4). The increase in percent of days exceeding the EC objective would be ~~19~~20–30% at Prisoners Point, depending on the operations scenario, and 15~~3~~% or less at the remaining locations. The increase in percent of days out of compliance would be 2~~1~~4–3~~0~~2% at Prisoners Point, depending on the operations scenario, and 1~~6~~7% or less at the remaining locations. In general, the changes in frequency of exceedances of EC objectives ~~were similar~~ relative to the No Action Alternative would be similar to those ~~as~~ discussed above relative to Existing Conditions, and thus the conclusions of the sensitivity analyses discussed above extend to the comparison to the No Action Alternative. The exception to this is for Emmaton. As discussed above, assuming the compliance location at Emmaton instead of Threemile Slough in the CALSIM II modeling decreased the frequency of objective exceedances at Emmaton from 28% to 15% under Alternative 4, operations scenario H3 (see Appendix 8H Attachment 1 for more discussion of these sensitivity analyses). This frequency of objective exceedance ~~, which was still greater than under Existing Conditions, but~~ is very similar to the ~~13%~~ frequency of exceedances under the No Action Alternative, which would be 13%. Nevertheless, Table 2 of Appendix 8H Attachment 1 indicates that exceedances due to deadpool conditions in 1981 and 1990 occurred under Alternative 4 and not under the No Action Alternative. As discussed above, it is unlikely that the Emmaton objective would actually be ~~violated~~exceeded due to dead pool conditions. However, these results indicate that water supply ~~and water quality~~ conditions could be either under greater stress or under stress earlier in the year, and ~~salinity~~ EC levels at Emmaton and in the western Delta may increase as a result, leading to ~~water quality~~ EC degradation and increased possibility of ~~impacts~~ adverse effects to agricultural beneficial uses. The frequency and magnitude of increased ~~impacts~~EC levels relative to the No Action Alternative at Emmaton is lower than relative to ~~the~~ Existing Conditions, since climate change and sea level rise present in both the No Action Alternative and Alternative 4 contribute to the extreme hydrologic conditions in several years.

For the entire period modeled, average EC levels would increase at western (scenarios H1 and H2 only), interior, and southern Delta locations; the average EC increase would be 12–13% at Emmaton (western Delta; for scenarios H1 and H2 only), 5–15% at interior Delta locations and 2% or less at southern Delta locations, depending on the operations scenario (Appendix 8H, Tables EC-15A through EC-15D). During the drought period modeled, average EC would increase at western (scenarios H1 and H2 only), interior, and southern Delta locations. The greatest average EC increase during the drought period modeled would occur in the interior Delta in the San Joaquin River at San Andreas Landing (7–13% depending on the operations scenario); the increase at the other locations would be <1–9% (Appendix 8H, Tables EC-15A through EC-15D). The comparison to the No Action Alternative reflects changes in EC due only to the different operational components of Scenarios H1–H4 of Alternative 4.

For Suisun Marsh, October–May is the period when Bay-Delta WQCP EC objectives for protection of fish and wildlife apply. Modeling data indicate that ~~A~~average EC for the entire period modeled would increase in the Sacramento River at Collinsville during the months of March through May under all operations scenarios of Alternative 4, relative to Existing Conditions, by 0.3–0.9 mS/cm (Appendix 8H, Table EC-21). Long-term average EC would decrease under all operations scenarios, relative to Existing Conditions, in Montezuma Slough at National Steel during October–May (Appendix 8H, Table EC-22). The most substantial EC increase would occur near Beldon Landing, with long-term average EC levels increasing by 1.3–6.0 mS/cm, depending on the month and operations scenario, at least doubling during some months the long-term average EC relative to Existing Conditions (Appendix 8H, Table EC-23). Sunrise Duck Club and Volanti Slough also would have long-term average EC increases during all months ranging 0.5–3.9 mS/cm (Appendix 8H, Tables EC-24 and EC-25). Modeling ~~data for~~of Alternative 4 assumed no operation of the Montezuma Slough Salinity Control Gates, but the project description assumes continued operation of the Salinity Control Gates, consistent with assumptions included in the No Action Alternative. A sensitivity analysis modeling run conducted for Alternative 4 scenario H3 with the gates operational consistent with the No Action Alternative resulted in substantially lower EC levels than indicated in the original Alternative 4 modeling results discussed above, but EC ~~was~~ levels were still somewhat higher than EC levels under Existing Conditions and the No Action Alternative for several locations and months. Another modeling run with the gates operational and ~~removing~~ restoration areas removed resulted in EC levels nearly equivalent to Existing Conditions and the No Action Alternative, indicating that design and siting of restoration areas has notable bearing on EC levels at different locations within Suisun Marsh (see Appendix 8H Attachme~~m~~nt 1 for more information on these sensitivity analyses). These analyses also indicate that increases are related primarily to the hydrodynamic effects of CM4, not operational components of CM1. Based on the sensitivity analyses, optimizing ~~It is believed that~~ the design and siting of restoration areas ~~can be optimized to the degree that~~ may limit the magnitude of long-term EC increases~~, if any, would be small (i.e.,~~ to be on the order of 1 mS/cm or less~~)~~.

The degree to which the long-term average EC increases in Suisun Marsh would cause exceedance of Bay-Delta WQCP objectives is unknown, because these objectives are expressed as a monthly average of daily high tide EC, which does not have to be met if it can be demonstrated “equivalent or better protection will be provided at the location” (State Water Resources Control Board 2006:14). The ~~described~~ long-term average EC increase may, or may not, contribute to adverse effects on beneficial uses, depending on how and when wetlands are flooded, soil leaching cycles, and how agricultural use of water is managed, and future actions taken with respect to the marsh. However, the EC increases at certain locations ~~would~~ could be substantial, depending on siting and design of restoration areas, and it is uncertain the degree to which current management plans for the Suisun Marsh would be able to address these substantially higher EC levels and protect beneficial uses. Thus, these increased EC levels in Suisun Marsh are considered to have a potentially adverse effect on marsh beneficial uses. Long-term average EC increases in Suisun Marsh under Alternative 4, Scenarios H1–H4, relative to the No Action Alternative would be similar to the increases relative to Existing Conditions.

SWP/CVP Export Service Area

At the Banks and Jones pumping plants, Alternative 4, Scenarios H1–H4,would result in no exceedances of the Bay-Delta WQCP’s 1,000 µmhos/cm EC objective for the entire period modeled (Appendix 8H, Table EC-10). Thus, there would be no adverse effect on the beneficial uses in the SWP/CVP Export Service Areas using water pumped at this location under the Alternative 4.

At the Banks pumping plant, relative to Existing Conditions, average EC levels under Alternative 4, Scenarios H1–H4, would decrease 23–27% for the entire period modeled and 21–27% during the drought period modeled, depending on the operations scenario. Relative to the No Action Alternative, average EC levels would similarly decrease, by 17–22% for the entire period modeled and 16–22% during the drought period modeled. (Appendix 8H, Tables EC-15A through EC-15D)

At the Jones pumping plant, relative to Existing Conditions, average EC levels under Alternative 4, Scenarios H1–H4, would decrease 21–26% for the entire period modeled and 17–23% during the drought period modeled, depending on the operations scenario. Relative to the No Action Alternative, average EC levels would similarly decrease by 17–22% for the entire period modeled and 14–20% during the drought period modeled. (Appendix 8H, Table EC-~~13~~15A through EC-15D).

Based on the decreases in long-term average EC levels that would occur at the Banks and Jones pumping plants, Alternative 4, Scenarios H1–H4, would not cause degradation of water quality with respect to EC in the SWP/CVP Export Service Areas; rather, Alternative 4, Scenarios H1–H4, would improve long-term average EC conditions in the SWP/CVP Export Service Areas.

Commensurate with the EC decrease in exported waters, an improvement in lower San Joaquin River average EC levels would be expected since EC in the lower San Joaquin River is, in part, related to irrigation water deliveries from the Delta. While the magnitude of this expected lower San

Joaquin River improvement in EC is difficult to predict, the relative decrease in overall loading of EC-elevating constituents to the Export Service Areas would likely alleviate or lessen any expected increase in EC at Vernalis related to decreased annual average San Joaquin River flows.

The export area of the Delta is listed on the state's CWA Section 303(d) list as impaired due to elevated EC. Alternative 4, Scenarios H1–H4, would result in lower average EC levels relative to Existing Conditions and the No Action Alternative and, thus, would not contribute to additional beneficial use impairment related to elevated EC in the SWP/CVP Export Service Areas waters.

NEPA Effects: In summary, based on the results of the modeling and sensitivity analyses conducted, it is unlikely that there would be ~~the~~ increased frequency of exceedance of agricultural EC objectives in the western, interior, or southern Delta. ~~, or that~~ ~~and~~ However, modeling results indicates that there could be increased long-term and drought period average EC levels that would occur ~~at~~ in the western~~, interior, and southern~~ Delta ~~compliance locations~~ under Alternative 4, Scenarios H1–H4, relative to the No Action Alternative, that would contribute to adverse effects on the agricultural beneficial uses. ~~In addition, t~~The increased frequency of exceedance of the San Joaquin River at Prisoners Point EC objective and long-term and drought period average EC could contribute to adverse effects on fish and wildlife beneficial uses (specifically, indirect adverse effects on striped bass spawning), though there is a high degree of uncertainty associated with this impact. ~~Given that~~~~Although t~~The western and southern Delta are CWA section 303(d) listed as impaired due to elevated EC, and increases in long-term average and drought period average EC in ~~this~~the western portion of the Delta ~~generally did not result in substantial increases in the frequency of objective exceedances, indicating the increase in the incidence of exceedance of EC objectives and long-term average and drought period average EC in this portion of the Delta has the potential~~ ~~a low~~have the potential to contribute to additional beneficial use impairment. The increases in long-term average EC levels that ~~would~~ could occur in Suisun Marsh would further degrade existing EC levels and could contribute ~~additional~~ to adverse effects on the fish and wildlife beneficial uses. Suisun Marsh is CWA section 303(d) listed as impaired due to elevated EC, and the potential increases in long-term average EC levels could contribute to additional beneficial use impairment. The effects on EC in the western Delta, San Joaquin River at Prisoners Point, and in Suisun Marsh ~~These increases in EC~~ constitute an adverse effect on water quality. Mitigation Measure WQ-11 would be available to reduce these effects (implementation of this measure along with a separate, non-environmental commitment as set forth in EIR/EIS Appendix 3B, *Environmental Commitments*, relating to the potential EC-related changes would reduce these effects). Specifically, Mitigation Measure WQ-11d would be expected to reduce effects in Suisun Marsh to a level that would not be adverse.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

River flow rate and reservoir storage reductions that would occur under Alternative 4, Scenarios H1–H4, relative to Existing Conditions, would not be expected to result in a substantial adverse change in EC levels in the reservoirs and rivers upstream of the Delta, given that: changes in the quality of watershed runoff and reservoir inflows would not be expected to occur in the future; the state's aggressive regulation of point-source discharge effects on Delta salinity-elevating parameters and the expected further regulation as salt management plans are developed; the salt-related TMDLs adopted and being developed for the San Joaquin River; and the expected improvement in lower San Joaquin River average EC levels commensurate with the lower EC of the irrigation water deliveries from the Delta.

Relative to Existing Conditions, Alternative 4, Scenarios H1–H4, would not result in any substantial increases in long-term average EC levels in the SWP/CVP Export Service Areas. There would be no exceedance of the EC objective at the Jones and Banks pumping plants. Average EC levels for the entire period modeled would decrease at both plants and, thus, this alternative would not contribute to additional beneficial use impairment related to elevated EC in the SWP/CVP Export Service Areas waters. Rather, this alternative would improve long-term EC levels in the SWP/CVP Export Service Areas, relative to Existing Conditions.

In the Plan Area, Alternative 4, Scenarios H1–H4, would result in an increase in the frequency with which Bay-Delta WQCP EC objectives are exceeded for the entire period modeled (1976–1991) in~~):~~ ~~in the Sacramento River at Emmaton, (agricultural objective; 17~~21~~–19~~23~~% increase)~~ the~~and~~ San Joaquin River at Jersey Point ~~(fish and wildlife objective; 0–2% increase), in the western Delta, and in the San Joaquin River at San Andreas Landing (agricultural objective; 2–3~~5~~% increase)~~ and the San Joaquin River at Prisoners Point ~~(fish and wildlife objective; 14~~5~~–25% increase), both in the interior Delta; and in Old River near Middle River and at Tracy Bridge (agricultural objectives; up to 2% increase), both in the southern Delta.~~. Though objective exceedance would likely not occur in the Sacramento River at Emmaton, ~~A~~average EC levels at Emmaton would increase by <1–14% for the entire period modeled and 8–13% during the drought period modeled. ~~Together with the increase in frequency of exceedances of the objectives that would occur in the Sacramento River at Emmaton, Average EC levels at San Andreas Landing would increase by 0–9% during for the entire period modeled and 7–13% during the drought period modeled. Tt~~These increases in long-term and drought period average EC levels ~~and increased frequency of exceedance of EC objectives that would occur in the Sacramento River at Emmaton and San Joaquin River at San Andreas Landing~~ would potentially contribute to adverse effects on the agricultural beneficial uses in the western ~~and interior~~ Delta. The comparison to Existing Conditions reflects changes in EC due to both Alternative 4 operations and climate change/sea level rise. The adverse effects expected to occur at Emmaton ~~are~~ would be due in part to the effects of climate change/sea level rise, ~~not~~and in part due to Alternative 4 operations. This is evidenced by the significant effects expected in the No Action Alternative at Emmaton relative to Existing Conditions (see Section 8.3.3.1, Impact WQ-11), as well as the fact that ~~no~~a lesser level of adverse effects ~~are~~is expected at Emmaton under Alternative 4 relative to the No Action Alternative (see "NEPA Effects" section above). Based on the results of the modeling and sensitivity analyses conducted, it is unlikely that there would be increased frequency of exceedance of agricultural EC objectives in the interior or southern Delta, or that increased long-term and drought period average EC levels that would occur in these areas, relative to Existing Conditions, would contribute to adverse effects on the agricultural beneficial uses. ~~Further, t~~The increased frequency of exceedance of the fish and wildlife objective at Jersey Point and Prisoners Point could contribute to adverse effects on aquatic life (specifically, indirect adverse effects on striped bass spawning), though there is a high degree of uncertainty associated with this impact. Because EC is not bioaccumulative, the increases in long-term average EC levels would not directly cause bioaccumulative problems in aquatic life or humans. The western and southern Delta are CWA section 303(d) listed for elevated EC and the increased ~~frequency of exceedance of EC objectives that would~~EC ~~and water quality~~ degradation that could occur in the western Delta ~~these portions of the Delta~~ could make beneficial use impairment measurably worse. Since there ~~is~~ would be very little change in EC levels in the southern Delta and there is not expected to be an increase in frequency of exceedances of objectives, theis Aalternative is not expected to make beneficial use impairment measurably worse in the southern Delta. This impact is considered to be significant.

Further, relative to Existing Conditions, Alternative 4, Scenarios H1–H4, would could result in substantial increases in long-term average EC during the months of October through May in Suisun Marsh, such that EC levels would be double that relative to Existing Conditions. The increases in long-term average EC levels that would occur in Suisun Marsh could further degrade existing EC levels and thus contribute additionally to adverse effects on the fish and wildlife beneficial uses. Because EC is not bioaccumulative, the increases in long-term average EC levels would not directly cause bioaccumulative problems in fish and wildlife. Suisun Marsh is CWA section 303(d) listed for elevated EC and the increases in long-term average EC that would occur in the marsh could make beneficial use impairment measurably worse. This impact is considered to be significant. However, based on sensitivity analyses conducted to date (see Appendix 8H Attachment 1), it is expected that implementation of WQ-11d will be able to reduce impacts on EC in Suisun Marsh to a less than significant level.

Implementation of Mitigation Measure WQ-11 along with a separate, non-environmental commitment relating to the potential increased costs associated with EC-related changes would reduce these effects. Although it is not known whether implementation of WQ-11 will be able to feasibly reduce water quality degradation in the western Delta, implementation of Mitigation Measure WQ-11 is recommended to attempt to reduce the effect that increased EC may have on Delta beneficial uses. However, because the effectiveness of this mitigation measure to result in feasible measures for reducing these water quality effects is uncertain, this impact is considered to remain significant and unavoidable. As mentioned above, it is expected that implementation of WQ-11d will be able to reduce impacts on EC in Suisun Marsh to a less than significant level.

Implementation of Mitigation Measure WQ-11 along with a separate, non-environmental commitment relating to the potential increased costs associated with EC-related changes would reduce these effects. While mitigation measures to reduce these water quality effects in affected water bodies to less than significant levels are not available, implementation of Mitigation Measure WQ-11 is recommended to attempt to reduce the effect that increased EC concentrations may have on Delta beneficial uses.However, because the effectiveness of this mitigation measure to result in feasible measures for reducing water quality effects is uncertain, this impact is considered to remain significant and unavoidable.

In addition to and to supplement Mitigation Measure WQ-11, the BDCP proponents have incorporated into the BDCP, as set forth in EIR/EIS Appendix 3B, *Environmental Commitments*, a separate, non-environmental commitment to address the potential increased water treatment costs that could result from EC concentration effects on municipal, industrial and agricultural water purveyor operations. Potential options for making use of this financial commitment include funding or providing other assistance towards acquiring alternative water supplies or towards modifying existing operations when EC concentrations at a particular location reduce opportunities to operate existing water supply diversion facilities. Please refer to Appendix 3B, *Environmental Commitments*, for the full list of potential actions that could be taken pursuant to this commitment in order to reduce the water quality treatment costs associated with water quality effects relating to chloride, electrical conductivity, and bromide.

Mitigation Measure WQ-11: Avoid, Minimize, or Offset, as Feasible, Reduced Water Quality Conditions

~~It remains to be determined whether, or to what degree, the available and existing salinity response and countermeasure actions of SWP and CVP facilities, municipal water purveyors, or Suisun Marsh salinity control facilities would be capable of offsetting the actual level of changes in EC that may occur from implementation of Alternative 4. Therefore, i~~In order to ~~determine the feasibility of reducing~~ reduce the effects of increased EC levels, and potential adverse effects on beneficial uses associated with CM1 operations (and hydrodynamic effects of tidal restoration under CM4), the proposed mitigation requires a series of phased actions to identify and evaluate ~~existing and possible~~ feasible actions, followed by development and implementation of the actions, if determined to be necessary. ~~The phased actions for reducing EC levels and associated adverse effects on agricultural water supply also could mitigate adverse effects on fish and wildlife life.~~ The emphasis and mitigation actions would be limited to those identified as necessary to avoid, reduce, or offset adverse EC effects at Delta compliance locations and the Suisun Marsh. The development and implementation of any mitigation actions shall be focused on those incremental effects attributable to implementation of Alternative 4 operations only. Development of mitigation actions for the incremental EC effects attributable to climate change/sea level rise are not required because these changed conditions would occur with or without implementation of Alternative 4. The goal of specific actions would be to reduce/avoid additional exceedances of Delta EC objectives and reduce long-term average concentration increases to levels that would not adversely affect beneficial uses within the Delta and Suisun Marsh.

Mitigation Measure WQ-11a: Conduct Additional Evaluation of Operational Ability to Reduce or Eliminate Water Quality Degradation in Western Delta Incorporating Site-Specific Restoration Areas and Updated Climate Change/Sea Level Rise Projections, if Available

The BDCP proponents will conduct additional evaluations and develop additional modeling (as necessary) to define the extent to which modified operations of the SWP and CVP could reduce or eliminate water quality degradation in the western Delta currently modeled to occur under Alternative 4. The additional evaluations will be conducted to consider specifically the changes in Delta hydrodynamic conditions associated with tidal habitat restoration under CM4 once the specific restoration locations and timing of their construction are identified and designed. The evaluations will also consider up-to-date estimates of climate change and sea level rise, if and when such information is available. These evaluations will be conducted concurrently with Mitigation Measure WQ-11b. Together, findings from WQ-11a and WQ-11b will indicate whether sufficient flexibility to prevent or offset EC increases is feasible under Alternative 4. These actions are identical to the actions discussed in Mitigation Measure WQ-7a regarding levels of chloride in the western Delta.

Mitigation Measure WQ-11b: Site and Design Restoration Sites to Reduce or Eliminate Water Quality Degradation in the Western Delta

BDCP proponents shall consider effects of site-specific restoration areas proposed under CM4 on EC levels in the western Delta. Design and siting of restoration areas shall attempt to reduce water quality degradation in the western Delta to the extent possible without compromising proposed benefits of the restoration areas. These evaluations will be conducted concurrently with Mitigation Measure WQ-11a. Together, findings from WQ-11a and WQ-11b will indicate whether sufficient flexibility to prevent or offset EC increases is feasible under Alternative 4. These actions are identical to the actions discussed in Mitigation Measure WQ-7b regarding levels of chloride in the western Delta.

Mitigation Measure WQ-~~11a~~11c: Design Restoration Sites to Reduce Effects on Compliance with the Fish and Wildlife EC Objective between Prisoners Point and Jersey Point, Evaluate Striped Bass Monitoring Data, and Consult with CDFW/USFWS/NMFS to Determine Whether Additional Actions are Warranted~~Conduct Additional Evaluation and Modeling of Increased ECLevels Following Initial Operations of CM1~~

~~Following commencement of initial operations of CM1, the BDCP proponents will conduct additional evaluations described herein, and develop additional modeling (as necessary), to define the extent to which modified operations could reduce or eliminate the additional exceedances of the Bay-Delta WQCP objectives for EC currently modeled to occur under Alternative 4. The additional evaluations should also consider specifically the changes in Delta hydrodynamic conditions associated with tidal habitat restoration under CM4 (in particular the potential for increased EC concentrations that could result from increased tidal exchange) once the specific restoration locations are identified and designed.If sufficient operational flexibility to offset EC increases is not feasible under Alternative 4 operations, achieving EC reduction pursuant to this mitigation measure would not be feasible under this Alternative.~~BDCP proponents shall consider effects of site-specific restoration areas proposed under CM4 on compliance with the fish and wildlife EC objective between Jersey Point and Prisoners point on the San Joaquin River. Design of restoration areas shall attempt to reduce potential effects to the extent possible without compromising proposed benefits of the restoration areas. Additionally, following commencement of initial operations of CM1, the BDCP proponents will evaluate ongoing monitoring of striped bass populations, and, specifically spawning in the San Joaquin River between Jersey Point and Prisoners Point, and will conduct such monitoring if it is not already being conducted by CDFW at that time. The BDCP proponents will consult with CDFW, USFWS, and NMFS to determine whether adaptive changes to Head of Old River Barrier operations and/or changes in North Delta vs. South Delta exports are warranted to avoid adverse impacts of salinity on striped bass spawning in the San Joaquin River. Because these actions may have adverse effects on other species, consultation is required, and the changes may not be warranted depending on conditions of striped bass populations and populations of other species at that time.

Mitigation Measure WQ-~~11b~~11d: Site and Design Restoration Sites and consult with CDFW/USFWS, and Suisun Marsh Stakeholders to Identify Potential Actions to Avoid or Reduce EC Level Increases in the Marsh~~Consult with CDFW/USFWS, and Suisun MarshStakeholders, to Identify Potential Actions to Avoid or Minimize ECLevel Increases in the Marsh~~

BDCP proponents shall consider effects of site-specific restoration areas proposed under CM4 on EC levels and compliance with the fish and wildlife EC objectives for Suisun Marsh. Design and siting of restoration areas shall attempt to reduce potential effects to the extent possible without compromising proposed benefits of the restoration areas. ~~In order to determine the feasibility of reducing the effects of CM1/CM4 operations on increased EC concentrations as shown in modeling estimates to occur in the Suisun Marsh, the~~ BDCP proponents will also consult with CDFW/USFWS, and Suisun Marsh stakeholders, to identify potential actions to avoid or minimize the EC increases in the marsh, with the goal of maintaining EC at levels that would not further impair fish and wildlife beneficial uses in Suisun Marsh. Potential actions may include modifications of the existing Suisun Marsh Salinity Control Gates for effective salinity control and evaluation of the efficacy of additional physical salinity control facilities or operations for the marsh to reduce the effects of increased EC levels. These actions are identical to the actions discussed in Mitigation Measure WQ-7~~c~~d regarding levels of chloride in Suisun Marsh.~~Based on the modeled conditions, the emphasis would be identification of potentially feasibleactions to reduce adverse EC-related effects. Any such action will be developed following, and in conjunction with, the completion of the evaluation and development of any feasible actions described in Mitigation Measure WQ-11a.~~

Impact WQ-12: Effects on Electrical Conductivity Resulting from Implementation ofCM2–~~CM22~~CM21

***NEPA Effects*: **The implementation of the other conservation measures (i.e., CM2–~~CM22~~CM21) present no new direct sources of EC to the affected environment, including areas upstream of the Delta, within the Delta region, and in the SWP/CVP Export Service Areas. As they pertain to EC, implementation of these conservation measures would not be expected to adversely affect any of the beneficial uses of the affected environment. Moreover, some habitat restoration conservation measures would occur on lands within the Delta currently used for irrigated agriculture. Such replacement or substitution of land use activity is not expected to result in new or increased sources of EC to the Delta and, in fact, could decrease EC through elimination of high EC agricultural runoff.

CM4 would result in substantial tidal habitat restoration that would increase the magnitude of daily tidal water exchange at the restoration areas, and alter other hydrodynamic conditions in adjacent Delta channels. The DSM2 modeling included assumptions regarding possible locations of tidal habitat restoration areas, and how restoration would affect Delta hydrodynamic conditions, and thus the effects of this restoration measure on Delta EC were included in the assessment of CM1 facilities operations and maintenance.

Implementation of CM2–~~CM22~~CM21 would not be expected to adversely affect EC levels in the affected environment and thus would not adversely affect beneficial uses or substantially degrade water quality with regard to EC within the affected environment.

The effects on EC from implementing CM2–~~CM22~~CM21 is determined to not be adverse.

***CEQA Conclusion*: **Implementation of CM2–~~CM22~~CM21 under Alternative 4 would not present new or substantially changed sources of EC to the affected environment. Some conservation measures may replace or substitute for existing irrigated agriculture in the Delta. This replacement or substitution is not expected to substantially increase or present new sources of EC, and could actually decrease EC loads to Delta waters. Thus, implementation of CM2–~~CM22~~CM21 would have negligible, if any, adverse effects on EC levels throughout the affected environment and would not cause exceedance of applicable state or federal numeric or narrative water quality objectives/criteria that would result in adverse effects on any beneficial uses within affected water bodies. Further, implementation of CM2–~~CM22~~CM21would not cause significant long-term water quality degradation such that there would be greater risk of adverse effects on beneficial uses. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-13: Effects on Mercury Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Under the various Alternative 4 scenarios (H1–H4), greater water demands and climate change would alter the magnitude and timing of reservoir releases and river flows upstream of the Delta in the Sacramento River watershed and east-side tributaries, relative to Existing Conditions.

The Sacramento River at Freeport and San Joaquin River at Vernalis (as summarized for water quality average concentrations in Tables 8-48 and 8-49) were examined for flow/concentration relationships for mercury and methylmercury. No significant, predictive regression relationships were discovered for mercury or methylmercury, except for total mercury with flow at Freeport (monthly or annual) (Appendix 8I, Figure ~~8~~I-10 through ~~8~~I-13).Such a positive relationship between total mercury and flow is to be expected based on the association of mercury with suspended sediment and the mobilization of sediments during storm flows. However, the changes in flow in the Sacramento River under the operational scenarios of Alternative 4 relative to Existing Conditions and No Action Alternative are not of the magnitude of storm flows, in which substantial sediment-associated mercury is mobilized. Therefore mercury loading should not be substantially different due to changes in flow. In addition, even though it may be flow-affected, total mercury concentrations remain well below criteria at upstream locations. Any negligible changes in mercury concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies as related to mercury. Both waterborne methylmercury concentrations and largemouth bass fillet mercury concentrations are expected to remain above guidance levels at upstream of Delta locations, but will not change substantially relative to Existing Conditions or No Action Alternative due to changes in flows under the operational scenarios of Alternative 4.

The upstream of Delta areas in the north will benefit from the implementation of the Cache Creek, Sulfur Creek, Harley Gulch, and Clear Lake Mercury TMDLs and the American River methylmercury TMDL. These projects will target specific sources of mercury and methylation upstream of the Delta and could result in net improvement to Delta mercury loading in the future. The implementation of these projects could help to ensure that upstream of Delta environments will not be substantially degraded for water quality with respect to mercury or methylmercury.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of ~~CM2-22~~~~CM2 through CM22~~CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for ~~CM2-22~~~~CM2 through CM22~~CM2–CM21. See section 8.3.1.3 for more information.

The water quality impacts of waterborne concentrations of mercury (Appendix 8I, Table I-5) and methylmercury (Appendix 8I, Table I-6) and fish tissue mercury concentrations (Appendix 8I, Tables I-11A through I-11D) were evaluated for nine~~9~~ Delta locations.

The analysis of percentage change in assimilative capacity of waterborne total mercury of Alternative 4 scenarios as compared to Existing Conditions showed the greatest decrease to be of -2.4% in the Old River at Rock Slough and the Contra Costa Pumping Plant for scenario. These are bounded by Alternative 4 H1 estimates of -1.4% and -1.5% at these two locations, respectively. In contrast the greatest increase in assimilative capacity relative to Existing Conditions was 4.4% for H4 at the Jones Pumping Plant (Figures 8-53 through 8-54).Scenarios H2 and H3 range in changes in assimilative capacity in relation to Existing Conditions from -2.1% (H3 at Contra Costa Pumping Plant to 4.1 (H2 at Banks).These small changes in assimilative capacity are not expected to result in adverse (or positive) effects to beneficial uses.

As compared to the No Action Alternative, Alternative 4 H4 showed the greatest range in changes in assimilative capacity for total mercury; ranging from 5.0% at the Jones Pumping Plant to -2.3% at the Old River site. These same sites show the smallest range of effects for Alternative 4 H1; with 4.3% and -1.4% for these same two stations, respectively. Scenarios H2 and H3 fall between these extremes. However, these small ranges of changes are not expected to result in adverse effects to beneficial uses.

All methylmercury concentrations in water were estimated to exceed TMDL guidelines and no assimilative capacity exists. Changes in methylmercury concentration are expected to be very small. The greatest annual average methylmercury concentration for drought conditions was 0.163 ng/L for the San Joaquin River at Buckley Cove (all scenarios) which was slightly higher than Existing Conditions (0.161 ng/L) and slightly lower than the No Action Alternative (0.167 ng/L)() (Appendix 8I Table I-6). In general, the Alternative 4 H4 conditions were highest in concentration and Alternative 4 H1 was lowest, as compared among scenarios for modeled methylmercury concentrations in water. All modeled concentrations exceeded the methylmercury TMDL guidance objective of 0.06 ng/L, therefore percentage change in assimilative capacity was not evaluated for methylmercury.

Similar to waterborne methylmercury, fish tissue mercury concentration estimates all exceed TMDL guidelines. Percentage changes were somewhat larger than for waterborne concentrations, but not expected to result in changes to beneficial use. Fish tissue estimates show only small or no increases in EQs based on long-term annual average concentrations for mercury at the Delta locations (Appendix 8I, Table I-11Aa through I-11Db). The greatest increase over Existing Conditions was for scenario H4 and was 15% at Old River at Rock Slough and 13% for Franks Tract as compared to H1 estimates for both of those locations of 9% (Table 1-11 Ab – Db). In comparison to the No Action Alternative, the greatest increases in concentrations mirrored the Existing Condition comparisons and were estimated to be 12% for Old River at Rock Slough, and 12% for Franks Tract. Scenario H1 provided the lowest set of percent changes in bass mercury for those locations (Figure 8-558-55a,b, Appendix 8I, Tables I-11Aa through I-11Db). Because these increases are relatively small, and it is not evident that substantive increases are expected at numerous locations throughout the Delta, these changes are expected to be within the uncertainty inherent in the modeling approach, and would likely not be measurable in the environment. See Appendix 8I for a discussion of the uncertainty associated with the fish tissue estimates.

SWP/CVP Export Service Areas

The analysis of mercury and methylmercury in the SWP/CVP Export Service Areas was based on concentrations estimated at the Banks and Jones pumping plants. Both waterborne total and methylmercury concentrations for Alternative 4, all scenarios, at the Jones and Banks pumping plants, were lower than Existing Conditions and the No Action Alternative (Appendix 8I, Figures ~~8~~I-4 and ~~8~~I-5).Therefore, mercury shows an increased assimilative capacity at these locations (Figures 8-53 and 8-54).The greatest increase was 5% for scenario H4 for Jones Plant (compared to No Action); the least was H2 at Banks of 2.9% (compared to Existing Conditions).

The largest improvements in bass tissue mercury concentrations and EQs for Alternative 4, relative to Existing Conditions and the No Action Alternative at any location within the Delta are expected for the export pump locations. The greatest improvement in bass tissue mercury concentration are expected for scenario H4 at the Banks and Jones pumping plants (-14% and -16%, respectively) (Figure ~~8-55~~8-55a,b, Appendix 8I Table I-11Aa through I-11Db).

NEPA Effects: Based on the above discussion, the effects of mercury and methylmercury in comparison of Scenarios H1–H4 of Alternative 4 to the No Action Alternative (as waterborne and bioaccumulated forms) are not considered to be adverse.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Under Alternative 4, greater water demands and climate change would alter the magnitude and timing of reservoir releases and river flows upstream of the Delta in the Sacramento River watershed and east-side tributaries, relative to Existing Conditions. Concentrations of mercury and methylmercury upstream of the Delta will not be substantially different relative to Existing Conditions due to the lack of important relationships between mercury/methylmercury concentrations and flow for the major rivers.

Methylmercury concentrations exceed criteria at all locations in the Delta and no assimilative capacity exists. However, monthly average waterborne concentrations of total and methylmercury, over the period of record, are very similar to Existing Conditions. Similarly, estimates of fish tissue mercury concentrations show almost no differences would occur among sites for Alternative 4 scenarios as compared to Existing Conditions for Delta sites. The greatest changes in assimilative capacity and tissue mercury estimates were for scenario H4; these least for scenario H1.

Assessment of effects of mercury in the SWP and CVP Export Service Areas were based on effects on mercury concentrations and fish tissue mercury concentrations at the Banks and Jones pumping plants. The Banks and Jones pumping plants are expected to show increased assimilative capacity for waterborne mercury and decreased fish tissue concentrations of mercury for Alternative 4, all scenarios, as compared to Existing Conditions.

As such, none of the H1–H4 scenarios for this alternative are expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because mercury concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Because any increases in mercury or methylmercury concentrations are not likely to be measurable, changes in mercury concentrations or fish tissue mercury concentrations would not make any existing mercury-related impairment measurably worse. In comparison to Existing Conditions, Alternative 4 would not increase levels of mercury by frequency, magnitude, and geographic extent such that the affected environment would be expected to have measurably higher body burdens of mercury in aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish) or humans consuming those organisms. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-14: Effects on Mercury Concentrations Resulting from Implementation of~~CM2–22~~~~CM2 through CM22~~CM2–CM21

***NEPA Effects*:** Some habitat restoration activities under Alternative 4 would occur on lands in the Delta formerly used for irrigated agriculture. Tidal and other restoration proposed under Alternative 4 have the potential to increase water residence times and increase accumulation of organic sediments that are known to enhance methylmercury bioaccumulation in biota in the restored habitat. Therefore, increases in mercury methylation in the habitat restoration areas is possible but uncertain depending on the specific restoration design implemented at a particular Delta location. Models to estimate the potential for methylmercury formation in restored areas are not currently available. However, DSM2 modeling for Alternative 4 operations does incorporate assumptions for certain habitat restoration activities proposed under CM2 and CM4 (see Section 8.3.1.3) that result in changes to Delta hydrodynamics compared to the No Action Alternative. These modeled restoration assumptions provide some insight into potential hydrodynamic changes that could be expected related to implementing CM2 and CM4 and are considered in the evaluation of the potential for increased mercury and methylmercury concentrations under Alternative 4.

BDCP Conservation Measure 12 (CM12) addresses the potential for methylmercury bioaccumulation associated with restoration activities and acknowledges the uncertainties associated with mitigating or minimizing this potential effect. CM12 proposes project-specific mercury management plans for restoration actions that will incorporate relevant approaches recommended in Phase 1 Methylmercury TMDL control studies. Specific approaches recommended under CM12 that are intended to minimize or mitigate for potential increases in methylmercury bioaccumulation at future restoration sites include:

- Characterizing mercury, methylmercury, organic carbon, iron, and sulfate concentrations to better inform restoration design,
- Sequestering methylmercury at restoration sites using low intensity chemical dosing techniques,
- Minimizing microbial methylation associated with anoxic conditions by reducing the amount of organic material at a restoration site(this approach could limit the benefit of restoration areas by limiting the amount of carbon supplied by these areas to the Delta as a whole. In some cases, this would run directly counter to the goals and objectives of the BDCP. This approach should not be implemented in such a way that it reduces the benefits to the Delta ecosystem provided by restoration areas),
- Designing restoration sites to enhance photo degeneration that converts methylmercury into a biologically unavailable, inorganic form of mercury,
- Remediating restoration site soils with iron to reduce methylation in sulfide rich soils, and
- Considering capping mercury laden sediments, where feasible, to reduce methylation potential at a site.

Because of the uncertainties associated with site-specific estimates of methylmercury concentrations and the uncertainties in source modeling and tissue modeling, the effectiveness of methylmercury management proposed under CM12 to reduce methylmercury concentrations would need to be evaluated separately for each restoration effort, as part of design and implementation. Because of this uncertainty and the known potential for methylmercury creation in the Delta this potential effect of implementing CM2–~~CM22~~CM21 is considered adverse.

CEQA Conclusion: There would be no substantial, long-term increase in mercury or methylmercury concentrations or loads in the rivers and reservoirs upstream of the Delta or the waters exported to the CVP and SWP service areas due to implementation of CM2–~~CM22~~CM21 relative to Existing Conditions. However, in the Delta, uptake of mercury from water and/or methylation of inorganic mercury may increase to an unquantified degree as part of the creation of new, marshy, shallow, or organic-rich restoration areas. Methylmercury is 303(d)-listed within the affected environment, and therefore any potential measurable increase in methylmercury concentrations would make existing mercury-related impairment measurably worse. Because mercury is bioaccumulative, increases in water-borne mercury or methylmercury that could occur in some areas could bioaccumulate to somewhat greater levels in aquatic organisms and would, in turn, pose health risks to fish, wildlife, or humans. Design of restoration sites under Alternative 4 would be guided by CM12 which requires development of site-specific mercury management plans as restoration actions are implemented. The effectiveness of minimization and mitigation actions implemented according to the mercury management plans is not known at this time, although the potential to reduce methylmercury concentrations exists based on current research. Although the BDCP will implement CM12 with the goal to reduce this potential effect, the uncertainties related to site specific restoration conditions and the potential for increases in methylmercury concentrations in the Delta result in this potential impact being considered significant. No mitigation measures would be available until specific restoration actions are proposed. Therefore this programmatic impact is considered significant and unavoidable.

Impact WQ-15: Effects on Nitrate Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Although point sources of nitrate do exist upstream of the Delta in the Sacramento River watershed, nitrate levels in the major rivers (Sacramento, Feather, American) are low, generally due to ample dilution available in the rivers relative to the magnitude of the discharges. Furthermore, while many dischargers have already improved facilities to remove more nitrate, many others are likely to do so over the next few decades. Non-point sources of nitrate within the Sacramento watersheds are also relatively low, thus resulting in generally low nitrate-N concentrations in the reservoirs and rivers of the watershed. Furthermore, there is no correlation between historical water year average nitrate concentrations and water year average flow in the Sacramento River at Freeport (Nitrate Appendix 8J, Figure 1). Consequently, any modified reservoir operations and subsequent changes in river flows under various operational scenarios of Alternative 4, relative to Existing Conditions or the No Action Alternative, are expected to have negligible, if any, effects on average reservoir and river nitrate-N concentrations in the Sacramento River watershed upstream of the Delta.

In the San Joaquin River watershed, nitrate concentrations are higher than in the Sacramento watershed, owing to use of nitrate based fertilizers throughout the lower watershed. The correlation between historical water year average nitrate concentrations and water year average flow in the San

Joaquin River at Vernalis is a weak inverse relationship—that is, generally higher flows result in lower nitrate concentrations, while low flows result in higher nitrate concentrations (linear regression r^2=0.49, Nitrate Appendix 8J, Figure 2). Under Alternative 4, Scenarios H1–H4, modeling indicates that long-term annual average flows on the San Joaquin River would decrease by an estimated 6% relative to Existing Conditions, and would remain virtually the same relative to the No Action Alternative (Appendix 5A). Given these relatively small decreases in flows and the weak correlation between nitrate and flows in the San Joaquin River (see Nitrate Appendix 8J, Figure 2), it is expected that nitrate concentrations in the San Joaquin River would be minimally affected, if at all, by changes in flow rates under any operational scenario of Alternative 4.

Any negligible changes in nitrate-N concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regards to nitrate.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of ~~CM2-22~~~~CM2 through CM22~~CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for ~~CM2-22~~CM2 ~~through CM22~~CM2–CM21. See section 8.3.1.3 for more information.

Mixing calculations indicate that under Alternative 4 (including the different operational components of Scenarios H1–H4), relative to Existing Conditions and the No Action Alternative, nitrate concentrations throughout the Delta are anticipated to remain low (<1.4 mg/L-N) relative to adopted objectives (~~Nitrate~~Appendix 8J,*Nitrate,* Table 16, 17~~A/1~~A through 17D). Although changes at specific Delta locations and for specific months may be substantial on a relative basis, the absolute concentration of nitrate in Delta waters would remain low (<1.4 mg/L-N) in relation to the drinking water MCL of 10 mg/L-N, as well as all other thresholds identified in Table 8-50. Long-term average nitrate concentrations are anticipated to remain below 1 mg/L-N at all 11 assessment locations except the San Joaquin River at Buckley Cove, where long-term average concentrations would be somewhat above 1 mg/L-N. Nevertheless, at this location, long-term average nitrate concentration would be somewhat reduced under Alternative 4 relative to Existing Conditions, and slightly increased relative to the No Action Alternative. Regardless of operational scenario, no additional exceedances of the MCL are anticipated at any location under Alternative 4 (~~Nitrate~~ Appendix 8J,*Nitrate,*Table 16).

Use of assimilative capacity relative to the drinking water MCL of 10 mg/L-N under the four operational scenarios of Alternative 4 is low or negligible (i.e., <5%) in comparison to both Existing Conditions and the No Action Alternative, for all locations and months, for all modeled years, and for the drought period (~~Nitrate~~Appendix 8J,*Nitrate,*Table 18~~A/1~~A through 18D). One exception is for Buckley Cove on the San Joaquin River in August, where use of assimilative capacity available during the drought period (1987–1991) relative to the No Action Alternative for the four operational scenarios of Alternative 4 ranged from 6.3% to 6.5%.

Nitrate concentrations will likely be higher than the modeling results indicate in certain locations. This includes in the Sacramento River between Freeport and Mallard Island and other areas in the

Delta downstream of Freeport that are influenced by Sacramento River water. These increases are associated with ammonia and nitrate that are discharged from the SRWTP, which are not included in the modeling.

- Under Existing Conditions, most of the ammonia discharged from the SRWTP is converted to nitrate downstream of the facility's discharge at Freeport, and thus, nitrate concentrations under Existing Conditions in these areas are expected to be higher than the modeling predicts, the increase becoming greater with increasing distance downstream. However, the increase in nitrate concentrations downstream of the SRWTP is expected to be small—the existing increase appears to be from approximately 0.1 mg/L-N to approximately 0.4–0.5 mg/L-N over this reach, due to approximately a 1:1 conversion of ammonia-N to nitrate-N (Central Valley Water Board 2010a:32).
- Under the four operational scenarios of Alternative 4, the planned upgrades to the SRWTP, which include nitrification/partial denitrification, would substantially decrease ammonia concentrations in the discharge, but would increase nitrate concentrations in the discharge up to 10 mg/L-N, which is substantially higher than under Existing Conditions.
- Overall, under the four operational scenarios of Alternative 4, the nitrogen load from the SRWTP discharge is expected to decrease (by up to 50%), relative to Existing Conditions, due to nitrification/partial dentrification ugrades at the SRWTP facility. Thus, while concentrations of nitrate downstream of the facility are expected to be higher than modeling results indicate for both Existing Conditions and the four operational scenarios of Alternative 4, the increase is expected to be greater under Existing Conditions than for the four operational scenarios of Alternative 4 due to the upgrades that are assumed under the four operational scenarios of Alternative 4.

The other areas in which nitrate concentrations will be higher than the modeling results indicate are immediately downstream of other wastewater treatment plants that practice nitrification, but not denitrification (e.g., City of Rio Vista Beach WWTF, Town of Discovery Bay WWTF, City of Stockton RWCF).For all such facilities in the Delta, the Regional Water Boards have issued NPDES permits that allow discharge of wastewater containing nitrate into the Delta, and under these permits, the State has determined that no beneficial uses are adversely affected by the discharge, and that the discharger's use of available assimilative capacity of the water body is acceptable. When dilution is necessary in order for the discharge to be in compliance with the Basin Plans (which incorporate the 10 mg/L-N MCL by reference), not all of the assimilative capacity of the receiving water is granted to the discharger. Thus, limited decreases in flows are not anticipated to result in systemic exceedances of the MCLs by these POTWs. Furthermore, NPDES permits are renewed on a 5-year basis, and thus, if under changes in flows, dilution was no longer sufficient to maintain nitrate below the MCL in the receiving water, the NPDES permit renewal process would address such cases.

In summary, any increases in nitrate-N concentrations that may occur at certain locations within the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to nitrate.

SWP/CVP Export Service Areas

Assessment of effects of nitrate in the SWP and CVP Export Service Areas is based on effects on nitrate-N at the Banks and Jones pumping plants.

Results of the mixing calculations indicate that the change in nitrate concentrations and use of assimilative capacity are similar for the four operational scenarios of Alternative 4 (~~Nitrate~~Appendix 8J, *Nitrate*, Tables 16, 17~~A/1~~A through 17D, 18~~A/1~~A through 18D). Relative to Existing Conditions and the No Action Alternative, nitrate concentrations at Banks and Jones pumping plants under Alternative 4 are anticipated to decrease on a long-term average annual basis ~~(Nitrate Appendix 8J,~~(Appendix 8J, *Nitrate*, Tables 17~~A/1~~A through 17D). During the late summer, particularly in the drought period assessed, concentrations are expected to increase substantially on a relative basis (i.e., >50%), but the absolute value of these changes (i.e., in mg/L-N) is small. Additionally, given the many factors that contribute to potential algal blooms in the SWP and CVP canals within the Export Service Area, and the lack of studies that have shown a direct relationship between nutrient concentrations in the canals and reservoirs and problematic algal blooms in these water bodies, there is no basis to conclude that these small (i.e., generally <0.3 mg/L-N), seasonal increases in nitrate concentrations would increase the potential for problem algal blooms in the SWP and CVP Export Service Area. No additional exceedances of the MCL are anticipated ~~(Nitrate Appendix 8J,~~(Appendix 8J, *Nitrate*, Table 16). On a monthly average basis and on a long term annual average basis, for all modeled years and for the drought period (1987–1991) only, use of assimilative capacity available under Existing Conditions and the No Action Alternative, relative to the 10 mg/L-N MCL, was negligible (<5%) for both Banks and Jones pumping plants ~~(Nitrate Appendix 8J,~~(Appendix 8J, *Nitrate*, Table 18~~A/1~~A through 18D).

Any increases in nitrate-N concentrations that may occur in water exported via Banks and Jones pumping plants are not expected to result in adverse effects to beneficial uses or substantially degrade the quality of exported water, with regards to nitrate.

NEPA Effects: In summary, based on the discussion above, the effects on nitrate from implementing CM1 are considered to be not adverse.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Nitrate-N concentrations are generally low in the reservoirs and rivers of the watersheds, owing to substantial dilution available for point sources and the lack of substantial nonpoint sources of nitrate-N upstream of the SRWTP in the Sacramento River watershed, and in the watersheds of the eastern tributaries (Cosumnes, Mokelumne, and Calaveras Rivers).Although higher in the San Joaquin River watershed, nitrate-N concentrations are not well-correlated with flow rates. Consequently, any modified reservoir operations and subsequent changes in river flows under Alternative 4, relative to Existing Conditions, are expected to have negligible, if any, effects on reservoir and river nitrate-N concentrations upstream of Freeport in the Sacramento River watershed and upstream of the Delta in the San Joaquin River watershed.

In the Delta, results of the mixing calculations indicate that under the four operational scenarios of Alternative 4 (H1 through H4), relative to Existing Conditions, nitrate concentrations throughout the Delta are anticipated to remain low (<1.4 mg/L-N) relative to adopted objectives. No additional exceedances of the MCL are anticipated at any location, and use of assimilative capacity available under Existing Conditions, relative to the drinking water MCL of 10 mg/L-N, was low or negligible (i.e., <5%) for all operational scenarios for virtually all locations and months.

Assessment of effects of nitrate in the SWP and CVP Export Service Areas is based on effects on nitrate-N concentrations at the Banks and Jones pumping plants. Results of the mixing calculations indicate that under Alternative 4 (including the different operational components of Scenarios H1–H4), relative to Existing Conditions, long-term average nitrate concentrations at Banks and Jones pumping plants are anticipated to change negligibly. No additional exceedances of the MCL are anticipated, and use of assimilative capacity available under Existing Conditions, relative to the MCL was negligible (i.e., <5%) for both Banks and Jones pumping plants for all months.

Based on the above, there would be no substantial, long-term increase in nitrate-N concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the waters exported to the CVP and SWP service areas under Alternative 4 relative to Existing Conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because nitrate concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Nitrate is not 303(d) listed within the affected environment and thus any increases that may occur in some areas and months would not make any existing nitrate-related impairment measurably worse because no such impairments currently exist. Because nitrate is not bioaccumulative, increases that may occur in some areas and months would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-16: Effects on Nitrate Concentrations Resulting from Implementation ofCM2–~~CM22~~CM21

NEPA Effects: Some habitat restoration activities included in CM2–CM11 would occur on lands within the Delta formerly used for agriculture. It is expected that this will decrease nitrate concentrations in the Delta, due to less use of nitrate-based fertilizers, relative to the No Action Alternative. Modeling scenarios included assumptions regarding how certain habitat restoration activities (i.e., CM2 and CM4) would affect Delta hydrodynamics, and thus such effects of these restoration measures were included in the assessment of CM1 facilities operations and maintenance (see Impact WQ-1). In general, aside from changes in Delta hydrodynamics resulting from habitat restoration discussed in Impact WQ-1, CM2–CM11 proposed for Alternative 4 are not expected to increase nitrate concentrations in water bodies of the affected environment, relative to the No Action Alternative.

Because urban stormwater is a source of nitrate in the affected environment, CM19, Urban Stormwater Treatment, is expected to slightly reduce nitrate loading to the Delta, thus slightly decreasing nitrate-N concentrations relative to the No Action Alternative. Implementation of CM12–CM18 and CM20–~~CM22~~CM21is not expected to substantially alter nitrate concentrations in any of the water bodies of the affected environment.

The effects on nitrate from implementing ~~CM2–22CM2 through CM22~~CM2–CM21 are considered to be not adverse.

CEQA Conclusion: There would be no substantial, long-term increase in nitrate-N concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the waters exported to the CVP and SWP service areas due to implementation of CM2–~~CM22~~CM21 under Alternative 4, Scenarios H1–H4, relative to Existing Conditions. Because urban stormwater is a source of nitrate in the affected environment, CM19, Urban Stormwater Treatment, is expected to slightly reduce nitrate loading to the Delta. As such, implementation of these conservation measures is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because nitrate concentrations are not expected to increase substantially due to these conservation measures, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Nitrate is not 303(d) listed within the affected environment and thus any minor increases that may occur in some areas would not make any existing nitrate-related impairment measurably worse because no such impairments currently exist. Because nitrate is not bioaccumulative, minor increases that may occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-17: Effects on Dissolved Organic Carbon Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Under Alternative 4, Scenarios H1–H4, there would be no substantial change to the sources of DOC within the watersheds upstream of the Delta. Moreover, long-term average flow and DOC levels in the Sacramento River at Hood and San Joaquin River at Vernalis are poorly correlated. Thus changes in system operations and resulting reservoir storage levels and river flows under the various operational scenarios of Alternative 4 would not be expected to cause a substantial long-term change in DOC concentrations in the water bodies upstream of the Delta. Any negligible changes in DOC levels in water bodies upstream of the Delta under Scenarios H1–H4 of Alternative 4, relative to Existing Conditions and the No Action Alternative, would not be of sufficient frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regards to DOC.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of ~~CM2-22~~~~CM2 through CM22~~CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for ~~CM2-22~~~~CM2 through CM22~~CM2–CM21. See section 8.3.1.3 for more information.

Under the four operational scenarios of Alternative 4, the geographic extent of effects pertaining to long-term average DOC concentrations in the Delta would be similar to that previously described for Alternative 1A, although the magnitude of predicted long-term change and relative frequency of concentration threshold exceedances would be slightly greater. For all the operational scenarios relative to Existing Conditions, the modeled effects would be greatest at Franks Tract, Rock Slough, and Contra Costa PP No. 1.Increased long-term average DOC concentrations at these locations would be greatest under Scenario H4 and would be least under Scenario H1, although differences would be generally small between operational scenarios (i.e., ≤0.2 mg/L).Under Scenario H4, long-term average DOC concentrations for the modeled 16-year hydrologic period and the modeled drought period would be predicted to increase between 0.4–0.5 mg/L at Franks Tract, Rock Slough, and Contra Costa PP No. 1 (≤14% net increase) (Appendix 8K, *Organic Carbon,* DOC Table 5). Under Scenario H4, increases in long-term average concentrations of between 0.4–0.5 mg/L at Franks Tract, Rock Slough, and Contra Costa PP No. 1would correspond to more frequent concentration threshold exceedances, with the greatest change occurring at Rock Slough and Contra Costa PP No. 1 locations. For Rock Slough, long-term average DOC concentrations exceeding 3 mg/L would increase from 52% under Existing Conditions to 76% under Scenario H4 of Alternative 4 (an increase from 47% to 67% for the drought period), and concentrations exceeding 4 mg/L would increase from 30% to 38% (32% to 38% for the drought period). For Contra Costa PP No. 1, long-term average DOC concentrations exceeding 3 mg/L would increase from 52% under Existing Conditions to 81% under Scenario H4 of Alternative 4 (45% to 78% for the drought period), and concentrations exceeding 4 mg/L would increase from 32% to 45% (35% to 47% for the drought period). Relative change in frequency of threshold exceedance for the other operational scenarios and at other assessment locations would be similar or less. While all of the operational scenarios of Alternative 4 would generally lead to slightly higher long-term average DOC concentrations (≤0.5 mg/L) at some municipal water intakes and Delta interior locations, the predicted change would not be expected to adversely affect MUN beneficial uses, or any other beneficial use. This comparison to Existing Conditions reflects changes in DOC due to both Alternative 4 operations (including north Delta intake capacity of 9,000 cfs and the different operational components of Scenarios H1–H4) and climate change/sea level rise.

In comparison, relative to the No Action Alternative, the operational scenarios of Alternative 4 would generally result in a similar magnitude of change to that discussed for the Alternative 4 operational scenario comparison to Existing Conditions. Scenario H4 would generally lead to the largest model predicted long-term average DOC concentration increases, and Scenario H1 would generally lead to the smallest model predicted increases, although the relative difference between operational scenarios would be small (i.e., ≤0.2 mg/L).Under Scenario H4, maximum increases of 0.3–0.4 mg/L DOC (i.e., ≤12%) would be predicted at Franks Tract, Rock Slough, and Contra Costa PP No. 1 relative to No Action Alternative(Appendix 8K,*Organic Carbon,* DOC Table 5). For the operational scenarios, threshold concentration exceedance frequency trends would also be similar to that discussed for the existing condition comparison, with exception to the drought period predicted 4 mg/L exceedance frequency at Buckley Cove. In comparison to the No Action Alternative, and regardless of operational scenario, the frequency which long-term average DOC concentrations exceeded 4 mg/L during the modeled drought period at Buckley Cove would increase from 42% to 50%. While the operational scenarios of Alternative 4 would generally lead to slightly higher long-term average DOC concentrations at some Delta assessment locations when compared to No Action Alternative conditions, the predicted change would not be expected to adversely affect MUN beneficial uses, or any other beneficial use, particularly when considering the relatively small change in long-term annual average concentration. Unlike the comparison to Existing Conditions, this comparison to the No Action Alternative reflects changes in DOC due only to the different operational components of Scenarios H1–H4 of Alternative 4.

As discussed for Alternative 1A, substantial change in ambient DOC concentrations would need to occur before significant changes in drinking water treatment plant design or operations are triggered. The increases in long-term average DOC concentrations estimated to occur at various Delta locations under the four alternative operational scenarios of Alternative 4 are of sufficiently small magnitude that they would not require existing drinking water treatment plants to substantially upgrade treatment for DOC removal above levels currently employed.

Relative to existing and No Action Alternative conditions, Alternative 4 would lead to predicted improvements in long-term average DOC concentrations at Barker Slough, as well as Banks and Jones pumping plants (discussed below). At Barker Slough, long-term average DOC concentrations would be predicted to decrease by as much as 0.1–0.2 mg/L, depending on operational scenario, baseline conditions comparison and modeling period.

SWP/CVP Export Service Areas

Under all operational scenarios of Alternative 4, relative to Existing Conditions and the No Action Alternative, modeled long-term average DOC concentrations would decrease at Banks and Jones pumping plants. Modeled decreases would be greatest under Scenarios H2 and H4.Relative to Existing Conditions, long-term average DOC concentrations at Banks under Scenarios H2 and H4 would be predicted to decrease by 0.4 mg/L (0.4 mg/L during drought period) (Appendix 8K, *Organic Carbon,* DOC Table 5). At Jones, long-term average DOC concentrations would be predicted to decrease by 0.4 mg/L (<0.1 mg/L during drought period). Under all the operational scenarios, decreases in long-term average DOC would result in generally lower exceedance frequencies for concentration thresholds, although the frequency of exceedance during the modeled drought period (i.e., 1987–1991) in particular would be predicted to increase. For the Banks pumping plant during the drought period, exceedance of the 3 mg/L threshold would increase from 57% under Existing Conditions to as much as 83% under Scenario H3, and exceedance of the 4 mg/L concentration threshold would increase slightly for only Scenarios H1 and H3 from 42% to as much as 45%. At the Jones pumping plant, exceedance of the 3 mg/L concentration threshold during the drought period would increase from 72% under Existing Conditions to as much as 93% under Scenario H1, and exceedance of the 4 mg/L threshold would increase slightly for all operational scenarios, from 35% to as much as 41% for Scenario H4. Comparisons to the No Action Alternative yield similar trends, but with slightly smaller magnitude drought period changes. Overall, modeling results for the SWP/CVP Export Service Areas predict an overall improvement in Export Service Areas water quality, although more frequent exports of >3mg/L DOC water would likely occur for drought periods.

Similar to the discussion pertaining to the No Action Alternative, maintenance of SWP and CVP facilities under Scenarios H1–H4 of Alternative 4 would not be expected to create new sources of DOC or contribute towards a substantial change in existing sources of DOC in the affected area. Maintenance activities would not be expected to cause any substantial change in long-term average DOC concentrations such that MUN beneficial uses, or any other beneficial use, would be adversely affected.

***NEPA Effects*:** In summary, the operations and maintenance activities under Scenarios H1–H4 of Alternative 4, relative to the No Action Alternative, would not cause a substantial long-term change in DOC concentrations in the water bodies upstream of the Delta. Depending on operational scenario, long-term average DOC concentrations at Banks and Jones pumping plants are predicted to decrease by as much as 0.5 mg/L, while long-term average DOC concentrations for some Delta interior locations, including Contra Costa PP #1, are predicted to increase by as much as 0.4 mg/L. Regardless of operational scenario, the increase in long-term average DOC concentration that could occur within the Delta interior would not be of sufficient magnitude to adversely affect the MUN beneficial use, or any other beneficial uses, of Delta waters. The effect of operations and maintenance activities on DOC under Scenarios H1–H4 of Alternative 4 is determined not to be adverse.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

While greater water demands under the operational scenarios of Alternative 4 would alter the magnitude and timing of reservoir releases north, south and east of the Delta, these activities would have no substantial effect on the various watershed sources of DOC. Moreover, long-term average flow and DOC at Sacramento River at Hood and San Joaquin River at Vernalis are poorly correlated; therefore, changes in river flows would not be expected to cause a substantial long-term change in DOC concentrations upstream of the Delta.

Relative to Existing Conditions, the operational scenarios of Alternative 4 would result in relatively small increases(i.e., ≤14%) in long-term average DOC concentrations at some Delta interior locations, including Franks Tract, Rock Slough, and Contra Costa PP No. 1.These increases would be greatest for Scenario H4, and least for Scenarios H1, although the difference in change would be relatively small. The predicted increases under the operational scenarios modeled would not substantially increase the frequency with which long-term average DOC concentrations exceeds 2, 3, or 4 mg/L. While Scenarios H1–H4 would generally lead to slightly higher long-term average DOC concentrations (≤0.2–0.5 mg/L) within the Delta interior and some municipal water intakes, the predicted change would not be expected to adversely affect MUN beneficial uses, or any other beneficial use.

The assessment of Alternative 4 Scenario H1–H4 effects on DOC in the SWP/CVP Export Service Areas is based on assessment of changes in DOC concentrations at Banks and Jones pumping plants. Relative decreases in long-term average DOC concentrations would be greatest under Scenarios H2 and H4, where long-predicted concentrations would decrease as much as 0.4 mg/L at Banks and Jones pumping plants. Regardless of operational scenario, however, slightly more frequent export of >3 mg/L DOC water is predicted during the drought period. Nevertheless, under any operational scenario, an overall improvement in DOC-related water quality would be predicted in the SWP/CVP Export Service Areas.

Based on the above, the operations and maintenance activities of Scenarios H1–H4 of Alternative 4 would not result in any substantial change in long-term average DOC concentration upstream of the Delta or result in substantial increase in the frequency with which long-term average DOC concentrations exceeds 2, 3, or 4 mg/L levels at the 11 assessment locations analyzed for the Delta. Increases in long-term average DOC concentrations at some Delta interior locations, including Franks Tract, Rock Slough, and Contra Costa PP No. 1 would be predicted, with the greatest increases occurring under Scenario H4 and the smallest increase occurring under Scenario H1.Under Scenario H4, modeled long-term average DOC concentrations would increase by no more than 0.5 mg/L at any single Delta assessment location (i.e., ≤14% relative increase) while under Scenario H1, modeled long-term DOC concentrations would increase by no more than 0.3 mg/L at any single Delta assessment location (i.e., ≤9% relative increase). For all operational scenarios considered, the increases in long-term average DOC concentration that could occur within the Delta would not be of sufficient magnitude to adversely affect the MUN beneficial use, or any other beneficial uses, of Delta waters or waters of the SWP/CVP Service Area. Because DOC is not bioaccumulative, the increases in long-term average DOC concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Finally, DOC is not causing beneficial use impairments and thus is not 303(d) listed for any water body within the affected environment. Thus, the increases in long-term average DOC that could occur at various locations would not make any beneficial use impairment measurably worse. Because long-term average DOC concentrations are not expected to increase substantially, no long-term water quality degradation with respect to DOC is expected to occur and, thus, no adverse effects on beneficial uses would occur This impact is considered to be less than significant. No mitigation is required.

Impact WQ-18: Effects on Dissolved Organic Carbon Concentrations Resulting from Implementation ofCM2–~~CM22~~CM21

NEPA Effects: The mostly non-land disturbing CM12–~~CM22~~CM21 present no new sources of DOC to the affected environment, including areas Upstream of the Delta, within the Plan Area, and the SWP/CVP Export Service Area. Implementation of methylmercury control measures (CM12) and urban stormwater treatment measures (CM19) may result in beneficial effects, to the extent that control measures treat or reduce organic carbon loading from tidal wetlands and urban land uses. Control of nonnative aquatic vegetation (CM13) may include killing mature aquatic vegetation in place, leading to their decay and contribution to DOC in Delta channels. However, this measure is not expected to be a significant source of long-term DOC loading as vegetation control would be sporadic and on an as needed basis, with decreasing need for treatments in the long-term as nonnative vegetation is eventually controlled and managed. Implementation of CM12–~~CM22~~CM21 would not be expected to have substantial, if even measurable, effect on DOC concentrations upstream of the Delta, within the Delta, and in the SWP/CVP service areas. Consequently, any negligible increases in DOC levels in these areas of the affected environment are not expected to be of sufficient frequency, magnitude and geographic extent that they would adversely affect the MUN beneficial use, or any other beneficial uses, of the affected environment, nor would potential increases substantially degrade water quality with regards to DOC.

For CM2–CM11, effects on DOC concentrations can generally be considered in terms of: (1) alternative-caused change in Delta hydrodynamics, and (2) alternative-caused change in Delta DOC sources. Change in Delta hydrodynamics involves a two part process, including the conveyance facilities and operational scenarios of CM1, as well as the change in Delta channel geometry and open water areas that would occur as a consequence of implementing tidal wetland restoration measures such as that described for CM4. Modeling scenarios included assumptions regarding how these habitat restoration activities would affect Delta hydrodynamics, and thus the effects of these restoration measures, via their effects on delta hydrodynamics, were included in the assessment of CM1 facilities operations and maintenance (see Impact WQ-17). The potential for these same conservation measures to change Delta DOC sources are addressed below.

CM2, CM3, CM8, CM9, and CM11 could include activities that would target increasing primary production (i.e., algae growth) within the Delta. Algae currently are not estimated to be a major source of DOC in the Delta (CALFED Bay-Delta Program 2008a: 4, 6), and comprise mostly the particulate fraction of TOC. Conventional drinking water treatment removes much of the POC from raw source water; therefore, conservation measure activities targeted at increased algae production are not expected to contribute substantial amounts of new DOC, or adversely affect MUN beneficial use, or any other beneficial uses, of the affected environment.

CM4–CM7 and CM10 include land disturbing restoration activities known to be sources of DOC. Research within the Delta has focused primarily on non-tidal wetlands and flooding of Delta island peat soils. The dynamics of DOC production and export from wetlands and seasonally flooded soils is complex, as well as highly site and circumstance specific. Age and configuration of a wetland significantly affects the amount of DOC that may be generated in a wetland. In a study of a permanently flooded non-tidal constructed wetland on Twitchell Island, initial DOC loading was determined to be much greater (i.e., approximately 10 times greater) than equivalent area of agricultural land, but trends in annual loading led researchers to estimate that loading from the wetland would be equivalent to that of agriculture within about 15 years (Fleck et. al. 2007: 18). It was observed that the majority of the wetland load originated from seepage through peat soils. Trends in declining load were principally associated with flushing of mobile DOC from submerged soils, the origins of which were related to previous agricultural activity prior to restoration to wetland. Peaks in annual loading, however, would be different, where peaks in agricultural drainage occur in winter months while peaks in wetland loading occur in spring and summer months. As such, age, configuration, location, operation, and season all factor into DOC loading, and long-term average DOC concentrations in the Delta.

Available evidence suggests that restoration activities establishing new tidal and non-tidal wetlands, new riparian and new seasonal floodplain habitat could potentially lead to new substantial sources of localized DOC loading within the Delta. If established in areas presently used for agriculture, these restoration activities could result in a substitution and temporary increase in localized DOC loading for years. Presently, the specific design, operational criteria, and location of these activities are not well established. Depending on localized hydrodynamics, such restoration activities could contribute substantial amounts of DOC to municipal raw water if established near municipal intakes. Substantially increased DOC concentrations in municipal source water may create a need for existing drinking water treatment plants to upgrade treatment systems in order to achieve EPA Stage 1 Disinfectants and Disinfection Byproduct Rule action thresholds. While treatment technologies sufficient to achieve the necessary DOC removals exist, implementation of such technologies would likely require substantial investment in new or modified infrastructure.

In summary, the habitat restoration elements of CM4–CM7 and CM10 under Alternative 4 would present new localized sources of DOC to the study area, and in some circumstances would substitute for existing sources related to replaced agriculture. Depending on localized hydrodynamics and proximity to municipal drinking water intakes, such restoration activities could contribute substantial amounts of DOC to municipal raw water. Substantial increases in municipal raw water DOC could necessitate changes in water treatment plant operations or require treatment plant upgrades in order to maintain DBP compliance, and thus would constitute an adverse effect on water quality. Mitigation Measure WQ-18 is available to reduce these effects.

CEQA Conclusion: Implementation of CM2, CM3, CM8,CM9, and CM11–~~CM22~~CM21 would not present new or substantially changed sources of organic carbon to the affected environment of the Delta, and thus would not contribute substantially to changes in long-term average DOC concentrations in the Delta. Therefore, related long-term water quality degradation would not be expected to occur and, thus, no adverse effects on beneficial uses would occur through implementation of CM2, CM3, CM8,CM9, and CM11–~~CM22~~CM21. Furthermore, DOC is not bioaccumulative, therefore changes in DOC concentrations would not cause bioaccumulative problems in aquatic life or humans. Nevertheless, implementation of CM4–CM7 and 10 would present new localized sources of DOC to the study area, and in some circumstances would substitute for existing sources related to replaced agriculture. Depending on localized hydrodynamics and proximity to municipal drinking water intakes, such restoration activities could contribute substantial amounts of DOC to municipal raw water. The potential for substantial increases in long-term average DOC concentrations related to the habitat restoration elements of CM4–CM7 and 10 could contribute to long-term water quality degradation with respect to DOC and, thus, adversely affect MUN beneficial uses. The impact is considered to be significant and mitigation is required. It is uncertain whether implementation of Mitigation Measure WQ-18 would reduce identified impacts to a less-than-significant level. Hence, this impact remains significant and unavoidable.

In addition to and to supplement Mitigation Measure WQ-18, the BDCP proponents have incorporated into the BDCP, as set forth in EIR/EIS Appendix 3B, *Environmental Commitments*, a separate, non-environmental commitment to address the potential increased water treatment costs that could result from DOC concentration effects on municipal and industrial water purveyor operations. Potential options for making use of this financial commitment include funding or providing other assistance towards implementing treatment for DOC and/or DBPs or DOC source control strategies. Please refer to Appendix 3B, *Environmental Commitments*, for the full list of potential actions that could be taken pursuant to this commitment in order to reduce the water quality treatment costs associated with water quality effects relating to DOC.

Mitigation Measure WQ-18: Design Wetland and Riparian Habitat Features to Minimize Effects on Municipal Intakes

The BDCP proponents will design wetland and riparian habitat features taking into consideration effects on Delta hydrodynamics and impacts on municipal intakes. Locate restoration features such that impacts on municipal intakes are minimized and habitat benefits are maximized. Incorporate design features to control the load and/or timing of DOC exports from habitat restoration features. This could include design elements to control seepage from non-tidal wetlands (e.g., incorporation of slurry walls into levees), and features to increase retention time and decrease tidal exchange in tidal wetlands and riparian and channel margin habitat designs. For restoration features directly connected to open channel waters, design wetlands with only channel margin exchanges to decrease DOC loading. Stagger construction of wetlands and channel margin/riparian sites both spatially and temporally so as to allow aging of the restoration features and associated decreased creation of localized “hot spots” and net Delta loading.

The BDCP proponents will also establish measures to help guide the design and creation of the target wetland habitats. At a minimum, the measures should limit potential increases in long-term average DOC concentrations, and thus guide efforts to site, design, and maintain wetland and riparian habitat features, consistent with the biological goals and objectives of the BDCP. For example, restoration activities could be designed and located with the goal of preventing, consistent with the biological goals and objectives of the BDCP, net long-term average DOC concentration increases of greater than 0.5 mg/L at any municipal intake location within the Delta.

However, it must be noted that some of these measures could limit the benefit of restoration areas by limiting the amount of carbon supplied by these areas to the Delta as a whole. In some cases, these measures would run directly counter to the goals and objectives of the BDCP. This mitigation measure should not be implemented in such a way that it reduces the benefits to the Delta ecosystem provided by restoration areas. As mentioned above, the BDCP proponents have incorporated into the BDCP, as set forth in EIR/EIS Appendix 3B, *Environmental Commitments*, a separate, non-environmental commitment to address the potential increased water treatment costs that could result from DOC concentration effects on municipal and industrial water purveyor operations.

Impact WQ-19: Effects on Pathogens Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Under Alternative 4, Scenarios H1–H4, the only pathogen sources expected to change in the watersheds upstream of the Delta relative to Existing Conditions or the No Action Alternative would be associated with population growth, i.e., increased municipal wastewater discharges and development contributing to increased urban runoff.

Increased municipal wastewater discharges resulting from future population growth would not be expected to measurably increase pathogen concentrations in receiving waters due to state and federal water quality regulations requiring disinfection of effluent discharges and the state's implementation of Title 22 filtration requirements for many wastewater dischargers in the Sacramento River and San Joaquin River watersheds.

Pathogen loading from urban areas would generally occur in association with both dry and wet weather runoff from urban landscapes. Municipal stormwater regulations and permits have become increasingly stringent in recent years, and such further regulation of urban stormwater runoff is expected to continue in the future. Municipalities may implement BMPs for reducing pollutant loadings from urban runoff, particularly in response to NPDES stormwater-related regulations requiring reduction of pollutant loading in urban runoff. The ability of these BMPs to consistently reduce pathogen loadings and the extent of future implementation is uncertain, but would be expected to improve as new technologies are continually tested and implemented. Also, some of the urbanization may occur on lands used by other pathogens sources, such as grazing lands, resulting in a change in pathogen source, but not necessarily an increase (and possibly a decrease) in pathogen loading.

Pathogen concentrations in the Sacramento and San Joaquin Rivers have a minimal relationship to flow rate in these rivers, although most of the high concentrations observed have been during the wet months (Tetra Tech 2007). Further, urban runoff contributions during the dry season would be expected to be a relatively small fraction of the rivers' total flow rates. During wet weather events, when urban runoff contributions would be higher, the flows in the rivers also would be higher. Given the small magnitude of urban runoff contributions relative to the magnitude of river flows, that pathogen concentrations in the rivers have a minimal relationship to river flow rate, and the expected reduced pollutant loadings in response to NPDES stormwater-related regulations, river flow rate and reservoir storage reductions that would occur under Alternative 4, Scenarios H1–H4, relative to Existing Conditions and the No Action Alternative, would not be expected to result in a substantial adverse change in pathogen concentrations in the reservoirs and rivers upstream of the Delta. As such, none of the operational scenarios of Alternative 4 would be expected to substantially increase the frequency with which applicable Basin Plan objectives or U.S. EPA-recommended pathogen criteria would be exceeded in water bodies of the affected environment located upstream of the Delta or substantially degrade the quality of these water bodies, with regard to pathogens.

Delta

The *Conceptual Model for Pathogens and Pathogen Indicators in the Central Valley and Sacramento-San Joaquin Delta* (Pathogens Conceptual Model; Tetra Tech 2007) provides a comprehensive evaluation of factors affecting pathogen levels in the Delta. The Pathogens Conceptual Model characterizes relative pathogen contributions to the Delta from the Sacramento and San Joaquin

Rivers and various pathogen sources, including wastewater discharges and urban runoff. Contributions from the San Francisco Bay to the Delta are not addressed. The Pathogens Conceptual Model is based on a database compiled by the Central Valley Drinking Water Policy Group in 2004–2005, supplemented with data from Natomas East Main Drainage Canal Studies, North Bay Aqueduct sampling, and the USGS. Data for multiple sites in the Sacramento River and San Joaquin River watersheds, and in the Delta were compiled. Indicator species evaluated include fecal coliforms, total coliforms, and *E. coli*. Because of its availability, *Cryptosporidium* and *Giardia* data for the Sacramento River also were evaluated. Key results of the data evaluation are:

Total Coliform

- In the Sacramento Valley, the highest total coliform concentrations (>10,0000 MPN/100 ml) were located near urban areas.
- Similarly high total coliform concentrations were not observed in the San Joaquin Valley, because reported results were capped at about 2,400 MPN/100 ml, though a large number of results were reported as being greater than this value.
- The data should not to be interpreted to conclude that Sacramento River has higher total coliform concentrations; rather, the "appearance" of the lower total coliform concentrations in the San Joaquin Valley is attributed to a lower upper limit of reporting (2,400 MPN/100 ml versus 10,000 MPN/100 ml).

E. coli

- Comparably high concentrations observed in the Sacramento River and San Joaquin River watersheds for waters affected by urban environments and intensive agriculture.
- The highest concentrations in the San Joaquin River were not at the most downstream location monitored, but rather at an intermediate location near Hills Ferry.
- *E. coli* concentrations in the Delta were somewhat higher than in the San Joaquin River and Sacramento River, indicating the importance of in-Delta sources and influence of distance of pathogen source on concentrations at a particular location in the receiving waters.
- Temporal (seasonal) trends were weak, however, the highest concentrations in the Sacramento River were observed during the wet months and the lowest concentrations were observed in July and August.

Fecal Coliform

- There was limited data from which to make comparisons/observations.

Cryptosporidium and Giardia

- Data were available only for the Sacramento River, limiting the ability to make comparisons between sources.
- Often not detected and when detected, concentrations typically less than 1 organism per liter.
- There may be natural/artificial barriers/processes that limit *Cryptosporidium* transport to water. Significant die off of those that reach the water may contribute to the low frequency of detection.

The Pathogens Conceptual Model found that coliform indicators vary by orders of magnitudes over small distances and short time-scales. Concentrations appear to be more closely related to what happens in the proximity of a sampling station, rather than what happens in the larger watershed where significant travel time and concomitant pathogen die-off can occur. Sites in the Delta close to urban discharges had elevated concentrations of coliform organisms. The highest total coliform and *E. coli* concentrations were observed in the discharge from the Natomas East Main Drainage Canal and several stations near sloughs, indicating the relative influence of urban and wildlife pathogen sources on receiving water concentrations.

The effects of the operational scenarios of Alternative 4 relative to Existing Conditions and the No Action Alternative would be changes in the relative percentage of water throughout the Delta being comprised of various source waters (i.e., water from the Sacramento River, San Joaquin River, Bay water, eastside tributaries, and agricultural return flow), due to potential changes in inflows particularly from the Sacramento River watershed due to increased water demands (see Table 8-55) and somewhat modified SWP and CVP operations. However, it is expected there would be no substantial change in Delta pathogen concentrations in response to a shift in the Delta source water percentages under this alternative or substantial degradation of these water bodies, with regard to pathogens. This conclusion is based on the Pathogens Conceptual Model, which found that pathogen sources in close proximity to a Delta site appear to have the greatest influence on pathogen levels at the site, rather than the primary source(s) of water to the site. In-Delta potential pathogen sources, including water-based recreation, tidal habitat, wildlife, and livestock-related uses, would continue under this alternative.

SWP/CVP Export Service Areas

None of the operational scenarios of Alternative 4 are expected to result in substantial changes in pathogen levels in Delta waters, relative to Existing Conditions or the No Action Alternative. As such, there is not expected to be substantial, if even measurable, changes in pathogen concentrations in the SWP/CVP Export Service Area waters.

***NEPA Effects*:** The effects on pathogens from implementing Alternative 4, Scenarios H1–H4, is determined to not be adverse.

***CEQA Conclusion*:** Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

River flow rate and reservoir storage reductions that would occur due to implementation of CM1 (water facilities and operations) under Alternative 4, relative to Existing Conditions, would not be expected to result in a substantial adverse change in pathogen concentrations in the reservoirs and rivers upstream of the Delta, given the small magnitude of urban runoff contributions relative to the magnitude of river flows, that pathogen concentrations in the rivers have a minimal relationship to river flow rate, and the expected reduced pollutant loadings in response to NPDES stormwater-related regulations.

It is expected there would be no substantial change in Delta pathogen concentrations in response to a shift in the Delta source water percentages under this alternative or substantial degradation of these water bodies, with regard to pathogens. This conclusion is based on the Pathogens Conceptual

Model, which found that pathogen sources in close proximity to a Delta site appear to have the greatest influence on pathogen levels at the site, rather than the primary source(s) of water to the site. In-Delta potential pathogen sources, including water-based recreation, tidal habitat, wildlife, and livestock-related uses, would continue under this alternative.

In the SWP/CVP Export Service Areas waters, relative to Existing Conditions, an increased proportion of water coming from the Sacramento River would not adversely affect beneficial uses in the SWP/CVP Export Service Areas. The pathogen levels in the Sacramento River are similar to or lower than the water diverted at the Delta export pumps. Further, it is localized sources of pathogens that appear to have the greatest influence on concentrations. Thus, an increased proportion of Sacramento River water diverted to the SWP/CVP Export Service Areas would result in minimal changes in pathogen levels in the SWP/CVP Export Service Areas waters.

Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because pathogen concentrations are not expected to increase substantially, no long-term water quality degradation for pathogens is expected to occur and, thus, no adverse effects on beneficial uses would occur. The San Joaquin River in the Stockton Deep Water Ship Channel is Clean Water Act section 303(d) listed for pathogens. Because no measurable increase in Deep Water Ship Channel pathogen concentrations are expected to occur on a long-term basis, further degradation and impairment of this area is not expected to occur. Finally, pathogens are not bioaccumulative constituents. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-20: Effects on Pathogens Resulting from Implementation ofCM2–~~CM22~~CM21

***NEPA Effects*:** CM2–CM11 would involve habitat restoration actions, and ~~CM22~~CM21 involves waterfowl and shorebird areas. Tidal wetlands are known to be sources of coliforms originating from aquatic, terrestrial, and avian wildlife that inhabit these areas (Desmarais et al. 2001, Grant et al. 2001, Evanson and Ambrose 2006, Tetra Tech 2007). Specific locations of restoration areas for this alternative have not yet been established. However, most low-lying land suitable for restoration is unsuitable for livestock. Therefore, it is likely that the majority of land to be converted to wetlands would be crop-based agriculture or fallow/idle land. Because of a great deal of scientific uncertainty in the loading of coliforms from these various sources, the resulting change in coliform loading is uncertain, but it is anticipated that coliform loading to Delta waters would increase. Based on findings from the Pathogens Conceptual Model that pathogen concentrations are greatly influenced by the proximity to the source, this could result in localized increases in wildlife-related coliforms relative to the No Action Alternative. The Delta currently supports similar habitat types and, with the exception of the Clean Water Act section 303(d) listing for the Stockton Deep Water Ship Channel, is not recognized as exhibiting pathogen concentrations that rise to the level of adversely affecting beneficial uses. As such, the potential increase in wildlife-related coliform concentrations due to tidal habitat creation is not expected to adversely affect beneficial uses.

CM19, which would fund projects to contribute to reducing pollutant discharges in stormwater, would be expected to reduce pathogen load relative to the No Action Alternative. The remaining conservation measures would not be expected to affect pathogen levels, because they are actions that do not affect the presence of pathogen sources.

The effects on pathogens from implementing CM2–~~CM22~~CM21 is determined to not be adverse.

CEQA Conclusion: Based on findings from the Pathogens Conceptual Model that pathogen concentrations are greatly influenced by the proximity to the source, implementation of CM2–CM11 and ~~CM22~~CM21 could result in localized increases in wildlife-related coliforms relative to Existing Conditions. The Delta currently supports similar habitat types and, with the exception of the Clean Water Act section 303(d) listing for the Stockton Deep Water Ship Channel, is not recognized as exhibiting pathogen concentrations that rise to the level of adversely affecting beneficial uses. As such, the potential increase in wildlife-related coliform concentrations due to tidal habitat creation is not expected to adversely affect beneficial uses. Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because pathogen concentrations are not expected to increase substantially, no long-term water quality degradation for pathogens is expected to occur and, thus, no adverse effects on beneficial uses would occur. The San Joaquin River in the Stockton Deep Water Ship Channel is Clean Water Act section 303(d) listed for pathogens. Because no measurable increase in Deep Water Ship Channel pathogen concentrations are expected to occur on a long-term basis, further degradation and impairment of this area is not expected to occur. Finally, pathogens are not bioaccumulative constituents. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-21: Effects on Pesticide Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Residues of "legacy" OC pesticides enter rivers primarily through surface runoff and erosion of terrestrial soils during storm events, and through resuspension of riverine bottom sediments, the combination of which to this day may contribute to excursions above water quality objectives (Central Valley Water Board 2010c). Operation of the CVP/SWP does not affect terrestrial sources, but may result in geomorphic changes to the affected environment that ultimately could result in changes to sediment suspension and deposition. However, as discussed in greater detail for Turbidity/TSS, operations under any alternative would not be expected to change TSS or turbidity levels (highs, lows, typical conditions) to any substantial degree. Changes in the magnitude, frequency, and geographic distribution of legacy pesticides in water bodies of the affected environment that would result in new or more severe adverse effects on aquatic life or other beneficial uses, relative to Existing Conditions or the No Action Alternative, would not be expected to occur. Therefore, the pesticide assessment focuses on the present use pesticides for which substantial information is available, namely diazinon, chlorpyrifos, pyrethroids, and diuron.

Upstream of the Delta

Pyrethroid and OP insecticides are applied to agricultural fields, orchards, row crops, and confined animal facilities on an annual basis, with peaks in agricultural application during the winter dormant season (January–February) and during field cropping in the spring and summer. Applications of diuron occur year-round, but the majority of diuron is applied to road rights-of-way as a pre-emergent and early post emergent weed treatment during the late fall and early winter (Green and Young 2006). Pyrethroid insecticides and urban use herbicides are additionally applied around urban and residential structures and landscapes on an annual basis. These applications throughout the upstream watershed represent the source and potential pool of these pesticides that may enter the rivers upstream of the Delta by way of surface runoff and/or drift. Principal factors contributing to pesticide loading in the Sacramento River watershed include the amount of pesticide used and amount of precipitation (Guo et al. 2004). Although urban dry weather runoff occurs, this is generally believed to be less significant source of pesticides to main stem receiving waters, but for pyrethroids a recent study concluded that municipal wastewater treatment plants in Sacramento and Stockton represent a continuous year-round source of pyrethroids to the lower Sacramento and San Joaquin River's (Weston and Lydy 2010).

Pesticide-related toxicity has historically been observed throughout the affected environment regardless of season or water year type; however, toxicity is generally observed with increased incidence during spring and summer months of April to June, coincident with the peak in irrigated agriculture in the Sacramento and San Joaquin Valleys, as well as the winter rainy season, particularly December through February, coincident with urban and agricultural storm-water runoff and the orchard dormant spraying season (Fox and Archibald 1997). Although OP insecticide incidence and related toxicity can be observed throughout the year, diazinon is most frequently observed during the winter months and chlorpyrifos is most frequently observed in the summer irrigation months (Central Valley Water Board 2007). These seasonal trends coincide with their use, where diazinon is principally used as an orchard dormant season spray, and chlorpyrifos is primarily used on crops during the summer.

Application of diuron peaks in the late fall and early winter. Coincidently, diuron is found most frequently in surface waters during the winter precipitation and runoff months of January through March (Green and Young 2006), although diruon can be found much less frequently in surface waters throughout the year (Johnson et al. 2010).

Monitoring for pyrethroid insecticides in main-stem rivers is limited and detections are rather few. With the replacement of many traditionally OP related uses, however, it is conservatively assumed that pyrethroid incidence and associated toxicity could ultimately take a pattern of seasonality similar to that of the chlorpyrifos or diazinon.

In comparison to the Valley floor, relatively small amounts of pesticides are used in watersheds upstream of project reservoirs. Water released from reservoirs flow through urban and agricultural areas at which point these waters may acquire a burden of pesticide from agricultural or urban sourced discharges. These discharges with their potential burden of pesticides are effectively diluted by reservoir water. Under the operational scenarios of Alternative 4, no activity of the SWP or CVP would substantially drive a change in pesticide use, and thus pesticide sources would remain unaffected. Nevertheless, changes in the timing and magnitude of reservoir releases could have an effect on available dilution capacity along river segments such as the Sacramento, Feather, American, and San Joaquin Rivers.

Under the operational scenarios of Alternative 4, winter (November–March) and summer (April–October) season average flow rates on the Sacramento River at Freeport, American River at Nimbus, Feather River at Thermalito and the San Joaquin River at Vernalis would change. Relative to Existing Conditions and the No Action Alternative, seasonal average flow rates on the Sacramento for Scenarios H1–H4 would decrease no more than 7% during the summer and 4% during the winter (Appendix 8L, *Pesticides,*~~Seasonal average flows~~ Tables 1~~-~~–4). On the Feather River, average flow rates for Scenarios H1–H4 would decrease no more than 9% during the summer and 2% during the winter, while on the American River average flow rates would decrease by as much as 19% in the summer but would increase by as much as 8% in the winter. Seasonal average flow rates for Scenarios H1–H4 on the San Joaquin River would decrease by as much as 12% in the summer, but increase by as much as 1% in the winter.

As previously stated, historically chlorpyrifos is used in greater amounts in agriculture in the summer, and consequently observed in surface waters with greater frequency in the summer, while diazinon and diuron are used and observed in surface water with greater frequency in the winter. While flow reductions in the summer on the American River would not coincide with urban stormwater discharges, summer flow reductions on the San Joaquin River would correspond to the agricultural irrigation season. However, summer average flow reductions of up to 19% are not considered of sufficient magnitude to substantially increase in-river concentrations or alter the long-term risk of pesticide-related effects on aquatic life beneficial uses. Greater long-term average flow reductions, and corresponding reductions in dilution/assimilative capacity, would be necessary before long-term risk of pesticide related effects on aquatic life beneficial uses would be adversely altered.

Delta

Sources of diuron, OP and pyrethroid insecticides to the Plan Area include direct input of surface runoff from in-Delta agriculture and Delta urbanized areas as well as inputs from rivers upstream of the Delta. Similar to Upstream of the Delta, CVP/SWP operations under Scenarios H1–H4 of Alternative 4 would not affect these sources.

Under Scenarios H1–H4, the distribution and mixing of Delta source waters would change. Percent change in monthly average source water fraction were evaluated for the modeled 16-year (1976–1991) hydrologic period and a representative drought period (1987–1991), with special attention given to changes in San Joaquin River, Sacramento River and Delta Agriculture sources water fractions. Changes in source water fractions at the modeled Delta assessment locations would vary depending on operational scenario, but relative differences between the operational scenarios would be small. Relative to Existing Conditions, under Scenarios H1–H4 of Alternative 4 modeled San Joaquin River fractions would increase greater than 10% at Buckley Cove (drought period only), Franks Tract, Rock Slough, and Contra Costa PP No. 1, with the largest changes occurring under Scenario H4 (Appendix 8D, Source Water Fingerprinting). At Buckley Cove under Scenario H4, change in drought period San Joaquin River source water fractions would increase 11% in July and 16% in August. At Franks Tract under Scenario H4, change in San Joaquin River source water fractions when modeled for the 16-year hydrologic period, would increase 11–16% during October through November and February through June. At Rock Slough, modeled San Joaquin River source water fractions under Scenario H4 would increase 15–22% during September through March (11–15% during October and November of the modeled drought period). Similarly, under Scenario H4 modeled San Joaquin River fractions at Contra Costa Pumping Plant No. 1 would increase 15–23% during October through April (12% during October and November of the modeled drought period). While the modeled 22–23% increases of San Joaquin River Fraction at Rock Slough and Contra Costa PP No. 1 in November are considerable, the resultant net fraction would be ≤29%. For all operational scenarios, relative to Existing Conditions, there would be no modeled increases in Sacramento River fractions greater than 14% (with exception to Banks and Jones, discussed below) and Delta agricultural fractions greater than 8%. These modeled changes in the source water fractions of Sacramento, San Joaquin and Delta agriculture water are not of sufficient magnitude to substantially alter the long-term risk of pesticide-related toxicity to aquatic life, nor adversely affect other beneficial uses of the Delta.

When compared to the No Action Alternative, changes in source water fractions resulting from Scenarios H1–H4would be similar in season, geographic extent, and magnitude to those discussed for Existing Conditions, with exception to Buckley Cove. Relative to the No Action Alternative, on a source water basis Buckley Cove is comprised predominantly of water of San Joaquin River origin (i.e., typically >80% San Joaquin River) for all months of the year but July and August. In July and

August, the combined operational effects on Delta hydrodynamics of the Delta Cross Channel being open, the absence of a barrier at Head of Old River, and seasonally high exports from south Delta pumps results in substantially lower San Joaquin River source water fraction at Buckley Cove relative to all other months of the year. Under the operational scenarios of Alternative 4, however, modeled July and August San Joaquin River fractions at Buckley Cove would increase relative to the No Action Alternative, with increases between 16–17% in July (31–34% for the modeled drought period) and 24–25% in August (47–49% for the modeled drought period) (Appendix 8D, Source Water Fingerprinting).Despite these San Joaquin River increases, the resulting net San Joaquin River source water fraction for July and August would remain less than all other months. As a result, these modeled changes in the source water fractions are not of sufficient magnitude to substantially alter the long-term risk of pesticide-related toxicity to aquatic life, nor adversely affect other beneficial uses of the Delta.

SWP/CVP Export Service Areas

Assessment of effects in SWP/CVP Export Service Areas is based on effects seen in the Plan Area at the Banks and Jones pumping plants. Under all operational scenarios of Alternative 4, Sacramento River source water fractions would increase substantially at both Banks and Jones pumping plants relative to Existing Conditions and the No Action Alternative (Appendix 8D, Source Water Fingerprinting). Sacramento River source water fractions would increase similarly by both season and magnitude extent under all operational scenarios at both Banks and Jones pumping plant. At Banks pumping plant, Sacramento source water fractions would generally increase from 16–48% for the period of January through June (12–35% for March through April of the modeled drought period) and at Jones pumping plant Sacramento source water fractions would generally increase from 21–56% for the period of January through June (15–48% for February through May of the modeled drought period). These increases in Sacramento source water fraction would primarily balance through equivalent decreases in San Joaquin River water. Based on the general observation that San Joaquin River, in comparison to the Sacramento River, is a greater contributor of OP insecticides in terms of greater frequency of incidence and presence at concentrations exceeding water quality benchmarks, modeled increases in Sacramento River fraction at Banks and Jones would generally represent an improvement in export water quality respective to pesticides.

***NEPA Effects*:** In summary, the changes in long-term average flows on the Sacramento, Feather, American, and San Joaquin Rivers, under Scenarios H1–H4 of Alternative 4 relative to the No Action Alternative, are of insufficient magnitude to substantially increase the long-term risk of pesticide-related water quality degradation and related toxicity to aquatic life in these water bodies upstream of the Delta. Similarly, modeled changes in source water fractions to the Delta are of insufficient magnitude to substantially alter the long-term risk of pesticide-related water quality degradation and related toxicity to aquatic life in the Delta or CVP/SWP export service areas. The effects on pesticides from operations and maintenance (CM1) are determined not to be adverse.

***CEQA Conclusion*:** Key findings discussed in the effects assessment relative to Existing Conditions provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Sources of pesticides upstream of the Delta include direct input of pesticide containing surface runoff from agriculture and urbanized areas. Flows in rivers receiving these discharges dilute these pesticide inputs. For all operational scenarios relative to Existing Conditions, however, modeled changes in long-term average flows on the Sacramento, Feather, American, and San Joaquin Rivers are of insufficient magnitude to substantially increase the long-term risk of pesticide-related water quality degradation and related toxicity to aquatic life in these water bodies upstream of the Delta.

In the Delta, sources of pesticides include direct input of surface runoff from Delta agriculture and Delta urbanized areas as well as inputs from rivers upstream of the Delta. While facilities operations and maintenance activities under Scenarios H1–H4 would not affect these sources, changes in Delta source water fraction could change the relative risk associated with pesticide related toxicity to aquatic life. Under Scenarios H1–H4 of Alternative 4, however, modeled changes in source water fractions relative to Existing Conditions are of insufficient magnitude to substantially alter the long-term risk of pesticide-related toxicity to aquatic life within the Delta, nor would such changes result in adverse pesticide-related effects on any other beneficial uses of Delta waters.

The assessment of Alternative 4 effects on pesticides in the SWP/CVP Export Service Areas is based on assessment of changes predicted at Banks and Jones pumping plants. As just discussed regarding Scenario H1–H4 effects to pesticides in the Delta, modeled changes in source water fractions at the Banks and Jones pumping plants are of insufficient magnitude to substantially alter the long-term risk of pesticide-related toxicity to aquatic life beneficial uses, or any other beneficial uses, in water bodies of the SWP and CVP export service area.

Based on the above, the considered operational scenarios of Alternative 4 would not result in any substantial change in long-term average pesticide concentration or result in substantial increase in the anticipated frequency with which long-term average pesticide concentrations would exceed aquatic life toxicity thresholds or other beneficial use effect thresholds upstream of the Delta, at the 11 assessment locations analyzed for the Delta, or the SWP/CVP service area. Numerous pesticides are currently used throughout the affected environment, and while some of these pesticides may be bioaccumulative, those present-use pesticides for which there is sufficient evidence for their presence in waters affected by SWP and CVP operations (i.e., diazinon, chlorpyrifos, diuron, and pyrethroids) are not considered bioaccumulative, and thus changes in their concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Furthermore, while there are numerous 303(d) listings throughout the affected environment that name pesticides as the cause for beneficial use impairment, the modeled changes in upstream river flows and Delta source water fractions under Scenarios H1–H4 would not be expected to make any of these beneficial use impairments measurably worse. Because long-term average pesticide concentrations are not expected to increase substantially, no long-term water quality degradation with respect to pesticides is expected to occur and, thus, no adverse effects on beneficial uses would occur. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-22: Effects on Pesticide Concentrations Resulting from Implementation ofCM2–~~CM22~~CM21

***NEPA Effects*:** With the exception of CM13, the mostly non-land disturbing CM12–~~CM22~~CM21 present no new sources of pesticides to the affected environment, including areas Upstream of the Delta, within the Plan Area, and the SWP/CVP Export Service Area. Implementation of urban stormwater treatment measures (CM19) may result in beneficial effects, to the extent that control measures treat or reduce pesticide loading from urban land uses. However, control of nonnative aquatic vegetation (CM13) associated with tidal habitat restoration efforts would include killing invasive and nuisance aquatic vegetation through direct application of herbicides or through alternative mechanical means. Use and selection of type of herbicides would largely be circumstance specific, but would follow existing control methods used by the CDBW. The CDBW's use of herbicides is regulated by permits and regulatory agreements with the Central Valley Water Board, US Fish and Wildlife Service, and National Marine Fisheries Service and is guided by research conducted on the efficacy of vegetation control in the Delta through herbicide use. Through a program of adaptive management and assessment, the CDBW has employed a program of herbicide use that reduces potential environmental impacts, nevertheless, the CDBW found that impacts on water quality and associated aquatic beneficial uses would continue to occur and could not be avoided, including non-target impacts on aquatic invertebrates and beneficial aquatic plants (California Department of Boating and Waterways 2006).

In addition to the potential beneficial and adverse effects of CM19 and CM13, respectively, the various restoration efforts of CM2–CM11 could involve the conversion of active or fallow agricultural lands to natural landscapes, such as wetlands, grasslands, floodplains, and vernal pools. In the long-term, conversion of agricultural land to natural landscapes could possibly result in a limited reduction in pesticide use throughout the Delta. In the short-term, tidal and non-tidal wetland restoration, as well as seasonal floodplain restoration (i.e., CM4, CM5, and CM10) over former agricultural lands may include the contamination of water with pesticide residues contained in the soils. Present use pesticides typically degrade fairly rapidly, and in such cases where pesticide containing soils are flooded, dissipation of those pesticides would be expected to occur rapidly. Moreover, seasonal floodplain restoration (CM5) and Yolo Bypass enhancements (CM2) may be managed alongside continuing agriculture, where pesticides may be used on a seasonal basis and where water during flood events may come in contact with residues of these pesticides. Similarly, however, rapid dissipation would be expected, particularly in the large volumes of water involved in flooding. During these flooding events, pesticides potentially suspended in water would not be expected to cause toxicity to aquatic life or cause substantial adverse effects on any other beneficial uses of these water bodies.

In summary, CM13 of Alternative 4proposes the use of herbicides to control invasive aquatic vegetation around habitat restoration sites. Herbicides directly applied to water could adversely affect non-target aquatic life, such as aquatic invertebrates and beneficial aquatic plants. Use of herbicides could potentially exceed aquatic life toxicity objectives with sufficient frequency and magnitude such that beneficial uses would be adversely affected, thus constituting an adverse effect on water quality. Mitigation Measure WQ-22 would be available to reduce this effect.

CEQA Conclusion: With the exception of CM13, implementation of CM2–~~CM22~~CM21 would not present new or substantially increased sources of pesticides in the Plan Area. In the long-term, implementation of conservation measures could possibly result in a limited reduction in pesticide use throughout the Delta through the potential repurposing of active or fallow agricultural land for natural habitat purposes. In the short-term, the repurposing of agricultural land associated with CM4, CM5, and CM10 may expose water used for habitat restoration to pesticide residues. Moreover, CM2 and CM5 may be managed alongside continuing agriculture, where pesticides may be used on a seasonal basis and where water during flood events may come in contact with residues of these pesticides. However, rapid dissipation would be expected, particularly in the large volumes of water involved in flooding, such that aquatic life toxicity objectives would not be exceeded by frequency, magnitude, and geographic extent whereby adverse effects on beneficial uses would be expected. ~~Conservation Measures 2–22~~CM2–CM21 do not include the use of pesticides known to be bioaccumulative in animals or humans, nor do the conservation measures propose the use of any pesticide currently named in a Section 303(d) listing of the affected environment. CM13 proposes the use of herbicides to control invasive aquatic vegetation around habitat restoration sites. Herbicides directly applied to water could include adverse effects on non-target aquatic life, such as aquatic invertebrates and beneficial aquatic plants. As such, aquatic life toxicity objectives could be exceeded with sufficient frequency and magnitude such that beneficial uses would be impacted. Potential environmental effects related only to CM13 are considered significant. Mitigation Measure WQ-22 is available to partially reduce this impact of pesticides on water quality; however, because of the uncertainty about successful implementation of this measure at specific restoration sites programmatic impact is considered significant and unavoidable.

Mitigation Measure WQ-22: Implement Least Toxic Integrated Pest Management Strategies

Implement the principals of IPM in the management of invasive aquatic vegetation under CM13, including the selective use of pesticides applied in a manner that minimizes risks to human health, nontarget organisms and the aquatic ecosystem. In doing so, the BDCP proponents will consult with the Central Valley Water Board, USFWS, NMFS, and CDBW to obtain effective IPM strategies such as selective application of pesticides, timing of applications in order to minimize tidal dispersion, and timing to target the invasive plant species at the most vulnerable times such that less herbicide can be used or the need for repeat applications can be reduced.

Impact WQ-23: Effects on Phosphorus Concentrations Resulting from Facilities Operations and Maintenance (CM1)

As described under Impact WQ-29, facilities operations and maintenance is not expected to result in substantial changes in TSS and Turbidity under the project alternative relative to Existing Conditions in surface waters upstream of the Delta, in the Delta, and in the SWP/CVP Export Service Areas. Thus in these areas, long-term changes in the levels of suspended sediment-bound phosphorus are not expected. Additional factors that may effect phosphorus levels are discussed below.

Upstream of the Delta

A conceptual model of nutrients in the Delta stated that: "previous attempts to relate concentration data to flow data in the Central Valley and Delta showed little correlation between the two variables (Tetra Tech 2006b, Conceptual Model for Organic Carbon in the Central Valley). One possible reason is that the Central Valley and Delta system is a highly managed system with flows controlled by major reservoirs on most rivers" (Tetra Tech 2006b:4-1 to 4-2). Attempts made in the Nitrate section of this chapter also showed weak correlation between nitrate and flows for major source waters to the Delta. The linear regressions between average dissolved ortho-phosphate concentrations and average flows in the San Joaquin and Sacramento Rivers were derived for this analysis (Figure 8-58 and Figure 8-59). As expected, neither relationship is very strong, although over the large range in flows for the Sacramento River, the relationship is stronger than for the San Joaquin River. However, over smaller changes in flows, neither relationship can function as a predictor of phosphorus concentrations because the variability in the data over small to medium ranges of flows (i.e., <10,000 CFS) is large.

Because phosphorus loading to waters upstream of the Delta is not anticipated to change, and because changes in flows do not necessarily result in changes in concentrations or loading of phosphorus to these water bodies, substantial changes in phosphorus concentration are not anticipated under the operational scenarios of Alternative 4, relative to Existing Conditions or the

No Action Alternative. Any negligible changes in phosphorus concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regards to phosphorus.

Delta

Because phosphorus concentrations in the major source waters to the Delta are similar for much of the year, phosphorus concentrations in the Delta are not anticipated to change substantially on a long term-average basis. Phosphorus concentrations may increase during January through March at locations where the source fraction of San Joaquin River water increases, due to the higher concentration of phosphorus in the San Joaquin River during these months compared to Sacramento River water or San Francisco Bay water. Based on the DSM2 fingerprinting results (see Appendix 8D), together with source water concentrations shown in Figure 8-56, the magnitude of increases during these months may range from negligible up to approximately 0.05 mg/L. However, there are no state or federal objectives/criteria for phosphorus and thus any increases would not cause exceedances of objectives/criteria. Because algal growth rates are limited by availability of light in the Delta, increases in phosphorus levels that may occur at some locations and times within the Delta under Alternative 4, Scenarios H1–H4, would be expected to have little effect on primary productivity in the Delta. Moreover, such increases in concentrations would not be anticipated to be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to phosphorus.

SWP/CVP Export Service Areas

The assessment of effects of phosphorus under Alternative 4, Scenarios H1–H4, in the SWP and CVP Export Service Areas is based on effects on phosphorus at the Banks and Jones pumping plants.

As noted in the Delta Region section above, phosphorus concentrations in the Delta (including Banks and Jones pumping plants) are not anticipated to change substantially on a long term-average basis. During January through March, phosphorus concentrations may increase as a result of more San Joaquin River water reaching Banks and Jones pumping plants and the higher concentration of phosphorus in the San Joaquin River. However, based on the DSM2 fingerprinting results (see Appendix 8D), together with source water concentrations show in Figure 8-56, the magnitude of this increase is expected to be negligible (<0.01 mg/L-P). Additionally, there are no state or federal objectives for phosphorus. Moreover, given the many factors that contribute to potential algal blooms in the SWP and CVP canals within the Export Service Area, and the lack of studies that have shown a direct relationship between nutrient concentrations in the canals and reservoirs and problematic algal blooms in these water bodies, there is no basis to conclude that any seasonal increases in phosphorus concentrations at the levels expected under this alternative, should they occur, would increase the potential for problem algal blooms in the SWP and CVP Export Service Area.

Any increases in phosphorus concentrations that may occur in water exported via Banks and Jones pumping plants are not expected to result in adverse effects to beneficial uses of exported water or substantially degrade the quality of exported water, with regards to phosphorus.

NEPA Effects: In summary, based on the discussion above, effects on phosphorus of CM1 are considered to be not adverse.

CEQA Conclusion: Key findings discussed in the effects assessment relative to Existing Conditions is provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Because phosphorus loading to waters upstream of the Delta is not anticipated to change, and because changes in flows do not necessarily result in changes in concentrations or loading of phosphorus to these water bodies, substantial changes in phosphorus concentration upstream of the Delta are not anticipated for any operational scenario of Alternative 4, relative to Existing Conditions.

Because phosphorus concentrations in the major source waters to the Delta are similar for much of the year, phosphorus concentrations in the Delta are not anticipated to change substantially on a long term-average basis under the operational scenarios of Alternative 4, relative to Existing Conditions. Algal growth rates are limited by availability of light in the Delta, and therefore any minor increases in phosphorus levels that may occur at some locations and times within the Delta would be expected to have little effect on primary productivity in the Delta.

The assessment of effects of phosphorus under the various operational scenarios of Alternative 4 in the SWP and CVP Export Service Areas is based on effects on phosphorus at the Banks and Jones pumping plants. As noted above, phosphorus concentrations in the Delta (including Banks and Jones pumping plants) are not anticipated to change substantially on a long term-average basis.

Based on the above, there would be no substantial, long-term increase in phosphorus concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the waters exported to the CVP and SWP service areas under any operational scenario of Alternative 4 relative to Existing Conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because phosphorus concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Phosphorus is not 303(d) listed within the affected environment and thus any minor increases that may occur in some areas would not make any existing phosphorus-related impairment measurably worse because no such impairments currently exist. Because phosphorus is not bioaccumulative, minor increases that may occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-24: Effects on Phosphorus Concentrations Resulting from Implementation ofCM2–~~CM22~~CM21

***NEPA Effects*:** CM2–CM11 include activities that create additional aquatic habitat within the affected environment, and therefore may increase the total amount of algae and plant-life within the Delta. These activities would not affect phosphorus loading to the affected environment, but may affect phosphorus dynamics and speciation. For example, water column concentrations of total phosphorus may increase or decrease in localized areas as a result of increased or decreased suspended solids, while ortho-phosphate concentrations may be locally altered as a result of changing planktonic and macroinvertebrate species contributing to the cycling of phosphorus within the affected environment. Additionally, depending on age, configuration, location, operation, and season, some of the restoration measures included under these conservation measures may function to remove or sequester phosphorus, but since presently, the specific design, operational criteria, and location of these activities are not well established, the degree to which this would occur is unknown. Overall, phosphorus concentrations are not expected to change substantially in the affected environment as a result of CM2–~~CM22~~CM21. Because increases or decreases in phosphorus levels are, in general, expected to have little effect on productivity, any changes in phosphorus concentrations that may occur at certain locations within the affected environment are not anticipated to be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to phosphorus.

Because urban stormwater is a source of phosphorus in the affected environment, CM19, Urban Stormwater Treatment, is expected to slightly reduce phosphorus loading to the Delta, thus slightly decreasing phosphorus concentrations relative to the No Action Alternative. Implementation of CM12–CM18 and CM20–~~CM22~~CM21 is not expected to substantially alter phosphorus concentrations in the affected environment.

The effects on phosphorus from implementing ~~CM2–22CM2 through CM22~~CM2–CM21 are considered to be not adverse.

CEQA Conclusion: There would be no substantial, long-term increase in phosphorus concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the waters exported to the CVP and SWP service areas due to implementation of CM2–~~CM22~~CM21 under Alternative 4 relative to Existing Conditions. Because urban stormwater is a source of phosphorus in the affected environment, CM19, Urban Stormwater Treatment, is expected to slightly reduce phosphorus loading to the Delta. As such, implementation of these conservation measures is not expected to cause adverse effects on any beneficial uses of waters in the affected environment. Because phosphorus concentrations are not expected to increase substantially due to these conservation measures, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Phosphorus is not 303(d) listed within the affected environment and thus any minor increases that may occur in some areas would not make any existing phosphorus-related impairment measurably worse because no such impairments currently exist. Because phosphorus is not bioaccumulative, minor increases that may occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-25: Effects on Selenium Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

~~For the same reasons stated for the No Action Alternative, Alternative 4 would have negligible, if any, effect on selenium concentrations in the rivers and reservoirs upstream of the Delta relative to Existing Conditions and the No Action Alternative. Any negligible increases in selenium concentrations that could occur in the water bodies of the affected environment upstream of the Delta would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regard to selenium.~~

Substantial point sources of selenium do not exist upstream in the Sacramento River watershed, in the watersheds of the eastern tributaries (Cosumnes, Mokelumne, and Calaveras Rivers), or upstream of the Delta in the San Joaquin River watershed. Nonpoint sources of selenium within the watersheds of the Sacramento River and the eastern tributaries also are relatively low, resulting in generally low selenium concentrations in the reservoirs and rivers of those watersheds. Consequently, any modified reservoir operations and subsequent changes in river flows under Alternative 4, Scenarios H1–H4, relative to Existing Conditions or the No Action Alternative, are expected to have negligible, if any, effects on reservoir and river selenium concentrations upstream of Freeport in the Sacramento River watershed or in the eastern tributaries upstream of the Delta.

Non-point sources of selenium in the San Joaquin River watershed are associated with discharges of subsurface agricultural drainage to the river and its tributaries. Selenium concentrations in the San Joaquin River upstream of the Delta comply with NTR criteria and Basin Plan objectives at Vernalis under Existing Conditions, and they are expected to do so under the No Action Alternative. This is because a TMDL has been developed by the Central Valley Water Board (2001), the Grassland Bypass Project has established limits that will result in reduced inputs of selenium to the Delta, and the Central Valley Water Board (2010ad) and State Water Board (2010db, 2010ec) have established Basin Plan objectives that are expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta, as previously discussed in 8.1.3.15.

Selenium concentrations at Vernalis are generally higher during lower San Joaquin River flows, with considerable variability in concentrations below about 3,000 cfs, as shown in Appendix 8M, *Selenium* (Table M-313 and Figures M-47 through M-1720). The only monthly average selenium concentrations greater than 2 µg/L were in March 2002 (2.3 µg/L) and February and March 2003 (2.1 and 2.3 µg/L), when monthly average flows were 1,879 to 2,193 cfs. Under the four operational scenarios of Alternative 4, modeling indicates that long-term annual average flows on the San Joaquin River would decrease by 6% relative to Existing Conditions and would remain virtually the same relative to the No Action Alternative (Appendix 5A). Given these relatively small decreases in flows and the considerable variability in the relationship between selenium concentrations and flows in the San Joaquin River, it is expected that selenium concentrations in the San Joaquin River would be minimally affected, if at all, by anticipated changes in flow rates under the operational scenarios of Alternative 4.

Thus, available information indicates selenium concentrations are well below the Basin Plan objective and are likely to remain so. Any negligible changes in selenium concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies as related to selenium.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics,. To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2-22CM2 through CM22CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for CM2-22CM2 through CM22CM2–CM21. See section 8.3.1.3 for more information.

Selenium concentrations and threshold comparisons for each of the 11 modeled Delta assessment locations under Alternative 4, relative to Existing Conditions and the No Action Alternative, are presented in Appendix 8M, *Selenium*, Table M-9b for water, Tables M-14a, through M-14d, and Tables M-24a through M-24d for most biota (whole-body fish (excluding sturgeon), bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets) throughout the Delta, and Tables M-30 through M-32 for sturgeon at the two western Delta locations. Figures 8-59b and 8-60b present graphical distributions of predicted selenium concentration changes (shown as changes in available assimilative capacity based on 1.3 µg/L) in water at each modeled assessment location for all years. Appendix 8M, Figure M-22 provides more detail in the form of monthly patterns of selenium concentrations in water during the modeling period.

All scenarios (H1, H2, H3, and H4) under Alternative 4 would result in small changes in average selenium concentrations in water relative to Existing Conditions and No Action Alternative at almost all modeled Delta assessment locations (Appendix 8M, *Selenium*, Table M-10B9b). Long-term average concentrations at some interior and western Delta locations would increase by 0.01–0.05 µg/L for the entire period modeled (1976–1991), depending on operational scenario. These small changes increases in selenium concentrations in water are reflected would result in small percent changes reductions (104% or less) in available assimilative capacity for selenium, relative to the (based on 21.3 µg/L ecological risk benchmarkUSEPA draft water quality criterion) for all years (Figures 8-59b and 8-60b). Relative to Existing Conditions, Scenario H1 would result in the largest modeled increase in assimilative capacity (range of +1% at Buckley Cove to -3% at Contra Costa PP), and the largest decrease would be under Scenario H4 (range of -4% at Contra Costa PP to +1% at Buckley Cove). Relative to the No Action Alternative, the largest modeled increase in assimilative capacity would be under Scenario H1 (range of <+1% at Staten Island to-4% at Buckley Cove) and the largest decrease would be under Scenario H4 (range of -4% at Buckley Cove to + 1% at Staten Island) (Figure 8-60). Although some small negative changes in selenium concentrations in water are expected, the effect of any of the scenarios under Alternative 4 would generally be minimal for the Delta locations. Furthermore, tThe modeled long-term average selenium concentrations in water under (Appendix 8M, *Selenium*, Table M-10B) for Existing Conditions (range 0.21–0.76 µg/L), No Action Alternative (range 0.21–0.69 µg/L), Alternative 4 Scenarios H1–H4 (range 0.2109–0.7440 µg/L), H2 (range 0.21–0.74 µg/L), H3 (range 0.22–0.74 µg/L), and H4 (range 0.22–0.74 µg/L) are would be generally similar to Existing Conditions (range 0.09–0.41 µg/L) and the No Action Alternative (range 0.09–0.38 µg/L), and would all be below the ecological risk benchmarkUSEPA draft water quality criterion (of 21.3 µg/L (Appendix 8M, *Selenium*, Table M-9b).

Relative to Existing Conditions and the No Action Alternative, all scenarios under Alternative 4 would result in small changes (approximately 1%) in estimated selenium concentrations in most biota (whole-body fish, bird eggs [invertebrate diet or fish diet], and fish fillets) throughout the Delta, with little difference among locations (Figures 8-61a through 8-64b; Appendix 8M, *Selenium*, Tables M-15A 24Aa through M-15D 24dDandTable 8M-2 in the sturgeon addendum to Appendix 8MAddendum M.A to Appendix 8M, *Selenium in Sturgeon*, Table M.A-2). Level of Concern Exceedance Quotients (i.e., modeled tissue divided by Level of Concern benchmarks) for selenium concentrations in those biota for all years and for drought years are less than 1.0 (indicating low probability of adverse effects). Similarly, Advisory Tissue Level Exceedance Quotients for selenium concentrations in fish fillets for all years and drought years also are less than 1.0. Estimated selenium concentrations in sturgeon for the San Joaquin River at Antioch are predicted to increase by 14 to 179 percent relativeRelative to Existing Conditions and to the No Action Alternative in all years fo (from about 4.7 to around 5.65 mg/kg dry weight [dw]), and those for sturgeon in the

Sacramento River at Mallard Island are predicted to increase by 9 to 11 percent in all years (from about 4.4 to 4.~~8~~9 mg/kg dw) (~~Figure 8-65;~~ Appendix 8M,Tables M-30 and M-31), with the highest percent increase for Scenario H4. Selenium concentrations in sturgeon during drought years are expected to increase by about 3 to 9 percent at those locations, with the highest increase in San Joaquin River Antioch in drought years for Scenario H4 (Appendix 8M,Tables M-30 and M-31). Detection of small changes in whole-body sturgeon such as those estimated for the western Delta would require very large sample sizes because of the inherent variability in fish tissue selenium concentrations. Low Toxicity Threshold Exceedance Quotients for selenium concentrations in sturgeon in the western Delta would exceed 1.0 (indicating a higher probability for adverse effects) for drought years at both locations (as they do for Existing Conditions and the No Action Alternative; Figure 8-65~~)~~) and would increase slightly, from 0.94 to 1.1, for all years in the San Joaquin River at Antioch ~~and for all years in the San Joaquin River at Antioch (where quotients increase from 0.94 to 1.1)~~ (Appendix 8M, Table M-32). ~~for all scenarios under Alternative 4, the largest increase of selenium concentrations in all biota would be at Contra Costa PP for all years and in sturgeon at the San Joaquin River at Antioch in all years, and the largest decrease of selenium in all biota would be at Buckley Cove for drought years. Relative to the No Action Alternative, the largest increases and decreases in estimated selenium concentrations in biota for each scenario are provided below.~~

~~Alternative 4, Scenario H1: The largest increase of estimated selenium concentrations in all biota would be at Buckley Cove for drought years (except for bird eggs [assuming a fish diet] at Buckley Cove for all years) and in sturgeon at the San Joaquin River at Antioch in all years; the largest decrease in all biota would be at Staten Island for all years (except for bird eggs [assuming a fish diet] at Staten Island for drought years).~~

~~Alternative 4, Scenario H2: The largest increase of estimated selenium concentrations in all biota would be at Buckley Cove for drought years (except for bird eggs [assuming a fish diet] at Buckley Cove for all years) and in sturgeon at the San Joaquin River at Antioch in all years; the largest decrease for all biota would be at Staten Island for drought years.~~

~~Alternatives 4, Scenarios H3 and H4: The largest increase of estimated selenium concentrations in all biota would be at Buckley Cove for drought years (except for bird eggs [assuming a fish diet] at Contra Costa PP for all years) and in sturgeon at the San Joaquin River at Antioch in all years; the largest decrease for all biota would be at Staten Island for drought years.~~

The disparity between larger estimated changes for sturgeon and smaller changes for other biota ~~are~~is attributable largely to differences in modeling approaches, as described in Appendix 8M, *Selenium*. The model for most biota was calibrated to encompass the varying concentration-dependent uptake from waterborne selenium concentrations (expressed as the K_d, which is the ratio of selenium concentrations in particulates [as the lowest level of the food chain] relative to the waterborne concentration) that was exhibited in data for largemouth bass in 2000, 2005, and 2007 at various locations across the Delta. In contrast, the modeling for sturgeon could not be similarly calibrated at the two western Delta locations and used literature-derived uptake factors and trophic transfer factors for the estuary from Presser and Luoma (2013). As noted in the appendix, there was a significant negative log-log relationship of K_d to waterborne selenium concentration that reflected the greater bioaccumulation rates for bass at low waterborne selenium than at higher concentrations. (There was no difference in bass selenium concentrations in the Sacramento River at Rio Vista in comparison to the San Joaquin River at Vernalis in 2000, 2005, and 2007 [Foe 2010], despite a nearly 10-fold difference in waterborne selenium.) Thus, there is more confidence in the site-specific modeling based on the Delta-wide model that was calibrated for bass data than in the estimates for sturgeon based on "fixed" K_ds for all years and for drought years without regard to waterborne selenium concentration at the two locations in different time periods.

Increased water residence times could increase the bioaccumulation of selenium in biota, thereby potentially increasing fish tissue and bird egg concentrations of selenium (see residence time discussion in Appendix 8M, *Selenium*, and Presser and Luoma [2010b]). Thus, residence time was assessed for its relevance to selenium bioaccumulation. Table 60a (presented originally in Section 8.3.1.7 in the *Microcystis* subsection) shows the time for neutrally buoyant particles to move through the Delta (surrogate for flow and residence time). Although an increase in residence time throughout the Delta is expected under the No Action Alternative, relative to Existing Conditions (because of climate change and sea level rise), the change is fairly small in most areas of the Delta. Thus, the changes in residence times between Alternative 4 and the No Action Alternative are very similar to the changes in residence times between Alternative 4 and the Existing Conditions.

Relative to Existing Conditions and the No Action Alternative, increases in residence times for Alternative 4 would be greater in the East Delta and South Delta than in other sub-regions. Relative to Existing Conditions, annual average residence times for Alternative 4 in the South Delta are expected to increase by more than 10 days (Table 60a). Relative to the No Action Alternative, annual average residence times for Alternative 4 in the South Delta are expected to increase by less than 10 days. Increases in residence times for other sub-regions would be smaller, especially as compared to Existing Conditions and the No Action Alternative (which are longer than those modeled for the South Delta). As mentioned above, these results incorporate hydrodynamic effects of both CM1 and CM2 and CM4, and the effects of CM1 cannot be distinguished from the effects of CM2 and CM4. However, it is expected that CM2 and CM4 are substantial drivers of the increased residence time.

Presser and Luoma (2010b) summarized and discussed selenium uptake in the Bay-Delta (including hydrologic conditions [e.g., Delta outflow and residence time for water], K_ds [the ratio of selenium concentrations in particulates, as the lowest level of the food chain, relative to the water-borne concentration], and associated tissue concentrations [especially in clams and their consumers, such as sturgeon]). When the Delta Outflow Index (daily average flow per month) decreased by five-fold (73,732 cubic feet per second [cfs] in June 1998 to 12, 251 cfs in October 1998), residence time doubled (from 11 to 22 days) and the calculated mean K_d also doubled (from 3,198 to 6,501). However, when daily average Delta outflow in November 1999 was only 6,951 cfs (i.e., about one-half that in October 1998) and residence time was 70 days, the calculated mean K_d (7,614) did not increase proportionally.

Models are not available to quantitatively estimate the level of changes in selenium bioaccumulation as related to residence time, but the effects of residence time are incorporated in the bioaccumulation modeling for selenium that was based on higher K_d values for drought years in comparison to wet, normal, or all years; see Appendix 8M, *Selenium*. If increases in fish tissue or bird egg selenium were to occur, the increases would likely be of concern only where fish tissues or bird eggs are already elevated in selenium to near or above thresholds of concern. That is, where biota concentrations are currently low and not approaching thresholds of concern (which, as discussed above, is the case throughout the Delta, except for sturgeon in the western Delta), changes in residence time alone would not be expected to cause them to then approach or exceed thresholds of concern. In consideration of this factor, although the Delta as a whole is a CWA Section 303(d)-listed water body for selenium, and although monitoring data of fish tissue or bird eggs in the Delta are sparse, the most likely area in which biota tissues would be at levels high enough that additional bioaccumulation due to increased residence time from restoration areas would be a concern is the western Delta and Suisun Bay for sturgeon, as discussed above. As shown in Table 60a, the overall increase in residence time estimated in the western Delta is 4 days relative to Existing Conditions, and 2 days relative to the No Action Alternative. Given the available information, these increases are small enough that they are not expected to substantially affect selenium bioaccumulation in the western Delta. Because CM2 and CM4 are expected to be substantial drivers of the increased residence times, further discussion is included in Impact WQ-26 below.

In summary, ~~R~~relative to Existing Conditions and the No Action Alternative, all scenarios under Alternative 4 would result in essentially no change in selenium concentrations throughout the Delta for most biota (approximately 1% or less), although increases in selenium concentrations are predicted for sturgeon in the western Delta. The Low Toxicity Threshold Exceedance Quotient for selenium concentrations in sturgeon for all years in the San Joaquin River at Antioch would increase from 0.94 for Existing Conditions and the No Action Alternative to 1.1 for Alternative 4. Concentrations of selenium in sturgeon would exceed only the lower benchmark, indicating a low potential for effects. The modeling of bioaccumulation for sturgeon is less calibrated to site-specific conditions than that for other biota, which was calibrated on a robust dataset for modeling of bioaccumulation in largemouth bass as a representative species for the Delta. Overall, all scenarios under Alternative 4 would not be expected to substantially increase the frequency with which applicable benchmarks would be exceeded in the Delta (there being only a small increase for sturgeon relative to the low benchmark and no exceedance of the high benchmark) or substantially degrade the quality of water in the Delta, with regard to selenium.~~Except for sturgeon in the western Delta, concentrations of selenium in whole-body fish and bird eggs (invertebrate and fish diets) would exceed only the lower benchmarks (4 and 6 mg/kg dry weight, respectively, indicating a low potential for effects) at Buckley Cove, under drought conditions, for Existing Conditions, No Action Alternative, and all scenarios for Alternative 4 (Figures 8-61, 8-62, and 8-63). However, Exceedance Quotients~~exceedance quotients ~~for these exceedances of the lower benchmarks for all Alternative 4 scenarios are between 1.0 and 1.5 (similar to Existing Conditions, and No Action Alternative), indicating a low risk to biota in the Delta and no substantial difference from baseline conditions. Estimated selenium concentrations in fish fillets would not exceed the screening value for protection of human health (Figure 8-64). For sturgeon in the western Delta, whole-body selenium concentrations would increase from 12.3 mg/kg under Existing Conditions and the No Action Alternative to 13.1-13.5 mg/kg under Alternative 4 (depending on the operational scenario), a 7-10% increase (Table 8M-2 in the sturgeon addendum to Appendix 8MTable M.A-2). Although all of these values exceed both the low and high toxicity benchmarks, it is unlikely that the modeled increases in whole-body selenium for sturgeon would be measurable in the environment (see also the discussion of results provided in the sturgeon addendum M.A to Appendix 8M).~~

~~Selenium concentrations in water and biota would slightly increase progressively from Alternative 4, Scenario H1 (smallest) to Alternative 4, Scenario H4 (largest). However, relative to baseline conditions, all scenarios under Alternative 4 would result in essentially no change in selenium concentrations throughout the Delta. Consequently, Alternative 4 scenarios would not be expected to substantially increase the frequency with which applicable benchmarks would be exceeded in the Delta or substantially degrade the quality of water in the Delta, with regard to selenium.~~

SWP/CVP Export Service Areas

Alternative 4 scenarios would result in small (0.05–0.08 μg/L) ~~changes~~ decreases in long-term average selenium concentrations in water at ~~both modeled Export Service Area assessment locations~~ the Banks and Jones pumping plants, relative to ~~baseline~~ Existing ~~c~~Conditions and the No

Action Alternative, for the entire period modeled (Appendix 8M, Table M-~~10B~~9b). These ~~small changes are reflected~~ decreases in long-term average selenium concentrations in water would result ~~in small percent changes (10% or less)~~ in increases in available assimilative capacity for selenium ~~for all years~~ at these pumping plants, relative to the 1.3 µg/L ~~ecological risk benchmark~~USEPA draft water quality criterion (Figures 8-59b and 8-60b)~~ and generally would have a small positive effect on the Export Service Area locations~~. ~~Relative to Existing Conditions, Alternative 4, Scenarios H1, H2, H3, and H4 would result in modeled increases in assimilative capacity at Banks PP (5%, 4%, 5%, and 4%, respectively) and at Jones PP (7%, 8%, 8%, and 8%, respectively). Relative to the No Action Alternative, Alternative 4, Scenarios H1, H2, H3, and H4 would result in modeled increases in assimilative capacity at Banks PP (5%, 4%, 4%, and 4%, respectively) and at Jones PP (8%, 9%, 9%, and 9%, respectively).~~ The ~~modeled~~ long-term average selenium concentrations in water ~~(Appendix 8M, *Selenium*, Table M-10B) for Existing Conditions (range 0.37–0.58 µg/L), No Action Alternative (range 0.37–0.59 µg/L),~~ for Alternative 4, Scenarios H1–H4 (range 0.~~37~~16–0.~~47~~21 µg/L)~~, H2 (range 0.37–0.46 µg/L), H3 (range 0.37–0.47 µg/L), and H4 (range 0.37–0.46 µg/L) are all similar, and all~~ would be well below the ~~ecological risk benchmark~~USEPA draft water quality criterion ~~(~~of ~~2~~1.3 µg/L (Appendix 8M, Table M-9b).

Relative to Existing Conditions and the No Action Alternative, all scenarios under Alternative 4 would result in small changes (approximately 1%) in estimated selenium concentrations in biota (whole-body fish, bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets) (Figures 8-61a through 8-64b; Appendix 8M, *Selenium*, Table M-24a through M-24d~~D~~) at ~~export service areas~~Banks and Jones pumping plants. Concentrations in biota would not exceed any selenium benchmarks for Alternative ~~1A~~4 (Figures 8-61a through 8-64b).

~~Relative to baseline conditions for Export Service Areas, all scenarios under Alternative 4 would result in small changes in estimated selenium concentrations in biota (Appendix 8M, *Selenium*, Table M-15A through M-15D). Relative to Existing Conditions and No Action Alternative, the largest increase of selenium concentrations in biota, under all scenarios, would be at Banks PP for drought years (except for bird eggs [assuming a fish diet] at Banks PP for all years). Relative to Existing Conditions, under all scenarios, the largest decrease would be at Jones PP for all years (except for bird eggs (assuming a fish diet) at Jones PP for drought years). Relative to the No Action Alternative, the largest decreases in estimated selenium concentrations in biota for each scenario are provided below.~~

- ~~Scenarios H1, H2, and H3: The largest decrease of estimated selenium concentration for biota would be at Jones PP for all years (except for bird eggs (assuming a fish diet) at Jones PP for drought years).~~
- ~~Scenario H4: the largest decrease of selenium concentrations in all biota would be at Jones PP for drought years.~~

~~Concentrations of selenium in biota would not exceed any benchmarks under any scenario for Alternative 4 (Figures 8-61 through 8-64). Thus, relative to baseline conditions, all scenarios under Alternative 4 would result in minimal changes in selenium concentrations at the Export Service Area locations. Selenium concentrations in water and biota generally would decrease for Alternative 4 scenarios and would not exceed ecological benchmarks at either location, whereas the lower benchmark for bird eggs (fish diet) would be exceeded under Existing Conditions and No Action Alternative at Jones PP under drought conditions. This small positive change in selenium concentrations under Alternative 4 scenarios would be expected to slightly decrease the frequency~~

~~with which applicable benchmarks would be exceeded or slightly improve the quality of water at the Export Service Area locations, with regard to selenium.~~

NEPA Effects: Selenium concentrations in water and biota very slightly increase progressively from Scenario H1 (smallest) to Scenario H4 (largest). However, based on the discussion above, the effects on selenium (both as waterborne and as bioaccumulated in biota) from all scenarios under Alternative 4 are not considered to be adverse.

~~Based on the discussion above, the effects on selenium (both as waterborne and as bioaccumulated in biota) from Alternative 4 are not considered to be adverse.~~

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for selenium. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

There are no substantial point sources of selenium in watersheds upstream of the Delta, and no substantial nonpoint sources of selenium in the watersheds of the Sacramento River and the eastern tributaries. Nonpoint sources in the San Joaquin Valley that contribute selenium to the Delta will be controlled through a TMDL developed by the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the Grassland Bypass Project, and Basin Plan objectives (Central Valley Water Board [2010~~c~~d~~)~~] and State Water Board ~~(~~[2010~~d~~b, 2010~~e~~c]) that are expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta. Consequently, any modified reservoir operations and subsequent changes in river flows under Alternative 4 scenarios, relative to Existing Conditions, are expected to cause negligible changes in selenium concentrations in water. Any negligible changes in selenium concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies as related to selenium.

Relative to Existing Conditions, modeling estimates indicate that all scenarios under Alternative 4 would result in essentially no change in selenium concentrations in water or most biota throughout the Delta, with no exceedances of benchmarks for biological effects. The Low Toxicity Threshold Exceedance Quotient for selenium concentrations in sturgeon for all years in the San Joaquin River at Antioch would increase slightly, from 0.94 for Existing Conditions ~~and the No Action Alternative~~ to 1.1 for Alternative 4. Concentrations of selenium in sturgeon would exceed only the lower benchmark, indicating a low potential for effects. Overall, Alternative 4 would not be expected to substantially increase the frequency with which applicable benchmarks would be exceeded in the Delta (there being only a small increase for sturgeon exceedance relative to the low benchmark for sturgeon and no exceedance of the high benchmark) or substantially degrade the quality of water in the Delta, with regard to selenium.

~~This Assessment~~ aAssessment of effects of selenium in the SWP~~, and~~ CVP Export Service Areas is based on effects on selenium concentrations at the Banks and Jones pumping plants. Relative to Existing Conditions, all scenarios under Alternative 4 would ~~slightly decrease~~cause no ~~change~~ increase in the frequency with which applicable benchmarks would be exceeded, ~~(there would be none) or~~ and would slightly improve the quality of water in selenium concentrations at the Banks and Jones pumping plants ~~locations~~.

Based on the above, selenium concentrations that would occur in water under all Alternative 4 scenarios would not cause additional exceedances of applicable state or federal numeric or narrative water quality objectives/criteria, or other relevant water quality effects thresholds identified for this assessment (Table 8-54), by frequency, magnitude, and geographic extent that would result in adverse effects to one or more beneficial uses within affected water bodies. In comparison to Existing Conditions, water quality conditions under all scenarios for Alternative 4 would not increase levels of selenium by frequency, magnitude, and geographic extent such that the affected environment would be expected to have measurably higher body burdens of selenium in aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish) or humans consuming those organisms. Water quality conditions under these alternative scenarios with respect to selenium would not cause long-term degradation of water quality in the affected environment, and therefore would not result in use of available assimilative capacity such that exceedances of water quality objectives/criteria would be likely and would result in substantially increased risk for adverse effects to one or more beneficial uses. All scenarios under this alternative would not further degrade water quality by measurable levels, on a long-term basis, for selenium and, thus, cause the CWA Section 303(d)-listed impairment of beneficial use to be made discernibly worse. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-26: Effects on Selenium Concentrations Resulting from Implementation ofCM2–~~CM22~~CM21

NEPA Effects**:** In general, with the possible exception of changes in Delta hydrodynamics resulting from habitat restoration, CM2–CM~~1~~21 would not substantially increase selenium concentrations in the water bodies of the affected environment. Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, and thus such effects of these restoration measures were included in the assessment of CM1 facilities operations and maintenance (see Impact WQ-25).

As discussed in Impact WQ-25, ~~I~~implementation of these conservation measures may increase water residence time within the restoration areas. Increased restoration area water residence times could increase the bioaccumulation of selenium in biota, thereby potentially increasing fish tissue and bird egg concentrations of selenium (see residence time discussion in Appendix 8M, *Selenium*, and Presser and Luoma [2010b]). Models are not available to quantitatively estimate the level of changes in selenium bioaccumulation as related to residence time, but the effects of residence time are incorporated in the bioaccumulation modeling for selenium that was based on higher K_d values for drought years in comparison to wet, normal, or all years; see Appendix 8M, *Selenium*. If increases in fish tissue or bird egg selenium were to occur, the increases would likely be of concern only where fish tissues or bird eggs are already elevated in selenium to near or above thresholds of concern. That is, where biota concentrations are currently low and not approaching thresholds of concern (which, as discussed above, is the case throughout the Delta, except for sturgeon in the western Delta), changes in residence time alone would not be expected to cause them to then approach or exceed thresholds of concern. In consideration of this factor, although the Delta as a whole is a CWA Section 303(d)-listed water body for selenium, and although monitoring data of fish tissue or bird eggs in the Delta are sparse, the most likely area in which biota tissues would be at levels high enough that additional bioaccumulation due to increased residence time from restoration areas would be a concern is the western Delta and Suisun Bay for sturgeon, as discussed above. As shown in Table 60a, the overall increase in residence time estimated in the western Delta is 4 days relative to Existing Conditions, and 2 days relative to the No Action Alternative. Given the available information, these increases are small enough that they are not expected to substantially affect selenium bioaccumulation in the western Delta.~~Models are not available to quantitatively estimate the level of changes in residence time and the associated selenium bioavailability, but the effects of residence time are incorporated in the bioaccumulation modeling for selenium that was based on higher K_d values (the ratio of selenium concentrations in particulates [as the lowest level of the food chain] relative to the water-borne concentration) for drought years in comparison to wet, normal, or all years; see Appendix 8M, *Selenium*. If increases in fish tissue or bird egg selenium were to occur, the increases would likely be of concern only where fish tissues or bird eggs are already elevated in selenium to near or above thresholds of concern. That is, where biota concentrations are currently low and not approaching thresholds of concern, changes in residence time alone would not be expected to cause them to then approach or exceed thresholds of concern. In consideration of this factor, although the Delta as a whole is a CWA Section 303(d)-listed water body for selenium, and although monitoring data of fish tissue or bird eggs in the Delta are sparse, the most likely areas in which biota tissues would be at levels high enough that additional bioaccumulation due to increased residence time from restoration areas would be a concern are the western Delta and Suisun Bay, and the South Delta in areas that receive San Joaquin River water.~~

The western Delta and Suisun Bay receive elevated selenium loads from North San Francisco Bay (including San Pablo Bay, Carquinez Strait, and Suisun Bay) and from the San Joaquin River. The San Francisco Bay Water Board is conducting a TMDL project to address selenium toxicity in the North San Francisco Bay (North Bay), defined to include a portion of the Delta, Suisun Bay, Carquinez Strait, San Pablo Bay, and the Central Bay (State Water Resources Control Board 2011).The North Bay selenium TMDL will identify and characterize selenium sources to the North Bay and the processes that control the uptake of selenium by wildlife. The TMDL will quantify selenium loads, develop and assign waste load and load allocations among sources, and include an implementation plan designed to achieve the TMDL and protect beneficial uses. Nonpoint sources of selenium in the San Joaquin Valley that contribute selenium to the San Joaquin River, and thus the Delta and Suisun Bay, will be controlled through a TMDL developed by the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the Grassland Bypass Project, and Basin Plan objectives (Central Valley Water Board 2010~~c,~~ d; State Water Board 2010b and 2010c) that are expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta.

~~(State Water Resources Control Board 2010b and 2010c)~~

The South Delta receives elevated selenium loads from the San Joaquin River~~.~~, and as Table 8-60a shows, residence times in this area are expected to increase on an annual average by 11 days relative to Existing Conditions, and 9 days relative to the No Action Alternative. However, as discussed in Impact WQ-25, biota concentrations in the South Delta are not approaching levels of concern. Furthermore, ~~I~~in contrast to Suisun Bay and possibly the western Delta in the future, the South Delta lacks the overbite clam (*Corbula* [*Potamocorbula*] *amurensis*), which is considered a key driver of selenium bioaccumulation in Suisun Bay, due to its high bioaccumulation of selenium and its role in the benthic food web that includes long-lived sturgeon. The South Delta does have *Corbicula fluminea*, another bivalve that bioaccumulates selenium, but to a lesser degree than the overbite clam (Lee et al. 2006).~~it is not as invasive as the overbite clam and thus likely makes up a smaller fraction of sturgeon diet.~~ Also, as mentioned above, nonpoint sources of selenium in the San Joaquin Valley that contribute selenium to the Delta will be controlled through a TMDL developed by the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the Grassland Bypass Project, and Basin Plan objectives (Central Valley Water Board 2010~~c,~~ d; State Water Board 2010b and 2010c) that are expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta. Further, if selenium levels in the San Joaquin River are not sufficiently reduced via these efforts, it is expected that the State Water Board and Central Valley Water Board would initiate additional TMDLs to further control nonpoint sources of selenium. Given the available information, these increases are small enough that they are not expected to cause selenium concentrations in biota in the south Delta to approach or exceed thresholds of concern.

Wetland restoration areas will not be designed such that water flows in and does not flow out. Exchange of water between the restoration areas and existing Delta channels is an important design factor, since one goal of the restoration areas is to export food produced in these areas to the rest of the Delta (see BDCP Chapter 3, *Conservation Strategy*, Section 3.3, Biological Goals and Objectives). Thus, these areas can be thought of as "flow-through" systems. Consequently, although water residence times associated with BDCP restoration could increase, they are not expected to increase without bound, and selenium concentrations in the water column would not continue to build up and be recycled in sediments and organisms as may be the case within a closed system.

However, because increases in bioavailable selenium in the habitat restoration areas are uncertain, proposed avoidance and minimization measures would require evaluating risks of selenium exposure at a project level for each restoration area, minimizing to the extent practicable potential risk of additional bioaccumulation, and monitoring selenium levels in fish and/or wildlife to establish whether, or to what extent, additional bioaccumulation is occurring. See Appendix 3B, *Environmental Commitments* for a description of the environmental commitment BDCP proponents are making with respect to Selenium Management; and Appendix 3.C. of the BDCP for additional detail on this avoidance and minimization measure (AMM27). Data generated as part of the avoidance and minimization measures will assist the State and Regional Water Boards in determining whether beneficial uses are being impacted by selenium, and thus will provide the data necessary to support regulatory actions (including additional TMDL development), should such actions be warranted.

Given the factors discussed in the assessment above, any increases in bioaccumulation rates from water-borne selenium that could occur in some areas as a result of increased water residence time would not be of sufficient magnitude and geographic extent that any portion of the Delta would be expected to have measurably higher body burdens of selenium in aquatic organisms and, therefore, would not substantially increase risk for adverse effects to beneficial uses. Furthermore, although the Delta is a 303(d)-listed water body for selenium, given the discussion in the assessment above, it is unlikely that restoration areas would result in measurable increases in selenium in fish tissues or bird eggs such that the beneficial use impairment would be made discernibly worse.

Because it is unlikely that substantial increases in selenium in fish tissues or bird eggs would occur such that effects on aquatic life beneficial uses would be anticipated, and because of the avoidance and minimization measures that are designed to further minimize and evaluate the risk of such increases, the effects of WQ-26 are considered not adverse.

***CEQA Conclusion*:** There would be no substantial, long-term increase in selenium concentrations in water in the rivers and reservoirs upstream of the Delta, water in the Delta, or the waters exported to the CVP and SWP service areas due to implementation of CM2–CM21 relative to Existing Conditions. Water-borne selenium concentrations under this alternative would not exceed applicable water quality objectives/criteria.

Given the factors discussed in the assessment above, any increases in bioaccumulation rates from water-borne selenium that could occur in some areas as a result of increased water residence times would not be of sufficient magnitude and geographic extent that any portion of the Delta would be expected to have measurably higher body burdens of selenium in aquatic organisms, and therefore would not substantially increase risk for adverse effects to beneficial uses. CM2–CM21 would not cause long-term degradation of water quality resulting in sufficient use of available assimilative capacity such that occasionally exceeding water quality objectives/criteria would be likely. Also, CM2–CM21 would not result in substantially increased risk for adverse effects to any beneficial uses. Furthermore, although the Delta is a 303(d)-listed water body for selenium, given the discussion in the assessment above, it is unlikely that restoration areas would result in measurable increases in selenium in fish tissues or bird eggs such that the beneficial use impairment would be made discernibly worse.

Because it is unlikely that substantial increases in selenium in fish tissues or bird eggs would occur such that effects on aquatic life beneficial uses would be anticipated, and because of the avoidance and minimization measures that are designed to further minimize and evaluate the risk of such increases (see Appendix 3.C. of the BDCP for more detail on AMM27) also described as the Selenium Management environmental commitment(see Appendix 3B, *Environmental Commitments*), this impact is considered less than significant. No mitigation is required.

***NEPA Effects*:** In general, with the possible exception of changes in Delta hydrodynamics resulting from habitat restoration, CM2–CM11 would not substantially increase selenium concentrations in the water bodies of the affected environment. Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, and thus such effects of these restoration measures were included in the assessment of CM1 facilities operations and maintenance (see Impact WQ-25).

However, iImplementation of these conservation measures may increase water residence time within the restoration areas. Increased restoration area water residence times could potentially increase the bioaccumulation of selenium in biota, thereby potentially increasing fish tissue and bird egg concentrations of selenium, but m. Models are not available to quantitatively estimate the level of changes in residence time and the associated selenium bioavailability, but the effects of residence time are incorporated in the bioaccumulation modeling for selenium that was based on higher K_d values (the ratio of selenium concentrations in particulates [as the lowest level of the food chain] relative to the water-borne concentration) for drought years in comparison to wet, normal, or all years; see Appendix 8M, *Selenium*. If increases in fish tissue or bird egg selenium were to occur, the increases would likely be of concern only where fish tissues or bird eggs are already elevated in selenium to near or above thresholds of concern. That is, where biota concentrations are currently low and not approaching thresholds of concern, changes in residence time alone would not be expected to cause them to then approach or exceed thresholds of concern. In consideration of this factor, although the Delta as a whole is a 303(d)-listed water body for selenium, and although monitoring data of fish tissue or bird eggs in the Delta are sparse, the most likely areas in which biota tissues would be at levels high enough that additional bioaccumulation due to increased residence time from restoration areas would be a concern are the western Delta and Suisun Bay, and the South Delta in areas that receive San Joaquin River water.

The western Delta and Suisun Bay receive elevated selenium loads from North San Francisco Bay (including San Pablo Bay, Carquinez Strait, and Suisun Bay) and from the San Joaquin River. Point sources of selenium in North San Francisco Bay (i.e., refineries) that contribute selenium to Suisun Bay are expected to be reduced through a TMDL under development by the San Francisco Bay Water Board (San Francisco Bay Water Board 2012) that is expected to result in decreasing discharges of selenium. Nonpoint sources of selenium in the San Joaquin Valley that contribute selenium to the San Joaquin River, and thus the Delta and Suisun Bay, will be controlled through a TMDL developed by the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the Grassland Bypass Project, and Basin Plan objectives (Central Valley Water Board 2010c, d) that are expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta. If selenium levels are not sufficiently reduced via these efforts, it is expected that the State Water Board and the San Francisco Bay and Central Valley Water Boards would initiate additional actions to further control sources of selenium.

The South Delta receives elevated selenium loads from the San Joaquin River. In contrast to Suisun Bay and possibly the western Delta in the future, the South Delta lacks the overbite clam (*Corbula* [*Potamocorbula*] *amurensis*), which is considered a key driver of selenium bioaccumulation in Suisun Bay, due to its high bioaccumulation of selenium and its role in the benthic food web that includes long-lived sturgeon. The South Delta does have *Corbicula fluminea*, another bivalve that bioaccumulates selenium, but it is not as invasive as the overbite clam and thus likely makes up a smaller fraction of sturgeon diet. Also, as mentioned above, nonpoint sources of selenium in the San Joaquin Valley that contribute selenium to the Delta will be controlled through a TMDL developed by the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the Grassland Bypass Project, and Basin Plan objectives (Central Valley Water Board 2010c, d) that are expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta. Further, if selenium levels in the San Joaquin River are not sufficiently reduced via these efforts, it is expected that the State Water Board and Central Valley Water Board would initiate additional TMDLs to further control nonpoint sources of selenium.

Wetland restoration areas will not be designed such that water flows in and does not flow out. Exchange of water between the restoration areas and existing Delta channels is an important design factor, since one goal of the restoration areas is to export food produced in these areas to the rest of the Delta (see BDCP Chapter 3, *Conservation Strategy*, Section 3.3, Biological Goals and Objectives). Thus, these areas can be thought of as “flow-through” systems. Consequently, althoughwater residence times associated with BDCP restoration could increase, they are not expected toincrease without bound. and selenium concentrations in the water column would not continue to build up and be recycled in sediments and organisms as may be the case within a closed system.

However, because increases in bioavailable selenium in the habitat restoration areas are uncertain, proposed avoidance and minimization measureswould require evaluating risks of selenium exposure at a project level for each restoration area, minimizing to the extent practicable potential risk of additional bioaccumulation, and monitoring selenium levels in fish and/or wildlife to establish whether, or to what extent, additional bioaccumulation is occurring. See Appendix 3B, *Environmental Commitments* for a description of the environmental commitment BDCP proponents are making with respect to Selenium Management; and Appendix 3.C. of the BDCP for additionaldetail on this avoidance and minimization measure (AMM27). Data generated as part of the avoidance and minimization measures will assist the State and Regional Water Boards in determining whether beneficial uses are being impacted by selenium, and thus will provide the data necessary to support regulatory actions (including additional TMDL development), should such actions be warranted.

Given the factors discussed in the assessment above, any increases in bioaccumulation rates from water-borne selenium that could occur in some areas as a result of increased water residence time would not be of sufficient magnitude and geographic extent that any portion of the Delta wouldbe

~~expected to have measurably higher body burdens of selenium in aquatic organisms and, therefore, would not substantially increase risk for adverse effects to beneficial uses. Furthermore, although the Delta is a 303(d)-listed water body for selenium, given the discussion in the assessment above, it is unlikely that restoration areas would result in measurable increases in selenium in fish tissues or bird eggs such that the beneficial use impairment would be made discernibly worse.~~

~~Because it is unlikely that substantial increases in selenium in fish tissues or bird eggs would occur such that effects on aquatic life beneficial uses would be anticipated, and because of the avoidance and minimization measures that are designed to further minimize and evaluate the risk of such increases, the effects of WQ-26 are considered not adverse.~~

~~***CEQA Conclusion*:** There would be no substantial, long-term increase in selenium concentrations in water in the rivers and reservoirs upstream of the Delta, water in the Delta, or the waters exported to the CVP and SWP service areas due to implementation of CM2–CM22CM21 relative to Existing Conditions. Waterborne selenium concentrations under this alternative would not exceed applicable water quality objectives/criteria.~~

~~Given the factors discussed in the assessment above, any increases in bioaccumulation rates from water-borne selenium that could occur in some areas as a result of increased water residence times would not be of sufficient magnitude and geographic extent that any portion of the Delta wouldbe expected to have measurably higher body burdens of selenium in aquatic organisms, and therefore would not substantially increase risk for adverse effects to beneficial uses. CM2-22 would not cause long-term degradation of water quality resulting in sufficient use of available assimilative capacity such that occasionally exceeding water quality objectives/criteria would be likely. Also, CM2-22 would not result in substantially increased risk for adverse effects to any beneficial uses. Furthermore, although the Delta is a 303(d)-listed water body for selenium, given the discussion in the assessment above, it is unlikely that restoration areas would result in measurable increases in selenium in fish tissues or bird eggs such that the beneficial use impairment would be made discernibly worse.~~

~~Since Because it is unlikely that substantial increases in selenium in fish tissues or bird eggs would occur such that effects on aquatic life beneficial uses would be anticipated, and because of the avoidance and minimization measures that are designed to further minimize and evaluate the risk of such increases (see Appendix 3.C. of the BDCP for more detail on AMM27) as well as the Selenium Management environmental commitment (see Appendix 3B, *Environmental Commitments*), this impact is considered less than significant. No mitigation is required.~~

Impact WQ-27: Effects on Trace Metal Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Relative to Existing Conditions and the No Action Alternative, under Alternative 4, Scenarios H1–H4, sources of trace metals would not be expected to change substantially with exception to sources related to population growth, such as increased municipal wastewater discharges and development contributing to increased urban dry and wet weather runoff. Facility operations could have an effect on these sources if concentrations of dissolved metals were closely correlated to river flow, suggesting that changes in river flow, and the related capacity to dilute these sources, could ultimately have a substantial effect on long-term metals concentrations.

On the Sacramento River, available dissolved trace metals data and river flow at Freeport are poorly associated (Appendix 8N, *Trace Metals,* Figure 1). Similarly, dissolved copper, iron, and manganese concentrations on the San Joaquin River at Vernalis are poorly associated (Appendix 8N, Figure 2). While there is an insufficient number of data for the other trace metals to observe trends at Vernalis, it is reasonable to assume that these metals similarly show poor association to San Joaquin River flow, as shown for the corresponding dissolved metals on the Sacramento River.

Given the poor association of dissolved trace metal concentrations with flow, river flow rate and reservoir storage reductions that would occur under Alternative 4, Scenarios H1–H4, relative to Existing Conditions and the No Action Alternative, would not be expected to result in a substantial adverse change in trace metal concentrations in the reservoirs and rivers upstream of the Delta. As such, the Alternative 4, Scenarios H1–H4, would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or CTR criteria would be exceeded in water bodies of the affected environment located upstream of the Delta or substantially degrade the quality of these water bodies, with regard to trace metals.

Delta

For metals of primarily aquatic life concern (copper, cadmium, chromium, lead, nickel, silver, and zinc), average and 95th percentile trace metal concentrations of the primary source waters to the Delta are very similar, with difference typically not greater than a factor of 2 to 5 (Appendix 8N, Table 1-–7). For example, average dissolved copper concentrations on the Sacramento River, San Joaquin River, and Bay (Martinez) are 1.7 µg/L, 2.4 µg/L, and 1.7 µg/L, respectively. The 95th percentile dissolved copper concentrations on the Sacramento River, San Joaquin River, and Bay (Martinez) are 3.4 µg/L, 4.5 µg/L, and 2.4 µg/L, respectively. Given this similarity, very large changes in source water fraction would be necessary to effect a relatively small change in trace metal concentration at a particular Delta location. Moreover, average and 95th percentile trace metal concentrations for these primary source waters are all below their respective water quality criteria, including those that are hardness-based without a WER adjustment (Tables 8-51 and 8-52). No mixing of these three source waters could result in a metal concentration greater than the highest source water concentration, and given that the average and 95th percentile source water concentrations for copper, cadmium, chromium, led, nickel, silver, and zinc do not exceed their respective criteria, more frequent exceedances of criteria in the Delta would not occur under the operational scenario for this alternative.

For metals of primarily human health and drinking water concern (arsenic, iron, manganese), average and 95th percentile concentrations are also very similar(Appendix 8N,*Trace Metals,* Tables 8-–10). The arsenic criterion was established to protect human health from the effects of long-term chronic exposure, while secondary maximum contaminant levels for iron and manganese were established as reasonable goals for drinking water quality. The primary source water average concentrations for arsenic, iron, and manganese are below these criteria. No mixing of these three source waters could result in a metal concentration greater than the highest source water concentration, and given that the average water concentrations for arsenic, iron, and manganese do not exceed water quality criteria, more frequent exceedances of drinking water criteria in the Delta would not be expected to occur under this alternative.

Relative to Existing Conditions and the No Action Alternative, facilities operation under Alternative 4, Scenarios H1–H4, would result in negligible change in trace metal concentrations throughout the Delta. The operational scenarios of Alternative 4 would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or CTR criteria would be exceeded in the Delta or substantially degrade the quality of water in the Delta, with regard to trace metals.

SWP/CVP Export Service Areas

Alternative 4, Scenarios H1–H4, would not result in substantial increases in trace metal concentrations in the water exported from the Delta or diverted from the Sacramento River through the proposed conveyance facilities. As such, there is not expected to be substantial changes in trace metal concentrations in the SWP/CVP export service area waters under any operational scenario of Alternative 4, relative to Existing Conditions or the No Action Alternative. As such, Alternative 4, Scenarios H1–H4, would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or CTR criteria would be exceeded in the water bodies of the affected environment in the SWP and CVP Service Area or substantially degrade the quality of these water bodies, with regard to trace metals.

NEPA Effects: In summary, relative to the No Action Alternative, Alternative 4, Scenarios H1–H4, would not cause a substantial increase in long-term average trace metals concentrations within the affected environment, nor would it cause an increased frequency of water quality objective/criteria exceedances within the affected environment. The effect on trace metals is determined not to be adverse.

CEQA Conclusion: Key findings discussed in the effects assessment relative to Existing Conditions is provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

While greater water demands under the operational scenarios of Alternative 4 would alter the magnitude and timing of reservoir releases north, south and east of the Delta, these activities would have no substantial effect on the various watershed sources of trace metals. Moreover, long-term average flow and trace metals at Sacramento River at Hood and San Joaquin River at Vernalis are poorly correlated; therefore, changes in river flows would not be expected to cause a substantial long-term change in trace metal concentrations upstream of the Delta.

Average and 95th percentile trace metal concentrations are very similar across the primary source waters to the Delta. Given this similarity, very large changes in source water fraction would be necessary to effect a relatively small change in trace metal concentration at a particular Delta location. Moreover, average and 95th percentile trace metal concentrations for these primary source waters are all below their respective water quality criteria, including those that are hardness-based without a WER adjustment. No mixing of these three source waters could result in a metal concentration greater than the highest source water concentration, and given that trace metals do not already exceed water quality criteria, more frequent exceedances of criteria in the Delta would not be expected to occur under any operational scenario of Alternative 4.

The assessment of Alternative 4, Scenario H1–H4, effects on trace metals in the SWP/CVP Export Service Areas is based on assessment of changes in trace metal concentrations at Banks and Jones pumping plants. As just discussed regarding similarities in Delta source water trace metal concentrations, no operational scenario of Alternative 4 is expected to result in substantial changes in trace metal concentrations in Delta waters, including Banks and Jones pumping plants, therefore effects on trace metal concentrations in the SWP/CVP Export Service Area are expected to be negligible.

Based on the above, there would be no substantial long-term increase in trace metal concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the SWP/CVP export service area waters under any operational scenario of Alternative 4 relative to Existing Conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because trace metal concentrations are not expected to increase substantially, no long-term water quality degradation for trace metals is expected to occur and, thus, no adverse effects to beneficial uses would occur. Furthermore, any negligible changes in long-term trace metal concentrations that may occur in water bodies of the affected environment would not be expected to make any existing beneficial use impairments measurably worse. The trace metals discussed in this assessment are not considered bioaccumulative, and thus would not directly cause bioaccumulative problems in aquatic life or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-28: Effects on Trace Metal Concentrations Resulting from Implementation ofCM2–CM22CM21

***NEPA Effects*:** Implementation of CM2–CM22CM21 present no new sources of trace metals to the affected environment, including areas upstream of the Delta, within the Delta, or in the SWP and CVP service areas. However, CM19, which would fund projects to contribute to reducing pollutant discharges in urban stormwater, would be expected to reduce trace metal loading to surface waters of the affected environment. The remaining conservation measures would not be expected to affect trace metal levels, because they are actions that do not affect the presence of trace metal sources. As they pertain to trace metals, implementation of these conservation measures would not be expected to adversely affect beneficial uses of the affected environment or substantially degrade water quality with respect to trace metals.

In summary, implementation of CM2–CM22CM21 under Alternative 4 relative to Existing Conditions and the No Action Alternative, would have negligible, if any, effect on trace metals concentrations. The effect on trace metals from implementing CM2–CM22CM21 is determined not to be adverse.

CEQA Conclusion: Implementation of CM2–CM22CM21 under Alternative 4 would not cause substantial long-term increase in trace metal concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the SWP/CVP export service area. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because trace metal concentrations are not expected to increase substantially, no long-term water quality degradation for trace metals is expected to occur and, thus, no adverse effects to beneficial uses would occur. Furthermore, any negligible changes in long-term trace metal concentrations that may occur throughout the affected environment would not be expected to make any existing beneficial use impairments measurably worse. The trace metals discussed in this assessment are not considered bioaccumulative, and thus would not directly cause bioaccumulative problems in aquatic life or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-29: Effects on TSS and Turbidity Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

TSS concentrations and turbidity levels in rivers upstream of the Delta are affected primarily by: 1) TSS concentrations and turbidity levels of the water released from the upstream reservoirs, 2) erosion occurring within the river channel beds, which is affected by river flow velocity and bank protection, 3) TSS concentrations and turbidity levels of tributary inflows, point-source inputs, and nonpoint runoff as influenced by surrounding land uses; and 4) phytoplankton, zooplankton and other biological material in the water.

Alternative 4, Scenarios H1–H4, would alter the magnitude and timing of water releases from reservoirs upstream of the Delta relative to Existing Conditions and the No Action Alternative, which in turn would alter downstream river flows. With respect to TSS and turbidity, an increase in river flow is generally the concern, as this increases shear stress on the channel, suspending particles resulting in higher TSS concentrations and turbidity levels. Schoellhamer et al. (2007b) noted that suspended sediment concentration was more affected by season than flow, with the higher concentrations for a given flow rate occurring during "first flush events" and lower concentrations occurring during spring snowmelt events. Because of such a relationship, the changes in mean monthly average river flows under the operational scenarios of Alternative 4 are not expected to cause river TSS concentrations or turbidity levels (highs, lows, typical conditions) to be outside the ranges occurring under Existing Conditions or the No Action Alternative. Consequently, this alternative is expected to have minimal effect on TSS concentrations and turbidity levels in the reservoirs and rivers upstream of the Delta.

Changes in land use that would occur relative to Existing Conditions and the No Action Alternative could have minor effects on TSS concentrations and turbidity levels throughout this portion of the affected environment. Site-specific and temporal exceptions may occur due to localized temporary construction activities, dredging activities, development, or other land use changes. These localized actions would generally require agency permits that would regulate and limit both their short-term and long-term effects on TSS concentrations and turbidity levels to less-than-substantial levels.

Delta

TSS concentrations and turbidity levels in Delta waters are affected by TSS concentrations and turbidity levels of the Delta inflows (and associated sediment load). TSS concentrations and turbidity levels within Delta waters also are affected by fluctuation in flows within the channels due to the tides, with sediments depositing as flow velocities and turbulence are low at periods of slack tide, and sediments becoming suspended when flow velocities and turbulence increase when tides are near the maximum. TSS and turbidity variations can also be attributed to phytoplankton, zooplankton and other biological material in the water.

Under Alternative 4, Scenarios H1–H4, any land use changes that may occur under this alternative would not be expected to have permanent, substantial effects on TSS concentrations and turbidity levels of Delta waters, relative to Existing Conditions or the No Action Alternative. Furthermore, this alternative would not cause the TSS concentrations or turbidity levels in the rivers contributing inflows to the Delta to be outside the ranges occurring under Existing Conditions or the No Action Alternative. Consequently, this alternative is expected to have minimal effect on TSS concentrations and turbidity levels in the Delta region. As such, any minor TSS and turbidity changes that may occur under Alternative 4, Scenarios H1–H4, would not be of sufficient frequency, magnitude, and geographic extent that would result in adverse effects on beneficial uses in the Delta region, or substantially degrade the quality of these water bodies, with regard to TSS and turbidity.

SWP/CVP Export Service Areas

The operational scenarios of Alternative 4 are expected to have minimal effect on TSS concentrations and turbidity levels in Delta waters, including water exported at the south Delta pumps, relative to Existing Conditions or the No Action Alternative. As such, Alternative 4 is expected to have minimal effect on TSS concentrations and turbidity levels in the SWP/CVP Export Service Areas waters.

NEPA Effects: The effects on TSS and turbidity from implementing any operational scenario of Alternative 4 is determined to not be adverse.

CEQA Conclusion: Key findings discussed in the effects assessment relative to Existing Conditions is provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Changes in river flow rate and reservoir storage that would occur under the operational scenarios of Alternative 4, relative to Existing Conditions, would not be expected to result in a substantial adverse change in TSS concentrations and turbidity levels in the reservoirs and rivers upstream of the Delta, given that suspended sediment concentrations are more affected by season than flow. Site-specific and temporal exceptions may occur due to localized temporary construction activities, dredging activities, development, or other land use changes would be site-specific and temporal, which would be regulated to limit both their short-term and long-term effects on TSS and turbidity levels to less than substantial levels.

Within the Delta, geomorphic changes associated with sediment transport and deposition are usually gradual, occurring over years, and high storm event inflows would not be substantially affected. Thus, it is expected that the TSS concentrations and turbidity levels in the affected channels would not be substantially different from the levels under Existing Conditions. Consequently, this alternative is expected to have minimal effect on TSS concentrations and turbidity levels in the Delta region, relative to Existing Conditions.

There is not expected to be substantial, if even measurable, changes in TSS concentrations and turbidity levels in the SWP/CVP Export Service Areas waters under any operational scenario of Alternative 4, relative to Existing Conditions, because as stated above, this alternative is not expected to result in substantial changes in TSS concentrations and turbidity levels at the south Delta export pumps, relative to Existing Conditions.

Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives where such objectives are not exceeded under Existing Conditions. Because TSS concentrations and turbidity levels are not expected to be substantially different, long-term water quality degradation is not expected, and, thus, beneficial uses are not expected to be adversely affected. Finally, TSS and turbidity are neither bioaccumulative nor Clean Water Act section 303(d) listed constituents. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-30: Effects on TSS and Turbidity Resulting from Implementation of CM2–~~CM22~~CM21

***NEPA Effects*:** Creation of habitat and open water through implementation of CM2–CM11 could affect Delta hydrodynamics and, thus, erosion and deposition potential in certain Delta channels. The magnitude of increases in TSS concentrations and turbidity levels in the affected channels due to higher potential of erosion cannot be readily quantified. The increases in TSS concentrations and turbidity levels in the affected channels could be substantial in localized areas, depending on how rapidly the Delta hydrodynamics are altered and the channels equilibrate with the new tidal flux regime, after implementation of this alternative. However, geomorphic changes associated with sediment transport and deposition are usually gradual, occurring over years. Within the reconfigured channels there could be localized increases in TSS concentrations and turbidity levels, but within the greater Plan Area it is expected that the TSS concentrations and turbidity levels would not be substantially different from the levels under the No Action Alternative.

CM19, which would fund projects to contribute to reducing pollutant discharges in stormwater, would be expected to reduce TSS and turbidity in urban discharges relative to the No Action Alternative. The remaining conservation measures would not be expected to affect TSS concentrations and turbidity levels, because they are actions that do not affect the presence of TSS and turbidity sources.

The effects on TSS and turbidity from implementing CM2–~~CM22~~CM21 is determined to not be adverse.

***CEQA Conclusion*:** It is expected that the TSS concentrations and turbidity levels Upstream of the Delta, in the Plan Area, and the SWP/CVP Export Service Areas due to implementation of CM2–~~CM22~~CM21 under Alternative 4 would not be substantially different relative to Existing Conditions, except within localized areas of the Delta modified through creation of habitat and open water. Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives where such objectives are not exceeded under Existing Conditions. Because TSS concentrations and turbidity levels Upstream of the Delta, in the greater Plan Area, and in the SWP/CVP Export Service Areas are not expected to be substantially different, long-term water quality degradation is not expected relative to TSS and turbidity, and, thus, beneficial uses are not expected to be adversely affected. Finally, TSS and turbidity are neither bioaccumulative nor Clean Water Act section 303(d) listed constituents. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-31: Water Quality Effects Resulting from Construction-Related Activities (CM1–~~CM22~~CM21)

This section addresses construction-related water quality effects to constituents of concern other than effects caused by changes in the operations and maintenance of CM1–~~CM22~~CM21, which are addressed in terms of constituent-specific impact assessments elsewhere in this chapter. The conveyance features for CM1 under Alternative 4 would be very similar to those discussed for Alternative 1A and most of the construction activity would occur in the Delta. The primary difference between Alternative 4 and Alternative 1A is that under Alternative 4, there would be two fewer intakes and two fewer pumping plant locations, which would result in a reduced level of construction activity. However, construction techniques and locations of major features of the conveyance system within the Delta would be similar. Alternative 4 additionally would include construction of an operable barrier at the head of Old River. The remainder of the facilities constructed under Alternative 4, including CM2–~~CM22~~CM21, would be very similar to, or the same as, those to be constructed for Alternative 1A. Few, if any, of the CM1–~~CM22~~CM21 actions involve construction work in the SWP and CVP Service Area or areas upstream of the Delta. The conservation measures, or components of measures, that are anticipated to be constructed in areas upstream of the Delta would be limited to: (1) the Yolo Bypass Fishery Enhancement (CM2) (i.e., the Fremont Weir component of the action), (2) Conservation Hatcheries (CM18) (i.e., the new hatchery facility), and (3) Urban Stormwater Treatment (CM19). Anticipated construction activities that may occur under CM11–~~CM22~~CM21, if any, would involve relatively minor disturbances, and thus would not be anticipated to result in substantial discharges of any constituents of concern.

Within the Delta, the construction-related activities for Alternative 4 would be most extensive for CM1 involving the new water conveyance facilities. Construction of water conveyance facilities would involve vegetation removal, material storage and handling, excavation, overexcavation for facility foundations, surface grading, trenching, road construction, levee construction, construction site dewatering, soil stockpiling, RTM dewatering basin construction and storage operations, and other general facility construction activities (i.e., concrete, steel, carpentry, and other building trades) over approximately 7,500 acres during the course of constructing the facilities. Vegetation would be removed (via grubbing and clearing) and grading and other earthwork would be conducted at the intakes, pumping plants, the intermediate forebay, the expanded Clifton Court Forebay, culvert siphon between the northern cell of the expanded Clifton Court Forebay to a new canal to the Jones Pumping Plant and a siphon under the Byron Highway into a short segment of canal leading to the Banks Pumping Plant, borrow areas, RTM and spoil storage areas, setback and transition levees, sedimentation basins, solids handling facilities, transition structures, surge shafts and towers, substations, transmission line footings, access roads, concrete batch plants, fuel stations, bridge abutments, barge unloading facilities, and laydown areas. Construction of each intake would take nearly 4 years to complete.

Construction activities necessary to develop the new habitat restoration areas for CM2 and CM4–CM10 including restored tidal wetlands, floodplain, and related channel margin and off-channel habitats, would likely involve a variety of extensive conventional clearing and grading activities on relatively dry sites of the Delta that are currently separated from the Delta channels by levees. Construction would involve new setback levees, excavation and soil placement for new wetland and other habitat feature development, and a variety of potential in-water construction activities such as excavation, sediment dredging, levee breaching, and hauling and placement or disposal of excavated sediment or dredge material. Construction activities for the proposed restoration sites, due to the direct connectivity with Delta channels, have the potential to result in direct discharge of eroded soil and construction-related contaminants, or indirectly through erosion and site inundation during the weeks or months following construction prior to stabilization of newly contoured and restored landforms and colonization by vegetation.

***NEPA Effects*:** The types and magnitude of potential construction-related water quality effects associated with implementation of CM1–~~CM22~~CM21 under Alternative 4 would be very similar to the effects discussed for Alternative 1A, and the effects anticipated with implementation of CM2–~~CM22~~CM21 would be essentially identical. Potential construction-related water quality effects may include discharges of turbidity/TSS due to the erosion of disturbed soils and associated sedimentation entering surface water bodies or other construction-related wastes (e.g., concrete, asphalt, cleaning agents, paint, and trash). Construction activities also may result in temporary or permanent changes in stormwater generation or drainage and runoff patterns (i.e., velocity, volume, and direction) that may cause or contribute to soil erosion and offsite sedimentation, such as creation of additional impervious surfaces (e.g., pavement, buildings, compacted soils), blockage or restriction of existing drainage channels, or general surface drainage changes from grading and excavation activity. Additionally, the use of heavy earthmoving equipment may result in spills and leakage of oils, gasoline, diesel fuel, and related petroleum contaminants used in the fueling and operation of such construction equipment.

Land surface grading and excavation activities, or exposure of disturbed sites immediately following construction and prior to stabilization, could result in rainfall- and stormwater-related soil erosion, runoff, and offsite sedimentation in surface water bodies. The initial runoff following construction, or return of seasonal rains to previously disturbed sites, can result in runoff with peak pollutant levels and is referred to as "first flush" storm events. Soil erosion and runoff can also result in increased concentrations and loading of organic matter, nutrients (nitrogen and phosphorus), and other contaminants contained in the soil such as trace metals, pesticides, or animal-related pathogens. Graded and exposed soils also can be compacted by heavy machinery, resulting in reduced infiltration of rainfall and runoff, thus increasing the rate of runoff (and hence contaminants) to downstream water bodies.

Construction activities also would be anticipated to involve the transport, handling, and use of a variety of hazardous substances and non-hazardous materials that may adversely affect water quality if discharged inadvertently to construction sites or directly to water bodies. Typical construction-related contaminants include petroleum products for refueling and maintenance of machinery (e.g., fuel, oils, solvents), concrete, paints and other coatings, cleaning agents, debris and trash, and human wastes. Construction activities also would involve large material storage and laydown areas, and occasional accidental spills of hazardous materials stored and used for construction may occur. Contaminants released or spilled on bare soil also may result in groundwater contamination. Dewatering operations may contain elevated levels of suspended sediment or other constituents that may cause water quality degradation.

The intensity of construction activity along with the fate and transport characteristics of the chemicals used, would largely determine the magnitude, duration, and frequency of construction-related discharges and resulting concentrations and degradation associated with the specific constituents of concern. The potential water quality concerns associated with the major categories of contaminants that might be discharged as a result of construction activity include the following.

- Suspended sediment: May increase turbidity (i.e., reduce water clarity) that can affect aquatic organisms and increase the costs and effort of removal in municipal/industrial water supplies. Downstream sedimentation can affect aquatic habitat, or cause a nuisance if it affects functions of agricultural or municipal intakes, or boat navigation.
- Organic matter: May contribute turbidity and oxygen demanding substances (i.e., reduce dissolved oxygen levels) that can affect aquatic organisms. Organic carbon may increase the potential for disinfection byproduct formation in municipal drinking water supplies.
- Nutrients: May contribute nitrogen, phosphorus, and other key nutrients that can contribute to nuisance biostimulation of algae and vascular aquatic plants, which may affect municipal water supplies, recreation, aquatic life, and aesthetics.
- Petroleum hydrocarbons: May contribute toxic compounds to aquatic life, and oily sheens may reduce oxygen/gas transfer in water, foul aquatic habitats, and reduce water quality for municipal supplies, recreation, and aesthetics.

- Trace constituents (metals, pesticides, synthetic organic compounds): Compounds in eroded soil or construction-related materials (e.g., paints, coatings, cleaning agents) may be toxic to aquatic life.
- Pathogens: Bacteria, viruses, and protozoans may affect aquatic life and increase human health risks via municipal water supplies, reduced recreational water quality, or contaminated shellfish beds.
- Other inorganic compounds: Construction-related materials can contain inorganic compounds such as acidic/basic materials which can change pH and may adversely affect aquatic life and habitats. Concrete contains lime which can increase pH levels, and drilling fluids may alter pH.

Some construction-related contaminants, such as PAHs that may be in some fuel and oil petroleum byproducts, may be bioaccumulative in aquatic and terrestrial organisms. Construction activities also may disturb areas where bioaccumulative constituents are present in the soil (e.g., mercury, selenium, organochlorine pesticides, PCBs, and dioxin/furan compounds), or may disturb soils that contain constituents included on the Section 303(d) lists of impaired water bodies in the affected environment. While the 303(d)-listed Delta channels impaired by mercury are widespread, impairment by selenium, pesticides, PCBs, and dioxin/furan compounds is more limited, and there are no 303(d) listings for PAH impairment. Bioaccumulation of constituents in the aquatic foodchain, and 303(d)-related impaired water bodies, arise as a result of long-term loading of a constituent or a pervasive and widespread source of constituent discharge (e.g., mercury).However, as a result of the generally localized disturbances, and intermittent and temporary nature of construction-related activities, construction would not be anticipated to result in contaminant discharges of substantial magnitude or duration to contribute to long-term bioaccumulation processes, or cause measureable long-term degradation such that existing 303(d) impairments would be made discernibly worse or TMDL actions to reduce loading would be adversely affected.

The environmental commitments for construction-related water quality protection would be specifically designed as a part of the final design, included in construction contracts as a required element, and would be implemented for Alternative 4 to avoid, prevent, and minimize the potential discharges of constituents of concern to water bodies and associated adverse water quality effects and comply with state water quality regulations. Additionally, temporary and permanent changes in stormwater drainage and runoff would be minimized and avoided through construction of new or modified drainage facilities, as described in the Chapter 3, *Description of Alternatives*. Alternative 4 would include installation of temporary drainage bypass facilities, long-term cross drainage, and replacement of existing drainage facilities that would be disrupted due to construction of new facilities.

Construction-related activities under Alternative 4 would be conducted in accordance with the environmental commitment to develop and implement BMPs for all activities that may result in discharge of soil, sediment, or other construction-related contaminants to surface water bodies, and obtain authorization for the construction activities under the State Water Board's NPDES Stormwater General Permit for Stormwater Discharges Associated with Construction and Land Disturbance Activities (Order No. 2009-0009-DWQ/NPDES Permit No. CAS000002). The General Construction NPDES Permit requires the preparation and implementation of SWPPPs, which are the principal plans within the required PRDs that identify the proposed erosion control and pollution prevention BMPs that would be used to avoid and minimize construction-related erosion and contaminant discharges. The development of the SWPPPs, and applicability of other provisions of this General Construction Permit depends on the "risk" classification for the construction which is determined based on the potential for erosion to occur as well as the susceptibility of the receiving water to potential adverse effects of construction. While the determination of project risk level, and planning and development of the SWPPPs and BMPs to be implemented, would be completed as a part of final design and contracting for the work, the responsibility for compliance with the provisions of the General Construction Permit necessitates that BMPs are applied to all disturbance activities. In addition to the BMPs, the SWPPPs would include BMP inspection and monitoring activities, and identify responsibilities of all parties, contingency measures, agency contacts, and training requirements and documentation for those personnel responsible for installation, inspection, maintenance, and repair of BMPs. The General Construction Permit contains NALs and for pH and turbidity, and specifies storm event water quality monitoring to determine if construction is resulting in elevated discharges of these constituents, and monitoring for any non-visible contaminants determined to have been potentially released. If an NAL is determined to have been exceeded, the General Construction Permit requires the discharger to conduct a construction site and run-on evaluation to determine whether contaminant sources associated with the site's construction activity may have caused or contributed to the exceedance and immediately implement corrective actions if they are needed.

The BMPs that are routinely implemented in the construction industry and have proven successful at reducing adverse water quality effects include, but are not limited to, the following broad categories of actions (letters refer to categories of specific BMPs identified in Appendix 3B, *Environmental Commitments*), for which Appendix 3B identifies specific BMPs within these categories:

- Waste Management and Spill Prevention and Response (BMP categories A.2 and A.3): Waste management BMPs are designed to minimize exposure of waste materials at all construction sites and staging areas such as waste collection and disposal practices, containment and protection of wastes from wind and rain, and equipment cleaning measures. Spill prevention and response BMPs involve planning, equipment, and training for personnel for emergency event response.

- Erosion and Sedimentation Control (BMP categories A.4 and A.5): Erosion control BMPs are designed to prevent erosion processes or events including scheduling work to avoid rain events, stabilizing exposed soils; minimize offsite sediment runoff; remove sediment from onsite runoff before it leaves the site; and slow runoff rates across construction sites. Identification of appropriate temporary and long-term seeding, mulching, and other erosion control measures as necessary. Sedimentation BMPs are designed to minimize offsite sediment runoff once erosion has occurred involving drainage controls, perimeter controls, detention/sedimentation basins, or other containment features.

- Good Housekeeping and Non-Stormwater Discharge Management (BMP category A.6 and A.7): Good housekeeping BMPs are designed to reduce exposure of construction sites and materials storage to stormwater runoff including truck tire tracking control facilities; equipment washing; litter and construction debris; and designated refueling and equipment inspection/maintenance practices Non-stormwater discharge management BMPs involve runoff measures for contaminants not directly associated with rain or wind including vehicle washing and street cleaning operations.

- Construction Site Dewatering and Pipeline Testing (BMP category A.8).Dewatering BMPs involve actions to prevent discharge of contaminants present in dewatering of groundwater during construction, discharges of water from testing of pipelines or other facilities, or the indirect erosion that may be caused by dewatering discharges.

- BMP Inspection and Monitoring (BMP category A.9): Identification of clear objectives for evaluating compliance with SWPPP provisions, and specific BMP inspection and monitoring procedures, environmental awareness training, contractor and agency roles and responsibilities, reporting procedures, and communication protocols.

In addition to the Category "A" BMPs for surface land disturbances identified in the environmental commitments (Appendix 3B, *Environmental Commitments*), BMPs implemented for Alternative 4 also would include the Category "B" BMPs for tunnel/pipeline construction that involves actions primarily to avoid and minimize sediment and contaminant discharges associated with RTM excavation, hauling, and RTM dewatering operations. Additionally, habitat restoration activities under CM2 and CM4–CM10 would be subject to implementation of the Category "C" BMPs (In-Water Construction BMPs) and Category "D" BMPs (Tidal and Wetland Restoration) designed to minimize disturbance and direct discharge of turbidity/suspended solids to the water during in-water construction activities. Category "E" BMPs identify general permanent post-construction actions that would be implemented for all terrestrial, in-water, and habitat restoration activities and would involve planning, design, and development of final site stabilization, revegetation, and drainage control features.

Finally, acquisition of applicable environmental permits may be required for specific conservation measures, which as described for the No Action Alternative, may include specific WDRs or CWA Section 401 water quality certifications from the appropriate Regional Water Boards, CDFW Streambed Alteration Agreements, and USACE CWA Section 404 dredge and fill permits. These other permit processes may include requirements to implement additional action-specific BMPs that may reduce potential adverse discharge effects of constituents of concern.

The potential construction-related contaminant discharges that could result from projects defined under Alternative 4 would not be anticipated to result in adverse water quality effects at a magnitude, frequency, or regional extent that would cause substantial adverse effects to aquatic life. Relative to Existing Conditions, this assessment indicates the following.

- Projects would be managed under state water quality regulations and project-defined actions to avoid and minimize contaminant discharges.
- Individual projects would generally be dispersed, and involve infrequent and temporary activities, thus not likely resulting in substantial exceedances of water quality standards or long-term degradation.
- Potential construction-related contaminant discharges under the Alternative 4 would not cause additional exceedance of applicable water quality objectives where such objectives are not exceeded under Existing Conditions. Long-term water quality degradation is not anticipated, and hence would not be expected to adversely affect beneficial uses.
- By the intermittent and temporary frequency of construction-related activities and potential contaminant discharges, the constituent-specific effects would not be of substantial magnitude or duration to contribute to long-term bioaccumulation processes, or cause measureable long-term degradation such that existing 303(d) impairments would be made discernibly worse or TMDL actions to reduce loading would be adversely affected.

Consequently, because the construction-related activities for the conservation measures would be conducted with implementation of environmental commitments, including but not limited to those identified in Appendix 3B, with respect to the Existing Conditions and No Action Alternative conditions, Alternative 4 would not be expected to cause constituent discharges of sufficient frequency and magnitude to result in a substantial increase of exceedances of water quality objectives/criteria, or substantially degrade water quality with respect to the constituents of concern, and thus would not adversely affect any beneficial uses in the Delta.

In summary, with implementation of environmental commitments in Appendix 3B, the potential construction-related water quality effects are considered to be not adverse.

CEQA Conclusion: Because environmental commitments would be implemented under Alternative 4 for construction-related activities along with agency-issued permits that also contain construction requirements to protect water quality, the construction-related effects, relative to Existing Conditions, would not be expected to cause or contribute to substantial alteration of existing drainage patterns which would result in substantial erosion or siltation on- or off-site, substantial increased frequency of exceedances of water quality objectives/criteria, or substantially degrade water quality with respect to the constituents of concern on a long-term average basis, and thus would not adversely affect any beneficial uses in water bodies upstream of the Delta, within the Delta, or in the SWP and CVP service area. Moreover, because the construction-related activities would be temporary and intermittent in nature, the construction would involve negligible discharges, if any, of bioaccumulative or 303(d) listed constituents to water bodies of the affected environment. As such, construction activities would not contribute measurably to bioaccumulation of contaminants in organisms or humans or cause 303(d) impairments to be discernibly worse. Based on these findings, this impact is determined to be less than significant. No mitigation is required.

Impact WQ-32. Effects on *Microcystis* Bloom Formation Resulting from Facilities Operations and Maintenance (CM1).

Upstream of the Delta

Impacts from *Microcystis* upstream of the Delta have only been documented in lakes such as Clear Lake, where eutrophic levels of nutrients give cyanobacteria a competitive advantage over other phytoplankton during the bloom season. Large reservoirs upstream of the Delta are typically characterized by low nutrient concentrations, where other phytoplankton outcompete cyanobacteria, including *Microcystis*. In the rivers and streams of the Sacramento River watershed, watersheds of the eastern tributaries (Cosumnes, Mokelumne, and Calaveras Rivers), and the San Joaquin River upstream of the Delta, under Existing Conditions and the No Action Alternative, bloom development is limited by high water velocity and low residence times. These conditions are not expected to change under the four operational scenarios of Alternative 4. Consequently, any modified reservoir operations under any of the four operational scenarios of Alternative 4 are not expected to promote *Microcystis* production upstream of the Delta, relative to Existing Conditions and the No Action Alternative.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics. To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related changes of water residence times and its effects on *Microcystis* production (i.e., CM1). Other effects of CM2 through CM21 not attributable to hydrodynamics are discussed within the impact header for CM2 through CM21.

Table ~~Ms-1~~8-60a shows modeled long-term average residence times in the six Delta sub-regions during the *Microcystis* summer and fall bloom periods for Existing Conditions, No Action Alternative, and operational scenario H3 of Alternative 4. Modeled average residence times for operational scenarios H1, H2, and H4 of Alternative 4 are not available. However, during the summer and fall period, the operations and maintenance of operational scenarios H3 and H4 are identical, and operations and maintenance of operational scenarios H1 and H2 during the summer and fall periods are identical to those of Alternative 3. Thus, the assessment of effects of water residence times on *Microcystis* during the summer and fall bloom periods under operational scenarios H1 and H2 of Alternative 4 are based on the assumption that the changes in modeled residence times that would occur under these two operational scenarios would be equivalent to those that would occur under Alternative 3, as shown in Table ~~Ms-1~~8-60a. Likewise, the assessment of effects of water residence times which would occur under operational scenario H4 assumes that the changes in modeled residence times that would occur under operational scenario H4 would be equivalent to those that would occur under operational scenario H3, as shown in Table ~~Ms-1~~8-60a.

Under the four operational scenarios of Alternative 4, modeled long-term average residence times in the six Delta sub-regions during the *Microcystis* bloom season of June through September show varying levels of change, depending on sub-region and timeframe (Table ~~Ms-1~~8-60a). Although an increase in residence time throughout the Delta is expected under the No Action Alternative, relative to Existing Conditions, because of climate change and sea level rise, the change is fairly small in most areas of the Delta. Thus, the changes in residence times between Alternative 4 and the No Action Alternative are very similar to the changes in residence times between Alternative 4 and the Existing Conditions. Below, residence times under Alternative 4 is compared to residence times under the No Action Alternative to remove the effect of climate change and sea level rise, thereby revealing the effect due to CM1 (i.e., operations) and the effect of the CM2 and CM4 restoration areas, which were accounted for in the modeling performed for CM1.

For operational scenarios H1 and H2 of Alternative 4 (as shown for Alternative 3 in Table ~~Ms-1~~8-60a), relative to the No Action Alternative, water residence time is expected to increase 3–10 days in the North Delta (summer and fall); increase 24 days in the summer and decrease 3 days in the fall in the Cache Slough sub-region; increase 6 days in the West Delta (both summer and fall); increase 8 days in the summer and decrease 3 days in the fall in the East Delta; increase 4 days in the summer and decrease 3 days in the fall in the South Delta; and decrease 22 days in the summer and increase 20 days in the fall in the Suisun Marsh sub-region.

For operational scenarios H3 and H4 of Alternative 4 (as shown for Alternative 4 in **Table ~~Ms-1~~8-60a**), relative to the No Action Alternative, water residence time is expected to increase 1–7 days in the North Delta (summer and fall); increase 18 days in the summer and decrease 6 days in the fall in the Cache Slough sub-region; increase 3–4 days in the West Delta (both summer and fall); increase 8–13 days in the East Delta (summer and fall); increase 6 days in the summer and 32 days in the fall in the South Delta; and decrease 23 days in the summer and increase 15 days in the fall in the Suisun Marsh sub-region.

The summer and fall period average residence times provide a general direction in which residence time may change under the four operational scenarios of Alternative 4 compared to the No Action

Alternative. The changes in residence time are driven by a number of factors accounted for in the modeling, including the hydrodynamic effects of restoration actions planned under CM2 and CM4, diversion of Sacramento River water at the proposed north Delta intake facility, as well as changes in net Delta outflows. Variability in local residence times is expected within any Delta sub-region because major portions of the Delta are comprised of complex networks of intertwining channels, shallow back water areas, and submerged islands. Siting and design of restoration areas has substantial influence on the magnitude of residence time increases that would occur under Alternative 4. However, the expected residence time increases that would occur during the summer bloom period at various Delta locations under the four operational scenarios of Alternative 4, compared to the No Action Alternative, are in a direction and of magnitude that could lead to an increase in the frequency, magnitude, and geographic extent of *Microcystis* blooms throughout the Delta.

The relationship between Delta water temperatures, climate change, and changes in water deliveries from upstream reservoirs are discussed in Appendix 29C. In short, ambient meteorological conditions are the primary driver of Delta water temperatures, meaning that climate warming and not water operations will determine future water temperatures in the Delta. Climate projections for the Central Valley, California discussed in Appendix 5A-D indicate substantial warming of ambient air temperatures with a median increase in annual temperature of about 1.1°C (2.0°F) by 2025 and 2.2°C (4.0°F) by 2060. The projected water temperature change ranges from 0.7 to 1.4°C (1.3 to 2.5°F) by 2025 and 1.6 to 2.7°C (2.9-4.9°F) by 2060. Increasing water temperatures could lead to earlier attainment of the water temperature threshold of 19°C required to initiate *Microcystis* bloom formation, and thus earlier occurrences of *Microcystis* blooms in the Delta, relative to Existing Conditions. Warmer water temperatures could also increase bloom duration and magnitude, relative to Existing Conditions. Elevated ambient water temperatures in the Delta, and thus an increase in *Microcystis* bloom duration and magnitude, are expected under operational scenarios H1–H4 of Alternative 4, relative to Existing Conditions, but these impacts are due entirely to climate change and not the project alternative. Because climate change is assumed under the No Action Alternative, potential water temperature-driven increases in *Microcystis* blooms in the Delta, relative to Existing Conditions, also would occur under the No Action Alternative. Therefore, no water temperature-driven increases in *Microcystis* blooms would occur in the Delta under Alternative 4, relative to the No Action Alternative.

SWP/CVP Export Service Areas

The assessment of effects from *Microcystis* in the SWP/CVP Export Service Areas is based on the assessment of *Microcystis* production in source waters to Banks and Jones Pumping plants, and upon the effects of residence time and water temperature on the potential for *Microcystis* blooms to occur in the Export Service Area.

Under operational scenarios H1–H4 of Alternative 4, exports from Banks and Jones pumping plants will consist of a mixture of Sacramento River water diverted around the Delta, with water quality characteristic of both upstream Sacramento River water, and Sacramento and San Joaquin River water that has flowed through various portions of the North, South, and West Delta. Water diverted from the Sacramento River in the North Delta is expected to be unaffected by *Microcystis* and microcystins. However, the fraction of water flowing through the Delta that reaches the existing south Delta intakes is expected to be influenced by an increase in the frequency, magnitude, and geographic extent of *Microcystis* blooms discussed in the "Delta" section above. Therefore, relative to Existing Conditions and the No Action Alternative, the addition of Sacramento River water from the North Delta under Alternative 4 serves to dilute *Microcystis* and microcystins in water diverted from the South Delta with water that is not expected to contain them. Because the degree to which *Microcystis* blooms, and thus microcystins concentrations, will increase in source water from the South Delta is unknown, it cannot be determined whether Alternative 4 will result in increased or decreased levels of microcystins in the mixture of source waters exported from Banks and Jones pumping plants, relative to Existing Conditions and the No Action Alternative.

Microcystis blooms have not occurred in the Export Service Areas even though source waters to the SWP and CVP have been affected. Conditions in the Export Service Areas under the four operational scenarios of Alternative 4 may become more conducive to *Microcystis* bloom formation, relative to Existing Conditions, because water temperatures will increase in the Export Service Areas due to the expected increase in ambient air temperatures resulting from climate change. Residence times in this area are not expected to substantially change under the four operational scenarios of Alternative 4, relative to Existing Conditions. Conditions in the Export Service Areas under the four operational scenarios of Alternative 4 are not expected to become more conducive to *Microcystis* bloom formation, relative to the No Action Alternative, because neither water residence time nor water temperatures will increase in the Export Service Areas.

NEPA Effects: In summary, operations and maintenance under the four operational scenarios of Alternative 4, relative to the No Action Alternative, would result in long-term increases in hydraulic residence time of various Delta sub-regions during the summer and fall *Microcystis* bloom period. During this period, the increased residence time could result in a concurrent increase in the frequency, magnitude, and geographic extent of *Microcystis* blooms, and thus microcystin levels, in affected areas of the Delta. As a result, Alternative 4 operation and maintenance activities would cause further degradation to water quality with respect to *Microcystis* in the Delta. Under the four operational scenarios of Alternative 4, relative to No Action Alternative, water exported to the SWP/CVP Export Service Area will be a mixture of *Microcystis*-affected source water from the south Delta intakes and unaffected source water from the Sacramento River, diverted at the north Delta intakes. It cannot be determined whether operations and maintenance under Alternative 4 will result in increased or decreased levels of *Microcystis* and microcystins in the mixture of source waters exported from Banks and Jones pumping plants. Mitigation Measure WQ-32a and WQ-32b are available to reduce the effects of degraded water quality in the Delta. Although there is considerable uncertainty regarding this impact, the effects on *Microcystis* from implementing CM1 is determined to be adverse.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Under the various operational scenarios of Alternative 4 additional impacts from *Microcystis* in the reservoirs and watersheds upstream of the Delta are not expected, relative to Existing Conditions. Operations and maintenance occurring under any of the operational scenarios of Alternative 4 is not expected to change nutrient levels in upstream reservoirs or hydrodynamic conditions in upstream rivers and streams such that conditions would be more conductive to *Microcystis* production.

Relative to Existing Conditions, water temperatures and hydraulic residence times in the Delta are expected to increase under all operational scenarios of Alternative 4, resulting in an increase in the frequency, magnitude and geographic extent of *Microcystis* blooms in the Delta. However, the degradation of water quality from *Microcystis* blooms due to the expected increases in Delta water temperatures is driven entirely by climate change, not effects of CM1. Increases in Delta residence times are expected throughout the Delta during the summer and fall bloom period, due in small part to climate change and sea level rise, but due more proportionately to CM1 and the hydrodynamic impacts of restoration included in CM2 and CM4. The precise change in local residence times and *Microcystis* production expected within any Delta sub-region is unknown because conditions will vary across the complex networks of intertwining channels, shallow back water areas, and submerged islands that compose the Delta. Nonetheless, ~~Delta~~ residence times are, in general, expected to increase during the *Microcystis* bloom period at various Delta locations under all operational scenarios of Alternative 4. Consequently, it is possible that increases in the frequency, magnitude, and geographic extent of *Microcystis* blooms in the Delta will occur due to the operations and maintenance ~~of~~ under the four operational scenarios of Alternative 4 and the hydrodynamic impacts of restoration (CM2 and CM4).

The assessment of effects of *Microcystis* on SWP/CVP Export Service Areas is based on the assessment of changes in *Microcystis* levels in export source waters, as well as the effects of temperature and residence time changes within the Export Service Areas on *Microcystis* production. Under the various operational scenarios of Alternative ~~1~~A4, relative to Existing Conditions, the potential for *Microcystis* to occur in the Export Service Area is expected to increase due to increasing water temperature, but this impact is driven entirely by climate change and not Alternative ~~1~~A4. Water exported from the Delta to the Export Service Area is expected to be a mixture of *Microcystis*-affected source water from the south Delta intakes and unaffected source water from the Sacramento River. Because of this, it cannot be determined whether operations and maintenance under the four operational scenarios of Alternative ~~1~~A4, relative to existing conditions, will result in increased or decreased levels of *Microcystis* and microcystins in the mixture of source waters exported from Banks and Jones pumping plants.

Based on the above, this alternative would not be expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause significant impacts on any beneficial uses of waters in the affected environment. *Microcystis* and microcystins are not 303(d) listed within the affected environment and thus any increases that could occur in some areas would not make any existing *Microcystis* impairment measurably worse because no such impairments currently exist. Because *Microcystis* and microcystins are not bioaccumulative, increases that could occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. However, because it is possible that increases in the frequency, magnitude, and geographic extent of *Microcystis* blooms in the Delta will occur due to the operations and maintenance of the four operational scenarios of Alternative ~~1A~~ 4 and the hydrodynamic impacts of restoration (CM2 and CM4), long-term water quality degradation may occur and, thus, significant impacts on beneficial uses could occur. Although there is considerable uncertainty regarding this impact, the effects on *Microcystis* from implementing CM1 is determined to be significant.

Implementation of Mitigation Measure WQ-32a and WQ-32b may reduce degradation of Delta water quality due to *Microcystis*. However, because the effectiveness of these mitigation measures to result in feasible measures for reducing water quality effects is uncertain, this impact is considered to remain significant and unavoidable.

Mitigation Measure WQ-32a: Design Restoration Sites to Reduce Potential for Increased *Microcystis* Blooms

It remains to be determined whether, or to what degree, *Microcystis* production will increase in Delta areas as a result of increased residence times associated with the implementation of the four operational scenarios of the project alternative. Mitigation actions shall be focused on those incremental effects attributable to implementation of operations under the project alternative only. Development of mitigation actions for the incremental increase in *Microcystis* effects attributable to water temperature and residence time increases driven by climate change and sea level rise is not required because these changed conditions would occur with or without implementation of the project alternative. The goal of specific actions would be to reduce/avoid additional degradation of Delta water quality conditions with respect to occurrences of *Microcystis* blooms.

Additional evaluation will be conducted as part of the development of tidal habitat restoration areas to determine the feasibility of using site placement and design criteria to reduce or eliminate local conditions conducive to *Microcystis* production. Design criteria would be developed to provide guidelines for developing restoration areas to discourage *Microcystis* growth by maintaining adequate flushing, while maintaining the benefits of habitat restoration in terms of zooplankton production, fish food quality, and fish feeding success. For example, a target range of typical summer/fall hydraulic residence time that is long enough to promote phytoplankton growth, but not so long as to promote growth of *Microcystis*, could be used to aid restoration site design. However, currently there is not sufficient scientific certainty to evaluate whether or not longer residence times would result in greater *Microcystis* production, and also whether longer residence times might produce greater benefits to fish and other aquatic life than shorter residence times. This mitigation measure requires that residence time considerations be incorporated into restoration area site design for ~~CM 2~~CM2 and CM4 using best available science at the time of design. It is possible that through these efforts, increases in *Microcystis* under CM1 attributable to the project alternative, relative to Existing Conditions, could be mitigated. However, there may be instances where this design consideration may not be feasible, and thus, achieving *Microcystis* reduction pursuant to this mitigation measure would not be feasible.

Mitigation Measure WQ-32b: Investigate and Implement Operational Measures to Manage Water Residence Time

Because it is not known where, when, and to what extent *Microcystis* will be more abundant under CM1 than under Existing Conditions, specific mitigation measures cannot be described. However, this mitigation measure requires the project proponents to monitor for *Microcystis* abundance in the Delta and use appropriate statistical methods to determine whether increases in abundance are significant. This mitigation measure also requires that if *Microcystis* abundance increases, relative to Existing Conditions, the project proponents will investigate and evaluate measures that could be taken to reduce residence time in the affected areas of the Delta. Operational actions could include timing of temporary or operable barrier openings and closings, reservoir releases, and location of Delta exports (i.e., North Delta vs. South Delta pumping facilities). Depending on the location and severity of the increases, one or more of these actions may be feasible for reducing residence times. If so, these actions could mitigate increases in *Microcystis* under CM1 attributable to the project alternative, relative to Existing Conditions. However, it is possible that these actions would not be feasible because they would conflict with other project commitments, would cause their own environmental impacts, or would not be expected to reduce or mitigate increases in *Microcystis*. In this case, achieving *Microcystis* reduction pursuant to this mitigation measure would not be feasible.

Impact WQ-33. Effects on *Microcystis* Bloom Formation Resulting from Other Conservation Measures (CM2-–CM21).

Implementation of CM3 and CM6-–CM21 is unlikely to ~~e~~affect ~~to~~ *Microcystis* abundance in the rivers and reservoirs upstream of the Delta, in the Delta region, or the waters exported to the CVP and SWP service areas. Implementation of CM5, Seasonally Inundated Floodplain Restoration, could result in increased local water temperatures in areas near restored seasonally inundated floodplains. However, floodplain inundation typically occurs during spring and winter months when *Microcystis* growth is limited in general by low water temperatures and by insufficient surface water irradiance, and water temperatures would not increase sufficiently due to floodplain inundation such that effects on *Microcystis* growth would occur. Therefore, implementation of CM5 is unlikely to affect *Microcystis* blooms in the project area. Implementation of CM13, Invasive Aquatic Vegetation Control, may increase turbidity and flow velocity, particularly in restored aquatic habitats, which could discourage *Microcystis* growth in these areas. To the extent that IAV removal would affect turbidity and water velocity, it is possible that IAV removal could, to some degree, help offset the increase in *Microcystis* production expected under Alternative 4, relative to the No Action Alternative.

As discussed in detail in Impact WQ-32, development of restoration areas which will occur under CM2 and CM4 could possibly increase the frequency, magnitude, and geographic extent of *Microcystis* blooms due to the hydrodynamic impacts that are expected to increase water residence times throughout various areas of the Delta relative to Existing Conditions and the No Action Alternative. Additionally, restoration activities that create shallow backwater areas, due to implementation of CM2 and CM4, could result in local warmer water that may encourage *Microcystis* growth during the summer bloom forming season and result in further degradation of water quality. Mitigation to specifically address the effects of local increases in water temperatures on *Microcystis* in the vicinity of such restoration areas is not available. Regardless of elevated water temperatures, sufficient residence time is required for *Microcystis* bloom formation. Thus, the combined effect on *Microcystis* from increased local water temperatures and increased water residence times may be reduced by implementation of Mitigation Measure WQ-32a and WQ-32b. The effectiveness of these mitigation measures to result in feasible measures for reducing water quality effects is uncertain.

NEPA Effects: Although there is considerable uncertainty regarding this impact, the effects on *Microcystis* from implementing CM2-CM21 are determined to be adverse.

CEQA Conclusions: Based on the above, this alternative would not be expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause significant impacts on any beneficial uses of waters in the affected environment. *Microcystis* and microcystins are not 303(d) listed within the affected environment and thus any increases that could occur in some areas would not make any existing *Microcystis* impairment measurably worse because no such impairments currently exist. Because *Microcystis* and microcystins are not bioaccumulative, increases that could occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. Because restoration actions implemented under CM2 and CM4 will increase residence time throughout the Delta and create local areas of warmer water during the bloom season, it is possible that increases in the frequency, magnitude, and geographic extent of *Microcystis* blooms, and thus long-term water quality degradation and significant impacts on beneficial uses, could occur. Although there is considerable uncertainty regarding this impact, the effects on *Microcystis* from implementing CM2–CM21 are determined to be significant.

Impact WQ-34: Effects on San Francisco Bay Water Quality Resulting from Facilities Operations and Maintenance (CM1) and Implementation of CM2–CM21

The effects analysis presented in the preceding impacts (Impact WQ-1 through WQ-33) concluded that Alternative 4 would have a less than significant impact/no adverse effect on the following constituents in the Delta:

- Boron
- Dissolved Oxygen
- Pathogens
- Pesticides
- Trace Metals
- Turbidity and TSS

Elevated concentrations of boron are of concern in drinking and agricultural water supplies. However, waters in the San Francisco Bay are not designated to support municipal water supply (MUN) and agricultural supply (AGR) beneficial uses. Changes in Delta dissolved oxygen, pathogens, pesticides, and turbidity and TSS are not anticipated to be of a frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of the Delta. Thus, changes in boron, dissolved oxygen, pathogens, pesticides, and turbidity and TSS in Delta outflow are not anticipated to be of a frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of the of San Francisco Bay.

The effects of Alternative 4 on bromide, chloride, and DOC, in the Delta were determined to be significant/adverse. Increases in bromide, chloride, and DOC concentrations are of concern in drinking water supplies; however, as described previously, the San Francisco Bay does not have a designated MUN use. Thus, changes in bromide, chloride, and DOC in Delta outflow would not adversely effect any beneficial uses of San Francisco Bay.

The effects of Alternative 4 on EC in the Delta were determined to be significant/adverse. Elevated EC, as assessed for this alternative, is of concern for its effects on the agricultural beneficial use (AGR) and fish and wildlife beneficial uses. As discussed above, San Francisco Bay does not have an AGR beneficial use designation. However, potential effects on bay salinity are discussed further below, with consideration to effects on fish and wildlife beneficial uses.

While effects of Alternative 4 on the nutrients ammonia, nitrate, and phosphorus were determined to be less than significant/not adverse, these constituents are addressed further below because the response of the seaward bays to changed nutrient concentrations/loading may differ from the response of the Delta. Because the potential change in *Microcystis* levels were found to be significant in the Delta, potential effects on *Microcystis* levels and microcystin concentrations in San Francisco Bay are discussed. Selenium and mercury are discussed further, because they are bioaccumulative constituents where changes in load due to both changes in Delta concentrations and exports are of concern.

Nutrients: Ammonia, Nitrate, and Phosphorus

Total nitrogen loads in Delta outflow to Suisun and San Pablo Bays under Alternative 4 would be dominated almost entirely by nitrate, because planned upgrades to the SRWTP will result in >95% removal of ammonia in its effluent. Total nitrogen loads to Suisun and San Pablo Bays would decrease by 24–28%, relative to Existing Conditions, and increase by 5–12%, relative to the No Action Alternative, depending on operations scenario (Appendix 8O, Table O-1). The change in nitrogen loading to Suisun and San Pablo Bays under Alternative 4 would not adversely impact primary productivity in these embayments because light limitation and grazing current limit algal production in these embayments. To the extent that algal growth increases in relation to a change in ammonia concentration, this would have net positive benefits, because current algal levels in these embayments are low. Nutrient levels and ratios are not considered a direct driver of *Microcystis* and cyanobacteria levels in the North Bay.

The phosphorus load exported from the Delta to Suisun and San Pablo Bays for Alternative 4 is estimated to increase by -1–+5%, relative to Existing Conditions and increase by 0–6% relative to the No Action Alternative (Appendix 8O, Table O-1)). The only postulated effect of changes in phosphorus loads to Suisun and San Pablo Bays is related to the influence of nutrient stoichiometry on primary productivity. However, there is uncertainty regarding the impact of nutrient ratios on phytoplankton community composition and abundance. Any effect on phytoplankton community composition would likely be small compared to the effects of grazing from introduced clams and zooplankton in the estuary (Senn and Novick 2014; Kimmerer and Thompson 2014). Therefore, the projected change in total nitrogen and phosphorus loading that would occur in Delta outflow to San Francisco Bay is not expected to result in degradation of water quality with regard to nutrients that would result in adverse effects to beneficial uses.

Mercury

The estimated long-term average mercury and methylmercury loads in Delta exports are shown in Appendix 8O, Table O-2. Loads of mercury and methylmercury from the Delta to San Francisco Bay are estimated to change relatively little due to changes in source water fractions and net Delta outflow that would occur under Alternative 4. Mercury load to the Bay, relative to Existing Conditions, is estimated to increase by 1–5 kg/yr (<1–2%), relative to Existing Conditions, and to increase by -2–+2kg/yr (-1–+1%), relative to the No Action Alternative, depending on operations scenario. Methylmercury load is estimated to increase by 0–0.13 kg/yr (0–4%), relative to Existing Conditions, and increase by -0.09–+0.04 kg/yr (-2–+1%) relative to the No Action Alternative. The estimated total mercury load to the Bay is 261–265 kg/yr, which would be less than the San Francisco Bay mercury TMDL WLA for the Delta of 330 kg/yr. The estimated changes in mercury and methylmercury loads would be within the overall uncertainty associated with the estimates of long-term average net Delta outflow and the long-term average mercury and methylmercury concentrations in Delta source waters. The estimated changes in mercury load under the alternative would also be substantially less than the considerable differences among estimates in the current mercury load to San Francisco Bay (SFBRWQCB 2006; David et al. 2009). Similar uncertainty is expected in the existing methylmercury load in net Delta exports, for which the best available current load estimate is based on approximately one year of monitoring data (Foe et al. 2008).

Given that the estimated incremental ~~decreases~~increases of mercury and methylmercury loading to San Francisco Bay would fall within the uncertainty of current mercury and methylmercury load estimates, the estimated changes in mercury and methylmerucy loads in Delta exports to San

Francisco Bay due to Alternative 4 are not expected to result in adverse effects to beneficial uses or substantially degrade the water quality with regard to mercury, or make the existing CWA Section 303(d) impairment measurably worse.

Salinity

Salinity throughout San Francisco Bay is largely a function of the tides, as well as to some extent the freshwater inflow from upstream. Thus, Delta outflow is the main mechanism by which the alternative could affect salinity in San Francisco Bay. According to the Delta Atlas (DWR 1995), average historical tidal flow through the Golden Gate Bridge is 2,300,000 cubic feet per second (cfs) and average historical tidal flow at Chipps Island is 170,000 cfs. The historical average tidal flows are two to three orders of magnitude larger than the largest mean monthly change in Delta outflow due to the No Action Alternative (shown in Appendix 5A, Section C.7). Thus, the changes in Delta outflow due to Alternative 4 would be minor compared to tidal flows, and thus no substantial adverse effects on salinity, or fish and wildlife beneficial uses, downstream of the Delta are expected.

Selenium

Changes in source water fraction and net Delta outflow under Alternative 4, relative to Existing Conditions, are projected to cause the total selenium load to the North Bay to increase by 6–11%, relative to Existing Conditions, and increase by 2–8%, relative to the No Action Alternative, depending on operations scenario (Appendix 8O, Table O-3). Changes in long-term average selenium concentrations of the North Bay are assumed to be proportional to changes in North Bay selenium loads. Under Alternative 4, the long-term average total selenium concentration of the North Bay is estimated to be 0.013–0.14 µg/L and the dissolved selenium concentration is estimated to be 0.12 µg/L, which would be 0.01 µg/L higher than Existing Conditions and the No Action Alternative (Appendix 8O, Table O-3). The dissolved selenium concentration would be below the target of 0.202 µg/L developed by Presser or Luoma (2013) to coincide with a white sturgeon whole-body fish tissue selenium concentration not greater than 8 mg/kg in the North Bay. The incremental increase in dissolved selenium concentrations in the North Bay, relative to Existing Conditions, would be negligible (0.01 µg/L) under this alternative. Thus, the estimated changes in selenium loads in Delta exports to San Francisco Bay due to Alternative 4 are not expected to result in adverse effects to beneficial uses or substantially degrade the water quality with regard to selenium, or make the existing CWA Section 303(d) impairment measurably worse.

Microcystis

Microcystis has not been detected in embayments of the San Francisco Bay downstream of Suisun Bay. Low levels of microcystins occur throughout San Francisco Bay, but their concentrations do not correspond to *Microcystis* abundance, nor is there evidence that they have been transported downstream from *Microcystis* blooms that have occurred in the Delta (Senn and Novick 2013). The low levels of microcystins present in San Francisco Bay are likely derived from cyanobacteria besides *Microcystis*, such as *Cyanobium sp.* and *Synechocystis*, which are currently resident in the San Francisco Bay at levels well below bloom magnitude (Senn and Novick 2013). Elevated microcystin levels could occur at various locations in the Delta during *Microcystis* blooms under Alternative 4, but because of the sufficient dilution available in San Francisco Bay, downstream transport of Delta-derived microcystins are not expected to result in measurable changes in the microcystin levels of San Francisco Bay.

The absence of *Microcystis* in San Francisco Bay is likely directly related to its intolerance of elevated salinity, as its growth ceases and breakdown of its cellular tissues starts at salinities of 10–12.6 ppt (Tonk et al. 2007; Black et al. 2011). San Pablo Bay is the only embayment of San Francisco Bay downstream of Suisun Bay that would experience salinities of this magnitude for any significant duration of the year, although these and lower salinities would only occur under conditions of high Delta outflow. However, high Delta outflows occur during wet years and during the winter and spring runoff season, under which water temperatures are expected to be low, turbidity high, and water residence times low, making the environment of San Pablo Bay unsuitable for *Microcystis* growth. Additionally, these hydrodynamics conditions typically only occur when the potential for *Microcystis* blooms to occur upstream of, and thus potentially seed *Microcystis* to, San Pablo Bay are minimal. Alternative 4 is not expected to result in significant modification to net Delta outflows or the timing of high outflow events related to wet season runoff. Thus, the effects of Alternative 4 on *Microcystis* levels in San Francisco Bay are expected to be negligible.

NEPA Effects: Based on the discussion above, Alternative 4, relative to the No Action Alternative, would not cause further degradation to water quality with respect to boron, bromide, chloride, dissolved oxygen, DOC, EC, mercury, pathogens, pesticides, selenium, nutrients (ammonia, nitrate, phosphorus), trace metals, or turbidity and TSS in the San Francisco Bay. Further, changes in these constituent concentrations in Delta outflow would not be expected to cause changes in Bay concentrations of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses. In summary, based on the discussion above, effects on the San Francisco Bay from implementation of CM1–CM21 are considered to be not adverse.

CEQA Conclusion: Based on the above, Alternative 4 would not be expected to cause long-term degradation of water quality in San Francisco Bay resulting in sufficient use of available assimilative capacity such that occasionally exceeding water quality objectives/criteria would be likely and would result in substantially increased risk for adverse effects to one or more beneficial uses. Further, based on the above, this alternative would not be expected to cause additional exceedance of applicable water quality objectives/criteria in the San Francisco Bay by frequency, magnitude, and geographic extent that would cause significant impacts on any beneficial uses of waters in the affected environment. Any changes in boron, bromide, chloride, and DOC in the San Francisco Bay would not adversely affect beneficial uses, because the uses most affected by changes in these parameters, MUN and AGR, are not beneficial uses of the Bay. Further, no substantial changes in dissolved oxygen, pathogens, pesticides, trace metals or turbidity or TSS are anticipated in the Delta, relative to Existing Conditions, therefore, no substantial changes these constituents levels in the Bay are anticipated. Changes in Delta salinity would not contribute to measurable changes in Bay salinity, as the change in Delta outflow would two to three orders of magnitude lower than (and thus minimal compared to) the Bay's tidal flow. Adverse changes in *Microcystis* levels that could occur in the Delta would not cause adverse *Microcystis* blooms in the Bay, because *Microcystis* are intolerant of the Bay's high salinity and, thus not have not been detected downstream of Suisun Bay. The 24–28% decrease in total nitrogen load and -1–+5% increase in phosphorus load, relative to Existing Conditions, are expected to have minimal effect on water quality degradation, primary productivity, or phytoplankton community composition. The estimated increase in mercury load (1–5 kg/yr; <1–2%) and methylmercury load (0.00–0.13 kg/yr; 0–4%), relative to Existing Conditions, is within the level of uncertainty in the mass load estimate and not expected to contribute to water quality degradation, make the CWA section 303(d) mercury impairment measurably worse or cause mercury/methylmercury to bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. The estimated increase in selenium load would be 6–11%, but estimated total and dissolved selenium concentrations under this alternative would be nearly the same as Existing Conditions, and less than the target associated with white sturgeon whole-body fish tissue levels for the North Bay. Thus, the small increase in selenium load is not expected to contribute to water quality degradation, or make the CWA section 303(d) selenium impairment measurably worse or cause selenium to bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant.

8.3.3.10 Alternative 5—Dual Conveyance with Pipeline/Tunnel and Intake (3,000 cfs; Operational Scenario C)

Impact WQ-5: Effects on Bromide Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2-22CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for CM2-22CM2–CM21. See section 8.3.1.3 for more information.

Under Alternative 5, the geographic extent of effects pertaining to long-term average bromide concentrations in the Delta would be similar to that previously described for Alternative 1A, although the magnitude of predicted long-term change and relative frequency of concentration threshold exceedances would be different. Using the mass-balance modeling approach for bromide (see Section 8.3.1.3), relative to Existing Conditions, modeled long-term average bromide concentrations would increase at Staten Island, Emmaton, and Barker Slough, while modeled long-term average bromide concentrations would decrease at the other assessment locations (Appendix 8E, *Bromide*, Table 12). Overall effects would be greatest at Barker Slough, where predicted long-term average bromide concentrations would increase from 51 µg/L to 63 µg/L (23% relative increase) for the modeled 16-year hydrologic period and would increase from 54 µg/L to 98 µg/L (84% relative increase) for the modeled drought period. At Barker Slough, the predicted 50 µg/L exceedance frequency would decrease from 49% under Existing Conditions to 38% under Alternative 5, but would increase from 55% to 68% during the drought period. At Barker Slough, the predicted 100 µg/L exceedance frequency would increase from 0% under Existing Conditions to 18% under Alternative 5, and would increase from 0% to 38% during the drought period. In contrast, increases in bromide at Staten Island would result in a 50 µg/L bromide threshold exceedance increase from 47% under Existing Conditions to 67% under Alternative 5 (52% to 77% during the modeled drought period). However, unlike Barker Slough, modeling shows that long-term average bromide concentration at Staten Island would exceed the 100 µg/L assessment threshold concentration 1% under Existing Conditions and 2% under Alternative 5 (0% to 2% during the modeled drought period). The long-term average bromide concentrations would be 59 µg/L (62 µg/L for the modeled drought period) at Staten Island under Alternative 5. Changes in exceedance frequency of the 50 µg/L and 100 µg/L concentration thresholds, as well as relative change in long-term average concentration, at other assessment locations would be less substantial. This comparison to Existing Conditions reflects changes in bromide due to both Alternative 5 operations (including north Delta intake capacity of 3,000 cfs and numerous other operational components of Scenario C) and climate change/sea level rise.

Due to the relatively small differences between modeled Existing Conditions and No Action baseline, changes in long-term average bromide concentrations and changes in exceedance frequencies relative to the No Action Alternative are generally of similar magnitude to those previously described for the existing condition comparison (Appendix 8E, *Bromide*, Table 12). Modeled long-term average bromide concentration increases would similarly be greatest at Barker Slough, where long-term average concentrations are predicted to increase by 27% (83% for the modeled drought period) relative to the No Action Alternative. However, unlike the Existing Conditions comparison, long-term average bromide concentrations at Buckley Cove, Rock Slough, and Contra Costa PP No. 1 would increase relative to No Action Alternative, although the increases would be relatively small (≤4%). Unlike the comparison to Existing Conditions, this comparison to the No Action Alternative reflects changes in bromide due only to Alternative 5operations.

At Barker Slough, modeled long-term average bromide concentrations for the two baseline conditions are very similar (Appendix 8E, *Bromide*, Table 12). Such similarity demonstrates that the modeled Alternative 5 change in bromide is almost entirely due to Alternative 5 operations, and not climate change/sea level rise. Therefore, operations are the primary driver of effects on bromide at Barker Slough, regardless whether Alternative 5 is compared to Existing Conditions, or compared to the No Action Alternative.

Results of the modeling approach which used relationships between EC and chloride and between chloride and bromide (see Section 8.3.1.3) differed somewhat from what is presented above for the mass-balance approach (see Appendix 8E, *Bromide*, Table 13).For most locations, the frequency of exceedance of the 50 µg/L and 100 µg/L were similar. The greatest difference between the methods was predicted for Barker Slough. The increases in frequency of exceedance of the 100 µg/L threshold, relative to Existing Conditions and the No Action Alternative, were not as great using this alternative EC to chloride and chloride to bromide relationship modeling approach as compared to that presented above from the mass-balance modeling approach. However, there were still substantial increases, resulting in 9% exceedance over the modeled period under Alternative 5, as compared to 1% under Existing Conditions and 2% under the No Action Alternative. For the drought period, exceedance frequency increased from 0% under Existing Conditions and the No Action Alternative, to 20% under Alternative 5.Because the mass-balance approach predicts a greater level of impact at Barker Slough, determination of impacts was based on the mass-balance results.

The increase in long-term average bromide concentrations predicted at Barker Slough, principally the relative increase in 100 µg/L exceedance frequency, would result in a substantial change in source water quality for existing drinking water treatment plants drawing water from the North Bay Aqueduct. As discussed for Alternative 1A, drinking water treatment plants obtaining water via the North Bay Aqueduct utilize a variety of conventional and enhanced treatment technologies in order to achieve DBP drinking water criteria. While the implications of such a modeled change in bromide at Barker Slough are difficult to predict, the substantial modeled increases could lead to adverse changes in the formation of disinfection byproducts such that considerable treatment plant upgrades may be necessary in order to achieve equivalent levels of health protection. Because many of the other modeled locations already frequently exceed the 100 µg/L threshold under Existing Conditions and the No Action Alternative, these locations likely already require treatment plant technologies to achieve equivalent levels of health protection, and thus no additional treatment technologies would be triggered by the small increases in the frequency of exceeding the 100 µg/L threshold. Hence, no further impact on the drinking water beneficial use would be expected at these locations.

The seasonal intakes at Mallard Slough and City of Antioch are infrequently used due to water quality constraints related to sea water intrusion. On a long-term average basis, bromide at these locations is in excess of 3,000 µg/L, but during seasonal periods of high Delta outflow can be <300 µg/L. Based on modeling using the mass-balance approach, use of the seasonal intakes at Mallard

Slough and City of Antioch under Alternative 5 would experience a period average increase in bromide during the months when these intakes would most likely be utilized. For those wet and above normal water year types where mass balance modeling would predict water quality typically suitable for diversion, predicted long-term average bromide would increase from 103 µg/L to 128 µg/L (25% increase) at City of Antioch and would increase from 150 µg/L to 194 µg/L (30% increase) at Mallard Slough relative to Existing Conditions (Appendix 8E, *Bromide*, Table 23). Increases would be similar for the No Action Alternative comparison. Modeling results using the EC to chloride and chloride to bromide relationships show increases during these months, but the relative magnitude of the increases is much lower (Appendix 8E, *Bromide*, Table 24).Regardless of the differences in the data between the two modeling approaches, the decisions surrounding the use of these seasonal intakes is largely driven by acceptable water quality, and thus have historically been opportunistic. Opportunity to use these intakes would remain, and the predicted increases in bromide concentrations at the City of Antioch and Mallard Slough intake would not be expected to adversely affect MUN beneficial uses, or any other beneficial use, at these locations.

Important to the results presented above is the assumed habitat restoration footprint on both the temporal and spatial scales incorporated into the modeling. Modeling sensitivity analyses have indicated that habitat restoration (which are reflected in the modeling—see Section 8.3.1.3), not operations covered under CM1, are the driving factor in the modeled bromide increases. The timing, location, and specific design of habitat restoration will have effects on Delta hydrodynamics, and any deviations from modeled habitat restoration and implementation schedule will lead to different outcomes. Although habitat restoration near Barker Slough is an important factor contributing to modeled bromide concentrations at the North Bay Aqueduct, BDCP habitat restoration elsewhere in the Delta can also have large effects. Because of these uncertainties, and the possibility of adaptive management changes to BDCP restoration activities, including location, magnitude, and timing of restoration, the estimates are not predictive of the bromide levels that would actually occur in Barker Slough or elsewhere in the Delta.

Impact WQ-7: Effects on Chloride Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of ~~CM2-22~~CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for ~~CM2-22~~CM2–CM21. See section 8.3.1.3 for more information.

Relative to Existing Conditions, modeling predicts that Alternative 5 would result in similar or reduced long-term average chloride concentrations for the 16-year period modeled at most of the assessment locations, and, depending on modeling approach (see Section 8.3.1.3), would result in increased concentrations at the North Bay Aqueduct at Barker Slough (i.e., ≤18%), Sacramento River at Emmaton (i.e., ≤3%), and ~~San Joaquin River at Staten Island~~SF Mokelumne at Staten Island (i.e., ≤16%) (Appendix 8G, *Chloride*, Table Cl-31 and Table Cl-32). Additionally, implementation of tidal habitat restoration under CM4 would increase the tidal exchange volume in the Delta, and thus may contribute to increased chloride concentrations in the Bay source water as a result of increased salinity intrusion. More discussion of this phenomenon is included in Section 8.3.1.3. Consequently, while uncertain, the magnitude of chloride increases may be greater than indicated herein and would affect the western Delta assessment locations the most which are influenced to the greatest extent by the Bay source water. This comparison to Existing Conditions reflects changes in chloride due to both Alternative 5 operations (including north Delta intake capacity of 3,000 cfs and numerous other operational components of Scenario C) and climate change/sea level rise.

Relative to the No Action Alternative conditions, the mass balance analysis of modeling results indicated that Alternative 5 would result in similar or reduced long-term average chloride concentrations for the 16-year period modeled at four of the assessment locations. Chloride concentrations would increase at the SF Mokelumne River at Staten Island (up to 19%) and the North Bay Aqueduct at Barker Slough (up to 23%) compared to the No Action Alternative conditions and increase only incrementally (3% or less) at five other stations (Appendix 8G, *Chloride,* Table Cl-31). The comparison to the No Action Alternative reflects changes in chloride due only to operations.

The following outlines the modeled chloride changes relative to the applicable objectives and beneficial uses of Delta waters.

Municipal Beneficial Uses–Relative to Existing Conditions

Estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3) were used to evaluate the 150 mg/L Bay-Delta WQCP objective for municipal and industrial beneficial uses on a basis of the percent of years the chloride objective is exceeded for the modeled 16-year period. The objective is exceeded if chloride concentrations exceed 150 mg/L for a specified number of days in a given water year at both the Antioch and Contra Costa Pumping Plant #1 locations. For Alternative 5, the modeled frequency of objective exceedance would ~~approximately double from 6~~remain unchanged at 7% of years under Existing Conditions~~, to 13% of years under~~and Alternative 5 (Appendix 8G, *Chloride,* Table Cl-64).

Similarly, estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3) were also used to evaluate the 250 mg/L Bay-Delta WQCP objective for chloride at Contra Costa Pumping Plant #1 where daily average objectives apply. The basis for the evaluation was the predicted number of days the objective was exceeded for the modeled 16-year period. For Alternative 5, the modeled frequency of objective exceedance would decrease by approximately one half, from 6% of modeled days under Existing Conditions, to 3% of modeled days under Alternative 5 (Appendix 8G, *Chloride,* Table Cl-63).

Given the limitations inherent to estimating future chloride concentrations (see Section 8.3.1.3), estimation of chloride concentrations through both amass balance approach and an EC-chloride relationship approach was used to evaluate the 250 mg/L Bay-Delta WQCP objectives in terms of both frequency of exceedance and use of assimilative capacity. When utilizing the mass balance approach to model monthly average chloride concentrations for the 16-year period, the predicted frequency of exceeding the 250 mg/L objective would decrease at the Contra Costa Canal at Pumping Plant #1 (Appendix 8G, *Chloride,* Table Cl-33 and Figure Cl-9). The frequency of exceedances would increase for the 16-year period modeled at the San Joaquin River at Antioch (i.e., from 66% under Existing Conditions to 72%) and Sacramento River at Mallard Island (i.e., from 85% under Existing Conditions to 87%) (Appendix 8G, Table Cl-33), and would cause further degradation at Antioch in March and April (i.e., maximum reduction of 45% of assimilative capacity for the 16-year period modeled, and 100% reduction, or elimination of assimilative capacity, during the drought period modeled) (Appendix 8G, Table Cl-35 and Figure Cl-9).

In comparison, when utilizing the chloride-EC relationship to model monthly average chloride concentrations for the 16-year period, trends in frequency of exceedance and use of assimilative capacity would be similar to that discussed when utilizing the mass balance modeling approach (Appendix 8G, *Chloride,* Table Cl-34 and Table Cl-36).However, as with Alternative 1A the modeling approach utilizing the chloride-EC relationships predicted changes of lesser magnitude, where predictions of change utilizing the mass balance approach were generally of greater magnitude, and thus more conservative. As discussed in Section 8.3.1.3, in cases of such disagreement, the approach that yielded the more conservative predictions was used as the basis for determining adverse impacts.

Based on the additional predicted annual and seasonal exceedances of ~~one or both~~the 250 mg/L Bay Delta WQCP objectives for chloride, and magnitude of associated long-term average water quality degradation in the western Delta, the potential exists for substantial adverse effects on the municipal and industrial beneficial uses through reduced opportunity for diversion of water with acceptable chloride levels.

303(d) Listed Water Bodies–Relative to Existing Conditions

With respect to the 303(d) listing for chloride in Tom Paine Slough, the monthly average chloride concentrations for the 16-year period modeled at Old River at Tracy Road would generally be similar compared to Existing Conditions, and thus, would not be further degraded on a long-term basis (Appendix 8G, Figure Cl-10). With respect to Suisun Marsh, the monthly average chloride concentrations for the 16-year period modeled would generally increase compared to Existing Conditions in some months during October through May at the Sacramento River at Collinsville (Appendix 8G, Figure Cl-11), Mallard Island (Appendix 8G, Figure Cl-9), and increase substantially at the Montezuma Slough at Beldon's Landing (i.e., over a doubling of concentration in December through February) (Appendix 8G, Figure Cl-12).~~,~~ However, modeling of Alternative 5 assumed no operation of the Montezuma Slough Salinity Control Gates, but the project description assumes continued operation of the Salinity Control Gates, consistent with assumptions included in the No Action Alternative. A sensitivity analysis modeling run conducted for Alternative 4 with the gates operational consistent with the No Action Alternative resulted in substantially lower EC levels than indicated in the original Alternative 4 modeling results for Suisun Marsh, but EC levels were still somewhat higher than EC levels under Existing Conditions for several locations and months. Although chloride was not specifically modeled in these sensitivity analyses, it is expected that chloride concentrations would be nearly proportional to EC levels in Suisun Marsh. Another modeling run with the gates operational and restoration areas removed resulted in EC levels nearly equivalent to Existing Conditions, indicating that design and siting of restoration areas has notable bearing on EC levels at different locations within Suisun Marsh (see Appendix 8H Attachment 1 for more information on these sensitivity analyses). These analyses also indicate that increases in salinity are related primarily to the hydrodynamic effects of CM4, not operational components of CM1. Based on the sensitivity analyses, optimizing the design and siting of restoration areas may limit the magnitude of long-term chloride increases in the Marsh. However, the chloride concentration increases at certain locations could be substantial, depending on siting and design of restoration areas. Thus, these increased chloride levels in Suisun Marsh are considered to contribute to additional, measureable long-term degradation that potentially would adversely affect the necessary actions to reduce chloride loading for any TMDL that is developed.~~thereby contributing to additional, measureable long-term degradation that potentially would adversely affect the necessary actions to reduce chloride loading for any TMDL that is developed.~~

Municipal Beneficial Uses–Relative to No Action Alternative

Similar to the assessment conducted for Existing Conditions, estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3) were used to evaluate the 150 mg/L Bay-Delta WQCP objective for municipal and industrial beneficial uses. For Alternative 5, the modeled frequency of objective exceedance would increase from 6 0% under the No Action Alternative to 137% of years under Alternative 5 (Appendix 8G, *Chloride,* Table Cl-64). The increase was due to a single year, 1977, which fell just short of the required number of days (i.e., was within 6 days minimum number of required days < 150 mg/L). Given the uncertainty in the chloride modeling approach, it is likely that real time operations of the SWP and CVP could achieve compliance with this objective (see Section 8.3.1.1 for a discussion of chloride compliance modeling uncertainties and a description of real time operations of the SWP and CVP).

Similarly, estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3) were also used to evaluate the 250 mg/L Bay-Delta WQCP objective for chloride at Contra Costa Pumping Plant #1 where daily average objectives apply. For Alternative 5, the modeled frequency of objective exceedance would decrease slightly from 5% of modeled days under the No Action Alternative to 3% of modeled days under Alternative 5 (Appendix 8G, *Chloride,* Table Cl-63).

Similar to Existing Conditions, a comparative assessment of modeling approaches was utilized to evaluate the 250 mg/L Bay-Delta WQCP objectives in terms of both frequency of exceedance and use of assimilative capacity on a monthly average basis. When utilizing the mass balance approach to model monthly average chloride concentrations for the 16-year period, a small decrease in exceedance frequency would be predicted at the San Joaquin River at Antioch (i.e., from 73% for the No Action Alternative to 72%), however, available assimilative capacity would be reduced in April (i.e., up to 10% for the 16 year period modeled, and 100% [i.e., eliminated] for the drought period modeled) (Appendix 8G, *Chloride,* Table Cl-35).The exceedance frequency would increase slightly at the Sacramento River at Mallard Island (i.e., from 86% to 87%) and at the Contra Costa Canal at Pumping Plant #1 (i.e., from 14% to 18%) (Appendix 8G, Table Cl-33), along with reduced assimilative capacity at the Contra Costa Canal at Pumping Plant #1 in September (i.e., up to 56%), reflecting substantial degradation during when average concentrations would be near, or exceed, the objective (Appendix 8G, Table Cl-35).

In comparison, when utilizing the chloride-EC relationship to model monthly average chloride concentrations for the 16-year period, trends in frequency of exceedance and use of assimilative capacity would be similar to that discussed when utilizing the mass balance modeling approach (Appendix 8G, *Chloride,* Table Cl-34 and Table Cl-36).However, as with Alternative 1A, the modeling approach utilizing the chloride-EC relationships predicted changes of lesser magnitude, where predictions of change utilizing the mass balance approach were generally of greater magnitude, and thus more conservative. As discussed in Section 8.3.1.3, in cases of such disagreement, the approach that yielded the more conservative predictions was used as the basis for determining adverse impacts.

Based on the additional predicted annual and seasonal exceedances of one or boththe 250 mg/L Bay Delta WQCP objectives for chloride, and the associated long-term average water quality degradation at interior and western Delta locations, the potential exists for substantial adverse effects on the municipal and industrial beneficial uses through reduced opportunity for diversion of water with acceptable chloride levels.

303(d) Listed Water Bodies–Relative to No Action Alternative

With respect to the 303(d) listing for chloride, Alternative 5 would generally result in similar changes to those discussed for the comparison to Existing Conditions. Monthly average chloride concentrations at Tom Paine Slough would not be further degraded on a long-term basis (Appendix 8G, Figure Cl-10). Monthly average chloride concentrations at source water channel locations for the Suisun Marsh (Appendix 8G, *Chloride,* Figures Cl-5, Cl-7, and Cl-8) would increase substantially in some months during October through May compared to the No Action Alternative conditions, but sensitivity analyses suggest that operation of the Salinity Control Gates and restoration area siting and design considerations could reduce these increases. However, the chloride concentration increases at certain locations could be substantial, depending on siting and design of restoration areas. Thus, these increased chloride levels in Suisun Marsh are considered to contribute to~~.~~ ~~Therefore,~~ additional, measureable long-term degradation would occur in Suisun Marsh that potentially would adversely affect the necessary actions to reduce chloride loading for any TMDL that is developed.

Impact WQ-9: Effects on Dissolved Oxygen Resulting from Facilities Operations and Maintenance (CM1)

NEPA Effects: Effects of CM1 on DO under Alternative 5 are the same as those discussed for Alternative 1A and are considered to not be adverse.

CEQA Conclusion: Effects of CM1 on DO under Alternative 5would be similar to those discussed for Alternative 1A, and are summarized here, then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion under the Alternative 1A.

~~River flow rate and r~~Reservoir storage reductions that would occur under Alternative 5, relative to Existing Conditions, would not be expected to result in a substantial adverse change in DO levels in the reservoirs, because oxygen sources (surface water aeration, aerated inflows, vertical mixing) would remain. Similarly, river flow rate reductions that would occur would not be expected to result in a substantial adverse change in DO levels in the ~~and~~ rivers upstream of the Delta, given that mean monthly flows would remain within the ranges historically seen under Existing Conditions and the affected river are large and turbulent. Any reduced DO saturation level that may be caused by increased water temperature would not be expected to cause DO levels to be outside of the range seen historically. Finally, amounts of oxygen demanding substances and salinity would not be expected to change sufficiently to affect DO levels.

It is expected there would be no substantial change in Delta DO levels in response to a shift in the Delta source water percentages under this alternative or substantial degradation of these water bodies, with regard to DO. DO levels would be affected by nutrient loading, which the state has begun to aggressively regulate the discharges of, and this loading would not be expected to lower DO levels relative to Existing Conditions based on historical DO levels. Further, the anticipated changes in salinity would have relatively minor effects on DO levels, and tidal exchange, which contribute to the reaeration of Delta waters would not be expected to change substantially.

There is not expected to be substantial, if even measurable, changes in DO levels in the SWP/CVP Export Service Areas waters under Alternative 5, relative to Existing Conditions, because the biochemical oxygen demand of the exported water would not be expected to substantially differ from that under Existing Conditions (due to ever increasing water quality regulations), canal turbulence and exposure of the water to the atmosphere and the algal communities that exist within the canals would establish an equilibrium for DO levels within the canals. The same would occur in downstream reservoirs.

Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would result in significant impacts on any beneficial uses within affected water bodies. Because no substantial changes in DO levels are expected, long-term water quality degradation would not be expected to occur, and, thus, beneficial uses would not be adversely affected. Various Delta waterways are 303(d)-listed for low DO, but because no substantial decreases in DO levels would be expected, greater degradation and DO-related impairment of these areas would not be expected. This impact would be less than significant. No mitigation is required.

Impact WQ-11: Effects on Electrical Conductivity Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of ~~CM2-22~~CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for ~~CM2-22~~CM2–CM21. See section 8.3.1.3 for more information.

Relative to Existing Conditions, Alternative 5 would result in an increase in the number of days the Bay-Delta WQCP EC objectives would be exceeded in the Sacramento River at Emmaton, San Joaquin River at San Andreas Landing, Jersey Point and Prisoners Point, and Old River at Tracy Bridge (Appendix 8H, *Electrical Conductivity*, Table EC-5).

The percent of days the Emmaton EC objective would be exceeded for the entire period modeled (1976–1991) would increase from 6% under Existing Conditions to 2~~3~~5% under Alternative 5, and the percent of days out of compliance would increase from 11% under Existing Conditions to 3~~5~~8% under Alternative 5.

The percent of days the San Andreas Landing EC objective would be exceeded would increase from 1% under Existing Conditions to ~~4~~5% under Alternative 5, and the percent of days out of compliance with the EC objective would increase from 1% under Existing Conditions to ~~7~~9% under Alternative 5. Sensitivity analyses were performed for Alternative 4 scenario H3, and indicated that many similar exceedances were modeling artifacts, and the small number of remaining exceedances were small in magnitude, lasted only a few days, and could be addressed with real time operations of the SWP and CVP (see Section 8.3.1.1 for a description of real time operations of the SWP and CVP). Due to similarities in the nature of the exceedances between alternatives, the findings from these analyses can be extended to this alternative as well.

The percent of days the Jersey Point fish and wildlife EC objective would be exceeded and the percent of days out of compliance for the entire period modeled would increase from 0% under Existing Conditions to 3% under Alternative 5. The percent of days the Prisoners Point EC objective would be exceeded for the entire period modeled would increase from 6% under Existing Conditions to ~~9~~8% under Alternative 5, and the percent of days out of compliance with the EC objective would increase from 10% under Existing Conditions to 1~~3~~2% under Alternative 5. These changes are very small, and are likely within the uncertainty of the modeling approach. Nevertheless, further discussion of EC increases relative to this objective can be found in Appendix 8H Attachment 2.

In Old River at Tracy Bridge, the percent of days exceeding the EC objective would increase from 4% under Existing Conditions to 5% under Alternative 5; the percent of days out of compliance would increase by <1% and would be 10% under both Existing Conditions and Alternative 5. These changes are minimal, but regardless, as noted in Section 8.1.3.7, SWP and CVP operations have relatively little influence on salinity levels at this location, and the elevated salinity in south Delta channels is affected substantially by local salt contributions discharged into the San Joaquin River downstream of Vernalis. Thus, the modeling has limited ability to estimate salinity accurately in this region.

Average EC levels at the western and southern Delta compliance locations, except at Emmaton in the western Delta, would decrease from 2–35% for the entire period modeled and 3–32% during the drought period modeled (1987–1991) (Appendix 8H, *Electrical Conductivity*, Table EC-16). At Emmaton, average EC would increase by 3% for the entire period modeled and 10% for the drought period modeled. At the two interior Delta locations, there would be increases in average EC: the S. Fork Mokelumne River at Terminous average EC would increase 3% for the entire and drought periods modeled; and San Joaquin River at San Andreas Landing average EC would increase 5% for the entire period modeled and 10% during the drought period modeled. On average, EC would increase at Emmaton during February through August. Average EC would increase at San Andreas Landing from January through September. Average EC in the S. Fork Mokelumne River at Terminous would increase from March through December (Appendix 8H, Table EC-16). The comparison to Existing Conditions reflects changes in EC due to both Alternative 5 operations (including north Delta intake capacity of 3,000 cfs and numerous other operational components of Scenario C) and climate change/sea level rise.

Relative to the No Action Alternative, the percent of days exceeding EC objectives and percent of days out of compliance would increase at: Sacramento River at Emmaton, San Joaquin River at Jersey Point, San Andreas Landing, and Prisoners Point; and Old River near Middle River and at Tracy Bridge (Appendix 8H, *Electrical Conductivity*, Table EC-5). The increase in percent of days exceeding the EC objective would be 11% at Emmaton and ~~8~~7% or less at the remaining locations. The increase in percent of days out of compliance would be 13% at Emmaton and 1~~2~~1% or less at the remaining locations. For the entire period modeled, average EC levels would increase at: Sacramento River at Emmaton (2%), S. Fork Mokelumne River (4%), San Joaquin River at San Andreas Landing (10%), and San Joaquin River at Prisoners Point (4%) (Appendix 8H, Table EC-16). During the drought period modeled, average EC would increase at these same locations, except at Emmaton, by a similar percentage as well as the San Joaquin River at Brandt Bridge (1%).The comparison to the No Action Alternative reflects changes in EC due only to Alternative 5 operations (including north Delta intake capacity of 3,000 cfs and numerous other operational components of Scenario C).

For Suisun Marsh, October–May is the period when Bay-Delta WQCP EC objectives for protection of fish and wildlife apply. Long-term average EC would increase under Alternative 5, relative to Existing Conditions, during the months of March through May by 0.4–0.6 mS/cm in the Sacramento

River at Collinsville (Appendix 8H, *Electrical Conductivity,* Table EC-21). Long-term average EC would decrease relative to Existing Conditions in Montezuma Slough at National Steel during October–May (Appendix 8H, Table EC-22). The most substantial increase would occur near Beldon Landing, with long-term average EC levels increasing by 1.6–5.0 mS/cm, depending on the month, at least doubling during some months the long-term average EC relative to Existing Conditions (Appendix 8H, Table EC-23). Sunrise Duck Club and Volanti Slough also would have long-term average EC increases during all months of 0.9–2.8 mS/cm (Appendix 8H, Tables EC-24 and EC-25). Modeling of this alternative assumed no operation of the Montezuma Slough Salinity Control Gates, but the project description assumes continued operation of the Salinity Control Gates, consistent with assumptions included in the No Action Alternative. A sensitivity analysis modeling run conducted for Alternative 4 scenario H3 with the gates operational consistent with the No Action Alternative resulted in substantially lower EC levels than indicated in the original Alternative 4 modeling results, but EC levels were still somewhat higher than EC levels under Existing Conditions and the No Action Alternative for several locations and months. Another modeling run with the gates operational and restoration areas removed resulted in EC levels nearly equivalent to Existing Conditions and the No Action Alternative, indicating that design and siting of restoration areas has notable bearing on EC levels at different locations within Suisun Marsh (see Appendix 8H Attachment 1 for more information on these sensitivity analyses). These analyses also indicate that increases are related primarily to the hydrodynamic effects of CM4, not operational components of CM1. Based on the sensitivity analyses, optimizing the design and siting of restoration areas may limit the magnitude of long-term EC increases to be on the order of 1 mS/cm or less. Due to similarities in the nature of the EC increases between alternatives, the findings from these analyses can be extended to this alternative as well.

The degree to which the long-term average EC increases in Suisun Marsh would cause exceedance of Bay-Delta WQCP objectives is unknown, because these objectives are expressed as a monthly average of daily high tide EC, which does not have to be met if it can be demonstrated "equivalent or better protection will be provided at the location" (State Water Resources Control Board 2006:14). The ~~described~~ long-term average EC increase may, or may not, contribute to adverse effects on beneficial uses, depending on how and when wetlands are flooded, soil leaching cycles, and how agricultural use of water is managed, and future actions taken with respect to the marsh. However, the EC increases at certain locations ~~would~~ could be substantial, depending on siting and design of restoration areas, and it is uncertain the degree to which current management plans for the Suisun Marsh would be able to address these substantially higher EC levels and protect beneficial uses. Thus, these increased EC levels in Suisun Marsh are considered to have a potentially adverse effect on marsh beneficial uses. Long-term average EC increases in Suisun Marsh under Alternative 5 relative to the No Action Alternative would be similar to the increases relative to Existing Conditions.

The western and southern Delta are CWA section 303(d) listed for elevated EC and the increased EC that could occur in the western Delta, relative to Existing Conditions and the No Action Alternative could lead to water quality degradation that would make beneficial use impairment measurably worse. Since there would be very little change in EC levels in the southern Delta and there is not expected to be an increase in frequency of exceedances of objectives, this alternative is not expected to make beneficial use impairment measurably worse in the southern Delta. ~~Given that the southern Delta is Clean Water Act section 303(d) listed as impaired due to elevated EC, the increase in the incidence of exceedance of EC objectives under Alternative 5, relative to Existing Conditions and the No Action Alternative, has the potential to contribute to additional impairment and potentially~~

~~adversely affect beneficial uses.~~ Suisun Marsh also is section 303(d) listed as impaired due to elevated EC, and the potential increases in long-term average EC concentrations could contribute to additional impairment~~, because the increases would be double that relative to Existing Conditions and the No Action Alternative~~.

SWP/CVP Export Service Area

NEPA Effects: In summary, the increased frequency of exceedance of EC objectives and increased long-term and drought period average EC levels that would occur at western~~, interior, and southern~~ Delta compliance locations under Alternative 5, relative to the No Action Alternative, would contribute to adverse effects on the agricultural beneficial uses. In addition. the increased frequency of exceedance of the San Joaquin River at Prisoners Point EC objective and long-term and drought period average EC could contribute to adverse effects on fish and wildlife beneficial uses (specifically, indirect adverse effects on striped bass spawning), though there is a high degree of uncertainty associated with this impact.. Given that the western ~~and southern Delta are~~is Clean Water Act section 303(d) listed as impaired due to elevated EC, the increase in the incidence of exceedance of EC objectives and long-term average and drought period average EC in these portions of the Delta has the potential to contribute to additional beneficial use impairment. The increases in long-term average EC levels that ~~would~~ could occur in Suisun Marsh ~~would~~ could further degrade existing EC levels and could contribute additional to adverse effects on the fish and wildlife beneficial uses. Suisun Marsh is section 303(d) listed as impaired due to elevated EC, and the potential increases in long-term average EC levels could contribute to additional beneficial use impairment. These increases in EC constitute an adverse effect on water quality. Mitigation Measure WQ-11 would be available to reduce these effects (implementation of this measure along with a separate, non-environmental commitment as set forth in EIR/EIS Appendix 3B, *Environmental Commitments*, relating to the potential EC-related changes would reduce these effects).

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

River flow rate and reservoir storage reductions that would occur under Alternative 5, relative to Existing Conditions, would not be expected to result in a substantial adverse change in EC levels in the reservoirs and rivers upstream of the Delta, given that: changes in the quality of watershed runoff and reservoir inflows would not be expected to occur in the future; the state's aggressive regulation of point-source discharge effects on Delta salinity-elevating parameters and the expected further regulation as salt management plans are developed; the salt-related TMDLs adopted and being developed for the San Joaquin River; and the expected improvement in lower San Joaquin River average EC levels commensurate with the lower EC of the irrigation water deliveries from the Delta.

Relative to Existing Conditions, Alternative 5 would not result in any substantial increases in long-term average EC levels in the SWP/CVP Export Service Areas. There would be no exceedance of the EC objective at the Jones and Banks pumping plants. Average EC levels for the entire period modeled would decrease at both plants and, thus, this alternative would not contribute to additional beneficial use impairment related to elevated EC in the SWP/CVP Export Service Areas waters.

Rather, this alternative would improve long-term EC levels in the SWP/CVP Export Service Areas, relative to Existing Conditions.

In the Plan Area, Alternative 5 would result in an increase in the frequency with which Bay-Delta WQCP EC objectives are exceeded for the entire period modeled (1976–1991): in the Sacramento River at Emmaton (agricultural objective; 1~~7~~9%; increase)~~ in the western Delta, in the San Joaquin River at San Andreas Landing (agricultural objective; 34% increase),~~ and at Jersety Point (fish and wildlife objective, 3%), and the San Joaquin River at Prisoners Point (fish and wildlife objective; ~~3~~2% increase)~~, both~~ in the interior Delta~~; and in Old River at Tracy Bridge (agricultural objective; 1% increase) in the southern Delta~~. Further, long-term average EC levels would increase in the Sacramento River at Emmaton by 3% for the entire period modeled and 10% during the drought period modeled, and in the San Joaquin River at San Andreas Landing by 5% during for the entire period modeled and 10% during the drought period modeled. The increases in long-term and drought period average EC levels and increased frequency of exceedance of EC objectives that would occur in the Sacramento River at Emmaton, and the increased long-term and drought period average EC levels ~~and~~ in the San Joaquin River at San Andreas Landing would potentially contribute to adverse effects on the agricultural beneficial uses in the western and interior Delta. Further, the increased frequency of exceedance of the fish and wildlife objective at Jersey Point and Prisoners Point could contribute to adverse effects on aquatic life (specifically, indirect adverse effects on striped bass spawning), though there is a high degree of uncertainty associated with this impact. Because EC is not bioaccumulative, the increases in long-term average EC levels would not directly cause bioaccumulative problems in aquatic life or humans. The western ~~and southern~~ Delta ~~are~~ is Clean Water Act section 303(d) listed for elevated EC and the increased frequency of exceedance of EC objectives that would occur in ~~these~~ this portions of the Delta could make beneficial use impairment measurably worse. This impact is considered to be significant.

Further, relative to Existing Conditions, Alternative 5 ~~would~~ could result in substantial increases in long-term average EC during the months of October through May in Suisun Marsh~~, such that EC levels would be double that relative to Existing Conditions~~. The increases in long-term average EC levels that would occur in Suisun Marsh could further degrade existing EC levels and thus contribute additionally to adverse effects on the fish and wildlife beneficial uses. Because EC is not bioaccumulative, the increases in long-term average EC levels would not directly cause bioaccumulative problems in fish and wildlife. Suisun Marsh is Clean Water Act section 303(d) listed for elevated EC and the increases in long-term average EC that would occur in the marsh could make beneficial use impairment measurably worse. This impact is considered to be significant.

Implementation of Mitigation Measure WQ-11 along with a separate, non-environmental commitment relating to the potential increased costs associated with EC-related changes would reduce these effects. While mitigation measures to reduce these water quality effects in affected water bodies to less than significant levels are not available, implementation of Mitigation Measure WQ-11 is recommended to attempt to reduce the effect that increased EC concentrations may have on Delta beneficial uses. However, because the effectiveness of this mitigation measure to result in feasible measures for reducing water quality effects is uncertain, this impact is considered to remain significant and unavoidable. Please see Mitigation Measure WQ-11 under Impact WQ-11 in the discussion of Alternative 1A.

In addition to and to supplement Mitigation Measure WQ-11, the BDCP proponents have incorporated into the BDCP, as set forth in EIR/EIS Appendix 3B, *Environmental Commitments*, a separate, non-environmental commitment to address the potential increased water treatment costs that could result from EC concentration effects on municipal, industrial and agricultural water purveyor operations. Potential options for making use of this financial commitment include funding or providing other assistance towards acquiring alternative water supplies or towards modifying existing operations when EC concentrations at a particular location reduce opportunities to operate existing water supply diversion facilities. Please refer to Appendix 3B, *Environmental Commitments*, for the full list of potential actions that could be taken pursuant to this commitment in order to reduce the water quality treatment costs associated with water quality effects relating to chloride, electrical conductivity, and bromide.

Impact WQ-13: Effects on Mercury Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of ~~CM2-22~~CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for ~~CM2-22~~CM2–CM21. See section 8.3.1.3 for more information.

The water quality impacts of waterborne concentrations of mercury and methylmercury and fish tissue mercury concentrations were evaluated for 9 Delta locations. The analysis of percentage change in assimilative capacity of waterborne total mercury of Alternative 5relative to the 25 ng/L ecological risk benchmark as compared to Existing Conditions showed the greatest decrease to be 0.9% at Old River at Rock Slough and the Contra Costa Pumping Plant, and 0.9% at Franks Tract relative to the No Action Alternative (Figures 8-53 and 8-54).These changes are not expected to result in adverse effects to beneficial uses. Similarly, changes in methylmercury concentration are expected to be very small. The greatest annual average methylmercury concentration for drought conditions was 0.165 ng/L for the San Joaquin River at Buckley Cove which was slightly higher than Existing Conditions (0.161 ng/L) and slightly lower than the No Action Alternative (0.167 ng/L)(Appendix 8I,*Mercury*, Table I-6).All modeled input concentrations exceeded the methylmercury TMDL guidance objective of 0.06 ng/L, therefore percentage change in assimilative capacity was not evaluated for methylmercury.

Fish tissue estimates show only small or no increases in exceedance quotients based on long-term annual average concentrations for mercury at the Delta locations. The greatest change in exceedance quotients of 6~~-~~–8% is expected for Franks Tract and Old River at Rock Slough relative to Existing Conditions and 7% for the Mokelumne River (South Fork) at Staten Island relative to the No Action Alternative (Figure ~~8-55~~8-55a,b, Appendix 8I, *Mercury*, Table I-12b). Because these increases are relatively small, and it is not evident that substantive increases are expected at numerous locations throughout the Delta, these changes are expected to be within the uncertainty inherent in the modeling approach, and would likely not be measurable in the environment. See Appendix 8I for a discussion of the uncertainty associated with the fish tissue estimates.

Impact WQ-25: Effects on Selenium Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics~~,~~. To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of ~~CM2-22~~CM2–CM21 not attributable to hydrodynamics, ~~for example,~~such as additional loading of a constituent to the Delta, are discussed within the impact header for ~~CM2-22~~CM2–CM21. See ~~section~~ Section 8.3.1.3 for more information.

Selenium concentrations and threshold comparisons for each of the 11 modeled Delta assessment locations under Alternative 5, relative to Existing Conditions and the No Action Alternative, are presented in Appendix 8M, *Selenium*, Table M-9a for water, Tables M-15 and M-25 for most biota (whole-body fish ~~(~~[excluding sturgeon~~)~~], bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets) throughout the Delta, and Tables M-30 through M-32 for sturgeon at the two western Delta locations. Figures 8-59a and 8-60a present graphical distributions of predicted selenium concentration changes (shown as changes in available assimilative capacity based on 1.3 µg/L) in water at each modeled assessment location for all years. Appendix 8M, Figure M-23 provides more detail in the form of monthly patterns of selenium concentrations in water during the modeling period.

Alternative 5 would result in small changes in average selenium concentrations in water at all modeled Delta assessment locations relative to Existing Conditions and the No Action Alternative (Appendix 8M, *Selenium*, Table M-~~10A~~9a). Long-term average concentrations at some interior and western Delta locations would increase by 0.01–0.02 µg/L for the entire period modeled (1976–1991). These small ~~changes~~ increases in selenium concentrations in water ~~are reflected in small percent changes (10% or less)~~ would result in small reductions (1–2% or less) in available assimilative capacity for selenium, relative to the ~~(based on 2~~1.3 µg/L ~~ecological risk benchmark~~USEPA draft water quality criterion~~)~~ ~~for all years~~ (Figures 8-59a and 8-60a). ~~Relative to Existing Conditions, Alternative 5 would result in the largest modeled increase in assimilative capacity at Buckley Cove (3%) and the largest decrease at Contra Costa PP (1%) (Figure 8-59). Relative to the No Action Alternative, the largest modeled increase in assimilative capacity would be at Staten Island (0.5%) and the largest decrease would be at Buckley Cove (3%) (Figure 8-60). Although some small negative changes in selenium concentrations in water are expected to occur, the effect of Alternative 5 would generally be minimal for the Delta locations. Furthermore, t~~The ~~ranges of modeled~~ long-term average selenium concentrations in water ~~(Appendix 8M, *Selenium*, Table M-10A)~~ for Alternative 5 (range 0.~~21~~09–0.~~73~~39 µg/L) would be similar to those for~~,~~ Existing Conditions (range 0.~~21~~09–0.~~76~~41 µg/L)~~,~~ and the No Action Alternative (range 0.~~21~~09–0.~~69~~38 µg/L), ~~are similar~~ and would be well below the ~~ecological risk benchmark~~USEPA draft water quality criterion of ~~(2~~1.3 µg/L~~)~~ (Appendix 8M, *Selenium*, Table M-9a).

Relative to Existing Conditions and the No Action Alternative, Alternative 5 would result in very small changes (less than 1%) in estimated selenium concentrations in most biota (whole-body fish, bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets) throughout the Delta, with little difference among locations (Figures 8-61a through 8-64b; Appendix 8M, *Selenium*, Table M-~~16~~ 25~~and Table 8M-2 in the sturgeon addendum to Appendix 8MAddendum M.A to Appendix 8M, Table~~

M.A-2). Level of Concern Exceedance Quotients (i.e., modeled tissue divided by Level of Concern benchmarks) for selenium concentrations in those biota for all years and for drought years are less than 1.0 (indicating low probability of adverse effects). Similarly, Advisory Tissue Level Exceedance Quotients for selenium concentrations in fish fillets for all years and drought years also are less than 1.0. Estimated selenium concentrations in sturgeon for the San Joaquin River at Antioch are predicted to increase by about 7 percent relativeRelative to Existing Conditions and the No Action Alternative in all years (from about 4.7 to 5.0 mg/kg dry weight [dw]), and those for sturgeon in the Sacramento River at Mallard Island are predicted to increase by about 4 percent in all years (from about 4.4 to 4.6 mg/kg dw) (Figure 8-65; Appendix 8M, Tables M-30 and M-31). Selenium concentrations in sturgeon during drought years are expected to increase by only 2 to 5 percent at those locations (Appendix 8M, Tables M-30 and M-31). Detection of small changes in whole-body sturgeon such as those estimated for the western Delta would require very large sample sizes because of the inherent variability in fish tissue selenium concentrations. Low Toxicity Threshold Exceedance Quotients for selenium concentrations in sturgeon in the western Delta would exceed 1.0 (indicating a higher probability for adverse effects) for drought years at both locations (as they do for Existing Conditions and the No Action Alternative; Figure 8-65); however, for the entire period modeled, the quotient would not be exceeded at either location and for all years in the San Joaquin River at Antioch (where quotients increase from 0.94 to 1.0) (Appendix 8M, Table M-32).

The disparity between larger estimated changes for sturgeon and smaller changes for other biota areis attributable largely to differences in modeling approaches, as described in Appendix 8M, *Selenium*. The model for most biota was calibrated to encompass the varying concentration-dependent uptake from waterborne selenium concentrations (expressed as the K_d, which is the ratio of selenium concentrations in particulates [as the lowest level of the food chain] relative to the waterborne concentration) that was exhibited in data for largemouth bass in 2000, 2005, and 2007 at various locations across the Delta. In contrast, the modeling for sturgeon could not be similarly calibrated at the two western Delta locations and used literature-derived uptake factors and trophic transfer factors for the estuary from Presser and Luoma (2013). As noted in the appendix, there was a significant negative log-log relationship of K_d to waterborne selenium concentration that reflected the greater bioaccumulation rates for bass at low waterborne selenium than at higher concentrations. (There was no difference in bass selenium concentrations in the Sacramento River at Rio Vista in comparison to the San Joaquin River at Vernalis in 2000, 2005, and 2007 [Foe 2010], despite a nearly 10-fold difference in waterborne selenium.) Thus, there is more confidence in the site-specific modeling based on the Delta-wide model that was calibrated for bass data than in the estimates for sturgeon based on “fixed” K_ds for all years and for drought years without regard to waterborne selenium concentration at the two locations in different time periods, the largest increase of selenium concentrations in biota would be at Barker Slough PP for drought years (except for bird eggs [assuming a fish diet] at Contra Costa PP for all years) and in sturgeon at the two western Delta locations in all years, and the largest decrease would be at Buckley Cove for drought years. Relative to the No Action Alternative, the largest increase would be at Buckley Cove for drought years (except for bird eggs [assuming a fish diet] at Buckley Cove for all years) and in sturgeon at the two western Delta locations in all years; the largest decrease would be at Staten Island for drought years. Except for sturgeon in the western Delta, concentrations of selenium in whole-body fish and bird eggs (invert and fish diets) would exceed only the lower benchmarks (4 and 6 mg/kg dry weight, respectively, indicating a low potential for effects), under drought conditions, at Buckley Cove for Existing Conditions and the No Action Alternativeand Alternative 5 (Figures 8-61 through 8-63). However, Exceedance Quotientsexceedance quotients for these exceedances of the lower benchmarks are between 1.0 and 1.5, indicating a low risk to biota in the

~~Delta and no substantial difference from Existing Conditions and the No Action Alternative. Selenium concentrations in fish fillets would not exceed the screening value for protection of human health (Figure 8-64). For sturgeon in the western Delta, whole-body selenium concentrations would increase from 12.3 mg/kg under Existing Conditions and the No Action Alternative to 12.7 mg/kg under Alternative 5, a 3% increase (Table 8M-2 in the sturgeon addendum to Appendix 8MTable M.A-2). Although all of these values exceed both the low and high toxicity benchmarks, it is unlikely that the modeled increases in whole-body selenium for sturgeon would be measurable in the environment (see also the discussion of results provided in the sturgeon addendum M.A to Appendix 8M).~~

Increased water residence times could increase the bioaccumulation of selenium in biota, thereby potentially increasing fish tissue and bird egg concentrations of selenium (see residence time discussion in Appendix 8M, *Selenium*, and Presser and Luoma [2010b]). Thus, residence time was assessed for its relevance to selenium bioaccumulation. Table 60a (presented originally in Section 8.3.1.7 in the *Microcystis* subsection) shows the time for neutrally buoyant particles to move through the Delta (surrogate for flow and residence time). Although an increase in residence time throughout the Delta is expected under the No Action Alternative, relative to Existing Conditions (because of climate change and sea level rise), the change is fairly small in most areas of the Delta. Thus, the changes in residence times between Alternative 5 and the No Action Alternative are very similar to the changes in residence times between Alternative 5 and the Existing Conditions.

Relative to Existing Conditions and the No Action Alternative, increases in residence times for Alternative 5 would be greater in the East Delta than in other sub-regions. Relative to Existing Conditions, annual average residence times for Alternative 5 in the East Delta are expected to increase by more than 16 days (Table 60a). Relative to the No Action Alternative, annual average residence times for Alternative 5 in the East Delta are expected to increase by less than 9 days. Increases in residence times for other sub-regions would be smaller, especially as compared to Existing Conditions and the No Action Alternative (which are longer than those modeled for the South Delta). As mentioned above, these results incorporate hydrodynamic effects of both CM1 and CM2 and CM4, and the effects of CM1 cannot be distinguished from the effects of CM2 and CM4. However, it is expected that CM2 and CM4 are substantial drivers of the increased residence time.

Presser and Luoma (2010b) summarized and discussed selenium uptake in the Bay-Delta (including hydrologic conditions [e.g., Delta outflow and residence time for water], K_ds [the ratio of selenium concentrations in particulates, as the lowest level of the food chain, relative to the water-borne concentration], and associated tissue concentrations [especially in clams and their consumers, such as sturgeon]). When the Delta Outflow Index (daily average flow per month) decreased by five-fold (73,732 cubic feet per second [cfs] in June 1998 to 12, 251 cfs in October 1998), residence time doubled (from 11 to 22 days) and the calculated mean K_d also doubled (from 3,198 to 6,501). However, when daily average Delta outflow in November 1999 was only 6,951 cfs (i.e., about one-half that in October 1998) and residence time was 70 days, the calculated mean K_d (7,614) did not increase proportionally.

Models are not available to quantitatively estimate the level of changes in selenium bioaccumulation as related to residence time, but the effects of residence time are incorporated in the bioaccumulation modeling for selenium that was based on higher K_d values for drought years in comparison to wet, normal, or all years; see Appendix 8M, *Selenium*. If increases in fish tissue or bird egg selenium were to occur, the increases would likely be of concern only where fish tissues or bird eggs are already elevated in selenium to near or above thresholds of concern. That is, where biota concentrations are currently low and not approaching thresholds of concern (which, as discussed above, is the case throughout the Delta, except for sturgeon in the western Delta), changes in residence time alone would not be expected to cause them to then approach or exceed thresholds of concern. In consideration of this factor, although the Delta as a whole is a CWA Section 303(d)-listed water body for selenium, and although monitoring data of fish tissue or bird eggs in the Delta are sparse, the most likely area in which biota tissues would be at levels high enough that additional bioaccumulation due to increased residence time from restoration areas would be a concern is the western Delta and Suisun Bay for sturgeon, as discussed above. As shown in Table 60a, the overall increase in residence time estimated in the western Delta is 5 days relative to Existing Conditions, and 3 days relative to the No Action Alternative. Given the available information, these increases are small enough that they are not expected to substantially affect selenium bioaccumulation in the western Delta. Because CM2 and CM4 are expected to be substantial drivers of the increased residence times, further discussion is included in Impact WQ-26 below,

In summary, ~~R~~relative to Existing Conditions and the No Action Alternative, Alternative 5 would result in ~~effectively~~ essentially no change in selenium concentrations throughout the Delta for most biota (less than 1%), although increases in selenium concentrations are predicted for sturgeon in the western Delta. Concentrations of selenium in sturgeon would exceed only the lower benchmark, indicating a low potential for effects. The modeling of bioaccumulation for sturgeon is less calibrated to site-specific conditions than that for other biota, which was calibrated on a robust dataset for modeling of bioaccumulation in largemouth bass as a representative species for the Delta. Overall,~~.~~ Alternative 5 would not be expected to substantially increase the frequency with which applicable benchmarks would be exceeded in the Delta (there being only a small increase for sturgeon relative to the low benchmark and no exceedance of the high benchmark) or substantially degrade the quality of water in the Delta, with regard to selenium.

SWP/CVP Export Service Areas

Alternative 5 would result in small ~~changes~~ decreases in long-term average selenium concentrations in water at the ~~two modeled Export Service Area assessment locations~~ Banks and Jones pumping plants, relative to Existing Conditions and the No Action Alternative, for the entire period modeled (Appendix 8M, *Selenium*, Table M-9a~~10A~~). These ~~small changes are reflected in small percent changes~~ decreases in long-term average selenium concentrations in water would result in increases ~~(10% or less)~~ in available assimilative capacity for selenium ~~for all years~~of 2–4%.~~.~~ Furthermore, ~~Relative to Existing Conditions and the No Action Alternative, Alternative 5 would result in modeled increases in assimilative capacity at Jones PP (3% and 4%, respectively) and at Banks PP (2%, Existing Conditions and the No Action Alternative) (Figures 8-59 and 8-60) and generally have a small positive effect on the Export Service Area locations. T~~the ~~ranges of modeled~~ long-term average selenium concentrations in water ~~(Appendix 8M, Table M-10A)~~ for Alternative 5 (range 0.~~37~~19–0.~~53~~25 μg/L)~~, Existing Conditions (range 0.37–0.58 μg/L), and the No Action Alternative (range 0.37–0.59 μg/L) are similar, and all~~ would be well below the ~~ecological risk benchmark~~USEPA draft water quality criterion ~~(~~of 1.3~~2~~ μg/L) (Appendix 8M, Table M-9a).

Relative to Existing Conditions and the No Action Alternative, Alternative 5 would result in very small changes (less than 1%) in estimated selenium concentrations in biota (whole-body fish, bird eggs [invertebrate diet] bird eggs [fish diet], and fish fillets) (Figures 8-61a through 8-64b; Appendix 8M, *Selenium*, Table M-~~16~~25) ~~at export service areas~~Banks and Jones pumping plants. ~~Relative to Existing Conditions, the largest increase of selenium concentrations in biota would be at Barker Slough PP for drought years (except for bird eggs [assuming a fish diet] at Barker Slough PP for all~~

~~years), and the largest decrease would be at Jones PP for all years (except for bird eggs [assuming a fish diet] at Jones PP for drought years). Relative to the No Action Alternative, the largest increase of selenium in biota would be at Barker Slough PP for drought years (except for bird eggs [assuming a fish diet] at Barker Slough PP for all years), and the largest decrease would be at Jones PP for drought years.~~ Concentrations in biota would not exceed any selenium benchmarks for Alternative 5 (Figures 8-61a through 8-64a).

~~Thus, relative to Existing Conditions and the No Action Alternative, Alternative 5 would result in small changes in selenium concentrations at the Export Service Area locations. Selenium concentrations in water and biota would generally decrease for Alternative 5 and would not exceed ecological benchmarks at either location, whereas the lower benchmark for bird eggs (fish diet) would be exceeded under Existing Conditions and the No Action Alternativeat Jones PP for drought years. This small positive change in selenium concentrations under Alternative 5 would be expected to slightly decrease the frequency with which applicable benchmarks would be exceeded or slightly improve the quality of water at the Export Service Area locations, with regard to selenium.~~

NEPA Effects: Based on the discussion above, the effects on selenium (both as waterborne and as bioaccumulated in biota) from Alternative 5 are not considered to be adverse.

***CEQA Conclusion*:** Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for selenium. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

There are no substantial point sources of selenium in watersheds upstream of the Delta, and no substantial nonpoint sources of selenium in the watersheds of the Sacramento River and the eastern tributaries. Nonpoint sources in the San Joaquin Valley that contribute selenium to the Delta will be controlled through a TMDL developed by the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the Grassland Bypass Project, and Basin Plan objectives (Central Valley Water Board [2010~~e~~d]~~)~~ and State Water Board ~~(~~[2010~~d~~b, 2010~~e~~c]) that are expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta. Consequently, any modified reservoir operations and subsequent changes in river flows under Alternative 5, relative to Existing Conditions, are expected to cause negligible changes in selenium concentrations in water. Any negligible changes in selenium concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies as related to selenium.

Relative to Existing Conditions, modeling estimates indicate that Alternative 5 would result in essentially no change in selenium concentrations in water or most biota throughout the Delta, with no exceedances of benchmarks for biological effects. The Low Toxicity Threshold Exceedance Quotient for selenium concentrations in sturgeon for all years in the San Joaquin River at Antioch would increase slightly, from 0.94 for Existing Conditions ~~and the No Action Alternative~~ to 1.0 for Alternative 5. Concentrations of selenium in sturgeon would exceed only the lower benchmark, indicating a low potential for effects. Overall, Alternative 5 would not be expected to substantially increase the frequency with which applicable benchmarks would be exceeded in the Delta (there being only a small exceedance relative to the low benchmark for sturgeon and no exceedance of the high benchmark) or substantially degrade the quality of water in the Delta, with regard to selenium.

~~Assessment The a~~Assessment of effects of selenium in the SWP/~~ and~~ CVP Export Service Areas is based on effects on selenium concentrations at the Banks and Jones pumping plants. Relative to Existing Conditions, Alternative 5 would ~~slightly decrease~~ cause no increase in the frequency with which applicable benchmarks would be exceeded and would slightly improve the quality of water in selenium concentrations at the Banks and Jones pumping plants~~ locations~~.

Based on the above, selenium concentrations that would occur in water under Alternative 5 would not cause additional exceedances of applicable state or federal numeric or narrative water quality objectives/criteria, or other relevant water quality effects thresholds identified for this assessment (Table 8-54), by frequency, magnitude, and geographic extent that would result in adverse effects to one or more beneficial uses within affected water bodies. In comparison to Existing Conditions and the No Action Alternative, water quality conditions under this alternative would not increase levels of selenium by frequency, magnitude, and geographic extent such that the affected environment would be expected to have measurably higher body burdens of selenium in aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish) or humans consuming those organisms. Water quality conditions under this alternative with respect to selenium would not cause long-term degradation of water quality in the affected environment, and therefore would not result in use of available assimilative capacity such that exceedances of water quality objectives/criteria would be likely and would result in substantially increased risk for adverse effects to one or more beneficial uses. This alternative would not further degrade water quality by measurable levels, on a long-term basis, for selenium and, thus, cause the 303(d)-listed impairment of beneficial use to be made discernibly worse. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-26: Effects on Selenium Concentrations Resulting from Implementation ofCM2–~~CM22~~CM21

NEPA Effects**:** Effects of CM2–CM21 on selenium under Alternative 5 are the same as those discussed for Alternative 1A and are considered not to be adverse.

CEQA Conclusion**:** CM2–CM21 proposed under Alternative 5 would be similar to those proposed under Alternative 1A. As such, effects on selenium resulting from the implementation of CM2–CM21 would be similar to that previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

~~***NEPA Effects*****:** In general, with the possible exception of changes in Delta hydrodynamics resulting from habitat restoration, CM2–CM11 would not substantially increase selenium concentrations in the water bodies of the affected environment. Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, and thus such effects of these restoration measures were included in the assessment of CM1 facilities operations and maintenance (see Impact WQ-25).~~

~~However, i~~Implementation of these conservation measures may increase water residence time within the restoration areas. Increased restoration area water residence times could potentially increase the bioaccumulation of selenium in biota, thereby potentially increasing fish tissue and bird egg concentrations of selenium. M, but models are not available to quantitatively estimate the level of changes in residence time and the associated selenium bioavailability. If increases in fish tissue or bird egg selenium were to occur, the increases would likely be of concern only where fish tissues or bird eggs are already elevated in selenium to near or above thresholds of concern. That is, where biota concentrations are currently low and not approaching thresholds of concern, changes in~~

~~residence time alone would not be expected to cause them to then approach or exceed thresholds of concern. In consideration of this factor, although the Delta as a whole is a 303(d)-listed water body for selenium, and although monitoring data of fish tissue or bird eggs in the Delta are sparse, the most likely areas in which biota tissues would be at levels high enough that additional bioaccumulation due to increased residence time from restoration areas would be a concern are the western Delta and Suisun Bay, and the South Delta in areas that receive San Joaquin River water.~~

~~The western Delta and Suisun Bay receive elevated selenium loads from North San Francisco Bay (including San Pablo Bay, Carquinez Strait, and Suisun Bay) and from the San Joaquin River. Point sources of selenium in North San Francisco Bay (i.e., refineries) that contribute selenium to Suisun Bay are expected to be reduced through a TMDL under development by the San Francisco Bay Water Board (San Francisco Bay Water Board 2012) that is expected to result in decreasing discharges of selenium. Nonpoint sources of selenium in the San Joaquin Valley that contribute selenium to the San Joaquin River, and thus the Delta and Suisun Bay, will be controlled through a TMDL developed by the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the Grassland Bypass Project, and Basin Plan objectives (Central Valley Water Board 2010c, d) that are expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta. If selenium levels are not sufficiently reduced via these efforts, it is expected that the State Water Board and the San Francisco Bay and Central Valley Water Boards would initiate additional actions to further control sources of selenium.~~

~~The South Delta receives elevated selenium loads from the San Joaquin River. In contrast to Suisun Bay and possibly the western Delta in the future, the South Delta lacks the overbite clam (*Corbula* [*Potamocorbula*] *amurensis*), which is considered a key driver of selenium bioaccumulation in Suisun Bay, due to its high bioaccumulation of selenium and its role in the benthic food web that includes long-lived sturgeon. The South Delta does have *Corbicula fluminea*, another bivalve that bioaccumulates selenium, but it is not as invasive as the overbite clam and thus likely makes up a smaller fraction of sturgeon diet. Also, as mentioned above, nonpoint sources of selenium in the San Joaquin Valley that contribute selenium to the Delta will be controlled through a TMDL developed by the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the Grassland Bypass Project, and Basin Plan objectives (Central Valley Water Board 2010c, d) that are expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta. Further, if selenium levels in the San Joaquin River are not sufficiently reduced via these efforts, it is expected that the State Water Board and Central Valley Water Board would initiate additional TMDLs to further control nonpoint sources of selenium.~~

~~Wetland restoration areas will not be designed such that water flows in and does not flow out. Exchange of water between the restoration areas and existing Delta channels is an important design factor, since one goal of the restoration areas is to export food produced in these areas to the rest of the Delta (see BDCP Chapter 3, *Conservation Strategy*, Section 3.3, Biological Goals and Objectives). Thus, these areas can be thought of as "flow-through" systems. Consequently, althoughwater residence times associated with BDCP restoration could increase, they are not expected toincrease without bound. and selenium concentrations in the water column would not continue to build up and be recycled in sediments and organisms as may be the case within a closed system.~~

~~However, because increases in bioavailable selenium in the habitat restoration areas are uncertain, proposed avoidance and minimization measureswould require evaluating risks of selenium exposure at a project level for each restoration area, minimizing to the extent practicable potential risk of additional bioaccumulation, and monitoring selenium levels in fish and/or wildlife to~~

establish whether, or to what extent, additional bioaccumulation is occurring. See Appendix 3B, *Environmental Commitments* for a description of the environmental commitment BDCP proponents are making with respect to Selenium Management; and Appendix 3.C. of the BDCP for additionaldetail on this avoidance and minimization measure (AMM27). Data generated as part of the avoidance and minimization measures will assist the State and Regional Water Boards in determining whether beneficial uses are being impacted by selenium, and thus will provide the data necessary to support regulatory actions (including additional TMDL development), should such actions be warranted.

Given the factors discussed in the assessment above, any increases in bioaccumulation rates from water-borne selenium that could occur in some areas as a result of increased water residence time would not be of sufficient magnitude and geographic extent that any portion of the Delta would be expected to have measurably higher body burdens of selenium in aquatic organisms and, therefore, would not substantially increase risk for adverse effects to beneficial uses. Furthermore, although the Delta is a 303(d)-listed water body for selenium, given the discussion in the assessment above, it is unlikely that restoration areas would result in measurable increases in selenium in fish tissues or bird eggs such that the beneficial use impairment would be made discernibly worse.

Because it is unlikely that substantial increases in selenium in fish tissues or bird eggs would occur such that effects on aquatic life beneficial uses would be anticipated, and because of the avoidance and minimization measures that are designed to further minimize and evaluate the risk of such increases, the effects of WQ-26 are considered not adverse.

***CEQA Conclusion*:** There would be no substantial, long-term increase in selenium concentrations in water in the rivers and reservoirs upstream of the Delta, water in the Delta, or the waters exported to the CVP and SWP service areas due to implementation of CM2–CM22CM21 relative to Existing Conditions. Waterborne selenium concentrations under this alternative would not exceed applicable water quality objectives/criteria.

Given the factors discussed in the assessment above, any increases in bioaccumulation rates from water-borne selenium that could occur in some areas as a result of increased water residence times would not be of sufficient magnitude and geographic extent that any portion of the Delta would be expected to have measurably higher body burdens of selenium in aquatic organisms, and therefore would not substantially increase risk for adverse effects to beneficial uses. CM2-22CM2–CM21 would not cause long-term degradation of water quality resulting in sufficient use of available assimilative capacity such that occasionally exceeding water quality objectives/criteria would be likely. Also, CM2-22 would not result in substantially increased risk for adverse effects to any beneficial uses. Furthermore, although the Delta is a 303(d)-listed water body for selenium, given the discussion in the assessment above, it is unlikely that restoration areas would result in measurable increases in selenium in fish tissues or bird eggs such that the beneficial use impairment would be made discernibly worse.

Since Because it is unlikely that substantial increases in selenium in fish tissues or bird eggs would occur such that effects on aquatic life beneficial uses would be anticipated, and because of the avoidance and minimization measures that are designed to further minimize and evaluate the risk of such increases (see Appendix 3.C. of the BDCP for more detail on AMM27) as well as the SeleniumManagement environmental commitment (see Appendix 3B, *Environmental Commitments*), this impact is considered less than significant. No mitigation is required.

Impact WQ-32. Effects on *Microcystis* Bloom Formation Resulting from Facilities Operations and Maintenance (CM1)

Effects of facilities and operations (CM1) on *Microcystis* abundance, and thus microcystins concentrations, in water bodies of the affected environment under Alternative 5 would be very similar (i.e., nearly the same) to those discussed for Alternative 1A. This is because factors that affect *Microcystis* abundance in waters upstream of the Delta, in the Delta, and in the SWP/CVP Export Services Areas under Alternative 1A would similarly change under Alternative 5, relative to Existing Conditions and the No Action Alternative. For the Delta in particular, there are differences in the direction and magnitude of water residence time changes during the *Microcystis* bloom period among the six Delta sub-regions under Alternative 5 compared to Alternative 1A, relative to Existing Conditions and No Action Alternative. However, under Alternative 5, relative to Existing Conditions and No Action Alternative, water residence times during the *Microcystis* bloom period in various Delta sub-regions are expected to increase to a degree that could, similar to Alternative 1A, lead to an increase in the frequency, magnitude, and geographic extent of *Microcystis* blooms throughout the Delta.

Similar to Alternative 1A, elevated ambient water temperatures relative to Existing Conditions would occur in the Delta under Alternative 5, which could lead to earlier occurrences of *Microcystis* blooms in the Delta, and increase the overall duration and magnitude of blooms. However, the degradation of water quality from *Microcystis* blooms due to the expected increases in Delta water temperatures is driven entirely by climate change, not effects of CM1. While *Microcystis* blooms have not occurred in the Export Service Areas, conditions in the Export Service Areas under Alternative 5 may become more conducive to *Microcystis* bloom formation, relative to Existing Conditions, because water temperatures will increase in the Export Service Areas due to the expected increase in ambient air temperatures resulting from climate change.

NEPA Effects: Effects of water facilities and operations (CM1) on Microcystis in water bodies of the affected environment under Alternative 5 would be very similar to (i.e., nearly the same) to those discussed for Alternative 1A. In summary, Alternative 5 operations and maintenance, relative to the No Action Alternative, would result in long-term increases in hydraulic residence time of various Delta sub-regions during the summer and fall Microcystis bloom period. During this period, the increased residence time could result in a concurrent increase in the frequency, magnitude, and geographic extent of Microcystis blooms, and thus microcystin levels, in affected areas of the Delta. As a result, Alternative 5 operation and maintenance activities would cause further degradation to water quality with respect to Microcystis in the Delta. Under Alternative 5, relative to No Action Alternative, water exported to the SWP/CVP Export Service Area will be a mixture of Microcystis-affected source water from the south Delta intakes and unaffected source water from the Sacramento River, diverted at the north Delta intakes. It cannot be determined whether operations and maintenance under Alternative 5 will result in increased or decreased levels of Microcystis and microcystins in the mixture of source waters exported from Banks and Jones pumping plants. Mitigation Measure WQ-32a and WQ-32b are available to reduce the effects of degraded water quality in the Delta. Although there is considerable uncertainty regarding this impact, the effects on Microcystis from implementing CM1 is determined to be adverse.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the

effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Under Alternative 5, additional impacts from *Microcystis* in the reservoirs and watersheds upstream of the Delta are not expected, relative to Existing Conditions. Operations and maintenance occurring under Alternative 5 is not expected to change nutrient levels in upstream reservoirs or hydrodynamic conditions in upstream rivers and streams such that conditions would be more conductive to *Microcystis* production.

Relative to Existing Conditions, water temperatures and hydraulic residence times in the Delta are expected to increase under Alternative 5, resulting in an increase in the frequency, magnitude and geographic extent of *Microcystis* blooms in the Delta. However, the degradation of water quality from *Microcystis* blooms due to the expected increases in Delta water temperatures is driven entirely by climate change, not effects of CM1. Increases in Delta residence times are expected throughout the Delta during the summer and fall bloom period, due in small part to climate change and sea level rise, but due more proportionately to CM1 and the hydrodynamic impacts of restoration included in CM2 and CM4. The precise change in local residence times and *Microcystis* production expected within any Delta sub-region is unknown because conditions will vary across the complex networks of intertwining channels, shallow back water areas, and submerged islands that compose the Delta. Nonetheless, Delta residence times are, in general, expected to increase due to Alternative 5. Consequently, it is possible that increases in the frequency, magnitude, and geographic extent of *Microcystis* blooms in the Delta will occur due to the operations and maintenance of Alternative 5 and the hydrodynamic impacts of restoration (CM2 and CM4).

The assessment of effects of *Microcystis* on SWP/CVP Export Service Areas is based on the assessment of changes in *Microcystis* levels in export source waters, as well as the effects of temperature and residence time changes within the Export Service Areas on *Microcystis* production. Under Alternative 5, relative to Existing Conditions, the potential for *Microcystis* to occur in the Export Service Area is expected to increase due to increasing water temperature, but this impact is driven entirely by climate change and not Alternative 5. Water exported from the Delta to the Export Service Area is expected to be a mixture of *Microcystis*-affected source water from the south Delta intakes and unaffected source water from the Sacramento River. Because of this, it cannot be determined whether operations and maintenance under Alternative 5, relative to existing conditions, will result in increased or decreased levels of *Microcystis* and microcystins in the mixture of source waters exported from Banks and Jones pumping plants.

Based on the above, this alternative would not be expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause significant impacts on any beneficial uses of waters in the affected environment. *Microcystis* and microcystins are not 303(d) listed within the affected environment and thus any increases that could occur in some areas would not make any existing *Microcystis* impairment measurably worse because no such impairments currently exist. Because *Microcystis* and microcystins are not bioaccumulative, increases that could occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. However, because it is possible that increases in the frequency, magnitude, and geographic extent of *Microcystis* blooms in the Delta will occur due to the operations and maintenance of Alternative 5 and the hydrodynamic impacts of restoration (CM2 and CM4), long-term water quality degradation may occur and, thus, significant impacts on beneficial uses could occur. Although there is considerable uncertainty regarding this impact, the effects on *Microcystis* from implementing CM1 is determined to be significant.

Implementation of Mitigation Measure WQ-32a and WQ-32b may reduce degradation of Delta water quality due to *Microcystis*. However, because the effectiveness of these mitigation measures to result in feasible measures for reducing water quality effects is uncertain, this impact is considered to remain significant and unavoidable.

Mitigation Measure WQ-32a: Design Restoration Sites to Reduce Potential for Increased *Microcystis* Blooms

Please see Mitigation Measure WQ-32a under Impact WQ-32 in the discussion of Alternative 1A.

Mitigation Measure WQ-32b: Investigate and Implement Operational Measures to Manage Water Residence Time

Please see Mitigation Measure WQ-32b under Impact WQ-32 in the discussion of Alternative 1A.

Impact WQ-33. Effects on *Microcystis* Bloom Formation Resulting from Other Conservation Measures (CM2-–CM21)

The effects of CM2–CM21 on *Microcystis* under Alternative 5~~9~~ are the same as those discussed for Alternative 1A. In summary, potential environmental effects related to CM2 and CM4 could result in an increase in the frequency, magnitude, and geographic extent of *Microcystis* blooms in the Delta, relative to Existing Conditions and the No Action Alternative, as a result of increased residence times for Delta waters from implementing CM2 and CM4 restoration areas. -Because the hydrodynamic effects associated with implementing CM2 and CM4 were incorporated into the modeling used to assess CM1, a detailed assessment of the effects of implementing CM2 and CM4 on *Microcystis* blooms in the Delta via their~~e~~ effects on Delta water residence time is provided under CM1 (above). The effects of ~~CM 2~~CM2 and ~~CM 4~~CM4 on *Microcystis* may be reduced by implementation of Mitigation Measures WQ-32A and WQ-32b. The effectiveness of these mitigation measures to result in feasible measures for reducing water quality effects is uncertain. Conservation Measures 3 (CM3) and CM5-CM21 would not result in an increase in the frequency, magnitude, and geographic extent of *Microcystis* blooms in the Delta.

NEPA Effects: Effects of CM2–CM21on Microcystis under Alternative 5 are the same as those discussed for Alternative 1A and are considered to be adverse.

CEQA Conclusion: Based on the above, this alternative would not be expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause significant impacts on any beneficial uses of waters in the affected environment. Microcystis and microcystins are not 303(d) listed within the affected environment and thus any increases that could occur in some areas would not make any existing Microcystis impairment measurably worse because no such impairments currently exist. Because Microcystis and microcystins are not bioaccumulative, increases that could occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. Because restoration actions implemented under CM2 and CM4 will increase residence time throughout the Delta and create local areas of warmer water during the bloom season, it is possible that increases in the frequency, magnitude, and geographic extent of Microcystis blooms, and thus long-term water quality degradation and significant impacts on beneficial uses, could occur. Although there is considerable uncertainty regarding this impact, the effects on Microcystis from implementing CM2–CM21 are determined to be significant.

Impact WQ-34: Effects on San Francisco Bay Water Quality Resulting from Facilities Operations and Maintenance (CM1) and Implementation of CM2–CM21

The effects analysis presented in the preceding impacts (Impact WQ-1 through WQ-33) concluded that Alternative 5 would have a less than significant impact/no adverse effect on the following constituents in the Delta:

- Boron
- Dissolved Oxygen
- Pathogens
- Pesticides
- Trace Metals
- Turbidity and TSS

Elevated concentrations of boron are of concern in drinking and agricultural water supplies. However, waters in the San Francisco Bay are not designated to support municipal water supply (MUN) and agricultural supply (AGR) beneficial uses. Changes in Delta dissolved oxygen, pathogens, pesticides, and turbidity and TSS are not anticipated to be of a frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of the Delta. Thus, changes in boron, dissolved oxygen, pathogens, pesticides, and turbidity and TSS in Delta outflow are not anticipated to be of a frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of the of San Francisco Bay.

The effects of Alternative 5 on bromide, chloride, and DOC, in the Delta were determined to be significant/adverse. Increases in bromide, chloride, and DOC concentrations are of concern in drinking water supplies; however, as described previously, the San Francisco Bay does not have a designated MUN use. Thus, changes in bromide, chloride, and DOC in Delta outflow would not adversely effect any beneficial uses of San Francisco Bay.

Elevated EC, as assessed for this alternative, is of concern for its effects on the agricultural beneficial use (AGR) and fish and wildlife beneficial uses. As discussed above, San Francisco Bay does not have an AGR beneficial use designation. Further, as discussed for the No Action Alternative, changes in Delta salinity would not contribute to measurable changes in Bay salinity, as the change in Delta outflow, which would be the primary driver of salinity changes, would two to three orders of magnitude lower than (and thus minimal compared to) the Bay's tidal flow.

Also, as discussed for the No Action Alternative, adverse changes in Microcystis levels that could occur in the Delta would not cause adverse Microcystis blooms in San Francisco Bay, because Microcystis are intolerant of the Bay's high salinity and, thus not have not been detected downstream of Suisun Bay.

While effects of Alternative 5 on the nutrients ammonia, nitrate, and phosphorus were determined to be less than significant/not adverse, these constituents are addressed further below because the response of the seaward bays to changed nutrient concentrations/loading may differ from the response of the Delta. Selenium and mercury are discussed further, because they are bioaccumulative constituents where changes in load due to both changes in Delta concentrations and exports are of concern.

Nutrients: Ammonia, Nitrate, and Phosphorus

Total nitrogen loads in Delta outflow to Suisun and San Pablo Bays under Alternative 5 would be dominated almost entirely by nitrate, because planned upgrades to the SRWTP will result in >95% removal of ammonia in its effluent. Total nitrogen loads to Suisun and San Pablo Bays would decrease by 31%, relative to Existing Conditions, and increase by 2%, relative to the No Action Alternative (Appendix 8O, Table O-1). The change in nitrogen loading to Suisun and San Pablo Bays under Alternative 5 would not adversely impact primary productivity in these embayments because light limitation and grazing current limit algal production in these embayments. To the extent that algal growth increases in relation to a change in ammonia concentration, this would have net positive benefits, because current algal levels in these embayments are low. Nutrient levels and ratios are not considered a direct driver of *Microcystis* and cyanobacteria levels in the North Bay.

The phosphorus load exported from the Delta to Suisun and San Pablo Bays for Alternative 5 is estimated to increase by 3%, relative to Existing Conditions, and decrease by 2% relative to the No Action Alternative (Appendix 8O, Table O-1)). The only postulated effect of changes in phosphorus loads to Suisun and San Pablo Bays is related to the influence of nutrient stoichiometry on primary productivity. However, there is uncertainty regarding the impact of nutrient ratios on phytoplankton community composition and abundance. Any effect on phytoplankton community composition would likely be small compared to the effects of grazing from introduced clams and zooplankton in the estuary (Senn and Novick 2014; Kimmerer and Thompson 2014). Therefore, the projected change in total nitrogen and phosphorus loading that would occur in Delta outflow to San Francisco Bay is not expected to result in degradation of water quality with regard to nutrients that would result in adverse effects to beneficial uses.

Mercury

The estimated long-term average mercury and methylmercury loads in Delta exports are shown in Appendix 8O, Table O-2. Loads of mercury and methylmercury from the Delta to San Francisco Bay are estimated to change relatively little due to changes in source water fractions and net Delta outflow that would occur under Alternative 5. Mercury load to the Bay, relative to Existing Conditions, is estimated to increase by 3 kg/yr (1%), relative to Existing Conditions, and be unchanged relative to the No Action Alternative. Methylmercury load is estimated to increase by 0.06 kg/yr (2%), relative to Existing Conditions, and decrease by 0.03 kg/yr (1%) relative to the No Action Alternative. The estimated total mercury load to the Bay is 263 kg/yr, which would be less than the San Francisco Bay mercury TMDL WLA for the Delta of 330 kg/yr. The estimated changes in mercury and methylmercury loads would be within the overall uncertainty associated with the estimates of long-term average net Delta outflow and the long-term average mercury and methylmercury concentrations in Delta source waters. The estimated changes in mercury load under the alternative would also be substantially less than the considerable differences among estimates in the current mercury load to San Francisco Bay (SFBRWQCB 2006; David et al. 2009). Similar uncertainty is expected in the existing methylmercury load in net Delta exports, for which the best available current load estimate is based on approximately one year of monitoring data (Foe et al. 2008).

Given that the estimated incremental ~~decreases~~increases of mercury and methylmercury loading to San Francisco Bay would fall within the uncertainty of current mercury and methylmercury load estimates, the estimated changes in mercury and methylmeruchy loads in Delta exports to San Francisco Bay due to Alternative 5 are not expected to result in adverse effects to beneficial uses or substantially degrade the water quality with regard to mercury, or make the existing CWA Section 303(d) impairment measurably worse.

Selenium

Changes in source water fraction and net Delta outflow under Alternative 5, relative to Existing Conditions, are projected to cause the total selenium load to the North Bay to increase by 4%, relative to Existing Conditions, and increase by 1%, relative to the No Action Alternative (Appendix 8O, Table O-3). Changes in long-term average selenium concentrations of the North Bay are assumed to be proportional to changes in North Bay selenium loads. Under Alternative 5, the long-term average total selenium concentration of the North Bay is estimated to be 0.13µg/L and the dissolved selenium concentration is estimated to be 0.11 µg/L, which would be the same as Existing Conditions and the No Action Alternative (Appendix 8O, Table O-3). The dissolved selenium concentration would be below the target of 0.202 µg/L developed by Presser or Luoma (2013) to coincide with a white sturgeon whole-body fish tissue selenium concentration not greater than 8 mg/kg in the North Bay. The incremental increase in dissolved selenium concentrations in the North Bay, relative to Existing Conditions, would be negligible (0.00 µg/L) under this alternative. Thus, the estimated changes in selenium loads in Delta exports to San Francisco Bay due to Alternative 5 are not expected to result in adverse effects to beneficial uses or substantially degrade the water quality with regard to selenium, or make the existing CWA Section 303(d) impairment measurably worse.

NEPA Effects: Based on the discussion above, Alternative 5, relative to the No Action Alternative, would not cause further degradation to water quality with respect to boron, bromide, chloride, dissolved oxygen, DOC, EC, mercury, pathogens, pesticides, selenium, nutrients (ammonia, nitrate, phosphorus), trace metals, or turbidity and TSS in the San Francisco Bay. Further, changes in these constituent concentrations in Delta outflow would not be expected to cause changes in Bay concentrations of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses. In summary, based on the discussion above, effects on the San Francisco Bay from implementation of CM1–CM21 are considered to be not adverse.

CEQA Conclusion: Based on the above, Alternative 5 would not be expected to cause long-term degradation of water quality in San Francisco Bay resulting in sufficient use of available assimilative capacity such that occasionally exceeding water quality objectives/criteria would be likely and would result in substantially increased risk for adverse effects to one or more beneficial uses. Further, based on the above, this alternative would not be expected to cause additional exceedance of applicable water quality objectives/criteria in the San Francisco Bay by frequency, magnitude, and geographic extent that would cause significant impacts on any beneficial uses of waters in the affected environment. Any changes in boron, bromide, chloride, and DOC in the San Francisco Bay would not adversely affect beneficial uses, because the uses most affected by changes in these parameters, MUN and AGR, are not beneficial uses of the Bay. Further, no substantial changes in dissolved oxygen, pathogens, pesticides, trace metals or turbidity or TSS are anticipated in the Delta, relative to Existing Conditions, therefore, no substantial changes these constituents levels in the Bay are anticipated. Changes in Delta salinity would not contribute to measurable changes in Bay salinity, as the change in Delta outflow would two to three orders of magnitude lower than (and thus minimal compared to) the Bay's tidal flow. Adverse changes in Microcystis levels that could occur in the Delta would not cause adverse Microcystis blooms in the Bay, because Microcystis are intolerant of the Bay's high salinity and, thus not have not been detected downstream of Suisun Bay. The 31% decrease in total nitrogen load and 3% increase in phosphorus load, relative to Existing Conditions, are expected to have minimal effect on water quality degradation, primary productivity, or phytoplankton community composition. The estimated increase in mercury load (3 kg/yr; 1%) and methylmercury load (0.06 kg/yr; 2%), relative to Existing Conditions, is within the level of uncertainty in the mass load estimate and not expected to contribute to water quality degradation, make the CWA section 303(d) mercury impairment measurably worse or cause mercury/methylmercury to bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. The estimated increase in selenium load would be 4%, but estimated total and dissolved selenium concentrations under this alternative would be the same as Existing Conditions, and less than the target associated with white sturgeon whole-body fish tissue levels for the North Bay. Thus, the small increase in selenium load is not expected to contribute to water quality degradation, or make the CWA section 303(d) selenium impairment measurably worse or cause selenium to bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant.

8.3.3.11 Alternative 6A—Isolated Conveyance with Pipeline/Tunnel and Intakes 1–5 (15,000 cfs; Operational Scenario D)

Impact WQ-5: Effects on Bromide Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of ~~CM2-22~~CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for ~~CM2-22~~CM2–CM21. See section 8.3.1.3 for more information.

Using the mass-balance modeling approach for bromide (see Section 8.3.1.3), relative to Existing Conditions, Alternative 6A would result in increases in long-term average bromide concentrations at Staten Island and Barker Slough, while long-term average concentrations would decrease at the other assessment locations (Appendix 8E, *Bromide*, Table 14). At Barker Slough, predicted long-term average bromide concentrations would increase from 51 µg/L to 61 µg/L (19% relative increase) for the modeled 16-year hydrologic period and would increase from 54 µg/L to 92 µg/L (73% relative increase) for the modeled drought period. At Barker Slough, the predicted 50 µg/L exceedance frequency would decrease from 49% under Existing Conditions to 38% under Alternative 6A, but would increase from 55% to 63% during the drought period. At Barker Slough, the predicted 100 µg/L exceedance frequency would increase from 0% under Existing Conditions to 17% under Alternative 6A, and would increase from 0% to 37% during the drought period. At Staten Island, predicted long-term average bromide concentrations would increase from 50 µg/L to 70 µg/L (41% relative increase) for the modeled 16-year hydrologic period and would increase from 51 µg/L to 70 µg/L (37% relative increase) for the modeled drought period. At Staten Island, increases in average bromide concentrations would correspond to an increased frequency of 50 µg/l threshold exceedance, from 47% under Existing Conditions to 85% under Alternative 6A (52% to 88% for the modeled drought period), and an increase from 1% to 10% (0% to 5% for the modeled drought period) for the 100 μg/L threshold. Changes in exceedance frequency of the 50 μg/L and 100 μg/L concentration thresholds at other assessment locations would be less considerable. This comparison to Existing Conditions reflects changes in bromide due to both Alternative 6A operations (including north Delta intake capacity of 15,000 cfs and numerous other operational components of Scenario D) and climate change/sea level rise.

Due to the relatively small differences between modeled Existing Conditions and No Action baselines, changes in long-term average bromide concentrations and changes in exceedance frequencies relative to the No Action Alternative are generally of similar magnitude to those previously described for the existing condition comparison (Appendix 8E, *Bromide*, Table 14). Modeled long-term average bromide concentration increases at Barker Slough are predicted to increase by 22% (72% for the modeled drought period) relative to the No Action Alternative. Modeled long-term average bromide concentration increases at Staten Island are predicted to increase by 45% (41% for the modeled drought period) relative to the No Action Alternative. However, unlike the Existing Conditions comparison, long-term average bromide concentrations at Buckley Cove would increase relative to the No Action Alternative, although the increases would be relatively small (≤4%). Unlike the comparison to Existing Conditions, this comparison to the No Action Alternative reflects changes in bromide due only to Alternative 6Aoperations.

At Barker Slough, modeled long-term average bromide concentrations for the two baseline conditions are very similar (Appendix 8E, *Bromide*, Table 14). Such similarity demonstrates that the modeled Alternative 6A change in bromide is almost entirely due to Alternative 6A operations, and not climate change/sea level rise. Therefore, operations are the primary driver of effects on bromide at Barker Slough, regardless whether Alternative 6A is compared to Existing Conditions, or compared to the No Action Alternative.

Results of the modeling approach which used relationships between EC and chloride and between chloride and bromide (see Section 8.3.1.3) differed somewhat from what is presented above for the mass-balance approach (see Appendix 8E, *Bromide,* Table 15).For most locations, the frequency of exceedance of the 50 μg/L and 100 μg/L were similar. The greatest difference between the methods was predicted for Barker Slough. The increases in frequency of exceedance of the 100 μg/L threshold, relative to Existing Conditions and the No Action Alternative, were not as great using this alternative EC to chloride and chloride to bromide relationship modeling approach as compared to that presented above from the mass-balance modeling approach. However, there were still substantial increases, resulting in 6% exceedance over the modeled period under Alternative 6A, as compared to 1% under Existing Conditions and 2% under the No Action Alternative. For the drought period, exceedance frequency increased from 0% under Existing Conditions and the No Action Alternative, to 17% under Alternative 6A.Because the mass-balance approach predicts a greater level of impact at Barker Slough, determination of impacts was based on the mass-balance results.

The increase in long-term average bromide concentrations predicted at Barker Slough, principally the relative increase in 100 μg/L exceedance frequency, would result in a substantial change in source water quality for existing drinking water treatment plants drawing water from the North Bay Aqueduct. As discussed for Alternative 1A, drinking water treatment plants obtaining water via the North Bay Aqueduct utilize a variety of conventional and enhanced treatment technologies in order to achieve DBP drinking water criteria. While the implications of such a modeled change in bromide at Barker Slough are difficult to predict, the substantial modeled increases could lead to adverse changes in the formation of disinfection byproducts such that considerable treatment plant upgrades may be necessary in order to achieve equivalent levels of health protection. Increases at Staten Island are also considerable, although there are no existing or foreseeable municipal intakes in the immediate vicinity. Because many of the other modeled locations already frequently exceed the 100 µg/L threshold under Existing Conditions and the No Action Alternative, these locations likely already require treatment plant technologies to achieve equivalent levels of health protection, and thus no additional treatment technologies would be triggered by the small increases in the frequency of exceeding the 100 µg/L threshold. Hence, no further impact on the drinking water beneficial use would be expected at these locations.

The seasonal intakes at Mallard Slough and City of Antioch are infrequently used due to water quality constraints related to sea water intrusion. On a long-term average basis, bromide at these locations is in excess of 3,000 µg/L, but during seasonal periods of high Delta outflow can be <300 µg/L. Based on modeling using the mass-balance approach, use of the seasonal intakes at Mallard Slough and City of Antioch under Alternative 6A would experience a period average increase in bromide during the months when these intakes would most likely be utilized. For those wet and above normal water year types where mass balance modeling would predict water quality typically suitable for diversion, predicted long-term average bromide would increase from 103 µg/L to 162 µg/L (58% increase) at City of Antioch and would increase from 150 µg/L to 199 µg/L (33% increase) at Mallard Slough relative to Existing Conditions(Appendix 8E, *Bromide*, Table 23). Increases would be similar for the No Action Alternative comparison. Modeling results using the EC to chloride and chloride to bromide relationships show increases during these months, but the relative magnitude of the increases is much lower (Appendix 8E, *Bromide*, Table 24).Regardless of the differences in the data between the two modeling approaches, the decisions surrounding the use of these seasonal intakes is largely driven by acceptable water quality, and thus have historically been opportunistic. Opportunity to use these intakes would remain, and the predicted increases in bromide concentrations at the City of Antioch and Mallard Slough intake would not be expected to adversely affect MUN beneficial uses, or any other beneficial use, at these locations.

Based on modeling using the mass-balance approach, relative to existing and No Action Alternative conditions, Alternative 6A would lead to predicted improvements in long-term average bromide concentrations at Franks Tract, Rock Slough, and Contra Costa PP No. 1, in addition to Banks and Jones (discussed below). At these locations, long-term average bromide concentrations would be predicted to decrease by as much as 41–61%, depending on baseline comparison. Modeling results using the EC to chloride and chloride to bromide relationships generally do not show similar decreases for Rock Slough and Contra Costa PP No. 1, but rather, predict small increases. Based on the small magnitude of increases predicted, these increases would not adversely affect beneficial uses at those locations.

Important to the results presented above is the assumed habitat restoration footprint on both the temporal and spatial scales incorporated into the modeling. Modeling sensitivity analyses have indicated that habitat restoration (which are reflected in the modeling—see Section 8.3.1.3), not operations covered under CM1, are the driving factor in the modeled bromide increases. The timing, location, and specific design of habitat restoration will have effects on Delta hydrodynamics, and any deviations from modeled habitat restoration and implementation schedule will lead to different outcomes. Although habitat restoration near Barker Slough is an important factor contributing to modeled bromide concentrations at the North Bay Aqueduct, BDCP habitat restoration elsewhere in the Delta can also have large effects. Because of these uncertainties, and the possibility of adaptive management changes to BDCP restoration activities, including location, magnitude, and timing of restoration, the estimates are not predictive of the bromide levels that would actually occur in Barker Slough or elsewhere in the Delta.

Impact WQ-7: Effects on Chloride Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Delta

Municipal Beneficial Uses

Estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3) were used to evaluate the 150 mg/L Bay-Delta WQCP objective for municipal and industrial beneficial uses on a basis of the percent of years the chloride objective is exceeded for the modeled 16-year period. The objective is exceeded if chloride concentrations exceed 150 mg/L for a specified number of days in a given water year at both the Antioch and Contra Costa Pumping Plant #1 locations. For Alternative 6A, the modeled frequency of objective exceedance would ~~increase from 6~~remain unchanged at 7% of years under Existing Conditions and ~~6% under the No Action Alternativeto 13% of years under~~ Alternative 6A (Appendix 8G, Chloride, Table Cl-64). The modeled frequency of objective exceedance would increase from 0% of years under the No Action Alternative to 7% under Alternative 6A. However, the increase was due to a single year, 1977, which fell just short of the required number of days (i.e., was within 9 days minimum number of required days < 150 mg/L). Given the uncertainty in the chloride modeling approach, it is likely that real time operations of the SWP and CVP could achieve compliance with this objective (see Section 8.3.1.1 for a discussion of chloride compliance modeling uncertainties and a description of real time operations of the SWP and CVP).

Similarly, estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3) were also used to evaluate the 250 mg/L Bay-Delta WQCP objective for chloride at Contra Costa Pumping Plant #1 where daily average objectives apply. The basis for the evaluation was the predicted number of days the objective was exceeded for the modeled 16-year period. For Alternative 6A, the modeled frequency of objective exceedance would be eliminated, from 6% of modeled days under Existing Conditions and 5% under the No Action Alternative to 0% of modeled days under Alternative 6A (Appendix 8G, Chloride, Table Cl-63).

Given the limitations inherent to estimating future chloride concentrations (see Section 8.3.1.3), estimation of chloride concentrations through both a mass balance approach and an EC-chloride relationship approach was used to evaluate the 250 mg/L Bay-Delta WQCP objectives in terms of both frequency of exceedance and use of assimilative capacity. When utilizing the mass balance approach to model monthly average chloride concentrations for the 16-year period, the predicted frequency of exceeding the 250 mg/L objective would be eliminated at the Contra Costa Canal at Pumping Plant #1 (24% for Existing Conditions to 0% for Alternative 6A), thus indicating complete compliance with this objective would be achieved (Appendix 8G, Chloride, Table Cl-39 and Figure Cl-9). The frequency of exceedances at the San Joaquin River at Antioch also would decrease compared to all of the alternative scenarios (i.e., 9% from 66% for Existing Conditions to 57%) with no substantial change predicted for Mallard Island (i.e., maximum increase of 1%) (Appendix 8G, Table Cl-39).However, available assimilative capacity would be reduced relative to Existing Conditions in April (i.e., up to 21%) (Appendix 8G, Table Cl-41) reflecting substantial degradation during a month when average concentrations would be near, or exceed, the objective.

In comparison, when utilizing the chloride-EC relationship to model monthly average chloride concentrations for the 16-year period, trends in frequency of exceedance generally agreed, but use of assimilative capacity were predicted to be larger at some locations (Appendix 8G, Chloride, Table Cl-40 and Table Cl-42). Specifically, while the model predicted exceedance frequency would decrease at the Contra Costa Canal at Pumping Plant #1 and Rock Slough locations, use of assimilative capacity would increase substantially for the months of February through June. (i.e., maximum of 81% in March for the modeled drought period). Due to such seasonal long-term average water quality degradation at these locations, the potential exists for substantial adverse effects on the municipal and industrial beneficial uses through reduced opportunity for diversion of water with acceptable chloride levels. Moreover, due to the increased frequency of exceeding the 150 mg/L Bay-Delta WQCP objective, the potential exists for additional adverse effects on the municipal and industrial beneficial uses at Contra Costa Pumping Plant #1 and Antioch.

303(d) Listed Water Bodies

With respect to the 303(d) listing for chloride in Tom Paine Slough, the monthly average chloride concentrations for the 16-year period modeled at Old River at Tracy Road would generally be similar compared to Existing Conditions, and thus, would not be further degraded on a long-term basis (Appendix 8G, Figure Cl-10). With respect to Suisun Marsh, the monthly average chloride concentrations for the 16-year period modeled would generally increase compared to Existing Conditions and No Action Alternative in some months during October through May at the Sacramento River at Collinsville (Appendix 8G, Figure Cl-11), Mallard Island (Appendix 8G, Figure Cl-9), and increase substantially at Montezuma Slough at Beldon's Landing (i.e., over a doubling of concentration in December through February) (Appendix 8G, Figure Cl-12), However, modeling of Alternative 6A assumed no operation of the Montezuma Slough Salinity Control Gates, but the project description assumes continued operation of the Salinity Control Gates, consistent with assumptions included in the No Action Alternative. A sensitivity analysis modeling run conducted for Alternative 4 with the gates operational consistent with the No Action Alternative resulted in substantially lower EC levels than indicated in the original Alternative 4 modeling results for Suisun Marsh, but EC levels were still somewhat higher than EC levels under Existing Conditions for several locations and months. Although chloride was not specifically modeled in these sensitivity analyses, it is expected that chloride concentrations would be nearly proportional to EC levels in Suisun Marsh. Another modeling run with the gates operational and restoration areas removed resulted in EC levels nearly equivalent to Existing Conditions, indicating that design and siting of restoration areas has notable bearing on EC levels at different locations within Suisun Marsh (see Appendix 8H Attachment 1 for more information on these sensitivity analyses). These analyses also indicate that increases in salinity are related primarily to the hydrodynamic effects of CM4, not operational components of CM1. Based on the sensitivity analyses, optimizing the design and siting of restoration areas may limit the magnitude of long-term chloride increases in the Marsh. However, the chloride concentration increases at certain locations could be substantial, depending on siting and design of restoration areas. Thus, these increased chloride levels in Suisun Marsh are considered to contribute to additional, measureable long-term degradation that potentially would adversely affect the necessary actions to reduce chloride loading for any TMDL that is developed.thereby contributing to additional, measureable long-term degradation that potentially would adversely affect the necessary actions to reduce chloride loading for any TMDL that is developed.

***NEPA Effects*:** In summary, relative to the No Action Alternative conditions, Alternative 6A would result in increased frequency of exceedance of the 150 mg/L Bay-Delta WCCP objective at Contra

~~Costa Pumping Plant #1 and Antioch,~~ substantial seasonal use of assimilative capacity at Contra Costa Pumping Plant #1, Antioch, and Rock Slough, and could result in increased concentrations with respect to the 303(d) impairment in Suisun Marsh. The predicted chloride increases constitute an adverse effect on water quality(see Mitigation Measure WQ-7 below; implementation of this measure along with a separate, non-environmental commitment relating to the potential increased chloride treatment costs would reduce these effects).Additionally, the predicted changes relative to the No Action Alternative conditions indicate that in addition to the effects of climate change/sea level rise, implementation of CM1 and CM4 under Alternative 6A would contribute substantially to the adverse water quality effects.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Chloride is not a constituent of concern in the Sacramento River watershed upstream of the Delta, thus river flow rate and reservoir storage reductions that would occur under the Alternative 6A, relative to Existing Conditions, would not be expected to result in a substantial adverse change in chloride levels. Additionally, relative to Existing Conditions, the Alternative 6A would not result in reductions in river flow rates (i.e., less dilution) or increased chloride loading such that there would be any substantial increase in chloride concentrations upstream of the Delta in the San Joaquin River watershed.

Relative to Existing Conditions, Alternative 6A operations would result in substantially reduced chloride concentrations in the Delta such that exceedances of the 250 mg/L Bay-Delta WQCP objective at the San Joaquin River at Antioch and Mallard Slough would be reduced. Nevertheless, due to the ~~predicted increased frequency of exceeding the 150 mg/L Bay-Delta WQCP objective at Contra Costa Pumping Plant #1 and Antioch, and the~~ substantial seasonal use of assimilative capacity at Contra Costa Pumping Plant #1 and Rock Slough, the potential exists for adverse effects on the municipal and industrial beneficial uses at these locations(see Mitigation Measure WQ-7 below; implementation of this measure along with a separate, non-environmental commitment relating to the potential increased chloride treatment costs would reduce these effects). Moreover, the modeled increased chloride concentrations and degradation in the western Delta could still occur and further contribute, at measurable levels ~~(i.e., over a doubling of concentration)~~, to the existing 303(d) listed impairment due to chloride in Suisun Marsh for the protection of fish and wildlife. Based on these findings, this impact is determined to be significant due to increased ~~frequency of exceedance of the 150 mg/L Bay-Delta WQCP objective as well as potential adverse effects on fish and wildlife beneficial uses~~degradation relative to the 250 mg/L objective in the western Delta as well as potential increased degradation relative to the 303(d) listing in Suisun Marsh.

Chloride concentrations would be reduced in water exported from the Delta to the CVP/SWP Export Service Areas, thus reflecting a potential improvement to chloride loading in the lower San Joaquin River.

Chloride is not a bioaccumulative constituent, thus any increased concentrations under Alternative 6A would not result in substantial chloride bioaccumulation impacts on aquatic life or humans. Alternative 6A maintenance would not result in any substantial changes in chloride concentration upstream of the Delta or in the SWP/CVP Export Service Areas. However, based on these findings, this impact is determined to be significant due to increased chloride concentrations and degradation in Suisun Marsh and its effects on fish and wildlife beneficial uses.

While mitigation measures to reduce these water quality effects in affected water bodies to less than significant levels are not available, implementation of Mitigation Measure WQ-7 is recommended to attempt to reduce the effect that increased chloride concentrations may have on Delta beneficial uses. However, because the effectiveness of this mitigation measure to result in feasible measures for reducing water quality effects is uncertain, this impact is considered to remain significant and unavoidable. Please see Mitigation Measure WQ-7 under Impact WQ-7 in the discussion of Alternative 1A.

In addition to and to supplement Mitigation Measure WQ-7, the BDCP proponents have incorporated into the BDCP, as set forth in EIR/EIS Appendix 3B, *Environmental Commitments*, a separate, non-environmental commitment to address the potential increased water treatment costs that could result from chloride concentration effects on municipal, industrial and agricultural water purveyor operations. Potential options for making use of this financial commitment include funding or providing other assistance towards acquiring alternative water supplies or towards modifying existing operations when chloride concentrations at a particular location reduce opportunities to operate existing water supply diversion facilities. Please refer to Appendix 3B, *Environmental Commitments*, for the full list of potential actions that could be taken pursuant to this commitment in order to reduce the water quality treatment costs associated with water quality effects relating to chloride, electrical conductivity, and bromide.

Impact WQ-9: Effects on Dissolved Oxygen Resulting from Facilities Operations and Maintenance (CM1)

NEPA Effects: Effects of CM1 on dissolved oxygen under Alternative 6A are the same as those discussed for Alternative 1A and are considered to not be adverse.

CEQA Conclusion: Effects of CM1 on DO under Alternative 6Awould be similar to those discussed for Alternative 1A, and are summarized here, then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion under the Alternative 1A.

~~River flow rate and r~~Reservoir storage reductions that would occur under Alternative 6A, relative to Existing Conditions, would not be expected to result in a substantial adverse change in DO levels in the reservoirs, because oxygen sources (surface water aeration, aerated inflows, vertical mixing) would remain. Similarly, river flow rate reductions that would occur would not be expected to result in a substantial adverse change in DO levels in the ~~and~~ rivers upstream of the Delta, given that mean monthly flows would remain within the ranges historically seen under Existing Conditions and the affected river are large and turbulent. Any reduced DO saturation level that may be caused by increased water temperature would not be expected to cause DO levels to be outside of the range seen historically. Finally, amounts of oxygen demanding substances and salinity would not be expected to change sufficiently to affect DO levels.

It is expected there would be no substantial change in Delta DO levels in response to a shift in the Delta source water percentages under this alternative or substantial degradation of these water bodies, with regard to DO. DO levels would be affected by nutrient loading, which the state has begun to aggressively regulate the discharges of, and this loading would not be expected to lower DO levels relative to Existing Conditions based on historical DO levels. Further, the anticipated changes in salinity would have relatively minor effects on DO levels, and tidal exchange, which contribute to the reaeration of Delta waters would not be expected to change substantially.

There is not expected to be substantial, if even measurable, changes in DO levels in the SWP/CVP Export Service Areas waters under Alternative 6A, relative to Existing Conditions, because the biochemical oxygen demand of the exported water would not be expected to substantially differ from that under Existing Conditions (due to ever increasing water quality regulations), canal turbulence and exposure of the water to the atmosphere and the algal communities that exist within the canals would establish an equilibrium for DO levels within the canals. The same would occur in downstream reservoirs.

Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would result in significant impacts on any beneficial uses within affected water bodies. Because no substantial changes in DO levels are expected, long-term water quality degradation would not be expected to occur, and, thus, beneficial uses would not be adversely affected. Various Delta waterways are 303(d)-listed for low DO, but because no substantial decreases in DO levels would be expected, greater degradation and DO-related impairment of these areas would not be expected. This impact would be less than significant. No mitigation is required.

Impact WQ-11: Effects on Electrical Conductivity Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of ~~CM2-22~~CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for ~~CM2-22~~CM2–CM21. See section 8.3.1.3 for more information.

Relative to Existing Conditions, Alternative 6A would result in an increase in the number of days the Bay-Delta WQCP EC objectives for fish and wildlife protection (which apply during April and May in all but critical water year types) would be exceeded in the San Joaquin River at Jersey Point and Prisoners Point (Appendix 8H, *Electrical Conductivity*, Table EC-6), and an increase in exceedance of the agricultural EC objective for the Sacramento River at Emmaton.

The percent of days the fish and wildlife EC objective would be exceeded at Jersey Point for the entire period modeled (1976–1991) would increase from 0% under Existing Conditions to 3% under Alternative 6A, and the percent of days out of compliance with the EC objective would increase from 0% under Existing Conditions to 5% under Alternative 6A. The percent of days the EC objective would be exceeded at Prisoners Point for the entire period modeled would increase from 6% under Existing Conditions to ~~3~~40% under Alternative 6A, and the percent of days out of compliance with the EC objective would increase from 10% under Existing Conditions to ~~3~~40% under Alternative 6A. Sensitivity analyses conducted for Alternative 4 scenario H3 indicated that removing all tidal restoration areas would reduce the number of exceedances, but there would still be substantially more exceedances than under Existing Conditions or the No Action Alternative. Results of the sensitivity analyses indicate that the exceedances are partially a function of the operations of the alternative itself, perhaps due to Head of Old River Barrier assumptions and south Delta export differences (see Appendix 8H Attachment 1 for more discussion of these sensitivity analyses). Due to similarities in the nature of the exceedances between alternatives, the findings from these analyses can be extended to this alternative as well. Appendix 8H Attachment 2 contains a more detailed assessment of the likelihood of these exceedances impacting aquatic life beneficial uses. Specifically, Appendix 8H Attachment 2 discusses whether these exceedances might have indirect effects on striped bass spawning in the Delta, and concludes that the high level of uncertainty precludes making a definitive determination.

At Emmaton, the percent of days the EC objective would be exceeded would increase from 6% under Existing Conditions to 32~~8~~% under Alternative 6A, and the percent of days out of compliance would increase from 11% under Existing Conditions to 44~~0~~% under Alternative 6A.

Average EC levels at the western and southern Delta compliance locations and San Joaquin River at San Andreas Landing (an interior Delta location) would decrease from 2–56% for the entire period modeled and 3–52% during the drought period modeled (1987–1991) (Appendix 8H, *Electrical Conductivity*, Table EC-17). In the S. Fork Mokelumne River at Terminous, average EC would increase 7% for the entire period modeled and 6% during the drought period modeled. Average EC in the S. Fork Mokelumne River at Terminous (an interior Delta location) would increase during all months (Appendix 8H, Table EC-17). The western Delta is Clean Water Act section 303(d) listed as impaired due to elevated EC and there would be an increased exceedance of the EC objective at Emmaton.~~,~~ Thus, relative to Existing Conditions, Alternative 6A could contribute to additional impairment of section 303(d) listed waters. The comparison to Existing Conditions reflects changes in EC due to both Alternative 6A operations (including north Delta intake capacity of 15,000 cfs and numerous other operational components of Scenario D) and climate change/sea level rise.

Relative to the No Action Alternative, the change in percent compliance with Bay-Delta WQCP EC objectives under Alternative 6A would be similar to that described above relative to Existing Conditions for the Sacramento River at Emmaton, and the San Joaquin River at Jersey Point and Prisoners Point. In addition, there would also be a slight increase (<1%) in the percent of days the EC objective would be exceeded in Old River at Tracy Bridge for the entire period modeled. For the entire period modeled, average EC levels would increase at: S. Fork Mokelumne River at Terminous; San Joaquin River at Brandt Bridge and Prisoners Point; and Old River at Tracy Bridge. The greatest average EC increase would occur in the S. Fork Mokelumne River at Terminous (8%); the average EC increase at the other locations would be <1–3% (Appendix 8H, *Electrical Conductivity*, Table EC-17). During the drought period modeled, average EC would increase at the same locations, except San Joaquin River at Prisoners Point. The greatest average EC increase during the drought period modeled would occur in the S. Fork Mokelumne River at Terminous (7%); the increase at the other locations would be 1–2% (Appendix 8H, Table EC-17). Given that the western ~~and southern~~ Delta ~~are~~ is Clean Water Act section 303(d) listed as impaired due to elevated EC, the increase in the incidence of exceedance of EC objectives ~~and increase in long-term and drought period average EC under Alternative 6A at southern Delta compliance locations and increase in exceedance of EC objectives~~ at Emmaton, relative to the No Action Alternative, has the potential to contribute to additional impairment and potentially adversely affect beneficial uses. The comparison to the No Action Alternative reflects changes in EC due only to Alternative 6A operations (including north Delta intake capacity of 15,000 cfs and numerous other operational components of Scenario D).

For Suisun Marsh, October–May is the period when Bay-Delta WQCP EC objectives for protection of fish and wildlife apply. Long-term average EC would increase under Alternative 6A, relative to Existing Conditions, during the months of April and May by 0.2–0.4 mS/cm in the Sacramento River at Collinsville (Appendix 8H, *Electrical Conductivity*, Table EC-21). Long-term average EC would decrease relative to Existing Conditions in Montezuma Slough at National Steel during October–May (Appendix 8H, Table EC-22). The most substantial increase would occur near Beldon Landing, with long-term average EC levels increasing by 0.8–2.2 mS/cm, depending on the month, nearly doubling during some months the long-term average EC relative to Existing Conditions (Appendix 8H, Table EC-23). Sunrise Duck Club and Volanti Slough also would have long-term average EC increases during February–May of 0.4–1.7 mS/cm (Appendix 8H, Tables EC-24 and EC-25). Modeling of this alternative assumed no operation of the Montezuma Slough Salinity Control Gates, but the project description assumes continued operation of the Salinity Control Gates, consistent with assumptions included in the No Action Alternative. A sensitivity analysis modeling run conducted for Alternative 4 scenario H3 with the gates operational consistent with the No Action Alternative resulted in substantially lower EC levels than indicated in the original Alternative 4 modeling results, but EC levels were still somewhat higher than EC levels under Existing Conditions and the No Action Alternative for several locations and months. Another modeling run with the gates operational and restoration areas removed resulted in EC levels nearly equivalent to Existing Conditions and the No Action Alternative, indicating that design and siting of restoration areas has notable bearing on EC levels at different locations within Suisun Marsh (see Appendix 8H Attachment 1 for more information on these sensitivity analyses). These analyses also indicate that increases are related primarily to the hydrodynamic effects of CM4, not operational components of CM1. Based on the sensitivity analyses, optimizing the design and siting of restoration areas may limit the magnitude of long-term EC increases to be on the order of 1 mS/cm or less. Due to similarities in the nature of the EC increases between alternatives, the findings from these analyses can be extended to this alternative as well.

The degree to which the long-term average EC increases in Suisun Marsh would cause exceedance of Bay-Delta WQCP objectives is unknown, because these objectives are expressed as a monthly average of daily high tide EC, which does not have to be met if it can be demonstrated "equivalent or better protection will be provided at the location" (State Water Resources Control Board 2006:14). The described long-term average EC increase may, or may not, contribute to adverse effects on beneficial uses, depending on how and when wetlands are flooded, soil leaching cycles, and how agricultural use of water is managed, and future actions taken with respect to the marsh. However, the EC increases at certain locations would could be substantial, depending on siting and design of restoration areas, and it is uncertain the degree to which current management plans for the Suisun Marsh would be able to address these substantially higher EC levels and protect beneficial uses. Thus, these increased EC levels in Suisun Marsh are considered to have a potentially adverse effect on marsh beneficial uses. Long-term average EC increases in Suisun Marsh under Alternative 6A relative to the No Action Alternative would be similar to the increases relative to Existing Conditions. Suisun Marsh also is section 303(d) listed as impaired due to elevated EC, and the potential increases in long-term average EC concentrations could contribute to additional impairment, because the increases would be double that relative to Existing Conditions and the No Action Alternative..

NEPA Effects: In summary, the increased frequency of exceedance of EC objectives and increased long-term and drought period average EC levels that would occur at southern Delta compliance locations, and increased exceedance of objectives in the western Delta under Alternative 6A, relative to the No Action Alternative, would contribute to adverse effects on the agricultural beneficial uses. In addition. the increased frequency of exceedance of the San Joaquin River at Prisoners Point and Jersey Point EC objectives and long-term and drought period average EC at Prisoners Point could contribute to adverse effects on fish and wildlife beneficial uses (specifically, indirect adverse effects on striped bass spawning), though there is a high degree of uncertainty associated with this impact. The western and southern Delta are CWA section 303(d) listed as impaired due to elevated EC, and the increase in incidence of exceedance of EC objectives in the western portion of the Delta have the potential to contribute to additional beneficial use impairment.~~Given that the western and southern Delta are Clean Water Act section 303(d) listed as impaired due to elevated EC, the increase in the incidence of exceedance of EC objectives and long-term average and drought period average EC in these portions of the Delta has the potential to contribute to additional beneficial use impairment.~~ The increases in long-term average EC levels that ~~would~~ could occur in Suisun Marsh would further degrade existing EC levels and could contribute ~~additional~~ to adverse effects on the fish and wildlife beneficial uses. Suisun Marsh is section 303(d) listed as impaired due to elevated EC, and the potential increases in long-term average EC levels could contribute to additional beneficial use impairment. These increases in EC constitute an adverse effect on water quality. Mitigation Measure WQ-11 would be available to reduce these effects (implementation of this measure along with a separate, non-environmental commitment as set forth in EIR/EIS Appendix 3B, *Environmental Commitments*, relating to the potential EC-related changes would reduce these effects).

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

River flow rate and reservoir storage reductions that would occur under Alternative 6A, relative to Existing Conditions, would not be expected to result in a substantial adverse change in EC levels in the reservoirs and rivers upstream of the Delta, given that: changes in the quality of watershed runoff and reservoir inflows would not be expected to occur in the future; the state's aggressive regulation of point-source discharge effects on Delta salinity-elevating parameters and the expected further regulation as salt management plans are developed; the salt-related TMDLs adopted and being developed for the San Joaquin River; and the expected improvement in lower San Joaquin River average EC levels commensurate with the lower EC of the irrigation water deliveries from the Delta.

Relative to Existing Conditions, Alternative 6A would not result in any substantial increases in long-term average EC levels in the SWP/CVP Export Service Areas. There would be no exceedance of the EC objective at the Jones and Banks pumping plants. Average EC levels for the entire period modeled would decrease at both plants and, thus, this alternative would not contribute to additional beneficial use impairment related to elevated EC in the SWP/CVP Export Service Areas waters. Rather, this alternative would improve long-term EC levels in the SWP/CVP Export Service Areas, relative to Existing Conditions.

Alternative 6A would result in an increase in the frequency with which Bay-Delta WQCP EC objectives for fish and wildlife protection are exceeded in the San Joaquin River at Jersey Point (from 0% under Existing Conditions to 3% under Alternative 6A) and Prisoners Point (from 6% under Existing Conditions to ~~3~~40% under Alternative 6A), and an increase in the EC agricultural objectives at Emmaton for the entire period modeled (1976–1991). Because EC is not bioaccumulative, the increases in long-term average EC levels would not directly cause bioaccumulative problems in aquatic life or humans. Portions of the Delta on the Clean Water Act section 303(d) list as impaired due to elevated EC would not have increased long-term average EC levels relative to Existing Conditions, However, at Emmaton, which is in the western Delta, there would be an increased frequency of exceedance of the EC objective. Thus, Alternative 6A could contribute to additional impairment of section 303(d) listed waters. The increased frequency of exceedance of fish and wildlife EC objectives at Prisoners Point and Jersey Point could adversely affect aquatic life beneficial uses specifically, indirect adverse effects on striped bass spawning), though there is a high degree of uncertainty associated with this impact.. This impact is considered to be significant.

Further, relative to Existing Conditions, Alternative 6A ~~would~~ could result in substantial increases in long-term average EC during the months of October through May in Suisun Marsh~~, such that EC levels would nearly double that relative to Existing Conditions~~. The increases in long-term average EC levels that would occur in Suisun Marsh could further degrade existing EC levels and thus contribute additionally to adverse effects on the fish and wildlife beneficial uses. Because EC is not bioaccumulative, the increases in long-term average EC levels would not directly cause bioaccumulative problems in wildlife. Suisun Marsh is Clean Water Act section 303(d) listed for elevated EC and the increases in long-term average EC that would occur in the marsh could make beneficial use impairment measurably worse. This impact is considered to be significant.

Implementation of Mitigation Measure WQ-11 along with a separate, non-environmental commitment relating to the potential increased costs associated with EC-related changes would reduce these effects. While mitigation measures to reduce these water quality effects in affected water bodies to less than significant levels are not available, implementation of Mitigation Measure WQ-11 is recommended to attempt to reduce the effect that increased EC concentrations may have on Delta beneficial uses. However, because the effectiveness of this mitigation measure to result in feasible measures for reducing water quality effects is uncertain, this impact is considered to remain significant and unavoidable. Please see Mitigation Measure WQ-11 under Impact WQ-11 in the discussion of Alternative 1A.

In addition to and to supplement Mitigation Measure WQ-11, the BDCP proponents have incorporated into the BDCP, as set forth in EIR/EIS Appendix 3B, *Environmental Commitments*, a separate, non-environmental commitment to address the potential increased water treatment costs that could result from EC concentration effects on municipal, industrial and agricultural water purveyor operations. Potential options for making use of this financial commitment include funding or providing other assistance towards acquiring alternative water supplies or towards modifying existing operations when EC concentrations at a particular location reduce opportunities to operate existing water supply diversion facilities. Please refer to Appendix 3B, *Environmental Commitments*, for the full list of potential actions that could be taken pursuant to this commitment in order to reduce the water quality treatment costs associated with water quality effects relating to chloride, electrical conductivity, and bromide.

Impact WQ-13: Effects on Mercury Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of ~~CM2-22~~CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for ~~CM2-22~~CM2–CM21. See section 8.3.1.3 for more information.

The water quality impacts of waterborne concentrations of mercury and methylmercury and fish tissue mercury concentrations were evaluated for 9 Delta locations. The analysis of percentage change in assimilative capacity of waterborne total mercury of Alternative 6A relative to the 25 ng/L ecological risk benchmark as compared to Existing Conditions showed the greatest decrease to be 9.2% at the Contra Costa Pumping Plant, 9.1% at the Contra Costa Pumping Plant relative to the No Action Alternative (Figures 8-53 and 8-54). These changes are not expected to result in adverse effects to beneficial use. Similarly, changes in methylmercury concentration are expected to be relatively small. The greatest annual average methylmercury concentration for drought conditions was 0.165 ng/L for the San Joaquin River at Buckley Cove which was slightly higher than Existing Conditions (0.161 ng/L) and slightly lower than the No Action Alternative (0.167 ng/L)(Appendix 8I, Table I-6).All modeled input concentrations exceeded the methylmercury TMDL guidance objective of 0.06 ng/L, therefore percentage change in assimilative capacity was not evaluated for methylmercury.

Fish tissue estimates show substantial percentage increases in concentration and exceedance quotients for mercury at some Delta locations. The greatest increases in exceedance quotients (ranging from 33 to 64%) are expected for Franks Tract and Old River at Rock Slough relative to Existing Conditions and the No Action Alternative (Figure ~~8-55~~8-55a,b, Appendix 8I, Table I-13b). Because these increases are substantial, and it is evident that substantive increases are expected at numerous locations throughout the Delta, these changes may be measurable in the environment. See Appendix 8I for a discussion of the uncertainty associated with the fish tissue estimates.

SWP/CVP Export Service Areas

The analysis of mercury and methylmercury in the SWP/CVP Export Service Areas was based on concentrations estimated at the Banks and Jones pumping plants. Both waterborne total and methylmercury concentrations for Alternative 6Aare projected to be lower than Existing Conditions and the No Action Alternative (Appendix 8I,Mercury,Figures ~~8~~I-4 and ~~8~~I-5).Therefore, mercury shows an increased assimilative capacity at these locations (Figures 8-53 and 8-54).

The largest improvements in bass tissue mercury concentrations and exceedance quotients for Alternative 6A, relative to Existing Conditions and the No Action Alternative at any location within the Delta are expected for the export pump locations (specifically, at Jones Pumping plant, 41% improvement relative to Existing Conditions, 43% relative to the No Action Alternative) (Figure ~~8-55~~8-55a,b, Appendix 8I, Mercury, Table I-13b).

NEPA Effects: Based on the above discussion, the effects of mercury and methylmercury in comparison of Alternative 6Ato the No Action Alternative (as waterborne and bioaccumulated forms) are considered to be adverse for the case of fish tissue bioaccumulation at some locations.

***CEQA Conclusion*:** Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the

effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Under Alternative 6A, greater water demands and climate change would alter the magnitude and timing of reservoir releases and river flows upstream of the Delta in the Sacramento River watershed and east-side tributaries, relative to Existing Conditions. Concentrations of mercury and methylmercury upstream of the Delta will not be substantially different relative to Existing Conditions due to the lack of important relationships between mercury/methylmercury concentrations and flow for the major rivers.

Methylmercury concentrations exceed criteria at all locations in the Delta and no assimilative capacity exists. Monthly average waterborne concentrations of total and methylmercury, over the period of record, are very similar to Existing Conditions, but showed notable increases at some locations. Estimates of fish tissue mercury concentrations show substantial increases would occur for several sites for ~~Methylmercury concentrations exceed criteria at all locations in the Delta and no assimilative capacity exists.However, monthly average waterborne concentrations of total and methylmercury, over the period of record, are very similar to Existing Conditions.Similarly, estimates of fish tissue mercury concentrations show almost no differences would occur among sites for~~ Alternative 6A as compared to Existing Conditions for Delta sites.

Assessment of effects of mercury in the SWP and CVP Export Service Areas were based on effects on mercury concentrations and fish tissue mercury concentrations at the Banks and Jones pumping plants. The Banks and Jones pumping plants are expected to show increased assimilative capacity for waterborne mercury and decreased fish tissue concentrations of mercury for Alternative 6A as compared to Existing Conditions.

As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. However, increases in fish tissue mercury concentrations are substantial, and changes in fish tissue mercury concentrations would make existing mercury-related impairment in the Delta measurably worse. In comparison to Existing Conditions, Alternative 6A would increase levels of mercury by frequency, magnitude, and geographic extent such that the affected environment would be expected to have measurably higher body burdens of mercury in aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish) or humans consuming those organisms. This impact is considered to be significant. Feasible or effective actions to reduce the effects on mercury resulting from CM1 are unknown. General mercury management measures through CM12, or actions taken by other entities or programs such as TMDL implementation, may minimize or reduce sources and inputs of mercury to the Delta and methylmercury formation. However, it is uncertain whether this impact would be reduced to a level that would be less than significant as a result of CM12 or other future actions. Therefore, the impact would be significant and unavoidable.

Impact WQ-25: Effects on Selenium Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics~~,~~. To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2-22CM2–CM21 not attributable to hydrodynamics, for example,such as additional loading of a constituent to the Delta, are discussed within the impact header for CM2-22CM2–CM21. See section Section 8.3.1.3 for more information.

Selenium concentrations and threshold comparisons for each of the 11 modeled Delta assessment locations under Alternative 5, relative to Existing Conditions and the No Action Alternative, are presented in Appendix 8M, Selenium, Table M-9a for water, Tables M-16 and M-26 for most biota (whole-body fish ([excluding sturgeon)], bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets) throughout the Delta, and Tables M-30 through M-32 for sturgeon at the two western Delta locations. Figures 8-59a and 8-60a present graphical distributions of predicted selenium concentration changes (shown as changes in available assimilative capacity based on 1.3 µg/L) in water at each modeled assessment location for all years. Appendix 8M, Figure M-23 provides more detail in the form of monthly patterns of selenium concentrations in water during the modeling period.

Alternative 6A would result in small to moderate changes in average selenium concentrations in water at all modeled Delta assessment locations relative to Existing Conditions and the No Action Alternative (Appendix 8M,Selenium, Table M-9a10A). Long-term average concentrations at interior and western Delta locations would increase by 0.01–0.17 µg/L for the entire period modeled (1976–1991). These changes increases in selenium concentrations in water are reflected in small (10% or less) to moderate (between 11% and 50%) percent changes would result in reductions in available assimilative capacity of 1–16%, for selenium (based on relative to the 21.3 µg/L ecological risk benchmarkUSEPA draft water quality criterion (Figures 8-59a and 8-60a)) for all years. Relative to Existing Conditions, Alternative 6A would result in the largest modeled increase in available assimilative capacity at Buckley Cove (2%); relative to the No Action Alternative, the largest increase would be at Staten Island (1%), and the largest decreases relative to Existing Conditions and the No Action Alternative would be at Contra Costa PP (16% and 15%, respectively) (Figures 8-59 and 8-60). Although there would be moderate negative changes in assimilative capacity at two locations (Contra Costa PP and Rock Slough [15% decrease in available assimilative capacity for Existing Conditions and the No Action Alternative]), the changes are small (10% or less decrease) at the other locations and the available assimilative capacity at all locations would remain substantial; therefore, the effect of Alternative 6A is generally minimal for the Delta. The long-term average Furthermore, the modeled selenium concentrations in water (Appendix 8M, Table M-1910A) for Alternative 6A (range 0.2409–0.740 µg/L) would be similar to, Existing Conditions (range 0.2109–0.7641 µg/L), and the No Action Alternative (range 0.2109–0.6938 µg/L) are generally similar, and all would be below the ecological risk benchmarkUSEPA draft water quality criterion of 1.3(2 µg/L) (Appendix 8M, Table M-9a).

Relative to Existing Conditions and the No Action Alternative, Alternative 6A would generally result in small changes increases (less than 54%) in estimated selenium concentrations in most biota (whole-body fish (excluding sturgeon), bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets) throughout the Delta, with little difference among locations (Figures 8-61a through 8-64b; Appendix 8M,Selenium, Table M-17 26and Table 8M-2 in the sturgeon addendum to Appendix 8MAddendum M.A, Selenium in Sturgeon, to Appendix 8M, Table M.A-2). Despite the small changesincreases in selenium concentrations in biota, Level of Concern Exceedance Quotients (i.e., modeled tissue divided by Level of Concern benchmarks) for selenium concentrations in those biota for all years and for drought years are less than 1.0 (indicating low probability of adverse effects). Similarly, Advisory Tissue Level Exceedance Quotients for selenium concentrations in fish fillets for all years and drought years also are less than 1.0. Estimated selenium concentrations in sturgeon for the San Joaquin River at Antioch are predicted to increase by about 41 percent relative~~Relative~~ to Existing Conditions and 42 percent relative to the No Action Alternative in all years (from about 4.7 to 6.6 mg/kg dry weight [dw]). Likewise, those for sturgeon in the Sacramento River at Mallard Island are predicted to increase by about 24 percent in all years (from about 4.4 to 5.5 mg/kg dw) (~~Figure 8-65;~~ Appendix 8M, Tables M-30 and M-31). Selenium concentrations in sturgeon during drought years are expected to increase by about 14 ~~or about~~ and 28 percent at those locations. Detection of small changes in whole-body sturgeon such as those estimated for the western Delta may require large sample sizes because of the inherent variability in fish tissue selenium concentrations. Low Toxicity Threshold Exceedance Quotients for selenium concentrations in sturgeon in the western Delta would exceed 1.0 for drought years at both locations (as they do for Existing Conditions and the No Action Alternative; Figure 8-65) and for all years at both locations, whereas Existing Conditions and the No Action Alternative do not (quotients increase from 0.94 to 1.3 at San Joaquin at Antioch, ~~to 1.3~~ and from 0.88 to 1.1 at Sacramento River at Mallard Island ~~to 1.1)~~ (Appendix 8M, Table M-32). High Toxicity Threshold Exceedance Quotients for selenium concentrations in sturgeon in the western Delta would exceed 1.0 for drought years in the San Joaquin River at Antioch, whereas Existing Conditions and the No Action Alternative do not (quotient ~~s~~ increases from ~~about~~ 0.8~~.~~5–0.86 to 1.1) (Figure 8-65; Appendix 8M, Table M-32).

The disparity between larger estimated changes for sturgeon and smaller changes for other biota ~~are~~is attributable largely to differences in modeling approaches, as described in Appendix 8M, Selenium. The model for most biota was calibrated to encompass the varying concentration-dependent uptake from waterborne selenium concentrations (expressed as the Kd, which is the ratio of selenium concentrations in particulates [as the lowest level of the food chain] relative to the waterborne concentration) that was exhibited in data for largemouth bass in 2000, 2005, and 2007 at various locations across the Delta. In contrast, the modeling for sturgeon could not be similarly calibrated at the two western Delta locations and used literature-derived uptake factors and trophic transfer factors for the estuary from Presser and Luoma (2013). As noted in the appendix, there was a significant negative log-log relationship of Kd to waterborne selenium concentration that reflected the greater bioaccumulation rates for bass at low waterborne selenium than at higher concentrations. (There was no difference in bass selenium concentrations in the Sacramento River at Rio Vista in comparison to the San Joaquin River at Vernalis in 2000, 2005, and 2007 [Foe 2010], despite a nearly 10-fold difference in waterborne selenium.) Thus, there is more confidence in the site-specific modeling based on the Delta-wide model that was calibrated for bass data than in the estimates for sturgeon based on "fixed" Kds for all years and for drought years without regard to waterborne selenium concentration at the two locations in different time periods.

Increased water residence times could increase the bioaccumulation of selenium in biota, thereby potentially increasing fish tissue and bird egg concentrations of selenium (see residence time discussion in Appendix 8M, *Selenium*, and Presser and Luoma [2010b]). Thus, residence time was assessed for its relevance to selenium bioaccumulation. Table 60a (presented originally in Section 8.3.1.7 in the *Microcystis* subsection) shows the time for neutrally buoyant particles to move through the Delta (surrogate for flow and residence time). Although an increase in residence time throughout the Delta is expected under the No Action Alternative, relative to Existing Conditions (because of climate change and sea level rise), the change is fairly small in most areas of the Delta. Thus, the changes in residence times between Alternative 6A and the No Action Alternative are very similar to the changes in residence times between Alternative 6A and the Existing Conditions.

Relative to Existing Conditions and the No Action Alternative, increases in residence times for Alternative 6A would be greater in the South Delta and East Delta than in other sub-regions. Relative to Existing Conditions, annual average residence times for Alternative 6A in the South Delta are expected to increase by more than 53 days (Table 60a). and in the East Delta increase by more than 32 days. Increases in residence times for other sub-regions would be smaller, especially as compared to Existing Conditions and the No Action Alternative (which are longer than those modeled for the South Delta). As mentioned above, these results incorporate hydrodynamic effects of both CM1 and CM2 and CM4, and the effects of CM1 cannot be distinguished from the effects of CM2 and CM4. However, it is expected that CM2 and CM4 are substantial drivers of the increased residence time.

Presser and Luoma (2010b) summarized and discussed selenium uptake in the Bay-Delta (including hydrologic conditions [e.g., Delta outflow and residence time for water], K_ds [the ratio of selenium concentrations in particulates, as the lowest level of the food chain, relative to the water-borne concentration], and associated tissue concentrations [especially in clams and their consumers, such as sturgeon]). When the Delta Outflow Index (daily average flow per month) decreased by five-fold (73,732 cubic feet per second [cfs] in June 1998 to 12, 251 cfs in October 1998), residence time doubled (from 11 to 22 days) and the calculated mean K_d also doubled (from 3,198 to 6,501). However, when daily average Delta outflow in November 1999 was only 6,951 cfs (i.e., about one-half that in October 1998) and residence time was 70 days, the calculated mean K_d (7,614) did not increase proportionally.

Models are not available to quantitatively estimate the level of changes in selenium bioaccumulation as related to residence time, but the effects of residence time are incorporated in the bioaccumulation modeling for selenium that was based on higher K_d values for drought years in comparison to wet, normal, or all years; see Appendix 8M, *Selenium*. If increases in fish tissue or bird egg selenium were to occur, the increases would likely be of concern only where fish tissues or bird eggs are already elevated in selenium to near or above thresholds of concern. That is, where biota concentrations are currently low and not approaching thresholds of concern (which, as discussed above, is the case throughout the Delta, except for sturgeon in the western Delta), changes in residence time alone would not be expected to cause them to then approach or exceed thresholds of concern. In consideration of this factor, although the Delta as a whole is a CWA Section 303(d)-listed water body for selenium, and although monitoring data of fish tissue or bird eggs in the Delta are sparse, the most likely area in which biota tissues would be at levels high enough that additional bioaccumulation due to increased residence time from restoration areas would be a concern is the western Delta and Suisun Bay for sturgeon, as discussed above. As shown in Table 60a, the overall increase in residence time estimated in the western Delta is 6 days relative to Existing Conditions, and 4 days relative to the No Action Alternative. Given the available information, these increases are small enough that they are not expected to substantially affect selenium bioaccumulation in the western Delta. Because CM2 and CM4 are expected to be substantial drivers of the increased residence times, further discussion is included in Impact WQ-26 below.

In summary, ~~and the No Action Alternative, the largest increase of selenium concentrations in biota would be at Contra Costa PP for drought years and in sturgeon at the two western Delta locations in all as well as drought years. Relative to Existing Conditions, the largest decrease in selenium concentrations in biota would be at Buckley Cove for drought years; relative to the No Action Alternative, the largest decrease would be at Staten Island for drought years. Except for sturgeon in the western Delta, concentrations of selenium in whole-body fish and bird eggs (invertebrate and fish diets) would exceed only the lower benchmarks (4 and 6 mg/kg dry weight, respectively,~~

~~indicating a low potential for effects), under drought conditions, at Buckley Cove for Alternative 6A and for Existing Conditions and the No Action Alternative(Figures 8-61 through 8-63). However, Exceedance Quotientsexceedance quotients for these exceedances of the lower benchmarks are between 1.0 and 1.5, indicating a low risk to biota in the Delta, with Alternative 6A being similar to Existing Conditions and the No Action Alternative. Selenium concentrations in fish fillets would not exceed the screening value for protection of human health (Figure 8-64). For sturgeon in the western Delta, whole-body selenium concentrations would increase from 12.3 mg/kg under Existing Conditions and the No Action Alternative to 15.1 mg/kg under Alternative 6A, a 23% increase (Table M.A-2Table 8M-2 in the sturgeon addendum to Appendix 8M).All of these values exceed both the low and high toxicity benchmarks. The predicted increases are high enough that they may represent a measurable increase in body burdens of sturgeon, which would constitute an adverse impact.~~

~~R~~relative to Existing Conditions and the No Action Alternative, Alternative 6A would result in small ~~changes~~increases in selenium concentrations throughout the Delta for most biota (less than ~~5~~4%), ~~although~~ although larger increases in selenium concentrations are predicted for sturgeon in the western Delta. The Low Toxicity Threshold Exceedance Quotient for selenium concentrations in sturgeon for all years in the San Joaquin River at Antioch would increase from 0.94 for Existing Conditions and the No Action Alternative to 1.3, and from 0.88 to 1.1 at Sacramento River at Mallard Island. ~~Concentrations of selenium in sturgeon would exceed only the lower benchmark, indicating a low potential for effects, with the exception of San Joaquin at Antioch for drought years.~~ The High Toxicity Threshold Exceedance Quotient for selenium concentrations for sturgeon ~~in the western Delta~~ at Antioch in drought years would increase from ~~about~~ 0.85 for Existing Conditions and 0.86 for the No Action Alternative to 1.1, indicating a high potential for effects. The modeling of bioaccumulation for sturgeon is less calibrated to site-specific conditions than that for other biota, which was calibrated on a robust dataset for modeling of bioaccumulation in largemouth bass as a representative species for the Delta. Overall, the predicted increases for Alternative 6A are high enough that they may represent a measurable increase in body burdens of sturgeon, which would constitute an adverse impact.

SWP/CVP Export Service Areas

Alternative 6A would result in ~~small to~~ moderate ~~changes in~~ (0.12–0.19 μg/L) decreases in long-term average selenium concentrations in water at the Banks and Jones pumping plants, relative to Existing Conditions and the No Action Alternative, for the entire period modeled (Appendix 8M, Selenium, Table M-~~10A~~9a). These decreases in long-term average selenium concentrations in water would result in increases in available assimilative capacity for selenium at these pumping plants of 11–20%, relative to the 1.3 μg/L ~~ecological risk benchmark~~USEPA draft water quality criterion (Figures 8-59a and 8-60a). Furthermore ~~These changes are reflected in small (10% or less) to moderate (between 11% and 50%) percent changes in available assimilative capacity for selenium for all years. Relative to Existing Conditions and the No Action Alternative, Alternative 6A would result in increases in available assimilative capacity at Banks PP (10% and 9%, respectively) and at Jones PP (18% and 19%, respectively) (Figures 8-59 and 8-60), and would have a positive effect at the Export Service Area locations. T~~the modeled selenium concentrations in water ~~(Appendix 8M, Table M-10A)~~ for Alternative 6A (0.~~32~~09 μg/L) ~~would be lower than the ranges for Existing Conditions (range 0.37–0.58 μg/L) and the No Action Alternative (range 0.37–0.59 μg/L), and all~~ would be below the ~~ecological risk benchmark~~USEPA draft water quality criterion ~~(~~of ~~2~~1.3 μg/L (Appendix 8M, Table M-9a).

Relative to Existing Conditions and the No Action Alternative, Alternative 6A would result in small changes (less than 5%) in estimated selenium concentrations in biota (whole-body fish, bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets) at export service areas (Figures 8-61a through 8-64b; Appendix 8M, Selenium, Table M-~~17~~26). ~~Relative to Existing Conditions, the largest increase of selenium concentrations in biota would be at Banks PP for drought years (except for bird eggs [assuming a fish diet] at Banks PP for all years), and relative to the No Action Alternative, the largest increase would be at Banks PP for drought years. Relative to Existing Conditions and the No Action Alternative, the largest decrease of selenium concentration in biota would be at Jones PP for drought years. However, c~~Concentrations in biota would not exceed any selenium benchmarks for Alternative 6A (Figures 8-61a through 8-64a).

~~Thus, relative to Existing Conditions and the No Action Alternative, Alternative 6A would result in small to moderate changes in selenium concentrations in water and minimal changes in selenium concentrations in biota at the Export Service Area locations. Selenium concentrations in water and biota would generally decrease under Alternative 6A and would not exceed ecological benchmarks at either location, whereas the lower benchmark for bird eggs (fish diet) would be exceeded under Existing Conditions and the No Action Alternative at Jones PP for drought years. This small positive change in selenium concentrations under Alternative 6A would be expected to slightly decrease the frequency with which applicable benchmarks would be exceeded or slightly improve the quality of water at the Export Service Area locations, with regard to selenium.~~

NEPA Effects: Based on the discussion above, the effects on selenium from Alternative 6A are considered to be adverse. This determination is reached because selenium concentrations in whole-body sturgeon modeled at two western Delta locations would increase by an ~~estimated~~ average of ~~23~~27%, which may represent a measurable increase in the environment. Because both low and high toxicity benchmarks ~~are~~ would be ~~already~~ exceeded ~~under the No Action Alternative~~, these potentially measurable increases represent an adverse impact.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for selenium. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

There are no substantial point sources of selenium in watersheds upstream of the Delta, and no substantial nonpoint sources of selenium in the watersheds of the Sacramento River and the eastern tributaries. Nonpoint sources in the San Joaquin Valley that contribute selenium to the Delta will be controlled through a TMDL developed by the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the Grassland Bypass Project, and Basin Plan objectives (Central Valley Water Board [2010~~c~~d]~~)~~ and State Water Board ~~(~~[2010~~d~~b, 2010~~e~~c]) that are expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta. Consequently, any modified reservoir operations and subsequent changes in river flows under Alternative 6A, relative to Existing Conditions, are expected to cause negligible changes in selenium concentrations in water. Any negligible changes in selenium concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies as related to selenium.

Relative to Existing Conditions, modeling estimates indicate that Alternative 6A would result in ~~essentially no~~ small changes in selenium concentrations in water or most biota throughout the Delta, with no exceedances of benchmarks for biological effects. Relative to Existing Conditions, modeling estimates indicate that Alternative 6A would increase selenium concentrations in whole-body sturgeon modeled at two western Delta locations by an average of 27%, which may represent a measurable increase in the environment. Because both low and high toxicity benchmarks are already exceeded under Existing Conditions, these potentially measurable increases represent and a potential adverse impact to ~~aquatic~~fish and wildlife ~~life~~ beneficial uses.

~~Relative to Existing Conditions, modeling estimates indicate that Alternative 6A would increase selenium concentrations in whole-body sturgeon modeled at two western Delta locations by an estimated 23%, which may represent a measurable increase in the environment. Because both low and high toxicity benchmarks are already exceeded under Existing Conditions, these potentially measurable increases represent a potential impact to aquatic life beneficial uses.~~

Assessment of effects of selenium in the SWP/~~ and~~ CVP Export Service Areas is based on effects on selenium concentrations at the Banks and Jones pumping plants. Relative to Existing Conditions, Alternative 6A would ~~slightly decrease~~cause no increase in the frequency with which applicable benchmarks would be exceeded and would ~~slightly~~ improve the quality of water in selenium concentrations at the Banks and Jones pumping plants locations.

Based on the above, although waterborne selenium concentrations would not exceed applicable water quality objectives/criteria, however, significant impacts on some beneficial uses of waters in the Delta could occur because ~~both low and~~ high toxicity benchmarks ~~are already~~ may be exceeded (where they are not under Existing Conditions), and uptake of selenium from water to biota may measurably increase. In comparison to Existing Conditions, water quality conditions under this alternative would increase levels of selenium (a bioaccumulative pollutant) by frequency, magnitude, and geographic extent such that the affected environment may have measurably higher body burdens of selenium in aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish); however, impacts to humans consuming those organisms are not expected to occur. Water quality conditions under this alternative with respect to selenium would cause long-term degradation of water quality in the western Delta. Except in the vicinity of the western Delta for sturgeon, water quality conditions under this alternative would not increase levels of selenium by frequency, magnitude, and geographic extent such that the affected environment would be expected to have measurably higher body burdens of selenium in aquatic organisms. The greater level of selenium bioaccumulation in the western Delta would further degrade water quality by measurable levels, on a long-term basis, for selenium and, thus, cause the CWA 303(d)-listed impairment of beneficial use to be made discernibly worse. This impact is considered significant. Environmental Commitment: Selenium Management (AMM27), which affords for site-specific measures to reduce effects, would be available to reduce BDCP-related effects associated with selenium. The effectiveness of AMM27 is uncertain and, therefore implementation may not reduce the identified impact to a level that would be less than significant, and therefore it is significant and unavoidable.

The need for, and the feasibility and effectiveness of, post-operation mitigation for the predicted level of selenium bioaccumulation is uncertain. The first step shall be to determine the reliability of the model in predicting biota selenium concentrations in the affected environment where effects are predicted but selenium data are lacking. For that reason, the model shall be validated with site-specific sampling before extensive mitigation measures relative to CM1 operations are developed and evaluated for feasibility, as the measures and their evaluation for feasibility are likely to be complex. Specifically, it remains to be determined whether the available existing data for transfer of selenium from water to particulates and through different trophic levels of the food chain are representative of conditions that may occur from implementation of Alternative 6A. Therefore, the proposed mitigation measure requires that sampling be conducted to characterize each step of data inputs needed for the model, and then the refined model be validated for local conditions. This impact is considered significant and unavoidable.

Impact WQ-26: Effects on Selenium Concentrations Resulting from Implementation ofCM2–~~CM22~~CM21

***NEPA Effects*: Effects of CM2–CM21 on selenium under Alternative 6A are the same as those discussed for Alternative 1A and are considered not to be adverse.**

CEQA Conclusion: CM2–CM21 proposed under Alternative 6A would be similar to those proposed under Alternative 1A. As such, effects on selenium resulting from the implementation of CM2–CM21 would be similar to that previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

~~***NEPA Effects***:In general, with the possible exception of changes in Delta hydrodynamics resulting from habitat restoration, CM2–CM11 would not substantially increase selenium concentrations in the water bodies of the affected environment. Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, and thus such effects of these restoration measures were included in the assessment of CM1 facilities operations and maintenance (see Impact WQ-25).~~

~~However, i~~I~~mplementation of these conservation measures may increase water residence time within the restoration areas. Increased restoration area water residence times could potentially increase the bioaccumulation of selenium in biota, thereby potentially increasing fish tissue and bird egg concentrations of selenium, but m~~. M~~odels are not available to quantitatively estimate the level of changes in residence time and the associated selenium bioavailability. If increases in fish tissue or bird egg selenium were to occur, the increases would likely be of concern only where fish tissues or bird eggs are already elevated in selenium to near or above thresholds of concern. That is, where biota concentrations are currently low and not approaching thresholds of concern, changes in residence time alone would not be expected to cause them to then approach or exceed thresholds of concern. In consideration of this factor, although the Delta as a whole is a 303(d)-listed water body for selenium, and although monitoring data of fish tissue or bird eggs in the Delta are sparse, the most likely areas in which biota tissues would be at levels high enough that additional bioaccumulation due to increased residence time from restoration areas would be a concern are the western Delta and Suisun Bay, and the South Delta in areas that receive San Joaquin River water.~~

~~The western Delta and Suisun Bay receive elevated selenium loads from North San Francisco Bay (including San Pablo Bay, Carquinez Strait, and Suisun Bay) and from the San Joaquin River. Point sources of selenium in North San Francisco Bay (i.e., refineries) that contribute selenium to Suisun Bay are expected to be reduced through a TMDL under development by the San Francisco Bay Water Board (San Francisco Bay Water Board 2012) that is expected to result in decreasing discharges of selenium. Nonpoint sources of selenium in the San Joaquin Valley that contribute selenium to the San Joaquin River, and thus the Delta and Suisun Bay, will be controlled through a TMDL developed by the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the Grassland Bypass Project, and Basin Plan objectives (Central Valley Water Board 2010c, d) that are~~

expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta. If selenium levels are not sufficiently reduced via these efforts, it is expected that the State Water Board and the San Francisco Bay and Central Valley Water Boards would initiate additional actions to further control sources of selenium.

The South Delta receives elevated selenium loads from the San Joaquin River. In contrast to Suisun Bay and possibly the western Delta in the future, the South Delta lacks the overbite clam (*Corbula* [*Potamocorbula*] *amurensis*), which is considered a key driver of selenium bioaccumulation in Suisun Bay, due to its high bioaccumulation of selenium and its role in the benthic food web that includes long-lived sturgeon. The South Delta does have *Corbicula fluminea*, another bivalve that bioaccumulates selenium, but it is not as invasive as the overbite clam and thus likely makes up a smaller fraction of sturgeon diet. Also, as mentioned above, nonpoint sources of selenium in the San Joaquin Valley that contribute selenium to the Delta will be controlled through a TMDL developed by the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the Grassland Bypass Project, and Basin Plan objectives (Central Valley Water Board 2010c, d) that are expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta. Further, if selenium levels in the San Joaquin River are not sufficiently reduced via these efforts, it is expected that the State Water Board and Central Valley Water Board would initiate additional TMDLs to further control nonpoint sources of selenium.

Wetland restoration areas will not be designed such that water flows in and does not flow out. Exchange of water between the restoration areas and existing Delta channels is an important design factor, since one goal of the restoration areas is to export food produced in these areas to the rest of the Delta (see BDCP Chapter 3, *Conservation Strategy*, Section 3.3, Biological Goals and Objectives). Thus, these areas can be thought of as “flow-through” systems. Consequently, althoughwater residence times associated with BDCP restoration could increase, they are not expected toincrease without bound. and selenium concentrations in the water column would not continue to build up and be recycled in sediments and organisms as may be the case within a closed system.

However, because increases in bioavailable selenium in the habitat restoration areas are uncertain, proposed avoidance and minimization measureswould require evaluating risks of selenium exposure at a project level for each restoration area, minimizing to the extent practicable potential risk of additional bioaccumulation, and monitoring selenium levels in fish and/or wildlife to establish whether, or to what extent, additional bioaccumulation is occurring. See Appendix 3B, *Environmental Commitments* for a description of the environmental commitment BDCP proponents are making with respect to Selenium Management; and Appendix 3.C. of the BDCP for additionaldetail on this avoidance and minimization measure (AMM27). Data generated as part of the avoidance and minimization measures will assist the State and Regional Water Boards in determining whether beneficial uses are being impacted by selenium, and thus will provide the data necessary to support regulatory actions (including additional TMDL development), should such actions be warranted.

Given the factors discussed in the assessment above, any increases in bioaccumulation rates from water-borne selenium that could occur in some areas as a result of increased water residence time would not be of sufficient magnitude and geographic extent that any portion of the Delta wouldbe expected to have measurably higher body burdens of selenium in aquatic organisms and, therefore, would not substantially increase risk for adverse effects to beneficial uses. Furthermore, although the Delta is a 303(d)-listed water body for selenium, given the discussion in the assessment above, it

~~is unlikely that restoration areas would result in measurable increases in selenium in fish tissues or bird eggs such that the beneficial use impairment would be made discernibly worse.~~

~~Because it is unlikely that substantial increases in selenium in fish tissues or bird eggs would occur such that effects on aquatic life beneficial uses would be anticipated, and because of the avoidance and minimization measures that are designed to further minimize and evaluate the risk of such increases, the effects of WQ-26 are considered not adverse.~~

~~***CEQA Conclusion*: There would be no substantial, long-term increase in selenium concentrations in water in the rivers and reservoirs upstream of the Delta, water in the Delta, or the waters exported to the CVP and SWP service areas due to implementation of CM2–CM22CM21 relative to Existing Conditions. Waterborne selenium concentrations under this alternative would not exceed applicable water quality objectives/criteria.~~

~~Given the factors discussed in the assessment above, any increases in bioaccumulation rates from water-borne selenium that could occur in some areas as a result of increased water residence times would not be of sufficient magnitude and geographic extent that any portion of the Delta wouldbe expected to have measurably higher body burdens of selenium in aquatic organisms, and therefore would not substantially increase risk for adverse effects to beneficial uses. CM2-22 would not cause long-term degradation of water quality resulting in sufficient use of available assimilative capacity such that occasionally exceeding water quality objectives/criteria would be likely. Also, CM2-22 would not result in substantially increased risk for adverse effects to any beneficial uses. Furthermore, although the Delta is a 303(d)-listed water body for selenium, given the discussion in the assessment above, it is unlikely that restoration areas would result in measurable increases in selenium in fish tissues or bird eggs such that the beneficial use impairment would be made discernibly worse.~~

~~Since it is unlikely that substantial increases in selenium in fish tissues or bird eggs would occur such that effects on aquatic life beneficial uses would be anticipated, and because of the avoidance and minimization measures that are designed to further minimize and evaluate the risk of such increases (see Appendix 3.C. of the BDCP for more detail on AMM27) as well as the Selenium Management environmental commitment (see Appendix 3B, *Environmental Commitments*), this impact is considered less than significant. No mitigation is required.~~

Impact WQ-32. Effects on *Microcystis* Bloom Formation Resulting from Facilities Operations and Maintenance (CM1).

Effects of facilities and operations (CM1) on Microcystis abundance, and thus microcystins concentrations, in water bodies of the affected environment under Alternative 6A would be very similar (i.e., nearly the same) to those discussed for Alternative 1A. This is because factors that affect Microcystis abundance in waters upstream of the Delta, in the Delta, and in the SWP/CVP Export Services Areas under Alternative 1A would similarly change under Alternative 6A, relative to Existing Conditions and the No Action Alternative. For the Delta in particular, there are differences in the direction and magnitude of water residence time changes during the Microcystis bloom period among the six Delta sub-regions under Alternative 6A compared to Alternative 1A, relative to Existing Conditions and No Action Alternative. However, under Alternative 6A, relative to Existing Conditions and No Action Alternative, water residence times during the Microcystis bloom period in various Delta sub-regions are expected to increase to a degree that could, similar to Alternative 1A, lead to an increase in the frequency, magnitude, and geographic extent of Microcystis blooms throughout the Delta. Water exported from the Delta under Alternative 1A will be a mixture of

Microcystis-affected water from the existing south Delta intake and unaffected Sacramento River water from the north Delta intake, which contrasts to Alternative 6, under which water exported to the SWP/CVP Export Service Areas consist entirely of water from the Sacramento River from the north Delta that is in unaffected by Microcystis. Because of this, the effects of Microcystis on and the microcystin concentrations of water exported to the SWP/CVP Export Service Areas could decrease under Alternative 6A, relative to Existing Conditions.

Similar to Alternative 1A, elevated ambient water temperatures relative to Existing Conditions would occur in the Delta under Alternative 6A, which could lead to earlier occurrences of Microcystis blooms in the Delta, and increase the overall duration and magnitude of blooms. However, the degradation of water quality from Microcystis blooms due to the expected increases in Delta water temperatures is driven entirely by climate change, not effects of CM1. While Microcystis blooms have not occurred in the Export Service Areas, conditions in the Export Service Areas under Alternative 6A may become more conducive to Microcystis bloom formation, relative to Existing Conditions, because water temperatures will increase in the Export Service Areas due to the expected increase in ambient air temperatures resulting from climate change.

NEPA Effects: Effects of water facilities and operations (CM1) on Microcystis in water bodies of the affected environment under Alternative 6A would be very similar to (i.e., nearly the same) to those discussed for Alternative 1A. In summary, Alternative 6A operations and maintenance, relative to the No Action Alternative, would result in long-term increases in hydraulic residence time of various Delta sub-regions during the summer and fall Microcystis bloom period. During this period, the increased residence time could result in a concurrent increase in the frequency, magnitude, and geographic extent of Microcystis blooms, and thus microcystin levels, in affected areas of the Delta. As a result, Alternative 6A operation and maintenance activities would cause further degradation to water quality with respect to Microcystis in the Delta. Under Alternative 6A, relative to No Action Alternative, water exported to the SWP/CVP Export Service Area will be a mixture of Microcystis-affected source water from the south Delta intakes and unaffected source water from the Sacramento River, diverted at the north Delta intakes. It cannot be determined whether operations and maintenance under Alternative 6A will result in increased or decreased levels of Microcystis and microcystins in the mixture of source waters exported from Banks and Jones pumping plants. Mitigation Measure WQ-32a and WQ-32b are available to reduce the effects of degraded water quality in the Delta. Although there is considerable uncertainty regarding this impact, the effects on Microcystis from implementing CM1 is determined to be adverse.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Under Alternative 6A, additional impacts from Microcystis in the reservoirs and watersheds upstream of the Delta are not expected, relative to Existing Conditions. Operations and maintenance occurring under Alternative 6A is not expected to change nutrient levels in upstream reservoirs or hydrodynamic conditions in upstream rivers and streams such that conditions would be more conductive to Microcystis production.

Relative to Existing Conditions, water temperatures and hydraulic residence times in the Delta are expected to increase under Alternative 6A, resulting in an increase in the frequency, magnitude and geographic extent of Microcystis blooms in the Delta. However, the degradation of water quality from Microcystis blooms due to the expected increases in Delta water temperatures is driven entirely by climate change, not effects of CM1. Increases in Delta residence times are expected throughout the Delta during the summer and fall bloom period, due in small part to climate change and sea level rise, but due more proportionately to CM1 and the hydrodynamic impacts of restoration included in CM2 and CM4. The precise change in local residence times and Microcystis production expected within any Delta sub-region is unknown because conditions will vary across the complex networks of intertwining channels, shallow back water areas, and submerged islands that compose the Delta. Nonetheless, Delta residence times are, in general, expected to increase due to Alternative 6A. Consequently, it is possible that increases in the frequency, magnitude, and geographic extent of Microcystis blooms in the Delta will occur due to the operations and maintenance of Alternative 6A and the hydrodynamic impacts of restoration (CM2 and CM4).

The assessment of effects of Microcystis on SWP/CVP Export Service Areas is based on the assessment of changes in Microcystis levels in export source waters, as well as the effects of temperature and residence time changes within the Export Service Areas on Microcystis production. Under Alternative 6A, relative to Existing Conditions, the potential for Microcystis to occur in the Export Service Area is expected to increase due to increasing water temperature, but this impact is driven entirely by climate change and not Alternative 6A. Water exported from the Delta to the Export Service Area will consist entirely of Sacramento River water from the north Delta which is unaffected by Microcystis. Operations and maintenance (CM1) under Alternative 6A, relative to existing conditions, is not expected to result in increased levels of Microcystis and microcystins in the mixture of source waters exported from Banks and Jones pumping plants.

Based on the above, this alternative would not be expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause significant impacts on any beneficial uses of waters in the affected environment. Microcystis and microcystins are not 303(d) listed within the affected environment and thus any increases that could occur in some areas would not make any existing Microcystis impairment measurably worse because no such impairments currently exist. Because Microcystis and microcystins are not bioaccumulative, increases that could occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. However, because it is possible that increases in the frequency, magnitude, and geographic extent of Microcystis blooms in the Delta will occur due to the operations and maintenance of Alternative 6A and the hydrodynamic impacts of restoration (CM2 and CM4), long-term water quality degradation may occur and, thus, significant impacts on beneficial uses could occur. Although there is considerable uncertainty regarding this impact, the effects on Microcystis from implementing CM1 is determined to be significant.

Implementation of Mitigation Measure WQ-32a and WQ-32b may reduce degradation of Delta water quality due to Microcystis. However, because the effectiveness of these mitigation measures to result in feasible measures for reducing water quality effects is uncertain, this impact is considered to remain significant and unavoidable.

Mitigation Measure WQ-32a: Design Restoration Sites to Reduce Potential for Increased Microcystis Blooms

Please see Mitigation Measure WQ-32a under Impact WQ-32 in the discussion of Alternative 1A.

Mitigation Measure WQ-32b: Investigate and Implement Operational Measures to Manage Water Residence Time

Please see Mitigation Measure WQ-32b under Impact WQ-32 in the discussion of Alternative 1A.

Impact WQ-33. Effects on *Microcystis* Bloom Formation Resulting from Other Conservation Measures (CM2-–CM21).

The effects of CM2–CM21 on Microcystis under Alternative 96A are the same as those discussed for Alternative 1A. In summary, potential environmental effects related to CM2 and CM4 could result in an increase in the frequency, magnitude, and geographic extent of Microcystis blooms in the Delta, relative to Existing Conditions and the No Action Alternative, as a result of increased residence times for Delta waters from implementing CM2 and CM4 restoration areas. -Because the hydrodynamic effects associated with implementing CM2 and CM4 were incorporated into the modeling used to assess CM1, a detailed assessment of the effects of implementing CM2 and CM4 on Microcystis blooms in the Delta via theire effects on Delta water residence time is provided under CM1 (above). The effects of CM 2CM2 and CM 4CM4 on Microcystis may be reduced by implementation of Mitigation Measures WQ-32A and WQ-32b. The effectiveness of these mitigation measures to result in feasible measures for reducing water quality effects is uncertain. Conservation Measures 3 (CM3) and CM5-CM21 would not result in an increase in the frequency, magnitude, and geographic extent of Microcystis blooms in the Delta.

NEPA Effects: Effects of CM2–CM21on Microcystis under Alternative 6A are the same as those discussed for Alternative 1A and are considered to be adverse.

CEQA Conclusion: Based on the above, this alternative would not be expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause significant impacts on any beneficial uses of waters in the affected environment. Microcystis and microcystins are not 303(d) listed within the affected environment and thus any increases that could occur in some areas would not make any existing Microcystis impairment measurably worse because no such impairments currently exist. Because Microcystis and microcystins are not bioaccumulative, increases that could occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. Because restoration actions implemented under CM2 and CM4 will increase residence time throughout the Delta and create local areas of warmer water during the bloom season, it is possible that increases in the frequency, magnitude, and geographic extent of Microcystis blooms, and thus long-term water quality degradation and significant impacts on beneficial uses, could occur. Although there is considerable uncertainty regarding this impact, the effects on Microcystis from implementing CM2–CM21 are determined to be significant.

Impact WQ-34: Effects on San Francisco Bay Water Quality Resulting from Facilities Operations and Maintenance (CM1) and Implementation of CM2–CM21

The effects analysis presented in the preceding impacts (Impact WQ-1 through WQ-33) concluded that Alternative 6A would have a less than significant impact/no adverse effect on the following constituents in the Delta:

- Boron
- Dissolved Oxygen

- Pathogens
- Pesticides
- Trace Metals
- Turbidity and TSS

Elevated concentrations of boron are of concern in drinking and agricultural water supplies. However, waters in the San Francisco Bay are not designated to support municipal water supply (MUN) and agricultural supply (AGR) beneficial uses. Changes in Delta dissolved oxygen, pathogens, pesticides, and turbidity and TSS are not anticipated to be of a frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of the Delta. Thus, changes in boron, dissolved oxygen, pathogens, pesticides, and turbidity and TSS in Delta outflow are not anticipated to be of a frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of the of San Francisco Bay.

The effects of Alternative 6A on bromide, chloride, and DOC, in the Delta were determined to be significant/adverse. Increases in bromide, chloride, and DOC concentrations are of concern in drinking water supplies; however, as described previously, the San Francisco Bay does not have a designated MUN use. Thus, changes in bromide, chloride, and DOC in Delta outflow would not adversely effect any beneficial uses of San Francisco Bay.

Elevated EC, as assessed for this alternative, is of concern for its effects on the agricultural beneficial use (AGR) and fish and wildlife beneficial uses. As discussed above, San Francisco Bay does not have an AGR beneficial use designation. Further, as discussed for the No Action Alternative, cAlso, as discussed for the No Action Alternative, adverse changes in Microcystis levels that could occur in the Delta would not cause adverse Microcystis blooms in San Francisco Bay, because Microcystis are intolerant of the Bay's high salinity and, thus not have not been detected downstream of Suisun Bay.

While effects of Alternative 6A on the nutrients ammonia, nitrate, and phosphorus were determined to be less than significant/not adverse, these constituents are addressed further below because the response of the seaward bays to changed nutrient concentrations/loading may differ from the response of the Delta. Selenium and mercury are discussed further, because they are bioaccumulative constituents where changes in load due to both changes in Delta concentrations and exports are of concern.

Nutrients: Ammonia, Nitrate, and Phosphorus

Total nitrogen loads in Delta outflow to Suisun and San Pablo Bays under Alternative 6A would be dominated almost entirely by nitrate, because planned upgrades to the SRWTP will result in >95% removal of ammonia in its effluent. Total nitrogen loads to Suisun and San Pablo Bays would decrease by 5%, relative to Existing Conditions, and increase by 40%, relative to the No Action Alternative (Appendix 8O, Table O-1). The change in nitrogen loading to Suisun and San Pablo Bays under Alternative 6A would not adversely impact primary productivity in these embayments because light limitation and grazing current limit algal production in these embayments. To the extent that algal growth increases in relation to a change in ammonia concentration, this would have net positive benefits, because current algal levels in these embayments are low. Nutrient levels and ratios are not considered a direct driver of *Microcystis* and cyanobacteria levels in the North Bay.

The phosphorus load exported from the Delta to Suisun and San Pablo Bays for Alternative 6A is estimated to increase by 9%, relative to Existing Conditions, and increase by 4% relative to the No

Action Alternative (Appendix 8O, Table O-1)). The only postulated effect of changes in phosphorus loads to Suisun and San Pablo Bays is related to the influence of nutrient stoichiometry on primary productivity. However, there is uncertainty regarding the impact of nutrient ratios on phytoplankton community composition and abundance. Any effect on phytoplankton community composition would likely be small compared to the effects of grazing from introduced clams and zooplankton in the estuary (Senn and Novick 2014; Kimmerer and Thompson 2014). Therefore, the projected change in total nitrogen and phosphorus loading that would occur in Delta outflow to San Francisco Bay is not expected to result in degradation of water quality with regard to nutrients that would result in adverse effects to beneficial uses.

Mercury

The estimated long-term average mercury and methylmercury loads in Delta exports are shown in Appendix 8O, Table O-2. Loads of mercury and methylmercury from the Delta to San Francisco Bay are estimated to change relatively little due to changes in source water fractions and net Delta outflow that would occur under Alternative 6A. Mercury load to the Bay, relative to Existing Conditions, is estimated to increase by 12 kg/yr (5%), relative to Existing Conditions, and 9 kg/yr (3%), relative to the No Action Alternative. Methylmercury load is estimated to increase by 0.37 kg/yr (10%), relative to Existing Conditions, and increase by 0.28 kg/yr (7%) relative to the No Action Alternative. The estimated total mercury load to the Bay is 272 kg/yr, which would be less than the San Francisco Bay mercury TMDL WLA for the Delta of 330 kg/yr. The estimated changes in mercury and methylmercury loads would be within the overall uncertainty associated with the estimates of long-term average net Delta outflow and the long-term average mercury and methylmercury concentrations in Delta source waters. The estimated changes in mercury load under the alternative would also be substantially less than the considerable differences among estimates in the current mercury load to San Francisco Bay (SFBRWQCB 2006; David et al. 2009). Similar uncertainty is expected in the existing methylmercury load in net Delta exports, for which the best available current load estimate is based on approximately one year of monitoring data (Foe et al. 2008).

Given that the estimated incremental ~~decreases~~increases of mercury and methylmercury loading to San Francisco Bay would fall within the uncertainty of current mercury and methylmercury load estimates, the estimated changes in mercury and methylmerucy loads in Delta exports to San Francisco Bay due to Alternative 6A are not expected to result in adverse effects to beneficial uses or substantially degrade the water quality with regard to mercury, or make the existing CWA Section 303(d) impairment measurably worse.

Selenium

Changes in source water fraction and net Delta outflow under Alternative 6A, relative to Existing Conditions, are projected to cause the total selenium load to the North Bay to increase by 24%, relative to Existing Conditions, and increase by 20%, relative to the No Action Alternative (Appendix 8O, Table O-3). Changes in long-term average selenium concentrations of the North Bay are assumed to be proportional to changes in North Bay selenium loads. Under Alternative 6A, the long-term average total selenium concentration of the North Bay is estimated to be 0.16µg/L and the dissolved selenium concentration is estimated to be 0.14 µg/L, which would be a 0.03 µg/L increase relative to Existing Conditions and the No Action Alternative (Appendix 8O, Table O-3). The dissolved selenium concentration would be below the target of 0.202 µg/L developed by Presser or Luoma (2013) to coincide with a white sturgeon whole-body fish tissue selenium concentration not greater than 8 mg/kg in the North Bay.

The incremental increase in dissolved selenium concentrations projected to occur under Alternative 6A, relative to Existing Conditions and the No Action Alternative, would be higher than under Alternatives 1–5, but still low (0.03 µg/L). The increased dissolved selenium concentration would be within the overall uncertainty of the analytical methods used to measure selenium in water column samples; however, it also would be within the uncertainty associated with estimating numeric water column selenium thresholds (Pressor and Luoma 2013). As described in Section 8.3.1.8, there have been improvements in selenium concentrations in the tissue of diving ducks and muscle of white sturgeon since the initial CWA Section 303(d) listing of the North Bay for selenium impairments, and selenium concentrations in white sturgeon muscle have also generally been below the USEPA's draft recommended fish muscle tissue concentration of 11.8 mg/kg dry weight (SFEI 2014). However, as described under Impact WQ-25, though there is some uncertainty in the estimate of sturgeon concentrations at western Delta locations, the predicted increases for Alternative 6A are high enough that they may represent measurably higher body burdens of selenium in aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish). Because the projected incremental increases in dissolved selenium could cause measurable changes in water column concentrations, and these incremental increases would be within the uncertainty in the target water column threshold for dissolved selenium for protection against adverse bioaccumulative effects in the North Bay ecosystem, and modeling predicts concentrations in the western Delta may represent a measurable increase in body burdens of sturgeon, there is potential that the incremental increase in dissolved selenium concentration projected to occur in the North Bay under Alternative 6A could result in adverse effects beneficial uses.

NEPA Effects: Based on the discussion above, Alternative 6A, relative to the No Action Alternative, would not cause further degradation to water quality with respect to boron, bromide, chloride, dissolved oxygen, DOC, EC, mercury, pathogens, pesticides, nutrients (ammonia, nitrate, phosphorus), trace metals, or turbidity and TSS in the San Francisco Bay. Further, changes in these constituent concentrations in Delta outflow would not be expected to cause changes in Bay concentrations of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses. In summary, based on the discussion above, effects on the San Francisco Bay from implementation of CM1–CM21 are considered to be not adverse with respect to boron, bromide, chloride, dissolved oxygen, DOC, EC, mercury, pathogens, pesticides, nutrients (ammonia, nitrate, phosphorus), trace metals, or turbidity and TSS. However, Alternative 6A could result in increases in selenium concentrations in the North San Francisco Bay that could result in adverse effects to fish and wildlife beneficial uses. This effect is considered to be adverse.

CEQA Conclusion: Based on the above, Alternative 6A would not be expected to cause long-term degradation of water quality in San Francisco Bay resulting in sufficient use of available assimilative capacity such that occasionally exceeding water quality objectives/criteria would be likely and would result in substantially increased risk for adverse effects to one or more beneficial uses with respect to boron, bromide, chloride, dissolved oxygen, DOC, EC, mercury, pathogens, pesticides, nutrients (ammonia, nitrate, phosphorus), trace metals, or turbidity and TSS. Further, based on the above, this alternative would not be expected to cause additional exceedance of applicable water quality objectives/criteria in the San Francisco Bay by frequency, magnitude, and geographic extent that would cause significant impacts on any beneficial uses of waters in the affected environment with respect to boron, bromide, chloride, dissolved oxygen, DOC, EC, mercury, pathogens, pesticides, nutrients (ammonia, nitrate, phosphorus), trace metals, or turbidity and TSS. Any changes in boron, bromide, chloride, and DOC in the San Francisco Bay would not adversely affect beneficial uses, because the uses most affected by changes in these parameters, MUN and AGR, are not beneficial uses of the Bay. Further, no substantial changes in dissolved oxygen, pathogens, pesticides, trace metals or turbidity or TSS are anticipated in the Delta, relative to Existing Conditions, therefore, no substantial changes these constituents levels in the Bay are anticipated. Changes in Delta salinity would not contribute to measurable changes in Bay salinity, as the change in Delta outflow would two to three orders of magnitude lower than (and thus minimal compared to) the Bay's tidal flow. Adverse changes in Microcystis levels that could occur in the Delta would not cause adverse Microcystis blooms in the Bay, because Microcystis are intolerant of the Bay's high salinity and, thus not have not been detected downstream of Suisun Bay. The 5% decrease in total nitrogen load and 40% increase in phosphorus load, relative to Existing Conditions, are expected to have minimal effect on water quality degradation, primary productivity, or phytoplankton community composition. The estimated increase in mercury load (9 kg/yr; 3%) and methylmercury load (0.37 kg/yr; 10%), relative to Existing Conditions, is within the level of uncertainty in the mass load estimate and not expected to contribute to water quality degradation, make the CWA section 303(d) mercury impairment measurably worse or cause mercury/methylmercury to bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans.

hough there is some uncertainty in the estimate of sturgeon concentrations at western Delta locations, the predicted increases are high enough that they may represent measurably higher body burdens of selenium in aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish). Environmental Commitment: Selenium Management (AMM27), which affords for site-specific measures to reduce effects, would be available to reduce BDCP-related effects associated with selenium. The effectiveness of AMM27 is uncertain and, therefore implementation may not reduce the identified impact to a level that would be less than significant, and therefore it is significant and unavoidable.

8.3.3.14 Alternative 7—Dual Conveyance with Pipeline/Tunnel, Intakes 2, 3, and 5, and Enhanced Aquatic Conservation (9,000 cfs; Operational Scenario E)

Impact WQ-5: Effects on Bromide Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of ~~CM2-22~~CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for ~~CM2-22~~CM2–CM21. See section 8.3.1.3 for more information.

Using the mass-balance modeling approach for bromide (see Section 8.3.1.3), relative to Existing Conditions, Alternative 7 would result in increases in long-term average bromide concentrations at Staten Island and Barker Slough (for the modeled drought period only), while long-term average concentrations would decrease at the other assessment locations (Appendix 8E, Bromide, Table 16).

At Barker Slough, predicted long-term average bromide concentrations would decrease from 51 µg/L to 50 µg/L (2% relative decrease) for the modeled 16-year hydrologic period, but would increase from 54 µg/L to 72 µg/L (34% relative increase) for the modeled drought period. At Barker Slough, the predicted 50 µg/L exceedance frequency would decrease from 49% under Existing Conditions to 29% under Alternative 7, but would increase slightly from 55% to 57% during the drought period. At Barker Slough, the predicted 100 µg/L exceedance frequency would increase from 0% under Existing Conditions to 8% under Alternative 7, and would increase from 0% to 22% during the drought period. At Staten Island, predicted long-term average bromide concentrations would increase from 50 µg/L to 63 µg/L (27% relative increase) for the modeled 16-year hydrologic period and would increase from 51 µg/L to 64 µg/L (25% relative increase) for the modeled drought period. At Staten Island, increases in average bromide concentrations would correspond to an increased frequency of 50 µg/l threshold exceedance, from 47% under Existing Conditions to 80% under Alternative 7 (52% to 88% for the modeled drought period), and an increase from 1% to 2% (0% to 0% for the modeled drought period) for the 100 µg/L threshold. Changes in exceedance frequency of the 50 µg/L and 100 µg/L concentration thresholds at other assessment locations would be less considerable, with exception to Franks Tract. Although long-term average bromide concentrations were modeled to decrease at Franks Tract, exceedances of the 100 µg/L threshold would increase slightly, from 82% under Existing Conditions to 99% under Alternative 7 (78% to 97% for the modeled drought period). This comparison to Existing Conditions reflects changes in bromide due to both Alternative 7 operations (including north Delta intake capacity of 9,000 cfs and numerous other operational components of Scenario E) and climate change/sea level rise.

Due to the relatively small differences between modeled Existing Conditions and No Action baselines, changes in long-term average bromide concentrations and changes in exceedance frequencies relative to the No Action Alternative are generally of similar magnitude to those previously described for the existing condition comparison (Appendix 8E, Bromide, Table 16).Modeled long-term average bromide concentration at Barker Slough is predicted to increase by 1% (34% for the modeled drought period) relative to the No Action Alternative. Modeled long-term average bromide concentration increases at Staten Island are predicted to increase by 31% (29% for the modeled drought period) relative to the No Action Alternative. However, unlike the Existing Conditions comparison, long-term average bromide concentrations at Buckley Cove would increase relative to the No Action Alternative, although the increases would be relatively small (≤9%). Unlike the comparison to Existing Conditions, this comparison to the No Action Alternative reflects changes in bromide due only to Alternative 7operations.

At Barker Slough, modeled long-term average bromide concentrations for the two baseline conditions are very similar(Appendix 8E, Bromide, Table 16). Such similarity demonstrates that the modeled Alternative 7 change in bromide is almost entirely due to Alternative 7 operations, and not climate change/sea level rise. Therefore, operations are the primary driver of effects on bromide at Barker Slough, regardless whether Alternative 7 is compared to Existing Conditions, or compared to the No Action Alternative.

Results of the modeling approach which used relationships between EC and chloride and between chloride and bromide (see Section 8.3.1.3) differed somewhat from what is presented above for the mass-balance approach (see Appendix 8E, Bromide, Table 17).For most locations, the frequency of exceedance of the 50 µg/L and 100 µg/L were similar. The greatest difference between the methods was predicted for Barker Slough. The increases in frequency of exceedance of the 100 µg/L threshold, relative to Existing Conditions and the No Action Alternative, were not as great using this alternative EC to chloride and chloride to bromide relationship modeling approach as compared to that presented above from the mass-balance modeling approach. Results indicate 2% exceedance over the modeled period under Alternative 7, as compared to 1% under Existing Conditions and 2% under the No Action Alternative. For the drought period, exceedance frequency increased from 0% under Existing Conditions and the No Action Alternative, to 7% under Alternative 7.Because the mass-balance approach predicts a greater level of impact at Barker Slough, determination of impacts was based on the mass-balance results.

While the increase in long-term average bromide concentrations at Barker Slough are relatively small when modeled over a representative 16-year hydrologic period, increases during the modeled drought period, principally the relative increase in 100 µg/L exceedance frequency, would represent a substantial change in source water quality during a season of drought. As discussed for Alternative 1A, drinking water treatment plants obtaining water via the North Bay Aqueduct utilize a variety of conventional and enhanced treatment technologies in order to achieve DBP drinking water criteria. While the implications of such a modeled drought period change in bromide concentrations at Barker Slough is difficult to predict, the substantial modeled increases could lead to adverse changes in the formation of disinfection byproducts such that considerable treatment plant upgrades may be necessary in order to achieve equivalent levels of health protection during seasons of drought. Increases at Staten Island are also considerable, although there are no existing or foreseeable municipal intakes in the immediate vicinity. Because many of the other modeled locations already frequently exceed the 100 µg/L threshold under Existing Conditions and the No Action Alternative, these locations likely already require treatment plant technologies to achieve equivalent levels of health protection, and thus no additional treatment technologies would be triggered by the small increases in the frequency of exceeding the 100 µg/L threshold. Hence, no further impact on the drinking water beneficial use would be expected at these locations.

The seasonal intakes at Mallard Slough and City of Antioch are infrequently used due to water quality constraints related to sea water intrusion. On a long-term average basis, bromide at these locations is in excess of 3,000 µg/L, but during seasonal periods of high Delta outflow can be <300 µg/L. Based on modeling using the mass-balance approach, use of the seasonal intakes at Mallard Slough and City of Antioch under Alternative 7 would experience a period average increase in bromide during the months when these intakes would most likely be utilized. For those wet and above normal water year types where mass balance modeling would predict water quality typically suitable for diversion, predicted long-term average bromide would increase from 103 µg/L to 152 µg/L (48% increase) at City of Antioch and would increase from 150 µg/L to 204 µg/L (36% increase) at Mallard Slough relative to Existing Conditions (Appendix 8E, Bromide, Table 23). Increases would be similar for the No Action Alternative comparison. Modeling results using the EC to chloride and chloride to bromide relationships show increases during these months, but the relative magnitude of the increases is much lower (Appendix 8E, Bromide, Table 24).Regardless of the differences in the data between the two modeling approaches, the decisions surrounding the use of these seasonal intakes is largely driven by acceptable water quality, and thus have historically been opportunistic. Opportunity to use these intakes would remain, and the predicted increases in bromide concentrations at the City of Antioch and Mallard Slough intake would not be expected to adversely affect MUN beneficial uses, or any other beneficial use, at these locations.

Based on modeling using the mass-balance approach, relative to existing and No Action Alternative conditions, Alternative 7 would lead to predicted improvements in long-term average bromide concentrations at Franks Tract, Rock Slough, and Contra Costa PP No. 1, in addition to Banks and Jones (discussed below). At these locations, long-term average bromide concentrations would be predicted to decrease by as much as 16–32%, depending on baseline comparison. Modeling results using the EC to chloride and chloride to bromide relationships generally do not show similar decreases for Rock Slough and Contra Costa PP No. 1, but rather, predict small increases. Based on the small magnitude of increases predicted, these increases would not adversely affect beneficial uses at those locations.

Important to the results presented above is the assumed habitat restoration footprint on both the temporal and spatial scales incorporated into the modeling. Modeling sensitivity analyses have indicated that habitat restoration (which are reflected in the modeling—see Section 8.3.1.3), not operations covered under CM1, are the driving factor in the modeled bromide increases. The timing, location, and specific design of habitat restoration will have effects on Delta hydrodynamics, and any deviations from modeled habitat restoration and implementation schedule will lead to different outcomes. Although habitat restoration near Barker Slough is an important factor contributing to modeled bromide concentrations at the North Bay Aqueduct, BDCP habitat restoration elsewhere in the Delta can also have large effects. Because of these uncertainties, and the possibility of adaptive management changes to BDCP restoration activities, including location, magnitude, and timing of restoration, the estimates are not predictive of the bromide levels that would actually occur in Barker Slough or elsewhere in the Delta.

Impact WQ-7: Effects on Chloride Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of ~~CM2-22~~CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for ~~CM2-22~~CM2–CM21. See section 8.3.1.3 for more information.

Relative to the Existing Conditions and No Action Alternative, Alternative 7 would result in similar or reduced long-term average chloride concentrations for the 16-year period modeled at most of the assessment locations, and, depending on modeling approach (see Section 8.3.1.3) increased concentrations at the Contra Costa Canal at Pumping Plant #1 (i.e., up to 29% compared to No Action Alternative), Rock Slough (i.e., up to 22% compared to No Action Alternative), and the ~~San Joaquin River at Staten Island~~SF Mokelumne at Staten Island (i.e., up to 28% compared to Existing Conditions and No Action Alternative) (Appendix 8G, Chloride, Table Cl-43 and Table Cl-44). Moreover, the direction and magnitude of predicted changes for Alternative 7 are similar between the alternatives, thus, the effects relative to Existing Conditions and the No Action Alternative are discussed together. Additionally, implementation of tidal habitat restoration under CM4 would increase the tidal exchange volume in the Delta, and thus may contribute to increased chloride concentrations in the Bay source water as a result of increased salinity intrusion. More discussion of this phenomenon is included in Section 8.3.1.3. Consequently, while uncertain, the magnitude of chloride increases may be greater than indicated herein and would affect the western Delta assessment locations the most which are influenced to the greatest extent by the Bay source water. The comparison to Existing Conditions reflects changes in chloride due to both Alternative 7 operations (including north Delta intake capacity of 9,000 cfs and numerous other operational components of Scenario E) and climate change/sea level rise. The comparison to the No Action

Alternative reflects changes in chloride due only to operations. The following outlines the modeled chloride changes relative to the applicable objectives and beneficial uses of Delta waters.

Municipal Beneficial Uses

Estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3) were used to evaluate the 150 mg/L Bay-Delta WQCP objective for municipal and industrial beneficial uses on a basis of the percent of years the chloride objective is exceeded for the modeled 16-year period. The objective is exceeded if chloride concentrations exceed 150 mg/L for a specified number of days in a given water year at both the Antioch and Contra Costa Pumping Plant #1 locations. For Alternative 7, the modeled frequency of objective exceedance would increase from ~~6~~7% of years under Existing Conditions and ~~6~~0% under the No Action Alternative to ~~25~~20% of years under Alternative 7 (Appendix 8G, Chloride, Table Cl-64).

Similarly, estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3) were also used to evaluate the 250 mg/L Bay-Delta WQCP objective for chloride at Contra Costa Pumping Plant #1 where daily average objectives apply. The basis for the evaluation was the predicted number of days the objective was exceeded for the modeled 16-year period. For Alternative 7, the modeled frequency of objective exceedance would decrease, from 6% of modeled days under Existing Conditions and 5% under the No Action Alternative to 1% of modeled days under Alternative 7 (Appendix 8G, Chloride, Table Cl-63).

Given the limitations inherent to estimating future chloride concentrations (see Section 8.3.1.3), estimation of chloride concentrations through both a mass balance approach and an EC-chloride relationship approach was used to evaluate the 250 mg/L Bay-Delta WQCP objectives in terms of both frequency of exceedance and use of assimilative capacity. When utilizing the mass balance approach to model monthly average chloride concentrations for the 16-year period, the predicted frequency of exceeding the 250 mg/L objective would decrease up to 12% (i.e., 24% for Existing Conditions to 12%) at the Contra Costa Canal at Pumping Plant #1 (Appendix 8G, Chloride, Table Cl-45 and Figure Cl-13). The frequency of exceedances would decrease at the San Joaquin River at Antioch (i.e., from 66% under Existing Conditions to 60%) with no substantial change predicted for Mallard Island (i.e., maximum increase of 1%) (Appendix 8G, Table Cl-45) and no substantial long-term degradation (Appendix 8G, Table Cl-47).However, relative to the No Action conditions, available assimilative capacity for chloride at the Contra Costa Canal at Pumping Plant #1 would be substantially reduced in August through October (i.e., reduction ranging from 35% to 74% for the 16 year period modeled, and 100% in August and September [i.e., eliminated]) (Appendix 8G, Table Cl-47), thus reflecting substantial degradation when concentrations would be near, or exceed, the objective.

In comparison, when utilizing the chloride-EC relationship to model monthly average chloride concentrations for the 16-year period, trends in frequency of exceedance generally agreed, but use of assimilative capacity were predicted to be larger at some locations (Appendix 8G, Chloride, Table Cl-46 and Table Cl-48). Specifically, while the model predicted exceedance frequency would decrease at the Contra Costa Canal at Pumping Plant #1 and Rock Slough locations, use of assimilative capacity would increase substantially for the months of February through June as well as September (i.e., maximum of 82% in March for the modeled drought period). Due to such seasonal long-term average water quality degradation at these locations, the potential exists for substantial adverse effects on the municipal and industrial beneficial uses through reduced opportunity for diversion of water with acceptable chloride levels. Moreover, due to the increased frequency of exceeding the 150 mg/L Bay-Delta WQCP objective, the potential exists for adverse effects on the municipal and industrial beneficial uses at Contra Costa Pumping Plant #1 and Antioch.

303(d) Listed Water Bodies

With respect to the 303(d) listing for chloride in Tom Paine Slough, the monthly average chloride concentrations for the 16-year period modeled at Old River at Tracy Road would generally be similar compared to Existing Conditions, and thus, would not be further degraded on a long-term basis (Appendix 8G, Figure Cl-14. With respect to Suisun Marsh, the monthly average chloride concentrations for the 16-year period modeled would generally increase compared to Existing Conditions in some months during October through May at the Sacramento River at Collinsville (Appendix 8G, Figure Cl-15), Mallard Island (Appendix 8G, Figure Cl-13), and increase substantially at Montezuma Slough at Beldon's Landing (i.e., over a doubling of concentration in December through February) (Appendix 8G, Figure Cl-16).~~,~~ However, modeling of Alternative 7 assumed no operation of the Montezuma Slough Salinity Control Gates, but the project description assumes continued operation of the Salinity Control Gates, consistent with assumptions included in the No Action Alternative. A sensitivity analysis modeling run conducted for Alternative 4 with the gates operational consistent with the No Action Alternative resulted in substantially lower EC levels than indicated in the original Alternative 4 modeling results for Suisun Marsh, but EC levels were still somewhat higher than EC levels under Existing Conditions for several locations and months. Although chloride was not specifically modeled in these sensitivity analyses, it is expected that chloride concentrations would be nearly proportional to EC levels in Suisun Marsh. Another modeling run with the gates operational and restoration areas removed resulted in EC levels nearly equivalent to Existing Conditions, indicating that design and siting of restoration areas has notable bearing on EC levels at different locations within Suisun Marsh (see Appendix 8H Attachment 1 for more information on these sensitivity analyses). These analyses also indicate that increases in salinity are related primarily to the hydrodynamic effects of CM4, not operational components of CM1. Based on the sensitivity analyses, optimizing the design and siting of restoration areas may limit the magnitude of long-term chloride increases in the Marsh. However, the chloride concentration increases at certain locations could be substantial, depending on siting and design of restoration areas. Thus, these increased chloride levels in Suisun Marsh are considered to contribute to additional, measureable long-term degradation that potentially would adversely affect the necessary actions to reduce chloride loading for any TMDL that is developed.

~~thereby contributing to additional, measureable long-term degradation that potentially would adversely affect the necessary actions to reduce chloride loading for any TMDL that is developed.~~

Impact WQ-9: Effects on Dissolved Oxygen Resulting from Facilities Operations and Maintenance (CM1)

NEPA Effects: Effects of CM1 on dissolved oxygen under Alternative 7 are the same as those discussed for Alternative 1A and are considered to not be adverse.

CEQA Conclusion: Effects of CM1 on DO under Alternative 7would be similar to those discussed for Alternative 1A, and are summarized here, then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion under Alternative 1A.

~~River flow rate and r~~Reservoir storage reductions that would occur under Alternative 7, relative to Existing Conditions, would not be expected to result in a substantial adverse change in DO levels in the reservoirs, because oxygen sources (surface water aeration, aerated inflows, vertical mixing) would remain. Similarly, river flow rate reductions that would occur would not be expected to result in a substantial adverse change in DO levels in the ~~and~~ rivers upstream of the Delta, given that mean monthly flows would remain within the ranges historically seen under Existing Conditions and the affected river are large and turbulent. Any reduced DO saturation level that may be caused by increased water temperature would not be expected to cause DO levels to be outside of the range seen historically. Finally, amounts of oxygen demanding substances and salinity would not be expected to change sufficiently to affect DO levels.

It is expected there would be no substantial change in Delta DO levels in response to a shift in the Delta source water percentages under this alternative or substantial degradation of these water bodies, with regard to DO. DO levels would be affected by nutrient loading, which the state has begun to aggressively regulate the discharges of, and this loading would not be expected to lower DO levels relative to Existing Conditions based on historical DO levels. Further, the anticipated changes in salinity would have relatively minor effects on DO levels, and tidal exchange, which contribute to the reaeration of Delta waters would not be expected to change substantially.

There is not expected to be substantial, if even measurable, changes in DO levels in the SWP/CVP Export Service Areas waters under Alternative 7, relative to Existing Conditions, because the biochemical oxygen demand of the exported water would not be expected to substantially differ from that under Existing Conditions (due to ever increasing water quality regulations), canal turbulence and exposure of the water to the atmosphere and the algal communities that exist within the canals would establish an equilibrium for DO levels within the canals. The same would occur in downstream reservoirs.

Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would result in significant impacts on any beneficial uses within affected water bodies. Because no substantial changes in DO levels are expected, long-term water quality degradation would not be expected to occur, and, thus, beneficial uses would not be adversely affected. Various Delta waterways are 303(d)-listed for low DO, but because no substantial decreases in DO levels would be expected, greater degradation and DO-related impairment of these areas would not be expected. This impact would be less than significant. No mitigation is required.

Impact WQ-11: Effects on Electrical Conductivity Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of ~~CM2-22~~CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for ~~CM2-22~~CM2–CM21. See section 8.3.1.3 for more information.

Relative to Existing Conditions, Alternative 7 would result in an increase in the number of days the Bay-Delta WQCP EC objectives would be exceeded in the Sacramento River at Emmaton, and the San Joaquin River at San Andreas Landing, Prisoners Point, and Brandt Bridge (Appendix 8H, *Electrical Conductivity*, Table EC-7).

The percent of days the Emmaton EC objective would be exceeded for the entire period modeled (1976–1991) would increase from 6% under Existing Conditions to 1~~6~~9% under Alternative 7, and the percent of days out of compliance would increase from 11% under Existing Conditions to 2~~6~~9% under Alternative 7.

The percent of days the San Andreas Landing EC objective would be exceeded would increase from 1% under Existing Conditions to 4~~3~~% under Alternative 7, and the percent of days out of compliance with the EC objective would increase from 1% under Existing Conditions to ~~6~~7% under Alternative 7. Sensitivity analyses were performed for Alternative 4 scenario H3, and indicated that many similar exceedances were modeling artifacts, and the small number of remaining exceedances were small in magnitude, lasted only a few days, and could be addressed with real time operations of the SWP and CVP (see Section 8.3.1.1 for a description of real time operations of the SWP and CVP). Due to similarities in the nature of the exceedances between alternatives, the findings from these analyses can be extended to this alternative as well.

The percent of days the Prisoners Point EC objective would be exceeded for the entire period modeled would increase from 6% under Existing Conditions to ~~35~~40% under Alternative 7, and the percent of days out of compliance with the EC objective would increase from 10% under Existing Conditions to ~~35~~40% under Alternative 7. Sensitivity analyses conducted for Alternative 4 scenario H3 indicated that removing all tidal restoration areas would reduce the number of exceedances, but there would still be substantially more exceedances than under Existing Conditions or the No Action Alternative. Results of the sensitivity analyses indicate that the exceedances are partially a function of the operations of the alternative itself, perhaps due to Head of Old River Barrier assumptions and south Delta export differences (see Appendix 8H Attachment 1 for more discussion of these sensitivity analyses). Due to similarities in the nature of the exceedances between alternatives, the findings from these analyses can be extended to this alternative as well. Appendix 8H Attachment 2 contains a more detailed assessment of the likelihood of these exceedances impacting aquatic life beneficial uses. Specifically, Appendix 8H Attachment 2 discusses whether these exceedances might have indirect effects on striped bass spawning in the Delta, and concludes that the high level of uncertainty precludes making a definitive determination.

In the San Joaquin River at Brandt Bridge, the percent of days exceeding the EC objective would increase from 3% under Existing Conditions to 4% under Alternative 7; the percent of days out of compliance would increase from 8% under Existing Conditions to 9% under Alternative 7. These changes are minimal, and are not considered substantial in light of overall modeling uncertainty.

Average EC levels at the western and southern Delta compliance locations and San Joaquin River at San Andreas Landing (an interior Delta location) would decrease from 0–46% for the entire period modeled and 2–45% during the drought period modeled (1987–1991) (Appendix 8H, Table EC-18). In the S. Fork Mokelumne River at Terminous, average EC would increase 6% for the entire period modeled and 5% during the drought period modeled. Average EC in the S. Fork Mokelumne River at Terminous would increase during all months (Appendix 8H, Table EC-18). Average EC in the San Joaquin River at Prisoners Point would increase by 1% during the drought period (Appendix 8H, Table EC-18). Given that the western ~~and southern~~ Delta ~~are~~ is Clean Water Act section 303(d) listed as impaired due to elevated EC, the increase in the incidence of exceedance of EC objectives under Alternative 7, relative to Existing Conditions, has the potential to contribute to additional impairment and potentially adversely affect beneficial uses. The comparison to Existing Conditions reflects changes in EC due to both Alternative 7 operations (including north Delta intake capacity of 9,000 cfs and numerous other operational components of Scenario E) and climate change/sea level rise.

Relative to the No Action Alternative, the percent of days exceeding EC objectives and percent of days out of compliance would increase at: Sacramento River at Emmaton, San Joaquin River at Jersey Point, San Andreas Landing, Vernalis, Brandt Bridge, and Prisoners Point; and Old River near Middle River and at Tracy Bridge (Appendix 8H, *Electrical Conductivity*, Table EC-7). The increase in percent of days exceeding the EC objective would be 3~~4~~9% at Prisoners Point and ~~10~~5% or less at the remaining locations. The increase in percent of days out of compliance would be 3~~4~~0% at Prisoners Point and ~~15~~6% or less at the remaining locations. For the entire period modeled, average EC levels would increase at: S. Fork Mokelumne River (6%), Old River at Tracy Bridge (1%), and San Joaquin River at Prisoners Point (10%) (Appendix 8H, Table EC-18). During the drought period modeled, average EC would increase at: S. Fork Mokelumne River (6%), San Joaquin River at Brandt Bridge (1%) and Prisoners Point (8%), and Old River at Tracy Bridge 1%) (Appendix 8H, Table EC-18). Given that the western and southern Delta are Clean Water Act section 303(d) listed as impaired due to elevated EC, the increase in the incidence of exceedance of EC objectives under Alternative 7, relative to the No Action Alternative, has the potential to contribute to additional impairment and potentially adversely affect beneficial uses. The comparison to the No Action Alternative reflects changes in EC due only to Alternative 7 operations (including north Delta intake capacity of 9,000 cfs and numerous other operational components of Scenario E).

For Suisun Marsh, October–May is the period when Bay-Delta WQCP EC objectives for protection of fish and wildlife apply. Long-term average EC would increase under Alternative 7, relative to Existing Conditions, during the months of April and May by 0.2 mS/cm in the Sacramento River at Collinsville (Appendix 8H, *Electrical Conductivity*, Table EC-21). Long-term average EC would decrease relative to Existing Conditions in Montezuma Slough at National Steel during October–May (Appendix 8H, Table EC-22). The most substantial increase would occur near Beldon Landing, with long-term average EC levels increasing by 0.8–3.3 mS/cm, depending on the month, nearly doubling during some months the long-term average EC relative to Existing Conditions (Appendix 8H, Table EC-23). Sunrise Duck Club and Volanti Slough also would have long-term average EC increases of 0.1–1.6 mS/cm (Appendix 8H, Tables EC-24 and EC-25). Modeling of this alternative assumed no operation of the Montezuma Slough Salinity Control Gates, but the project description assumes continued operation of the Salinity Control Gates, consistent with assumptions included in the No Action Alternative. A sensitivity analysis modeling run conducted for Alternative 4 scenario H3 with the gates operational consistent with the No Action Alternative resulted in substantially lower EC levels than indicated in the original Alternative 4 modeling results, but EC levels were still somewhat higher than EC levels under Existing Conditions and the No Action Alternative for several locations and months. Another modeling run with the gates operational and restoration areas removed resulted in EC levels nearly equivalent to Existing Conditions and the No Action Alternative, indicating that design and siting of restoration areas has notable bearing on EC levels at different locations within Suisun Marsh (see Appendix 8H Attachment 1 for more information on these sensitivity analyses). These analyses also indicate that increases are related primarily to the hydrodynamic effects of CM4, not operational components of CM1. Based on the sensitivity analyses, optimizing the design and siting of restoration areas may limit the magnitude of long-term EC increases to be on the order of 1 mS/cm or less. Due to similarities in the nature of the EC increases between alternatives, the findings from these analyses can be extended to this alternative as well.

The degree to which the long-term average EC increases in Suisun Marsh would cause exceedance of Bay-Delta WQCP objectives is unknown, because these objectives are expressed as a monthly average of daily high tide EC, which does not have to be met if it can be demonstrated “equivalent or better protection will be provided at the location” (State Water Resources Control Board 2006:14). The ~~described~~ long-term average EC increase may, or may not, contribute to adverse effects on beneficial uses, depending on how and when wetlands are flooded, soil leaching cycles, and how agricultural use of water is managed, and future actions taken with respect to the marsh. However, the EC increases at certain locations ~~would~~ could be substantial, depending on siting and design of restoration areas, and it is uncertain the degree to which current management plans for the Suisun Marsh would be able to address these substantially higher EC levels and protect beneficial uses. Thus, these increased EC levels in Suisun Marsh are considered to have a potentially adverse effect on marsh beneficial uses. Long-term average EC increases in Suisun Marsh under Alternative 7 relative to the No Action Alternative would be similar to the increases relative to Existing Conditions. Suisun Marsh is section 303(d) listed as impaired due to elevated EC, and the potential increases in long-term average EC concentrations could contribute to additional impairment.~~, because the increases would be double that relative to Existing Conditions and the No Action Alternative.~~

NEPA Effects: In summary, ~~the increased frequency of exceedance of EC objectives and increased long-term and drought period average EC levels that would occur at interior and southern Delta compliance locations, and~~the increased frequency of exceedance of EC objectives in the western Delta under Alternative 7, relative to the No Action Alternative, would contribute to adverse effects on the agricultural beneficial uses. In addition. the increased frequency of exceedance of the San Joaquin River at Prisoners Point EC objective and long-term and drought period average EC could contribute to adverse effects on fish and wildlife beneficial uses (specifically, indirect adverse effects on striped bass spawning), though there is a high degree of uncertainty associated with this impact.~~.~~ Given that the western ~~and southern~~ Delta ~~are~~ is Clean Water Act section 303(d) listed as impaired due to elevated EC, the increase in the incidence of exceedance of EC objectives ~~and long-term average and drought period average EC in these~~in this portion~~s~~ of the Delta has the potential to contribute to additional beneficial use impairment. The increases in long-term average EC levels that ~~would~~ could occur in Suisun Marsh would further degrade existing EC levels and could contribute ~~additional~~ to adverse effects on the fish and wildlife beneficial uses. Suisun Marsh is section 303(d) listed as impaired due to elevated EC, and the potential increases in long-term average EC levels could contribute to additional beneficial use impairment. These increases in EC constitute an adverse effect on water quality. Mitigation Measure WQ-11 would be available to reduce these effects (implementation of this measure along with a separate, non-environmental commitment as set forth in EIR/EIS Appendix 3B, *Environmental Commitments*, relating to the potential EC-related changes would reduce these effects).

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

River flow rate and reservoir storage reductions that would occur under Alternative 7, relative to Existing Conditions, would not be expected to result in a substantial adverse change in EC levels in the reservoirs and rivers upstream of the Delta, given that: changes in the quality of watershed runoff and reservoir inflows would not be expected to occur in the future; the state's aggressive regulation of point-source discharge effects on Delta salinity-elevating parameters and the expected further regulation as salt management plans are developed; the salt-related TMDLs adopted and being developed for the San Joaquin River; and the expected improvement in lower San Joaquin River average EC levels commensurate with the lower EC of the irrigation water deliveries from the Delta.

Relative to Existing Conditions, Alternative 7 would not result in any substantial increases in long-term average EC levels in the SWP/CVP Export Service Areas. There would be no exceedance of the EC objective at the Jones and Banks pumping plants. Average EC levels for the entire period modeled would decrease at both plants and, thus, this alternative would not contribute to additional beneficial use impairment related to elevated EC in the SWP/CVP Export Service Areas waters. Rather, this alternative would improve long-term EC levels in the SWP/CVP Export Service Areas, relative to Existing Conditions.

In the Plan Area, Alternative 7 would result in an increase in the frequency with which Bay-Delta WQCP EC objectives are exceeded in the Sacramento River at Emmaton (agricultural objective; 1~~0~~3% increase), ~~San Joaquin River at San Andreas Landing (agricultural objective; 23% increase) and Brandt Bridge (agricultural objective; 1% increase) in the southern Delta,~~ and San Joaquin River at Prisoners Point (fish and wildlife objective; ~~29~~34% increase) in the interior Delta for the entire period modeled (1976–1991). The increased frequency of exceedance of the fish and wildlife objective at Prisoners Point could contribute to adverse effects on aquatic life (specifically, indirect adverse effects on striped bass spawning), though there is a high degree of uncertainty associated with this impact~~,~~. ~~and t~~The increased frequency of the EC exceedance at Emmaton could contribute to adverse effects on agricultural uses. Because EC is not bioaccumulative, the increases in long-term average EC levels would not directly cause bioaccumulative problems in aquatic life or humans. The western ~~and southern~~ Delta ~~are~~ is Clean Water Act section 303(d) listed for elevated EC and the increased frequency of exceedance of EC objectives that would occur in ~~these~~ this portion~~s~~ of the Delta could make beneficial use impairment measurably worse. This impact is considered to be significant.

Further, relative to Existing Conditions, Alternative 7 ~~would~~ could result in substantial increases in long-term average EC during the months of October through May in Suisun Marsh~~, such that EC levels would be double that relative to Existing Conditions~~. The increases in long-term average EC levels that ~~would~~ could occur in Suisun Marsh could further degrade existing EC levels and thus contribute additionally to adverse effects on the fish and wildlife beneficial uses. Because EC is not bioaccumulative, the increases in long-term average EC levels would not directly cause bioaccumulative problems in wildlife. Suisun Marsh is Clean Water Act section 303(d) listed for elevated EC and the increases in long-term average EC that would occur in the marsh could make beneficial use impairment measurably worse. This impact is considered to be significant.

Implementation of Mitigation Measure WQ-11 along with a separate, non-environmental commitment relating to the potential increased costs associated with EC-related changes would reduce these effects. While mitigation measures to reduce these water quality effects in affected water bodies to less than significant levels are not available, implementation of Mitigation Measure WQ-11 is recommended to attempt to reduce the effect that increased EC concentrations may have on Delta beneficial uses. However, because the effectiveness of this mitigation measure to result in feasible measures for reducing water quality effects is uncertain, this impact is considered to remain significant and unavoidable. Please see Mitigation Measure WQ-11 under Impact WQ-11 in the discussion of Alternative 1A.

In addition to and to supplement Mitigation Measure WQ-11, the BDCP proponents have incorporated into the BDCP, as set forth in EIR/EIS Appendix 3B, Environmental Commitments, a separate, non-environmental commitment to address the potential increased water treatment costs that could result from EC concentration effects on municipal, industrial and agricultural water purveyor operations. Potential options for making use of this financial commitment include funding or providing other assistance towards acquiring alternative water supplies or towards modifying existing operations when EC concentrations at a particular location reduce opportunities to operate existing water supply diversion facilities. Please refer to Appendix 3B, Environmental Commitments, for the full list of potential actions that could be taken pursuant to this commitment in order to reduce the water quality treatment costs associated with water quality effects relating to chloride, electrical conductivity, and bromide.

Impact WQ-13: Effects on Mercury Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2-22CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for CM2-22CM2–CM21. See section 8.3.1.3 for more information.

The water quality impacts of waterborne concentrations of mercury and methylmercury and fish tissue mercury concentrations were evaluated for 9 Delta locations. The analysis of percentage change in assimilative capacity of waterborne total mercury of Alternative 7 relative to the 25 ng/L ecological risk benchmark as compared to Existing Conditions showed a 6.7% reduction at Old River at Rock Slough and Contra Costa Pumping Plant, and a 6.6% reduction at those same locations relative to the No Action Alternative. These changes are not expected to result in adverse effects to beneficial use (Figures 8-53 and 8-54). Similarly, changes in methylmercury concentration are expected to be relatively small. The greatest annual average methylmercury concentration for drought conditions was 0.164 ng/L for the San Joaquin River at Buckley Cove which was slightly higher than Existing Conditions (0.161 ng/L), and slightly lower than the No Action Alternative (0.167 ng/L) (Appendix 8I,*Mercury,* Table I-6).All modeled input concentrations exceeded the methylmercury TMDL guidance objective of 0.06 ng/L, therefore percentage change in assimilative capacity was not evaluated for methylmercury.

Fish tissue estimates show substantial percentage increases in concentration and exceedance quotients for mercury at some Delta locations. The greatest changes in exceedance quotients relative to Existing Conditions and the No Action Alternative are 30- –39% at the Contra Costa Pumping Plant and 32–45% for Old River at Rock Slough (Figure 8-558-55a,b, Appendix 8I, Table I-14b). Because these increases are substantial, and it is evident that substantive increases are expected at numerous locations throughout the Delta, these changes may be measurable in the environment. See Appendix 8I for a discussion of the uncertainty associated with the fish tissue estimates.

NEPA Effects: Based on the above discussion, the effects of mercury and methylmercury in comparison of Alternative 7 to the No Action Alternative (as waterborne and bioaccumulated forms) are considered to be adverse for the case of fish tissue bioaccumulation at some locations.

***CEQA Conclusion*:** Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Under Alternative 7, greater water demands and climate change would alter the magnitude and timing of reservoir releases and river flows upstream of the Delta in the Sacramento River watershed and east-side tributaries, relative to Existing Conditions. Concentrations of mercury and methylmercury upstream of the Delta will not be substantially different relative to Existing Conditions due to the lack of important relationships between mercury/methylmercury concentrations and flow for the major rivers.

Methylmercury concentrations exceed criteria at all locations in the Delta and no assimilative capacity exists. Monthly average waterborne concentrations of total and methylmercury, over the period of record, are very similar to Existing Conditions, but showed notable increases at some locations. Estimates of fish tissue mercury concentrations show substantial increases would occur for several sites for ~~Methylmercury concentrations exceed criteria at all locations in the Delta and no assimilative capacity exists.However, monthly average waterborne concentrations of total and methylmercury, over the period of record, are very similar to Existing Conditions.Similarly, estimates of fish tissue mercury concentrations show almost no differences would occur among sites for~~ Alternative 7 as compared to Existing Conditions for Delta sites.

Assessment of effects of mercury in the SWP and CVP Export Service Areas were based on effects on mercury concentrations and fish tissue mercury concentrations at the Banks and Jones pumping plants. The Banks and Jones pumping plants are expected to show increased assimilative capacity for waterborne mercury and decreased fish tissue concentrations of mercury for Alternative 7 as compared to Existing Conditions.

As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. However, increases in fish tissue mercury concentrations are substantial, and changes in fish tissue mercury concentrations would make existing mercury-related impairment in the Delta measurably worse. In comparison to Existing Conditions, Alternative 7 would increase levels of mercury by frequency, magnitude, and geographic extent such that the affected environment would be expected to have measurably higher body burdens of mercury in aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish) or humans consuming those organisms. This impact is considered to be significant. Feasible or effective actions to reduce the effects on mercury resulting from CM1 are unknown. General mercury management measures through CM12, or actions taken by other entities or programs such as TMDL implementation, may minimize or reduce sources and inputs of mercury to the Delta and methylmercury formation. However, it is uncertain whether this impact would be reduced to a level that would be less than significant as a result of CM12 or other future actions. Therefore, the impact would be significant and unavoidable.

Impact WQ-25: Effects on Selenium Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics~~,~~. To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of ~~CM2-22~~CM2–CM21 not attributable to hydrodynamics, ~~for example,~~such as additional loading of a constituent to the Delta, are discussed within the impact header for ~~CM2-22~~CM2–CM21. See ~~section~~ Section 8.3.1.3 for more information.

Selenium concentrations and threshold comparisons for each of the 11 modeled Delta assessment locations under Alternative 7, relative to Existing Conditions and the No Action Alternative, are presented in Appendix 8M, *Selenium*, Table M-9a for water, Tables M-17 and M-27 for most biota (whole-body fish ~~(~~[excluding sturgeon~~)~~], bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets) throughout the Delta, and Tables M-30 through M-32 for sturgeon at the two western Delta locations. Figures 8-59a and 8-60a present graphical distributions of predicted selenium concentration changes (shown as changes in available assimilative capacity based on 1.3 μg/L) in water at each modeled assessment location for all years. Appendix 8M, Figure M-24 provides more detail in the form of monthly patterns of selenium concentrations in water during the modeling period.

Alternative 7 would result in small to moderate changes in average selenium concentrations in water at all modeled Delta assessment locations relative to Existing Conditions and the No Action Alternative (Appendix 8M,*Selenium*, Table M-~~10A~~9a). Long-term average concentrations at some interior and western Delta locations would increase by 0.01–0.13 μg/L for the entire period modeled. The increases in selenium concentrations in water would result in reductions ~~Changes in selenium concentrations in water are reflected in small (10% or less) to moderate (between 11% and 50%) percent changes~~ in available assimilative capacity for selenium of 1–12%, relative to the ~~(based on 2~~1.3 μg/L ~~ecological risk benchmark~~USEPA draft water quality criterion (Figures 8-59a and 8-60a).~~ for all years. Relative to Existing Conditions, Alternative 7 would result in the largest modeled increases in available assimilative capacity at Buckley Cove (4%); relative to the No Action Alternative, the largest increase would be at Staten Island (1%), and the largest decreases for Existing Conditions and the No Action Alternativewould be at Rock Slough and Contra Costa PP (12%) (Figures 8-59 and 8-60). Although moderate negative changes in assimilative capacity would occur at two locations (Rock Slough and Contra Costa PP), the changes are minimal at the other locations and the available assimilative capacity at all locations would remain substantial; therefore, the effect of Alternative 7 is generally minimal for the Delta. Furthermore, t~~The long-term average selenium concentrations in water ~~ranges of modeled selenium concentrations in water~~under ~~(Appendix 8M, Table M-10A) for~~ Alternative 7 (range 0.~~24~~09–0.~~71~~38 μg/L) would be similar to those for~~,~~ Existing Conditions (range 0.~~21~~09–0.~~76~~41 μg/L)~~,~~ and the No Action Alternative (range 0.~~21~~09–0.~~69~~38 μg/L)~~ are similar~~, and all would be well below the ~~ecological risk benchmark~~USEPA draft water quality criterion of ~~(~~1.3~~2~~ μg/L~~)~~ (Appendix 8M, Table 9a).

Relative to Existing Conditions and the No Action Alternative, Alternative 7 would generally result in small changes (less than 4~~5~~%) in estimated selenium concentrations in most biota (whole-body fish (excluding sturgeon), bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets) throughout the Delta, with little difference among locations (Figures 8-61a through 8-64b; Appendix 8M, *Selenium*, Table M-~~18~~ 27)~~Table 8M-2 in the sturgeon addendum to Appendix 8Mand Addendum M.A, *Selenium in Sturgeon*, to Appendix 8M, Table M.A-2)~~. Despite the small changes in selenium concentrations in biota, Level of Concern Exceedance Quotients (i.e., modeled tissue divided by Level of Concern benchmarks) for selenium concentrations in those biota for all years and for drought years are less than 1.0 (indicating low probability of adverse effects). Similarly, Advisory Tissue Level Exceedance Quotients for selenium concentrations in fish fillets for all years and drought years also are less than 1.0. Estimated selenium concentrations in sturgeon for the San Joaquin River at Antioch are predicted to increase by about 30 percent relative~~Relative~~ to Existing Conditions and to the No Action Alternative in all years (from about 4.7 to 6.1 mg/kg dry weight [dw]). Likewise, those for sturgeon in the Sacramento River at Mallard Island are predicted to increase by about 18 percent in all years (from about 4.4 to 5.2 mg/kg dw) (~~Figure 8-65;~~ Appendix 8M, Tables M-30 and M-31). Selenium concentrations in sturgeon during drought years are expected to increase by 11 to 24 percent at those locations. Detection of changes in whole-body sturgeon such as those estimated for the western Delta may require large sample sizes because of the inherent variability in fish tissue selenium concentrations. Low Toxicity Threshold Exceedance Quotients for selenium concentrations in sturgeon in the western Delta would exceed 1.0 for drought years at both locations (as they do for Existing Conditions and the No Action Alternative; Figure 8-65) and for all years at the San Joaquin River at Antioch~~both locations~~, whereas Existing Conditions and the No Action Alternative do not (quotient~~s~~ increases from 0.94 to 1.2 at San Joaquin at Antioch ~~to 1.2 and from 0.88 at Sacramento River at Mallard Island to 1.0~~) (Appendix 8M, Table M-32). High Toxicity Threshold Exceedance Quotients for selenium concentrations in sturgeon in the western Delta would exceed 1.0 for drought years in the San Joaquin River at Antioch, whereas Existing Conditions and the No Action Alternative do not (quotient~~s~~ increases from about ~~8.~~0.85 to 1.1) (Figure 8-65; Appendix 8M, Table M-32). ~~and the No Action Alternative, the largest increase of selenium concentrations in biota would be at Contra Costa PP for drought years and in sturgeon at the two western Delta locations in all as well as drought years. Relative to Existing Conditions, the largest decrease would be at Buckley Cove for drought years. Relative to the No Action Alternative, the largest decrease would be at Staten Island for drought years (except for bird eggs [assuming a fish diet] at Buckley Cove for drought years). Except for sturgeon in the western Delta, concentrations of selenium in whole-body fish and bird eggs (invertebrate and fish diets) would exceed only the lower benchmarks (4 and 6 mg/kg dry weight, respectively, indicating a low potential for effects), under drought conditions, at Buckley Cove for Alternative 7 and Existing Conditions and the No Action Alternative(Figures 8-61 through 8-63). Exceedance Quotients for these exceedances of the lower benchmarks are between 1.0 and 1.5, indicating a low risk to biota in the Delta and no substantial difference for Alternative 7 from Existing Conditions and the No Action Alternative. Selenium concentrations in fish fillets would not exceed the screening value for protection of human health (Figure 8-64). For sturgeon in the western Delta, whole-body selenium concentrations would increase from 12.3 mg/kg under Existing Conditions and the No Action Alternative to 14.7 mg/kg under Alternative 7, a 20% increase (Table M.A-2). All of these values exceed both the low and high toxicity benchmarks. These increases are high enough that they may represent a measurable increase in body burdens of sturgeon, which would constitute an adverse impact (see also the discussion of results provided in addendum M.Ato Appendix 8M).~~

The disparity between larger estimated changes for sturgeon and smaller changes for other biota areis attributable largely to differences in modeling approaches, as described in Appendix 8M, *Selenium*. The model for most biota was calibrated to encompass the varying concentration-dependent uptake from waterborne selenium concentrations (expressed as the K_d, which is the ratio of selenium concentrations in particulates [as the lowest level of the food chain] relative to the waterborne concentration) that was exhibited in data for largemouth bass in 2000, 2005, and 2007 at various locations across the Delta. In contrast, the modeling for sturgeon could not be similarly calibrated at the two western Delta locations and used literature-derived uptake factors and trophic transfer factors for the estuary from Presser and Luoma (2013). As noted in the appendix, there was a significant negative log-log relationship of K_d to waterborne selenium concentration that reflected the greater bioaccumulation rates for bass at low waterborne selenium than at higher concentrations. (There was no difference in bass selenium concentrations in the Sacramento River at Rio Vista in comparison to the San Joaquin River at Vernalis in 2000, 2005, and 2007 [Foe 2010], despite a nearly 10-fold difference in waterborne selenium.) Thus, there is more confidence in the site-specific modeling based on the Delta-wide model that was calibrated for bass data than in the estimates for sturgeon based on "fixed" K_ds for all years and for drought years without regard to waterborne selenium concentration at the two locations in different time periods.

Increased water residence times could increase the bioaccumulation of selenium in biota, thereby potentially increasing fish tissue and bird egg concentrations of selenium (see residence time discussion in Appendix 8M, *Selenium*, and Presser and Luoma [2010b]). Thus, residence time was assessed for its relevance to selenium bioaccumulation. Table 60a (presented originally in Section 8.3.1.7 in the *Microcystis* subsection) shows the time for neutrally buoyant particles to move through the Delta (surrogate for flow and residence time). Although an increase in residence time throughout the Delta is expected under the No Action Alternative, relative to Existing Conditions (because of climate change and sea level rise), the change is fairly small in most areas of the Delta. Thus, the changes in residence times between Alternative 7 and the No Action Alternative are very similar to the changes in residence times between Alternative 7 and the Existing Conditions.

Relative to Existing Conditions and the No Action Alternative, increases in residence times for Alternative 7 would be greater in the South Delta and East Delta than in other sub-regions. Relative to Existing Conditions, annual average residence times for Alternative 7 in the South Delta are expected to increase by more than 35 days (Table 60a). and in the East Delta increase by more than 20 days. Increases in residence times for other sub-regions would be smaller, especially as compared to Existing Conditions and the No Action Alternative (which are longer than those modeled for the South Delta). As mentioned above, these results incorporate hydrodynamic effects of both CM1 and CM2 and CM4, and the effects of CM1 cannot be distinguished from the effects of CM2 and CM4. However, it is expected that CM2 and CM4 are substantial drivers of the increased residence time.

Presser and Luoma (2010b) summarized and discussed selenium uptake in the Bay-Delta (including hydrologic conditions [e.g., Delta outflow and residence time for water], K_ds [the ratio of selenium concentrations in particulates, as the lowest level of the food chain, relative to the water-borne concentration], and associated tissue concentrations [especially in clams and their consumers, such as sturgeon]). When the Delta Outflow Index (daily average flow per month) decreased by five-fold (73,732 cubic feet per second [cfs] in June 1998 to 12, 251 cfs in October 1998), residence time doubled (from 11 to 22 days) and the calculated mean K_d also doubled (from 3,198 to 6,501). However, when daily average Delta outflow in November 1999 was only 6,951 cfs (i.e., about one-half that in October 1998) and residence time was 70 days, the calculated mean K_d (7,614) did not increase proportionally.

Models are not available to quantitatively estimate the level of changes in selenium bioaccumulation as related to residence time, but the effects of residence time are incorporated in the bioaccumulation modeling for selenium that was based on higher K_d values for drought years in comparison to wet, normal, or all years; see Appendix 8M, *Selenium*. If increases in fish tissue or bird egg selenium were to occur, the increases would likely be of concern only where fish tissues or bird eggs are already elevated in selenium to near or above thresholds of concern. That is, where biota concentrations are currently low and not approaching thresholds of concern (which, as discussed above, is the case throughout the Delta, except for sturgeon in the western Delta), changes in residence time alone would not be expected to cause them to then approach or exceed thresholds of concern. In consideration of this factor, although the Delta as a whole is a CWA Section 303(d)-listed water body for selenium, and although monitoring data of fish tissue or bird eggs in the Delta are sparse, the most likely area in which biota tissues would be at levels high enough that additional bioaccumulation due to increased residence time from restoration areas would be a concern is the western Delta and Suisun Bay for sturgeon, as discussed above. As shown in Table 60a, the overall increase in residence time estimated in the western Delta is 3 days relative to Existing Conditions, and 1 day relative to the No Action Alternative. Given the available information, these increases are small enough that they are not expected to substantially affect selenium bioaccumulation in the western Delta. Because CM2 and CM4 are expected to be substantial drivers of the increased residence times, further discussion is included in Impact WQ-26 below.

In summary, ~~R~~relative to Existing Conditions and the No Action Alternative, Alternative 7 would result in small changes (less than ~~5~~4%) in selenium concentrations throughout the Delta for most biota, although larger increases in selenium concentrations are predicted for sturgeon in the western Delta. The Low Toxicity Threshold Exceedance Quotient for selenium concentrations in sturgeon for all years in the San Joaquin River at Antioch would increase from 0.94 for Existing Conditions and the No Action Alternative to 1.2, and from 0.88 to 1.0 at Sacramento River at Mallard Island. The ~~h~~High Toxicity Threshold Exceedance Quotient for selenium concentrations for sturgeon at Antioch would increase from ~~about~~ 0.85 for ~~e~~Existing ~~c~~Conditions and 0.86 for the No Action Alternative to 1.1. Concentrations of selenium in sturgeon would exceed the higher benchmark for Antioch only in drought years, indicating a high potential for effects. The modeling of bioaccumulation for sturgeon is less calibrated to site-specific conditions than that for other biota, which was calibrated on a robust dataset for modeling of bioaccumulation in largemouth bass as a representative species for the Delta. Overall the predicted increase for ~~a~~Alternative 7 is high enough that it may represent a measureable increase in body burdens of sturgeon, which would constitute an adverse impact.

SWP/CVP Export Service Areas

Alternative 7 would result in ~~small to~~ moderate (0.09–0.15 µg/L) ~~changes~~ decreases in average selenium concentrations in water at the Banks and Jones pumping plants, relative to the Existing Conditions and the No Action Alternative, for the entire period modeled (Appendix 8M, *Selenium*, Table M-~~10A~~9a). These decreases in long-term average selenium concentrations in water would result increases in ~~These changes in selenium concentrations in water are reflected in small (10% or less) to moderate (between 11% and 50%) percent changes in~~ available assimilative capacity for selenium ~~for all years~~at these pumping plants of 9–16%, relative to the USEPA draft water quality criterion of 1.3 µg/L. ~~Relative to Existing Conditions and the No Action Alternative, Alternative 7~~

~~would result in modeled increases in available assimilative capacity at Jones PP (14% and 15%, respectively) and at Banks PP (8%) (Figures 8-59 and 8-60) and would have a positive effect at the Export Service Area locations.~~ Furthermore, ~~T~~the ~~ranges of modeled~~ long-term average selenium concentrations in water ~~(Appendix 8M, Table M-10A)~~ for Alternative 7 (range 0.~~3~~12–0.13~~7~~ µg/L)~~,~~ ~~Existing Conditions (range 0.37–0.58 µg/L), and the No Action Alternative (range 0.37–0.59 µg/L) are similar, and all~~ would be well below the ~~ecological risk benchmark~~USEPA draft water quality criterion of ~~(2~~1.3 µg/L~~)~~ (Appendix 8M, Table 9a).

Relative to Existing Conditions and the No Action Alternative, Alternative 7 would result in small changes (less than ~~5~~3%) in estimated selenium concentrations in biota (whole-body fish, bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets) at ~~export service areas~~ Banks and Jones pumping plants (Figures 8-61a through 8-64b; Appendix 8M, *Selenium*, Table M-~~18~~27). ~~Relative to Existing Conditions and the No Action Alternative, the largest increase of selenium concentrations in biota would be at Banks PP for drought years (except for bird eggs [assuming a fish diet] at Banks PP for all years), and the largest decrease would be at Jones PP for drought years. However, c~~Concentrations in biota would not exceed any selenium benchmarks for Alternative 7 (Figures 8-61a through 8-64a).

~~Thus, relative to Existing Conditions and the No Action Alternative, Alternative 7 would result in small to moderate changes in selenium concentrations in water and minimal changes in selenium concentrations in biota at the Export Service Area locations. Selenium concentrations in water and biota generally would decrease under Alternative 7 and would not exceed ecological benchmarks at either location, whereas the lower benchmark for bird eggs (fish diet) would be exceeded under Existing Conditions and the No Action Alternative at Jones PP for drought years. This small positive change in selenium concentrations under Alternative 7 would be expected to slightly decrease the frequency with which applicable benchmarks would be exceeded or slightly improve the quality of water in the Export Services Areas, with regard to selenium.~~

NEPA Effects: Based on the discussion above, the effects on selenium from Alternative 7 are considered to be adverse. This determination is reached because selenium concentrations in whole-body sturgeon modeled at two western Delta locations would increase by an average of~~estimated~~ 21~~0~~%, which may represent a measurable increase in the environment. ~~Because both low and high toxicity benchmarks are already exceeded under the No Action Alternative, t~~These potentially measurable increases represent an adverse impact.

***CEQA Conclusion*:** Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for selenium. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

There are no substantial point sources of selenium in watersheds upstream of the Delta, and no substantial nonpoint sources of selenium in the watersheds of the Sacramento River and the eastern tributaries. Nonpoint sources in the San Joaquin Valley that contribute selenium to the Delta will be controlled through a TMDL developed by the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the Grassland Bypass Project, and Basin Plan objectives (Central Valley Water Board[2010~~c~~d]~~)~~ and State Water Board ~~(~~[2010~~d~~b, 2010~~e~~c]) that are expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta. Consequently, any modified reservoir operations and subsequent changes in river flows under Alternative 7, relative to

Existing Conditions, are expected to cause negligible changes in selenium concentrations in water. Any negligible changes in selenium concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies as related to selenium.

Relative to Existing Conditions, modeling estimates indicate that Alternative 7 would result in essentially no change in selenium concentrations in water or most biota throughout the Delta, with no exceedances of benchmarks for biological effects. Relative to Existing Conditions, modeling estimates indicate that Alternative 7 would increase selenium concentrations in whole-body sturgeon modeled at two western Delta locations by an estimated 21~~0~~%, which may represent a measurable increase in the environment. Because both low and high toxicity benchmarks are ~~already~~ exceeded ~~under Existing Conditions~~, these potentially measurable increases represent a potential impact to ~~aquatic~~ fish and wildlife ~~life~~ beneficial uses.

~~Assessment The a~~Assessment of effects of selenium in the SWP~~ and ~~/CVP Export Service Areas is based on effects on selenium concentrations at the Banks and Jones pumping plants. Relative to Existing Conditions, Alternative 7 would ~~slightly decrease~~cause no ~~change~~ increase in the frequency with which applicable benchmarks would be exceeded, ~~(there would be none) or~~ and would slightly improve the quality of water in selenium concentrations at the Banks and Jones pumping plants ~~locations~~.

Based on the above, although waterborne selenium concentrations would not exceed applicable water quality objectives/criteria, however, significant impacts on some beneficial uses of waters in the Delta could occur because ~~both low and~~ high toxicity benchmarks ~~are already~~ would be exceeded (where they are not under Existing Conditions), and uptake of selenium from water to biota may measurably increase. In comparison to Existing Conditions, water quality conditions under this alternative would increase levels of selenium (a bioaccumulative pollutant) by frequency, magnitude, and geographic extent such that the affected environment may have measurably higher body burdens of selenium in aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish); however, impacts to humans consuming those organisms are not expected to occur. Water quality conditions under this alternative with respect to selenium would cause long-term degradation of water quality in the western Delta. Except in the vicinity of the western Delta for sturgeon, water quality conditions under this alternative would not increase levels of selenium by frequency, magnitude, and geographic extent such that the affected environment would be expected to have measurably higher body burdens of selenium in aquatic organisms. The greater level of selenium bioaccumulation in the western Delta would further degrade water quality by measurable levels, on a long-term basis, for selenium and, thus, cause the CWA Section 303(d)-listed impairment of beneficial use to be made discernibly worse. This impact is considered significant. Environmental Commitment: Selenium Management (AMM27), which affords for site-specific measures to reduce effects, would be available to reduce BDCP-related effects associated with selenium. The effectiveness of AMM27 is uncertain and, therefore implementation may not reduce the identified impact to a level that would be less than significant, and therefore it is significant and unavoidable.

The need for, and the feasibility and effectiveness of, post-operation mitigation for the predicted level of selenium bioaccumulation is uncertain. The first step shall be to determine the reliability of the model in predicting biota selenium concentrations in the affected environment where effects are predicted but selenium data are lacking. For that reason, the model shall be validated with site-specific sampling before extensive mitigation measures relative to CM1 operations are developed and evaluated for feasibility, as the measures and their evaluation for feasibility are likely to be complex. Specifically, it remains to be determined whether the available existing data for transfer of selenium from water to particulates and through different trophic levels of the food chain are representative of conditions that may occur from implementation of Alternative 7. Therefore, the proposed mitigation measure requires that sampling be conducted to characterize each step of data inputs needed for the model, and then the refined model be validated for local conditions. This impact is considered significant and unavoidable.

Impact WQ-26: Effects on Selenium Concentrations Resulting from Implementation ofCM2–~~CM22~~CM21

NEPA Effects: Effects of CM2–CM21 on selenium under Alternative 7 are the same as those discussed for Alternative 1A and are considered not to be adverse.

CEQA Conclusion: CM2–CM21 proposed under Alternative 7 would be similar to those proposed under Alternative 1A. As such, effects on selenium resulting from the implementation of CM2–CM21 would be similar to that previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

~~***NEPA Effects:*** In general, with the possible exception of changes in Delta hydrodynamics resulting from habitat restoration, CM2–CM11 would not substantially increase selenium concentrations in the water bodies of the affected environment. Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, and thus such effects of these restoration measures were included in the assessment of CM1 facilities operations and maintenance (see Impact WQ-25).~~

~~However, iImplementation of these conservation measures may increase water residence time within the restoration areas. Increased restoration area water residence times could potentially increase the bioaccumulation of selenium in biota, thereby potentially increasing fish tissue and bird egg concentrations of selenium, but m. Models are not available to quantitatively estimate the level of changes in residence time and the associated selenium bioavailabilityIf increases in fish tissue or bird egg selenium were to occur, the increases would likely be of concern only where fish tissues or bird eggs are already elevated in selenium to near or above thresholds of concern. That is, where biota concentrations are currently low and not approaching thresholds of concern, changes in residence time alone would not be expected to cause them to then approach or exceed thresholds of concern. In consideration of this factor, although the Delta as a whole is a 303(d)-listed water body for selenium, and although monitoring data of fish tissue or bird eggs in the Delta are sparse, the most likely areas in which biota tissues would be at levels high enough that additional bioaccumulation due to increased residence time from restoration areas would be a concern are the western Delta and Suisun Bay, and the South Delta in areas that receive San Joaquin River water.~~

~~The western Delta and Suisun Bay receive elevated selenium loads from North San Francisco Bay (including San Pablo Bay, Carquinez Strait, and Suisun Bay) and from the San Joaquin River. Point sources of selenium in North San Francisco Bay (i.e., refineries) that contribute selenium to Suisun Bay are expected to be reduced through a TMDL under development by the San Francisco Bay Water Board (San Francisco Bay Water Board 2012) that is expected to result in decreasing discharges of selenium. Nonpoint sources of selenium in the San Joaquin Valley that contribute selenium to the San Joaquin River, and thus the Delta and Suisun Bay, will be controlled through a TMDL developed by the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the~~

~~Grassland Bypass Project, and Basin Plan objectives (Central Valley Water Board 2010c, d) that are expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta. If selenium levels are not sufficiently reduced via these efforts, it is expected that the State Water Board and the San Francisco Bay and Central Valley Water Boards would initiate additional actions to further control sources of selenium.~~

~~The South Delta receives elevated selenium loads from the San Joaquin River. In contrast to Suisun Bay and possibly the western Delta in the future, the South Delta lacks the overbite clam (Corbula [Potamocorbula] amurensis), which is considered a key driver of selenium bioaccumulation in Suisun Bay, due to its high bioaccumulation of selenium and its role in the benthic food web that includes long-lived sturgeon. The South Delta does have Corbicula fluminea, another bivalve that bioaccumulates selenium, but it is not as invasive as the overbite clam and thus likely makes up a smaller fraction of sturgeon diet. Also, as mentioned above, nonpoint sources of selenium in the San Joaquin Valley that contribute selenium to the Delta will be controlled through a TMDL developed by the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the Grassland Bypass Project, and Basin Plan objectives (Central Valley Water Board 2010c, d) that are expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta. Further, if selenium levels in the San Joaquin River are not sufficiently reduced via these efforts, it is expected that the State Water Board and Central Valley Water Board would initiate additional TMDLs to further control nonpoint sources of selenium.~~

~~Wetland restoration areas will not be designed such that water flows in and does not flow out. Exchange of water between the restoration areas and existing Delta channels is an important design factor, since one goal of the restoration areas is to export food produced in these areas to the rest of the Delta (see BDCP Chapter 3, Conservation Strategy, Section 3.3, Biological Goals and Objectives). Thus, these areas can be thought of as "flow-through" systems. Consequently, althoughwater residence times associated with BDCP restoration could increase, they are not expected toincrease without bound. and selenium concentrations in the water column would not continue to build up and be recycled in sediments and organisms as may be the case within a closed system.~~

~~However, because increases in bioavailable selenium in the habitat restoration areas are uncertain, proposed avoidance and minimization measureswould require evaluating risks of selenium exposure at a project level for each restoration area, minimizing to the extent practicable potential risk of additional bioaccumulation, and monitoring selenium levels in fish and/or wildlife to establish whether, or to what extent, additional bioaccumulation is occurring. See Appendix 3B, Environmental Commitments for a description of the environmental commitment BDCP proponents are making with respect to Selenium Management; and Appendix 3.C. of the BDCP for additionaldetail on this avoidance and minimization measure (AMM27). Data generated as part of the avoidance and minimization measures will assist the State and Regional Water Boards in determining whether beneficial uses are being impacted by selenium, and thus will provide the data necessary to support regulatory actions (including additional TMDL development), should such actions be warranted.~~

~~Given the factors discussed in the assessment above, any increases in bioaccumulation rates from water-borne selenium that could occur in some areas as a result of increased water residence time would not be of sufficient magnitude and geographic extent that any portion of the Delta would be expected to have measurably higher body burdens of selenium in aquatic organisms and, therefore, would not substantially increase risk for adverse effects to beneficial uses. Furthermore, although the Delta is a 303(d)-listed water body for selenium, given the discussion in the assessment above, it~~

~~is unlikely that restoration areas would result in measurable increases in selenium in fish tissues or bird eggs such that the beneficial use impairment would be made discernibly worse.~~

~~Because it is unlikely that substantial increases in selenium in fish tissues or bird eggs would occur such that effects on aquatic life beneficial uses would be anticipated, and because of the avoidance and minimization measures that are designed to further minimize and evaluate the risk of such increases, the effects of WQ-26 are considered not adverse.~~

~~***CEQA Conclusion:*** There would be no substantial, long-term increase in selenium concentrations in water in the rivers and reservoirs upstream of the Delta, water in the Delta, or the waters exported to the CVP and SWP service areas due to implementation of CM2–CM22CM21 relative to Existing Conditions. Waterborne selenium concentrations under this alternative would not exceed applicable water quality objectives/criteria.~~

~~Given the factors discussed in the assessment above, any increases in bioaccumulation rates from water-borne selenium that could occur in some areas as a result of increased water residence times would not be of sufficient magnitude and geographic extent that any portion of the Delta wouldbe expected to have measurably higher body burdens of selenium in aquatic organisms, and therefore would not substantially increase risk for adverse effects to beneficial uses. CM2-22 would not cause long-term degradation of water quality resulting in sufficient use of available assimilative capacity such that occasionally exceeding water quality objectives/criteria would be likely. Also, CM2-22 would not result in substantially increased risk for adverse effects to any beneficial uses. Furthermore, although the Delta is a 303(d)-listed water body for selenium, given the discussion in the assessment above, it is unlikely that restoration areas would result in measurable increases in selenium in fish tissues or bird eggs such that the beneficial use impairment would be made discernibly worse.~~

~~Since it is unlikely that substantial increases in selenium in fish tissues or bird eggs would occur such that effects on aquatic life beneficial uses would be anticipated, and because of the avoidance and minimization measures that are designed to further minimize and evaluate the risk of such increases (see Appendix 3.C. of the BDCP for more detail on AMM27) as well as the Selenium Management environmental commitment (see Appendix 3B, Environmental Commitments), this impact is considered less than significant. No mitigation is required.~~

Impact WQ-32. Effects on *Microcystis* Bloom Formation Resulting from Facilities Operations and Maintenance (CM1).

Effects of facilities and operations (CM1) on Microcystis abundance, and thus microcystins concentrations, in water bodies of the affected environment under Alternative 7 would be very similar (i.e., nearly the same) to those discussed for Alternative 1A. This is because factors that affect Microcystis abundance in waters upstream of the Delta, in the Delta, and in the SWP/CVP Export Services Areas under Alternative 1A would similarly change under Alternative 7, relative to Existing Conditions and the No Action Alternative. For the Delta in particular, there are differences in the direction and magnitude of water residence time changes during the Microcystis bloom period among the six Delta sub-regions under Alternative 7 compared to Alternative 1A, relative to Existing Conditions and No Action Alternative. However, under Alternative 7, relative to Existing Conditions and No Action Alternative, water residence times during the Microcystis bloom period in various Delta sub-regions are expected to increase to a degree that could, similar to Alternative 1A, lead to an increase in the frequency, magnitude, and geographic extent of Microcystis blooms throughout the Delta.

Similar to Alternative 1A, elevated ambient water temperatures relative to Existing Conditions would occur in the Delta under Alternative 7, which could lead to earlier occurrences of Microcystis blooms in the Delta, and increase the overall duration and magnitude of blooms. However, the degradation of water quality from Microcystis blooms due to the expected increases in Delta water temperatures is driven entirely by climate change, not effects of CM1. While Microcystis blooms have not occurred in the Export Service Areas, conditions in the Export Service Areas under Alternative 7 may become more conducive to Microcystis bloom formation, relative to Existing Conditions, because water temperatures will increase in the Export Service Areas due to the expected increase in ambient air temperatures resulting from climate change.

Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Under Alternative 7, additional impacts from Microcystis in the reservoirs and watersheds upstream of the Delta are not expected, relative to Existing Conditions. Operations and maintenance occurring under Alternative 7 is not expected to change nutrient levels in upstream reservoirs or hydrodynamic conditions in upstream rivers and streams such that conditions would be more conductive to Microcystis production.

Relative to Existing Conditions, water temperatures and hydraulic residence times in the Delta are expected to increase under Alternative 7, resulting in an increase in the frequency, magnitude and geographic extent of Microcystis blooms in the Delta. However, the degradation of water quality from Microcystis blooms due to the expected increases in Delta water temperatures is driven entirely by climate change, not effects of CM1. Increases in Delta residence times are expected throughout the Delta during the summer and fall bloom period, due in small part to climate change and sea level rise, but due more proportionately to CM1 and the hydrodynamic impacts of restoration included in CM2 and CM4. The precise change in local residence times and Microcystis production expected within any Delta sub-region is unknown because conditions will vary across the complex networks of intertwining channels, shallow back water areas, and submerged islands that compose the Delta. Nonetheless, Delta residence times are, in general, expected to increase due to Alternative 7. Consequently, it is possible that increases in the frequency, magnitude, and geographic extent of Microcystis blooms in the Delta will occur due to the operations and maintenance of Alternative 7 and the hydrodynamic impacts of restoration (CM2 and CM4).

The assessment of effects of Microcystis on SWP/CVP Export Service Areas is based on the assessment of changes in Microcystis levels in export source waters, as well as the effects of temperature and residence time changes within the Export Service Areas on Microcystis production. Under Alternative 7, relative to Existing Conditions, the potential for Microcystis to occur in the Export Service Area is expected to increase due to increasing water temperature, but this impact is driven entirely by climate change and not Alternative 7. Water exported from the Delta to the Export Service Area is expected to be a mixture of Microcystis-affected source water from the south Delta intakes and unaffected source water from the Sacramento River. Because of this, it cannot be determined whether operations and maintenance under Alternative 7, relative to existing conditions, will result in increased or decreased levels of Microcystis and microcystins in the mixture of source waters exported from Banks and Jones pumping plants.

Based on the above, this alternative would not be expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause significant impacts on any beneficial uses of waters in the affected environment. Microcystis and microcystins are not 303(d) listed within the affected environment and thus any increases that could occur in some areas would not make any existing Microcystis impairment measurably worse because no such impairments currently exist. Because Microcystis and microcystins are not bioaccumulative, increases that could occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. However, because it is possible that increases in the frequency, magnitude, and geographic extent of Microcystis blooms in the Delta will occur due to the operations and maintenance of Alternative 7 and the hydrodynamic impacts of restoration (CM2 and CM4), long-term water quality degradation may occur and, thus, significant impacts on beneficial uses could occur. Although there is considerable uncertainty regarding this impact, the effects on Microcystis from implementing CM1 is determined to be significant.

Implementation of Mitigation Measure WQ-32a and WQ-32b may reduce degradation of Delta water quality due to Microcystis. However, because the effectiveness of these mitigation measures to result in feasible measures for reducing water quality effects is uncertain, this impact is considered to remain significant and unavoidable.

Mitigation Measure WQ-32a: Design Restoration Sites to Reduce Potential for Increased Microcystis Blooms

Please see Mitigation Measure WQ-32a under Impact WQ-32 in the discussion of Alternative 1A.

Mitigation Measure WQ-32b: Investigate and Implement Operational Measures to Manage Water Residence Time

Please see Mitigation Measure WQ-32b under Impact WQ-32 in the discussion of Alternative 1A.

Impact WQ-33. Effects on Microcystis Bloom Formation Resulting from Other Conservation Measures (CM2-–CM21).

The effects of CM2–CM21 on *Microcystis* under Alternative 7~~9~~ are the same as those discussed for Alternative 1A. In summary, potential environmental effects related to CM2 and CM4 could result in an increase in the frequency, magnitude, and geographic extent of *Microcystis* blooms in the Delta, relative to Existing Conditions and the No Action Alternative, as a result of increased residence times for Delta waters from implementing CM2 and CM4 restoration areas. -Because the hydrodynamic effects associated with implementing CM2 and CM4 were incorporated into the modeling used to assess CM1, a detailed assessment of the effects of implementing CM2 and CM4 on *Microcystis* blooms in the Delta via their~~e~~ effects on Delta water residence time is provided under CM1 (above). The effects of ~~CM 2~~CM2 and ~~CM 4~~CM4 on *Microcystis* may be reduced by implementation of Mitigation Measures WQ-32A and WQ-32b. The effectiveness of these mitigation measures to result in feasible measures for reducing water quality effects is uncertain. Conservation Measures 3 (CM3) and CM5-CM21 would not result in an increase in the frequency, magnitude, and geographic extent of *Microcystis* blooms in the Delta.

NEPA Effects: Effects of CM2–CM21on Microcystis under Alternative 7 are the same as those discussed for Alternative 1A and are considered to be adverse.

CEQA Conclusion: Based on the above, this alternative would not be expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause significant impacts on any beneficial uses of waters in the affected environment. Microcystis and microcystins are not 303(d) listed within the affected environment and thus any increases that could occur in some areas would not make any existing Microcystis impairment measurably worse because no such impairments currently exist. Because Microcystis and microcystins are not bioaccumulative, increases that could occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. Because restoration actions implemented under CM2 and CM4 will increase residence time throughout the Delta and create local areas of warmer water during the bloom season, it is possible that increases in the frequency, magnitude, and geographic extent of Microcystis blooms, and thus long-term water quality degradation and significant impacts on beneficial uses, could occur. Although there is considerable uncertainty regarding this impact, the effects on Microcystis from implementing CM2–CM21 are determined to be significant.

Impact WQ-34: Effects on San Francisco Bay Water Quality Resulting from Facilities Operations and Maintenance (CM1) and Implementation of CM2–CM21

The effects analysis presented in the preceding impacts (Impact WQ-1 through WQ-33) concluded that Alternative 7 would have a less than significant impact/no adverse effect on the following constituents in the Delta:

- Boron
- Dissolved Oxygen
- Pathogens
- Pesticides
- Trace Metals
- Turbidity and TSS

Elevated concentrations of boron are of concern in drinking and agricultural water supplies. However, waters in the San Francisco Bay are not designated to support municipal water supply (MUN) and agricultural supply (AGR) beneficial uses. Changes in Delta dissolved oxygen, pathogens, pesticides, and turbidity and TSS are not anticipated to be of a frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of the Delta. Thus, changes in boron, dissolved oxygen, pathogens, pesticides, and turbidity and TSS in Delta outflow are not anticipated to be of a frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of the of San Francisco Bay.

The effects of Alternative 7 on bromide, chloride, and DOC, in the Delta were determined to be significant/adverse. Increases in bromide, chloride, and DOC concentrations are of concern in drinking water supplies; however, as described previously, the San Francisco Bay does not have a designated MUN use. Thus, changes in bromide, chloride, and DOC in Delta outflow would not adversely effect any beneficial uses of San Francisco Bay.

Elevated EC, as assessed for this alternative, is of concern for its effects on the agricultural beneficial use (AGR) and fish and wildlife beneficial uses. As discussed above, San Francisco Bay does not have an AGR beneficial use designation. Further, as discussed for the No Action Alternative, changes in Delta salinity would not contribute to measurable changes in Bay salinity, as the change in Delta outflow, which would be the primary driver of salinity changes, would two to three orders of magnitude lower than (and thus minimal compared to) the Bay's tidal flow.

Also, as discussed for the No Action Alternative, adverse changes in Microcystis levels that could occur in the Delta would not cause adverse Microcystis blooms in San Francisco Bay, because Microcystis are intolerant of the Bay's high salinity and, thus not have not been detected downstream of Suisun Bay.

While effects of Alternative 7 on the nutrients ammonia, nitrate, and phosphorus were determined to be less than significant/not adverse, these constituents are addressed further below because the response of the seaward bays to changed nutrient concentrations/loading may differ from the response of the Delta. Selenium and mercury are discussed further, because they are bioaccumulative constituents where changes in load due to both changes in Delta concentrations and exports are of concern.

Nutrients: Ammonia, Nitrate, and Phosphorus

Total nitrogen loads in Delta outflow to Suisun and San Pablo Bays under Alternative 7 would be dominated almost entirely by nitrate, because planned upgrades to the SRWTP will result in >95% removal of ammonia in its effluent. Total nitrogen loads to Suisun and San Pablo Bays would decrease by 13%, relative to Existing Conditions, and increase by 28%, relative to the No Action Alternative (Appendix 8O, Table O-1). The change in nitrogen loading to Suisun and San Pablo Bays under Alternative 7 would not adversely impact primary productivity in these embayments because light limitation and grazing current limit algal production in these embayments. To the extent that algal growth increases in relation to a change in ammonia concentration, this would have net positive benefits, because current algal levels in these embayments are low. Nutrient levels and ratios are not considered a direct driver of Microcystis and cyanobacteria levels in the North Bay.

The phosphorus load exported from the Delta to Suisun and San Pablo Bays for Alternative 7 is estimated to increase by 9%, relative to Existing Conditions, and increase by 4% relative to the No Action Alternative (Appendix 8O, Table O-1)). The only postulated effect of changes in phosphorus loads to Suisun and San Pablo Bays is related to the influence of nutrient stoichiometry on primary productivity. However, there is uncertainty regarding the impact of nutrient ratios on phytoplankton community composition and abundance. Any effect on phytoplankton community composition would likely be small compared to the effects of grazing from introduced clams and zooplankton in the estuary (Senn and Novick 2014; Kimmerer and Thompson 2014). Therefore, the projected change in total nitrogen and phosphorus loading that would occur in Delta outflow to San Francisco Bay is not expected to result in degradation of water quality with regard to nutrients that would result in adverse effects to beneficial uses.

Mercury

The estimated long-term average mercury and methylmercury loads in Delta exports are shown in Appendix 8O, Table O-2. Loads of mercury and methylmercury from the Delta to San Francisco Bay are estimated to change relatively little due to changes in source water fractions and net Delta outflow that would occur under Alternative 7. Mercury load to the Bay, relative to Existing Conditions, is estimated to increase by 10 kg/yr (4%), relative to Existing Conditions, and 7 kg/yr (3%), relative to the No Action Alternative. Methylmercury load is estimated to increase by 0.29 kg/yr (8%), relative to Existing Conditions, and increase by 0.20 kg/yr (5%) relative to the No Action Alternative. The estimated total mercury load to the Bay is 270 kg/yr, which would be less than the San Francisco Bay mercury TMDL WLA for the Delta of 330 kg/yr. The estimated changes in mercury and methylmercury loads would be within the overall uncertainty associated with the estimates of long-term average net Delta outflow and the long-term average mercury and methylmercury concentrations in Delta source waters. The estimated changes in mercury load under the alternative would also be substantially less than the considerable differences among estimates in the current mercury load to San Francisco Bay (SFBRWQCB 2006; David et al. 2009). Similar uncertainty is expected in the existing methylmercury load in net Delta exports, for which the best available current load estimate is based on approximately one year of monitoring data (Foe et al. 2008).

Given that the estimated incremental ~~decreases~~increases of mercury and methylmercury loading to San Francisco Bay would fall within the uncertainty of current mercury and methylmercury load estimates, the estimated changes in mercury and methylmerucy loads in Delta exports to San Francisco Bay due to Alternative 7 are not expected to result in adverse effects to beneficial uses or substantially degrade the water quality with regard to mercury, or make the existing CWA Section 303(d) impairment measurably worse.

Selenium

Changes in source water fraction and net Delta outflow under Alternative 7, relative to Existing Conditions, are projected to cause the total selenium load to the North Bay to increase by 20%, relative to Existing Conditions, and increase by 16%, relative to the No Action Alternative (Appendix 8O, Table O-3). Changes in long-term average selenium concentrations of the North Bay are assumed to be proportional to changes in North Bay selenium loads. Under Alternative 7, the long-term average total selenium concentration of the North Bay is estimated to be 0.15 µg/L and the dissolved selenium concentration is estimated to be 0.13 µg/L, which would be a 0.02 µg/L increase relative to Existing Conditions and the No Action Alternative (Appendix 8O, Table O-3). The dissolved selenium concentration would be below the target of 0.202 µg/L developed by Presser or Luoma (2013) to coincide with a white sturgeon whole-body fish tissue selenium concentration not greater than 8 mg/kg in the North Bay.

The incremental increase in dissolved selenium concentrations in water projected to occur under Alternative 7, relative to Existing Conditions and the No Action Alternative, would be higher than under Alternatives 1–5, but still low (0.02 µg/L). The increased dissolved selenium concentration would be within the overall uncertainty of the analytical methods used to measure selenium in water column samples; however, it also would be within the uncertainty associated with estimating numeric water column selenium thresholds (Pressor and Luoma 2013). As described in Section 8.3.1.8, there have been improvements in selenium concentrations in the tissue of diving ducks and muscle of white sturgeon since the initial CWA Section 303(d) listing of the North Bay for selenium impairments, and selenium concentrations in white sturgeon muscle have also generally been below the USEPA's draft recommended fish muscle tissue concentration of 11.8 mg/kg dry weight (SFEI 2014). However, as described under Impact WQ-25, though there is some uncertainty in the estimate of sturgeon concentrations at western Delta locations, the predicted increases for Alternative 7 are high enough that they may represent measurably higher body burdens of selenium in aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish). Because the projected incremental increases in dissolved selenium could cause measurable changes in water column concentrations, and these incremental increases would be within the uncertainty in the target water column threshold for dissolved selenium for protection against adverse bioaccumulative effects in the North Bay ecosystem, and modeling predicts concentrations in the western Delta may represent a measurable increase in body burdens of sturgeon, there is potential that the incremental increase in dissolved selenium concentration projected to occur in the North Bay under Alternative 7 could result in adverse effects beneficial uses.

NEPA Effects: Based on the discussion above, Alternative 7, relative to the No Action Alternative, would not cause further degradation to water quality with respect to boron, bromide, chloride, dissolved oxygen, DOC, EC, mercury, pathogens, pesticides, nutrients (ammonia, nitrate, phosphorus), trace metals, or turbidity and TSS in the San Francisco Bay. Further, changes in these constituent concentrations in Delta outflow would not be expected to cause changes in Bay concentrations of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses. In summary, based on the discussion above, effects on the San Francisco Bay from implementation of CM1–CM21 are considered to be not adverse with respect to boron, bromide, chloride, dissolved oxygen, DOC, EC, mercury, pathogens, pesticides, nutrients (ammonia, nitrate, phosphorus), trace metals, or turbidity and TSS. However, Alternative 7 could result in increases in selenium concentrations in the North San Francisco Bay that could result in adverse effects to fish and wildlife beneficial uses. This effect is considered to be adverse.

CEQA Conclusion: Based on the above, Alternative 7 would not be expected to cause long-term degradation of water quality in San Francisco Bay resulting in sufficient use of available assimilative capacity such that occasionally exceeding water quality objectives/criteria would be likely and would result in substantially increased risk for adverse effects to one or more beneficial uses with respect to boron, bromide, chloride, dissolved oxygen, DOC, EC, mercury, pathogens, pesticides, nutrients (ammonia, nitrate, phosphorus), trace metals, or turbidity and TSS. Further, based on the above, this alternative would not be expected to cause additional exceedance of applicable water quality objectives/criteria in the San Francisco Bay by frequency, magnitude, and geographic extent that would cause significant impacts on any beneficial uses of waters in the affected environment with respect to boron, bromide, chloride, dissolved oxygen, DOC, EC, mercury, pathogens, pesticides, nutrients (ammonia, nitrate, phosphorus), trace metals, or turbidity and TSS. Any changes in boron, bromide, chloride, and DOC in the San Francisco Bay would not adversely affect beneficial uses, because the uses most affected by changes in these parameters, MUN and AGR, are not beneficial uses of the Bay. Further, no substantial changes in dissolved oxygen, pathogens, pesticides, trace metals or turbidity or TSS are anticipated in the Delta, relative to Existing Conditions, therefore, no substantial changes these constituents levels in the Bay are anticipated. Changes in Delta salinity would not contribute to measurable changes in Bay salinity, as the change in Delta outflow would two to three orders of magnitude lower than (and thus minimal compared to) the Bay's tidal flow. Adverse changes in Microcystis levels that could occur in the Delta would not cause adverse Microcystis blooms in the Bay, because Microcystis are intolerant of the Bay's high salinity and, thus not have not been detected downstream of Suisun Bay. The 13% decrease in total nitrogen load and 9% increase in phosphorus load, relative to Existing Conditions, are expected to have minimal effect on water quality degradation, primary productivity, or phytoplankton community composition. The estimated increase in mercury load (10 kg/yr; 4%) and methylmercury load (0.29 kg/yr; 8%), relative to Existing Conditions, is within the level of uncertainty in the mass load estimate and not expected to contribute to water quality degradation, make the CWA section 303(d) mercury impairment measurably worse or cause mercury/methylmercury to bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans.

hough there is some uncertainty in the estimate of sturgeon concentrations at western Delta locations, the predicted increases are high enough that they may represent measurably higher body burdens of selenium in aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish). Environmental Commitment: Selenium Management (AMM27), which affords for site-specific measures to reduce effects, would be available to reduce BDCP-related effects associated with selenium. The effectiveness of AMM27 is uncertain and, therefore implementation may not reduce the identified impact to a level that would be less than significant, and therefore it is significant and unavoidable.

8.3.3.15 Alternative 8—Dual Conveyance with Pipeline/Tunnel, Intakes 2, 3, and 5 and Increased Delta Outflow (9,000 cfs; Operational Scenario F)

Impact WQ-5: Effects on Bromide Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of ~~CM2-22~~CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for ~~CM2-22~~CM2–CM21. See section 8.3.1.3 for more information.

Using the mass-balance modeling approach for bromide (see Section 8.3.1.3), relative to Existing Conditions, Alternative 8 would result in increases in long-term average bromide concentrations at Staten Island and Barker Slough, while long-term average concentrations would decrease at the other assessment locations (Appendix 8E, Bromide, Table 18). At Barker Slough, predicted long-term average bromide concentrations would increase from 51 µg/L to 54 µg/L (4% relative increase) for the modeled 16-year hydrologic period, and would increase from 54 µg/L to 80 µg/L (50% relative increase) for the modeled drought period. At Barker Slough, the predicted 50 µg/L exceedance frequency would decrease from 49% under Existing Conditions to 34% under Alternative 8, but would increase slightly from 55% to 62% during the drought period. At Barker Slough, the predicted 100 µg/L exceedance frequency would increase from 0% under Existing Conditions to 10% under Alternative 8, and would increase from 0% to 27% during the drought period. At Staten Island, predicted long-term average bromide concentrations would increase from 50 µg/L to 64 µg/L (29% relative increase) for the modeled 16-year hydrologic period and would increase from 51 µg/L to 65 µg/L (26% relative increase) for the modeled drought period. At Staten Island, increases in average bromide concentrations would correspond to an increased frequency of 50 µg/l threshold exceedance, from 47% under Existing Conditions to 80% under Alternative 8 (52% to 87% for the modeled drought period), and an increase from 1% to 2% (0% to 0% for the modeled drought period) for the 100 µg/L threshold. Changes in exceedance frequency of the 50 µg/L and 100 µg/L concentration thresholds at other assessment locations would be less considerable, with exception to Franks Tract. Although long-term average bromide concentrations were modeled to decrease at Franks Tract, exceedances of the 100 µg/L threshold would increase slightly, from 82% under Existing Conditions to 98% under Alternative 8 (78% to 93% for the modeled drought period). This comparison to Existing Conditions reflects changes in bromide due to both Alternative 8 operations (including north Delta intake capacity of 9,000 cfs and numerous other operational components of Scenario F) and climate change/sea level rise.

Due to the relatively small differences between modeled Existing Conditions and the No Action baseline, changes in long-term average bromide concentrations and changes in exceedance frequencies relative tithe No Action Alternative are generally of similar magnitude to those previously described for the existing condition comparison(Appendix 8E, Bromide, Table 18). Modeled long-term average bromide concentration at Barker Slough is predicted to increase by 8% (50% for the modeled drought period) relative to the No Action Alternative. Modeled long-term average bromide concentration increases at Staten Island are predicted to increase by 33% (30% for the modeled drought period) relative to the No Action Alternative. However, unlike the Existing Conditions comparison, long-term average bromide concentrations at Buckley Cove would increase relative to the No Action Alternative, although the increases would be relatively small (≤2%). Unlike the comparison to Existing Conditions, this comparison to the No Action Alternative reflects changes in bromide due only to Alternative 8operations.

At Barker Slough, modeled long-term average bromide concentrations for the two baseline conditions are very similar (Appendix 8E, Bromide, Table 18). Such similarity demonstrates that the modeled Alternative 8 change in bromide is almost entirely due to Alternative 8 operations, and not climate change/sea level rise. Therefore, operations are the primary driver of effects on bromide at Barker Slough, regardless whether Alternative 8 is compared to Existing Conditions, or compared to the No Action Alternative.

Results of the modeling approach which used relationships between EC and chloride and between chloride and bromide (see Section 8.3.1.3) differed somewhat from what is presented above for the mass-balance approach (see Appendix 8E, Bromide, Table 19).For most locations, the frequency of exceedance of the 50 μg/L and 100 μg/L were similar. The greatest difference between the methods was predicted for Barker Slough. The increases in frequency of exceedance of the 100 μg/L threshold, relative to Existing Conditions and the No Action Alternative, were not as great using this alternative EC to chloride and chloride to bromide relationship modeling approach as compared to that presented above from the mass-balance modeling approach. Results indicate 4% exceedance over the modeled period under Alternative 8, as compared to 1% under Existing Conditions and 2% under the No Action Alternative. For the drought period, exceedance frequency increased from 0% under Existing Conditions and the No Action Alternative, to 12% under Alternative 8.Because the mass-balance approach predicts a greater level of impact at Barker Slough, determination of impacts was based on the mass-balance results.

While the increase in long-term average bromide concentrations at Barker Slough are relatively small when modeled over a representative 16-year hydrologic period, increases during the modeled drought period, principally the relative increase in 100 μg/L exceedance frequency, would represent a substantial change in source water quality during a season of drought. As discussed for Alternative 1A, drinking water treatment plants obtaining water via the North Bay Aqueduct utilize a variety of conventional and enhanced treatment technologies in order to achieve DBP drinking water criteria. While the implications of such a modeled drought period change in bromide concentrations at Barker Slough is difficult to predict, the substantial modeled increases could lead to adverse changes in the formation of disinfection byproducts such that considerable treatment plant upgrades may be necessary in order to achieve equivalent levels of health protection during seasons of drought. Increases at Staten Island are also considerable, although there are no existing or foreseeable municipal intakes in the immediate vicinity. Because many of the other modeled locations already frequently exceed the 100 μg/L threshold under Existing Conditions and the No Action Alternative, these locations likely already require treatment plant technologies to achieve equivalent levels of health protection, and thus no additional treatment technologies would be triggered by the small increases in the frequency of exceeding the 100 µg/L threshold. Hence, no further impact on the drinking water beneficial use would be expected at these locations.

The seasonal intakes at Mallard Slough and City of Antioch are infrequently used due to water quality constraints related to sea water intrusion. On a long-term average basis, bromide at these locations is in excess of 3,000 µg/L, but during seasonal periods of high Delta outflow can be <300 µg/L. Based on modeling using the mass-balance approach, use of the seasonal intakes at Mallard Slough and City of Antioch under Alternative 8 would experience a period average increase in bromide during the months when these intakes would most likely be utilized. For those wet and above normal water year types where mass balance modeling would predict water quality typically suitable for diversion, predicted long-term average bromide would increase from 103 µg/L to 146 µg/L (42% increase) at City of Antioch and would increase from 150 µg/L to 193 µg/L (29% increase) at Mallard Slough relative to Existing Conditions (Appendix 8E, Bromide, Table 23). Increases would be similar for the No Action Alternative comparison. Modeling results using the EC to chloride and chloride to bromide relationships show increases during these months, but the relative magnitude of the increases is much lower (Appendix 8E, Bromide, Table 24).Regardless of the differences in the data between the two modeling approaches, the decisions surrounding the use of these seasonal intakes is largely driven by acceptable water quality, and thus have historically been opportunistic. Opportunity to use these intakes would remain, and the predicted increases in bromide concentrations at the City of Antioch and Mallard Slough intake would not be expected to adversely affect MUN beneficial uses, or any other beneficial use, at these locations.

Based on modeling using the mass-balance approach, relative to existing and No Action Alternative conditions, Alternative 8would lead to predicted improvements in long-term average bromide concentrations at Franks Tract, Rock Slough, and Contra Costa PP No. 1, in addition to Banks and Jones (discussed below). At these locations, long-term average bromide concentrations would be predicted to decrease by as much as 11–37%, depending on baseline comparison. Modeling results using the EC to chloride and chloride to bromide relationships generally do not show similar decreases for Rock Slough and Contra Costa PP No. 1, but rather, predict small increases. Based on the small magnitude of increases predicted, these increases would not adversely affect beneficial uses at those locations.

Important to the results presented above is the assumed habitat restoration footprint on both the temporal and spatial scales incorporated into the modeling. Modeling sensitivity analyses have indicated that habitat restoration (which are reflected in the modeling—see Section 8.3.1.3), not operations covered under CM1, are the driving factor in the modeled bromide increases. The timing, location, and specific design of habitat restoration will have effects on Delta hydrodynamics, and any deviations from modeled habitat restoration and implementation schedule will lead to different outcomes. Although habitat restoration near Barker Slough is an important factor contributing to modeled bromide concentrations at the North Bay Aqueduct, BDCP habitat restoration elsewhere in the Delta can also have large effects. Because of these uncertainties, and the possibility of adaptive management changes to BDCP restoration activities, including location, magnitude, and timing of restoration, the estimates are not predictive of the bromide levels that would actually occur in Barker Slough or elsewhere in the Delta.

Impact WQ-7: Effects on Chloride Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of ~~CM2-22~~CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for ~~CM2-22~~CM2–CM21. See section 8.3.1.3 for more information.

Relative to the Existing Conditions and No Action Alternative, Alternative 8 would result in similar or reduced long-term average chloride concentrations for the 16-year period modeled at most of the assessment locations, and, depending on the modeling approach (see Section 8.3.1.3), increased concentrations at the North Bay Aqueduct at Barker Slough (i.e., up to 6% compared to No Action Alternative), Contra Costa Canal at Pumping Plant #1 (i.e., up to 24% compared to No Action Alternative), Rock Slough (i.e., up to 18% compared to No Action Alternative), and the ~~San Joaquin River at Staten Island~~SF Mokelumne at Staten Island (i.e., up to 29% compared to No Action Alternative) (Appendix 8G, Chloride, Table Cl-49 and Table Cl-50). Moreover, the direction and magnitude of predicted changes for Alternative 8 are similar between the alternatives, thus, the effects relative to Existing Conditions and the No Action Alternative are discussed together. Additionally, implementation of tidal habitat restoration under CM4 would increase the tidal exchange volume in the Delta, and thus may contribute to increased chloride concentrations in the Bay source water as a result of increased salinity intrusion. More discussion of this phenomenon is included in Section 8.3.1.3. Consequently, while uncertain, the magnitude of chloride increases may be greater than indicated herein and would affect the western Delta assessment locations the most which are influenced to the greatest extent by the Bay source water. The comparison to Existing Conditions reflects changes in chloride due to both Alternative 8 operations (including north Delta intake capacity of 9,000 cfs and numerous other operational components of Scenario E) and climate change/sea level rise. The comparison to the No Action Alternative reflects changes in chloride due only to operations. The following outlines the modeled chloride changes relative to the applicable objectives and beneficial uses of Delta waters.

Municipal Beneficial Uses

Estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3) were used to evaluate the 150 mg/L Bay-Delta WQCP objective for municipal and industrial beneficial uses on a basis of the percent of years the chloride objective is exceeded for the modeled 16-year period. The objective is exceeded if chloride concentrations exceed 150 mg/L for a specified number of days in a given water year at both the Antioch and Contra Costa Pumping Plant #1 locations. For Alternative 8, the modeled frequency of objective exceedance would increase from ~~6~~7% of years under Existing Conditions and ~~6~~0% under the No Action Alternative to ~~19~~13% of years under Alternative 8 (Appendix 8G, Chloride, Table Cl-64).

Similarly, estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3) were also used to evaluate the 250 mg/L Bay-Delta WQCP objective for chloride at Contra Costa Pumping Plant #1 where daily average objectives apply. The basis for the evaluation was the predicted number of days the objective was exceeded for the modeled 16-

year period. For Alternative 8, the modeled frequency of objective exceedance would decrease, from 6% of modeled days under Existing Conditions and 5% under the No Action Alternative to 1% of modeled days under Alternative 8 (Appendix 8G, Chloride, Table Cl-63).

Given the limitations inherent to estimating future chloride concentrations (see Section 8.3.1.3), estimation of chloride concentrations through both amass balance approach and an EC-chloride relationship approach was used to evaluate the 250 mg/L Bay-Delta WQCP objectives in terms of both frequency of exceedance and use of assimilative capacity. When utilizing the mass balance approach to model monthly average chloride concentrations for the 16-year period, the predicted frequency of exceeding the 250 mg/L objective would decrease up to 15% (i.e., 24% for Existing Conditions to 9%) at the Contra Costa Canal at Pumping Plant #1 (Appendix 8G, Chloride, Table Cl-51 and Figure Cl-13). The frequency of exceedances would decrease at the San Joaquin River at Antioch (i.e., from 66% under Existing Conditions to 58%) with no substantial change predicted for Mallard Island (i.e., maximum increase of 1%) (Appendix 8G, Table Cl-51) and no substantial long-term degradation (Appendix 8G, Table Cl-53). However, relative to the No Action conditions, available assimilative capacity for chloride at the Contra Costa Canal at Pumping Plant #1 would be substantially reduced in September and October (i.e., up to 100%, or eliminated, for the drought period modeled) (Appendix 8G, Table Cl-53), reflecting substantial degradation when concentrations would be near, or exceed, the objective.

In comparison, when utilizing the chloride-EC relationship to model monthly average chloride concentrations for the 16-year period, trends in frequency of exceedance generally agreed, but use of assimilative capacity were predicted to be larger at some locations (Appendix 8G, Table Cl-52 and Table Cl-54). Specifically, while the model predicted exceedance frequency would decrease at the Contra Costa Canal at Pumping Plant #1 and Rock Slough locations, use of assimilative capacity would increase substantially for the months of February through June as well as September (i.e., maximum of 82% in March for the modeled drought period). Due to such seasonal long-term average water quality degradation at these locations, the potential exists for substantial adverse effects on the municipal and industrial beneficial uses through reduced opportunity for diversion of water with acceptable chloride levels. Moreover, due to the increased frequency of exceeding the 150 mg/L Bay-Delta WQCP objective, the potential exists for adverse effects on the municipal and industrial beneficial uses at Contra Costa Pumping Plant #1 and Antioch.

303(d) Listed Water Bodies

With respect to the 303(d) listing for chloride in Tom Paine Slough, the monthly average chloride concentrations for the 16-year period modeled at Old River at Tracy Road would generally be similar compared to Existing Conditions, and thus, would not be further degraded on a long-term basis (Appendix 8G, Figure Cl-14). With respect to Suisun Marsh, the monthly average chloride concentrations for the 16-year period modeled would generally be similar, or decrease, compared to Existing Conditions in some months during October through May at the Sacramento River at Collinsville (Appendix 8G, Figure Cl-15), Mallard Island (Appendix 8G, Figure Cl-13).However, chloride concentrations would increase substantially at Montezuma Slough at Beldon's Landing (i.e., over a doubling of concentration in December through February) (Appendix 8G, Figure Cl-16). ; However, modeling of Alternative 8 assumed no operation of the Montezuma Slough Salinity Control Gates, but the project description assumes continued operation of the Salinity Control Gates, consistent with assumptions included in the No Action Alternative. A sensitivity analysis modeling run conducted for Alternative 4 with the gates operational consistent with the No Action Alternative resulted in substantially lower EC levels than indicated in the original Alternative 4 modeling results for Suisun Marsh, but EC levels were still somewhat higher than EC levels under Existing Conditions for several locations and months. Although chloride was not specifically modeled in these sensitivity analyses, it is expected that chloride concentrations would be nearly proportional to EC levels in Suisun Marsh. Another modeling run with the gates operational and restoration areas removed resulted in EC levels nearly equivalent to Existing Conditions, indicating that design and siting of restoration areas has notable bearing on EC levels at different locations within Suisun Marsh (see Appendix 8H Attachment 1 for more information on these sensitivity analyses). These analyses also indicate that increases in salinity are related primarily to the hydrodynamic effects of CM4, not operational components of CM1. Based on the sensitivity analyses, optimizing the design and siting of restoration areas may limit the magnitude of long-term chloride increases in the Marsh. However, the chloride concentration increases at certain locations could be substantial, depending on siting and design of restoration areas. Thus, these increased chloride levels in Suisun Marsh are considered to contribute to additional, measureable long-term degradation that potentially would adversely affect the necessary actions to reduce chloride loading for any TMDL that is developed.

~~thereby contributing to additional, measureable long-term degradation that potentially would adversely affect the necessary actions to reduce chloride loading for any TMDL that is developed.~~

Impact WQ-9: Effects on Dissolved Oxygen Resulting from Facilities Operations and Maintenance (CM1)

NEPA Effects: Effects of CM1 on dissolved oxygen under Alternative 8 are the same as those discussed for Alternative 1A and are considered not to be adverse.

CEQA Conclusion: Effects of CM1 on DO under Alternative 8would be similar to those discussed for Alternative 1A, and are summarized here, then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion under Alternative 1A.

~~River flow rate and r~~Reservoir storage reductions that would occur under Alternative 8, relative to Existing Conditions, would not be expected to result in a substantial adverse change in DO levels in the reservoirs, because oxygen sources (surface water aeration, aerated inflows, vertical mixing) would remain. Similarly, river flow rate reductions that would occur would not be expected to result in a substantial adverse change in DO levels in the ~~and~~ rivers upstream of the Delta, given that mean monthly flows would remain within the ranges historically seen under Existing Conditions and the affected river are large and turbulent. Any reduced DO saturation level that may be caused by increased water temperature would not be expected to cause DO levels to be outside of the range seen historically. Finally, amounts of oxygen demanding substances and salinity would not be expected to change sufficiently to affect DO levels.

It is expected there would be no substantial change in Delta DO levels in response to a shift in the Delta source water percentages under this alternative or substantial degradation of these water bodies, with regard to DO. DO levels would be affected by nutrient loading, which the state has begun to aggressively regulate the discharges of, and this loading would not be expected to lower DO levels relative to Existing Conditions based on historical DO levels. Further, the anticipated changes in salinity would have relatively minor effects on DO levels, and tidal exchange, which contribute to the reaeration of Delta waters would not be expected to change substantially.

There is not expected to be substantial, if even measurable, changes in DO levels in the SWP/CVP Export Service Areas waters under Alternative 8, relative to Existing Conditions, because the biochemical oxygen demand of the exported water would not be expected to substantially differ from that under Existing Conditions (due to ever increasing water quality regulations), canal turbulence and exposure of the water to the atmosphere and the algal communities that exist within the canals would establish an equilibrium for DO levels within the canals. The same would occur in downstream reservoirs.

Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would result in significant impacts on any beneficial uses within affected water bodies. Because no substantial changes in DO levels are expected, long-term water quality degradation would not be expected to occur, and, thus, beneficial uses would not be adversely affected. Various Delta waterways are 303(d)-listed for low DO, but because no substantial decreases in DO levels would be expected, greater degradation and DO-related impairment of these areas would not be expected. This impact would be less than significant. No mitigation is required.

Impact WQ-11: Effects on Electrical Conductivity Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of ~~CM2-22~~CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for ~~CM2-22~~CM2–CM21. See section 8.3.1.3 for more information.

Relative to Existing Conditions, Alternative 8 would result in an increase in the number of days the Bay-Delta WQCP EC objectives would be exceeded in the Sacramento River at Emmaton, and the San Joaquin River at Vernalis, Prisoners Point, and Brandt Bridge, and in the Old River near Middle River (Appendix 8H,*Electrical Conductivity*, Table EC-8).

The percent of days the Emmaton EC objective would be exceeded for the entire period modeled (1976–1991) would increase from 6% under Existing Conditions to ~~16~~22% under Alternative 8, and the percent of days out of compliance would increase from 11% under Existing Conditions to ~~28~~34% under Alternative 7.

The increase in the percent of days the Vernalis EC objective would be exceeded would be <1%, and the percent of days out of compliance with the EC objective would increase from 7% under Existing Conditions to 8% under Alternative 8. These increases are minimal, and are not considered substantial, in light of the overall modeling uncertainty.

The percent of days the Prisoners Point EC objective would be exceeded for the entire period modeled would increase from 6% under Existing Conditions to 3~~2~~8% under Alternative 8, and the percent of days out of compliance with the EC objective would increase from 10% under Existing Conditions to 3~~2~~8% under Alternative 8. Sensitivity analyses conducted for Alternative 4 scenario H3 indicated that removing all tidal restoration areas would reduce the number of exceedances, but there would still be substantially more exceedances than under Existing Conditions or the No Action Alternative. Results of the sensitivity analyses indicate that the exceedances are partially a function of the operations of the alternative itself, perhaps due to Head of Old River Barrier assumptions and south Delta export differences (see Appendix 8H Attachment 1 for more discussion of these sensitivity analyses). Due to similarities in the nature of the exceedances between alternatives, the findings from these analyses can be extended to this alternative as well. Appendix 8H Attachment 2 contains a more detailed assessment of the likelihood of these exceedances impacting aquatic life beneficial uses. Specifically, Appendix 8H Attachment 2 discusses whether these exceedances might have indirect effects on striped bass spawning in the Delta, and concludes that the high level of uncertainty precludes making a definitive determination.

In the San Joaquin River at Brandt Bridge, the percent of days exceeding the EC objective would increase from 3% under Existing Conditions to 4% under Alternative 8; the percent of days out of compliance would increase from 8% under Existing Conditions to 9% under Alternative 8. The increase in the percent of days the Old River EC objective would be exceeded and out of compliance for the entire period modeled (1976–1991) would be <1%. These increases are minimal, and are not considered substantial, in light of the overall modeling uncertainty.

Average EC levels at the western and southern Delta compliance locations and San Joaquin River at San Andreas Landing (an interior Delta location) would decrease from 0–44% for the entire period modeled and 2–43% during the drought period modeled (1987–1991) (Appendix 8H, Table EC-19). In the S. Fork Mokelumne River at Terminous, average EC would increase 5% for the entire period modeled and drought period modeled. Average EC in the S. Fork Mokelumne River at Terminous would increase during all months (Appendix 8H, Table EC-19). Given that the western ~~and southern~~ Delta ~~are~~ is Clean Water Act section 303(d) listed as impaired due to elevated EC, the increase in the incidence of exceedance of EC objectives under Alternative 8, relative to Existing Conditions has the potential to contribute to additional impairment and potentially adversely affect beneficial uses. The comparison to Existing Conditions reflects changes in EC due to both Alternative 8 operations (including north Delta intake capacity of 9,000 cfs and numerous other operational components of Scenario F) and climate change/sea level rise.

Relative to the No Action Alternative, the change in percent compliance with Bay-Delta WQCP EC objectives under Alternative 8 would be similar to that described above relative to Existing Conditions. The exception is that there would also be a slight increase (<1%) in the percent of days the EC objective would be exceeded in the Old River at Tracy for the entire period modeled. Also, Old River at Tracy also would have an increase in the number of days out of compliance with the EC objectives. The percent of days out of compliance with Tracy Bridge EC objectives would increase from 8% to 9% for the entire period modeled. For the entire period modeled, average EC levels would increase at all Delta compliance locations relative to the No Action Alternative, except in ~~Three Mile Slough near the Sacramento River, and~~ the San Joaquin River at San Andreas Landing and Jersey Point. The greatest average EC increase would occur in the San Joaquin River at Prisoners Point (7%); the increase at the other locations would be <1–6% (Appendix 8H, *Chloride,* Table EC-19). Similarly, during the drought period modeled, average EC would increase at all locations, except ~~Three Mile Slough and~~the San Joaquin River at San Andreas Landing and Jersey Point. The greatest average EC increase during the drought period modeled would occur in the S. Fork Mokelumne River at Terminous (6%); the increases at the other locations would be 1–4% (Appendix 8H, Table EC-19). Given that the western and southern Delta are Clean Water Act section 303(d) listed as impaired due to elevated EC, the increase in the incidence of exceedance of EC objectives under Alternative 7, relative to the No Action Alternative, has the potential to contribute to additional impairment and potentially adversely affect beneficial uses. The comparison to the No Action Alternative reflects changes in EC due only to Alternative 8 operations (including north Delta intake capacity of 9,000 cfs and numerous other operational components of Scenario F).

For Suisun Marsh, October–May is the period when Bay-Delta WQCP EC objectives for protection of fish and wildlife apply. Long-term average EC would decrease under Alternative 8, relative to Existing Conditions, during October–May in the Sacramento River at Collinsville and Montezuma Slough at National Steel (Appendix 8H, *Electrical Conductivity*, Table EC-21 and EC-22). The most substantial increase would occur near Beldon Landing, with long-term average EC levels increasing by 0.1–3.5 mS/cm, depending on the month (Appendix 8H, Table EC-23). Sunrise Duck Club would have long-term average EC increases of 0.2–0.8 mS/cm (Appendix 8H, Table EC-24) and Volanti Slough would have long-term average EC increases of 0.1–1.1 mS/cm. The degree to which the long-term average EC increases would cause exceedance of Bay-Delta WQCP objectives is unknown, because objectives are expressed as a monthly average of daily high tide EC, which does not have to be met if it can be demonstrated "equivalent or better protection will be provided at the location" (State Water Resources Control Board 2006:14). Modeling of this alternative assumed no operation of the Montezuma Slough Salinity Control Gates, but the project description assumes continued operation of the Salinity Control Gates, consistent with assumptions included in the No Action Alternative. A sensitivity analysis modeling run conducted for Alternative 4 scenario H3 with the gates operational consistent with the No Action Alternative resulted in substantially lower EC levels than indicated in the original Alternative 4 modeling results, but EC levels were still somewhat higher than EC levels under Existing Conditions and the No Action Alternative for several locations and months. Another modeling run with the gates operational and restoration areas removed resulted in EC levels nearly equivalent to Existing Conditions and the No Action Alternative, indicating that design and siting of restoration areas has notable bearing on EC levels at different locations within Suisun Marsh (see Appendix 8H Attachment 1 for more information on these sensitivity analyses). These analyses also indicate that increases are related primarily to the hydrodynamic effects of CM4, not operational components of CM1. Based on the sensitivity analyses, optimizing the design and siting of restoration areas may limit the magnitude of long-term EC increases to be on the order of 1 mS/cm or less. Due to similarities in the nature of the EC increases between alternatives, the findings from these analyses can be extended to this alternative as well.

The ~~described~~ long-term average EC increase in Suisun Marsh may, or may not, contribute to adverse effects on beneficial uses, depending on how and when wetlands are flooded, soil leaching cycles, and how agricultural use of water is managed, and future actions taken with respect to the marsh. However, the EC increases at certain locations ~~would~~ could be substantial and it is uncertain the degree to which current management plans for the Suisun Marsh would be able to address these substantially higher EC levels and protect beneficial uses. Thus, these increased EC levels in Suisun Marsh are considered to have a potentially adverse effect on marsh beneficial uses. Long-term average EC increases in Suisun Marsh under Alternative 8 relative to the No Action Alternative would be similar to the increases relative to Existing Conditions. Suisun Marsh is section 303(d) listed as impaired due to elevated EC, and the potential increases in long-term average EC concentrations could contribute to additional impairment relative to Existing Conditions and the No Action Alternative.

NEPA Effects: In summary, the increased frequency of exceedance of EC objectives ~~and increased long-term and drought period average EC levels that would occur at southern Delta compliance locations, and increased frequency of exceedance of EC objectives~~ in the western Delta under Alternative 8, relative to the No Action Alternative, would contribute to adverse effects on the agricultural beneficial uses. In addition. the increased frequency of exceedance of the San Joaquin River at Prisoners Point EC objective and long-term and drought period average EC could contribute to adverse effects on fish and wildlife beneficial uses (specifically, indirect adverse effects on striped bass spawning), though there is a high degree of uncertainty associated with this impact. Given that the western ~~and southern~~ Delta ~~are~~ is Clean Water Act section 303(d) listed as impaired due to elevated EC, the increase in the incidence of exceedance of EC objectives ~~and long-term average and drought period average EC~~ in ~~these~~ this portion~~s~~ of the Delta has the potential to contribute to additional beneficial use impairment. The increases in long-term average EC levels that ~~would~~ could occur in Suisun Marsh would further degrade existing EC levels and could contribute additional to adverse effects on the fish and wildlife beneficial uses. Suisun Marsh is section 303(d) listed as impaired due to elevated EC, and the potential increases in long-term average EC levels could contribute to additional beneficial use impairment. These increases in EC constitute an adverse effect on water quality. Mitigation Measure WQ-11 would be available to reduce these effects (implementation of this measure along with a separate, non-environmental commitment as set forth in EIR/EIS Appendix 3B, *Environmental Commitments*, relating to the potential EC-related changes would reduce these effects).

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

River flow rate and reservoir storage reductions that would occur under Alternative 8, relative to Existing Conditions, would not be expected to result in a substantial adverse change in EC levels in the reservoirs and rivers upstream of the Delta, given that: changes in the quality of watershed runoff and reservoir inflows would not be expected to occur in the future; the state's aggressive regulation of point-source discharge effects on Delta salinity-elevating parameters and the expected further regulation as salt management plans are developed; the salt-related TMDLs adopted and being developed for the San Joaquin River; and the expected improvement in lower San Joaquin River average EC levels commensurate with the lower EC of the irrigation water deliveries from the Delta.

Relative to Existing Conditions, Alternative 8 would not result in any substantial increases in long-term average EC levels in the SWP/CVP Export Service Areas. There would be no exceedance of the EC objective at the Jones and Banks pumping plants. Average EC levels for the entire period modeled would decrease at both plants and, thus, this alternative would not contribute to additional beneficial use impairment related to elevated EC in the SWP/CVP Export Service Areas waters. Rather, this alternative would improve long-term EC levels in the SWP/CVP Export Service Areas, relative to Existing Conditions.

In the Plan Area, Alternative 8 would result in an increase in the frequency with which Bay-Delta WQCP EC objectives are exceeded in the Sacramento River at Emmaton (agricultural objective; 1~~0~~6% increase) ~~, San Joaquin River at Vernalis (agricultural objective; <1% increase) and Brandt Bridge (agricultural objective; 1% increase), and in the Old River near Middle River (agricultural objective: <1% increase), all in the southern Delta,~~ and Prisoners Point (fish and wildlife objective; 32~~6~~% increase) in the interior Delta for the entire period modeled (1976–1991). The increased frequency of exceedance of the fish and wildlife objective at Prisoners Point could contribute to adverse effects on aquatic life~~,~~ (specifically, indirect adverse effects on striped bass spawning), though there is a high degree of uncertainty associated with this impact. ~~and t~~The increased frequency of the EC exceedance at Emmaton could contribute to adverse effects on agricultural uses. Because EC is not bioaccumulative, the increases in long-term average EC levels would not directly cause bioaccumulative problems in aquatic life or humans. The western ~~and southern~~ Delta ~~are~~ is Clean Water Act section 303(d) listed for elevated EC and the increased frequency of exceedance of EC objectives that would occur in ~~these~~ this portion~~s~~ of the Delta could make beneficial use impairment measurably worse. This impact is considered to be significant.

Further, relative to Existing Conditions, Alternative 8 ~~would~~ could result in substantial increases in long-term average EC during the months of October through May in Suisun Marsh. The increases in long-term average EC levels that would occur in Suisun Marsh could further degrade existing EC levels and thus contribute additionally to adverse effects on the fish and wildlife beneficial uses. Because EC is not bioaccumulative, the increases in long-term average EC levels would not directly cause bioaccumulative problems in wildlife. Suisun Marsh is Clean Water Act section 303(d) listed for elevated EC and the increases in long-term average EC that would occur in the marsh could make beneficial use impairment measurably worse. This impact is considered to be significant.

Implementation of Mitigation Measure WQ-11 along with a separate, non-environmental commitment relating to the potential increased costs associated with EC-related changes would reduce these effects. While mitigation measures to reduce these water quality effects in affected water bodies to less than significant levels are not available, implementation of Mitigation Measure WQ-11 is recommended to attempt to reduce the effect that increased EC concentrations may have on Delta beneficial uses. However, because the effectiveness of this mitigation measure to result in feasible measures for reducing water quality effects is uncertain, this impact is considered to remain significant and unavoidable. Please see Mitigation Measure WQ-11 under Impact WQ-11 in the discussion of Alternative 1A.

In addition to and to supplement Mitigation Measure WQ-11, the BDCP proponents have incorporated into the BDCP, as set forth in EIR/EIS Appendix 3B, *Environmental Commitments*, a separate, non-environmental commitment to address the potential increased water treatment costs that could result from EC concentration effects on municipal, industrial and agricultural water purveyor operations. Potential options for making use of this financial commitment include funding or providing other assistance towards acquiring alternative water supplies or towards modifying existing operations when EC concentrations at a particular location reduce opportunities to operate existing water supply diversion facilities. Please refer to Appendix 3B, *Environmental Commitments*, for the full list of potential actions that could be taken pursuant to this commitment in order to reduce the water quality treatment costs associated with water quality effects relating to chloride, electrical conductivity, and bromide.

Impact WQ-13: Effects on Mercury Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of ~~CM2-22~~CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for ~~CM2-22~~CM2–CM21. See section 8.3.1.3 for more information.

The water quality impacts of waterborne concentrations of mercury and methylmercury and fish tissue mercury concentrations were evaluated for 9 Delta locations. The analysis of percentage change in assimilative capacity of waterborne total mercury of Alternative 8 relative to the 25 ng/L ecological risk benchmark as compared to Existing Conditions showed the greatest decrease of 7% for the Contra Costa Pumping Plant, and 6.9% at the same location for the No Action Alternative (Figures 8-53 and 8-54). Similarly, changes in methylmercury concentration are expected to be relatively small . The greatest annual average methylmercury concentration for drought conditions was 0.165 ng/L for the San Joaquin River at Buckley Cove, which was slightly higher than Existing Conditions and slightly lower than the No Action Alternative ~~The highest methylmercury concentration is 0.229 ng/L at the North Bay Aqueduct at Barker Slough, which is about 100% greater than Existing Conditions or the No Action Alternative~~(Appendix 8I, Figure I-9). All modeled input concentrations exceeded the methylmercury TMDL guidance objective of 0.06 ng/L, therefore percentage change in assimilative capacity was not evaluated for methylmercury.

Fish tissue estimates show more substantial percentage increases in concentration and exceedance quotients for mercury at some Delta locations. The greatest changes in exceedance quotients relative to Existing Conditions and the No Action Alternative are 33–40% at the Contra Costa Pumping Plant and 34–46% for Old River at Rock Slough ~~The highest exceedance quotients for any modeled location are predicted for the North Bay Aqueduct pump site at Barker Slough (EQ = 7.6), with an increase relative to Existing Conditions, and the No Action Alternative ranging from 221 to 224% at that location~~ (Figure ~~8-55~~8-55a,b, Appendix 8I, *Mercury*, Table I-15b). ~~As mentioned above, these changes mirror and enhance the pattern of increased concentrations in methylmercury projected for that location. The Sacramento River at Emmaton site also shows a relatively large percentage increase in tissue concentrations over Existing Conditions and the No Action Alternative (122 to 124%) and a relatively elevated exceedance quotient of 4.6 (Appendix 8I, Table I-15b).~~ Because these increases are substantial, and it is evident that substantive increases are expected at numerous locations throughout the Delta, these changes may be measurable in the environment. See Appendix 8I for a discussion of the uncertainty associated with the fish tissue estimates.

NEPA Effects: Based on the above discussion, the effects of mercury and methylmercury in comparison of Alternative 8 to the No Action Alternative (as waterborne and bioaccumulated forms) are considered to be adverse for the case of fish tissue bioaccumulation at some locations.

***CEQA Conclusion*:** Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Under Alternative 8, greater water demands and climate change would alter the magnitude and timing of reservoir releases and river flows upstream of the Delta in the Sacramento River watershed and east-side tributaries, relative to Existing Conditions. Concentrations of mercury and methylmercury upstream of the Delta will not be substantially different relative to Existing Conditions due to the lack of important relationships between mercury/methylmercury concentrations and flow for the major rivers.

Methylmercury concentrations exceed criteria at all locations in the Delta and no assimilative capacity exists. Monthly average waterborne concentrations of total and methylmercury, over the period of record, are very similar to Existing Conditions, but showed notable increases at some locations. Estimates of fish tissue mercury concentrations show substantial increases would occur for several sites for ~~Methylmercury concentrations exceed criteria at all locations in the Delta and no assimilative capacity exists.However, monthly average waterborne concentrations of total and methylmercury, over the period of record, are very similar to Existing Conditions.Estimates of fish tissue mercury concentrations at some locations show substantial increases under~~ Alternative 8, relative to Existing Conditions~~, particularly at North Bay Aqueduct and Sacramento River at Emmaton~~.

Assessment of effects of mercury in the SWP and CVP Export Service Areas were based on effects on mercury concentrations and fish tissue mercury concentrations at the Banks and Jones pumping plants. The Banks and Jones pumping plants are expected to show increased assimilative capacity for waterborne mercury and decreased fish tissue concentrations of mercury for Alternative 8 as compared to Existing Conditions.

As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. However, increases in fish tissue mercury concentrations are substantial, and changes in fish tissue mercury concentrations would make existing mercury-related impairment in the Delta measurably worse. In comparison to Existing Conditions, Alternative 8 would increase levels of mercury by frequency, magnitude, and geographic extent such that the affected environment would be expected to have measurably higher body burdens of mercury in aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish) or humans consuming those organisms.

This impact is considered to be significant. Feasible or effective actions to reduce the effects on mercury resulting from CM1 are unknown. General mercury management measures through CM12, or actions taken by other entities or programs such as TMDL implementation, may minimize or reduce sources and inputs of mercury to the Delta and methylmercury formation. However, it is uncertain whether this impact would be reduced to a level that would be less than significant as a result of CM12 or other future actions. Therefore, the impact would be significant and unavoidable.

Impact WQ-25: Effects on Selenium Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics~~,~~. To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of ~~CM2-22~~CM2–CM21 not attributable to hydrodynamics, ~~for example,~~such as additional loading of a constituent to the Delta, are discussed within the impact header for ~~CM2-22~~CM2–CM21. See ~~section~~ Section 8.3.1.3 for more information.

Selenium concentrations and threshold comparisons for each of the 11 modeled Delta assessment locations under Alternative 8, relative to Existing Conditions and the No Action Alternative, are presented in Appendix 8M, *Selenium*, Table M-9a for water, Tables M-18 and M-28 for most biota (whole-body fish ~~(~~[excluding sturgeon~~)~~], bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets) throughout the Delta, and Tables M-30 through M-32 for sturgeon at the two western Delta locations. Figures 8-59a and 8-60a present graphical distributions of predicted selenium concentration changes (shown as changes in available assimilative capacity based on 1.3 µg/L) in water at each modeled assessment location for all years. Appendix 8M, Figure M-24 provides more detail in the form of monthly patterns of selenium concentrations in water during the modeling period.

Alternative 8 would result in small to moderate changes in average selenium concentrations in water at modeled Delta assessment locations relative to Existing Conditions and the No Action Alternative (Appendix 8M, *Selenium*, Table M-~~10A~~9a). Long-term average concentrations at some interior and western Delta locations would increase by 0.01–0.14 µg/L for the entire period modeled (1976–1991). These increases ~~The changes~~ in selenium concentrations in water ~~are reflected in small (10% or less) to moderate (between 11% and 50%) changes~~ would result in reductions in available assimilative capacity for selenium of 1-13%, relative to the ~~(based on 2~~1.3 µg/L ~~ecological risk benchmark~~USEPA draft water quality criterion~~) for all years~~ (Figures 8-59a and 8-60a). ~~Relative to Existing Conditions, Alternative 8 would result in the largest modeled increase in assimilative capacity at Buckley Cove (3%) and the largest decreases at Rock Slough and Contra Costa PP (12% and 13%, respectively) (Figure 8-59). Relative to the No Action Alternative, the largest modeled increase in assimilative capacity would be at Staten Island (1%) and the largest decrease would be at Rock Slough and Contra Costa PP (13% and 12%, respectively) (Figure 8-60). Although moderate negative changes in assimilative capacity would be expected to occur at two locations (Rock Slough and Contra Costa PP), the changes would be small at the other locations and the available assimilative capacity at all locations would remain substantial; therefore, the effect of Alternative 8 is generally minimal for the Delta. Furthermore, t~~The ~~ranges of modeled~~ long-term average selenium concentrations in water ~~(Appendix 8M, Table M-10A)~~ for Alternative 8 (range 0.~~24~~09–0.~~72~~39 µg/L) would be similar to~~,~~ Existing Conditions (range 0.~~21~~09–0.~~76~~41 µg/L)~~,~~ and the No Action Alternative (range 0.~~21~~09–0.~~69~~38 µg/L) ~~are similar~~, and all would be below the ~~ecological risk benchmark~~USEPA draft water quality criterion of ~~(2~~1.3 µg/L~~)~~ (Appendix 8M, Table 9a).

Relative to Existing Conditions and the No Action Alternative, Alternative 8 would generally result in small changes (less than 54%) in estimated selenium concentrations in most biota (whole-body fish (excluding sturgeon), bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets) (Figures 8-61a through 8-64b; Appendix 8M, *Selenium*, Table M-~~19~~ 28~~and Table 8M-2 in the sturgeon addendum to Appendix 8MAddendum M.A, *Selenium in Sturgeon*, to Appendix 8M, Table M.A-2~~). Despite the small changes in selenium concentrations in biota, Level of Concern Exceedance Quotients (i.e., modeled tissue divided by Level of Concern benchmarks) for selenium concentrations in those biota for all years and for drought years are less than 1.0 (indicating low probability of adverse effects). Similarly, Advisory Tissue Level Exceedance Quotients for selenium concentrations in fish fillets for all years and drought years also are less than 1.0. Estimated selenium concentrations in sturgeon for the San Joaquin River at Antioch are predicted to increase by about 3~~0~~1 percent relative~~Relative~~ to Existing Conditions and to the No Action Alternative in all years (from about 4.7 to 6.1 mg/kg dry weight [dw]). Likewise, those for sturgeon in the Sacramento River at Mallard Island are predicted to increase by about 17 percent in all years (from about 4.4 to 5.2 mg/kg dw) (~~Figure 8-65;~~ Appendix 8M, Tables M-30 and M-31). Selenium concentrations in sturgeon during drought years are expected to increase by 23 percent at Antioch and 11 percent at Mallard Island. Detection of changes in whole-body sturgeon such as those estimated for the western Delta may require large sample sizes because of the inherent variability in fish tissue selenium concentrations. Low Toxicity Threshold Exceedance Quotients for selenium concentrations in sturgeon in the western Delta would exceed 1.0 for drought years at both locations (as they do for Existing Conditions and the No Action Alternative; Figure 8-65) and for all years at ~~both locations~~Antioch, whereas Existing Conditions and the No Action Alternative do not (quotient~~s~~ increases from 0.94 to 1.2 at Antioch~~ and from 0.88 at Sacramento River at Mallard Island 1.0~~) (Appendix 8M, Table M-32). High Toxicity Threshold Exceedance Quotients for selenium concentrations in sturgeon in the western Delta would exceed 1.0 for drought years at Antioch unlike Existing Conditions and the No Action Alternative (~~where ~~quotient increases from 0.85 to 1.1) (Appendix 8M, Table M-32).~~and the No Action Alternative, the largest increase of selenium concentrations in biota would be at Contra Costa PP for drought years and in sturgeon at the two western Delta locations in all as well as drought years. Relative to Existing Conditions, the largest decrease in selenium concentration in biota would be at Buckley Cove for drought years; relative to the No Action Alternative, the largest decrease would be at Staten Island for drought years. Except for sturgeon in the western Delta, concentrations of selenium in whole-body fish and bird eggs (invertebrate and fish diets) would exceed only the lower benchmarks (4 and 6 mg/kg dry weight, respectively, indicating a low potential for effects), under drought conditions, at Buckley Cove for Alternative 8 and Existing Conditions and the No Action Alternative (Figures 8-61 through 8-63). Exceedance QuotientsExceedance quotients for these exceedances of the lower benchmarks are all between 1.0 and 1.5, indicating a low risk to biota in the Delta and the similarity of Alternative 8 to Existing Conditions and the No Action Alternative. Selenium concentrations in fish fillets would not exceed the screening value for protection of human health (Figure 8-64). For sturgeon in the western Delta, whole-body selenium concentrations would increase from 12.3 mg/kg under Existing Conditions and the No Action Alternative to 14.7 mg/kg under Alternative 8, a 20% increase (Table 8M-2 in the sturgeon addendum to Appendix 8MTable M.A-2). All of these values exceed both the low and high toxicity benchmarks. The predicted increases are high enough that they may represent a measurable increase in body burdens of sturgeon, which would constitute an adverse impact (see also the discussion of results provided in the sturgeon addendum M.A to Appendix 8M).~~

The disparity between larger estimated changes for sturgeon and smaller changes for other biota ~~are~~is attributable largely to differences in modeling approaches, as described in Appendix 8M, *Selenium*. The model for most biota was calibrated to encompass the varying concentration-dependent uptake from waterborne selenium concentrations (expressed as the K_d, which is the ratio of selenium concentrations in particulates [as the lowest level of the food chain] relative to the waterborne concentration) that was exhibited in data for largemouth bass in 2000, 2005, and 2007 at various locations across the Delta. In contrast, the modeling for sturgeon could not be similarly calibrated at the two western Delta locations and used literature-derived uptake factors and trophic transfer factors for the estuary from Presser and Luoma (2013). As noted in the appendix, there was a significant negative log-log relationship of K_d to waterborne selenium concentration that reflected the greater bioaccumulation rates for bass at low waterborne selenium than at higher concentrations. (There was no difference in bass selenium concentrations in the Sacramento River at Rio Vista in comparison to the San Joaquin River at Vernalis in 2000, 2005, and 2007 [Foe 2010], despite a nearly 10-fold difference in waterborne selenium.) Thus, there is more confidence in the site-specific modeling based on the Delta-wide model that was calibrated for bass data than in the estimates for sturgeon based on "fixed" K_ds for all years and for drought years without regard to waterborne selenium concentration at the two locations in different time periods.

Increased water residence times could increase the bioaccumulation of selenium in biota, thereby potentially increasing fish tissue and bird egg concentrations of selenium (see residence time discussion in Appendix 8M, *Selenium*, and Presser and Luoma [2010b]). Thus, residence time was assessed for its relevance to selenium bioaccumulation. Table 60a (presented originally in Section 8.3.1.7 in the *Microcystis* subsection) shows the time for neutrally buoyant particles to move through the Delta (surrogate for flow and residence time). Although an increase in residence time throughout the Delta is expected under the No Action Alternative, relative to Existing Conditions (because of climate change and sea level rise), the change is fairly small in most areas of the Delta. Thus, the changes in residence times between Alternative 8 and the No Action Alternative are very similar to the changes in residence times between Alternative 8 and the Existing Conditions.

Relative to Existing Conditions and the No Action Alternative, increases in residence times for Alternative 8 would be greater in the South Delta and East Delta than in other sub-regions. Relative to Existing Conditions, annual average residence times for Alternative 8 in the South Delta are expected to increase by more than 37 days (Table 60a). and in the East Delta increase by more than 23 days. Increases in residence times for other sub-regions would be smaller, especially as compared to Existing Conditions and the No Action Alternative (which are longer than those modeled for the South Delta). As mentioned above, these results incorporate hydrodynamic effects of both CM1 and CM2 and CM4, and the effects of CM1 cannot be distinguished from the effects of CM2 and CM4. However, it is expected that CM2 and CM4 are substantial drivers of the increased residence time.

Presser and Luoma (2010b) summarized and discussed selenium uptake in the Bay-Delta (including hydrologic conditions [e.g., Delta outflow and residence time for water], K_ds [the ratio of selenium concentrations in particulates, as the lowest level of the food chain, relative to the water-borne concentration], and associated tissue concentrations [especially in clams and their consumers, such as sturgeon]). When the Delta Outflow Index (daily average flow per month) decreased by five-fold (73,732 cubic feet per second [cfs] in June 1998 to 12, 251 cfs in October 1998), residence time doubled (from 11 to 22 days) and the calculated mean K_d also doubled (from 3,198 to 6,501). However, when daily average Delta outflow in November 1999 was only 6,951 cfs (i.e., about one-half that in October 1998) and residence time was 70 days, the calculated mean K_d (7,614) did not increase proportionally.

Models are not available to quantitatively estimate the level of changes in selenium bioaccumulation as related to residence time, but the effects of residence time are incorporated in the bioaccumulation modeling for selenium that was based on higher K_d values for drought years in comparison to wet, normal, or all years; see Appendix 8M, *Selenium*. If increases in fish tissue or bird egg selenium were to occur, the increases would likely be of concern only where fish tissues or bird eggs are already elevated in selenium to near or above thresholds of concern. That is, where biota concentrations are currently low and not approaching thresholds of concern (which, as discussed above, is the case throughout the Delta, except for sturgeon in the western Delta), changes in residence time alone would not be expected to cause them to then approach or exceed thresholds of concern. In consideration of this factor, although the Delta as a whole is a CWA Section 303(d)-listed water body for selenium, and although monitoring data of fish tissue or bird eggs in the Delta are sparse, the most likely area in which biota tissues would be at levels high enough that additional bioaccumulation due to increased residence time from restoration areas would be a concern is the western Delta and Suisun Bay for sturgeon, as discussed above. As shown in Table 60a, the overall increase in residence time estimated in the western Delta is 4 days relative to Existing Conditions, and 2 days relative to the No Action Alternative. Given the available information, these increases are small enough that they are not expected to substantially affect selenium bioaccumulation in the western Delta. Because CM2 and CM4 are expected to be substantial drivers of the increased residence times, further discussion is included in Impact WQ-26 below.

In summary, ~~R~~relative to Existing Conditions and the No Action Alternative, Alternative 8 would result in ~~a minimal~~ small changes in selenium concentrations throughout the Delta for most biota (less than ~~5~~4%), although larger increases in selenium concentrations are predicted for sturgeon in the western Delta. Concentrations of selenium in sturgeon would exceed the lower benchmark for both western Delta locations for all years and drought years, indicating a low potential for effects. Concentrations of selenium in sturgeon would exceed the higher benchmark ~~for~~ for Antioch only in drought years, indicating a high potential for effects. The modeling of bioaccumulation for sturgeon is less calibrated to site-specific conditions than that for other biota, which was calibrated on a robust dataset for modeling of bioaccumulation in largemouth bass as a representative species for the Delta. Overall, the predicted increases for Alternative 8 are high enough that they may represent a measureable increase in body burdens of sturgeon, which would constitute an adverse impact

~~. Alternative 8 would not be expected to substantially increase the frequency with which applicable benchmarks would be exceeded in the Delta or substantially degrade the quality of water in the Delta, with regard to selenium.~~

SWP/CVP Export Service Areas

Alternative 8 would result in ~~small to~~ moderate (0.08–0.15 µg/L) ~~changes~~ decreases in average selenium concentrations at the Banks and Jones pumping plants, relative to Existing Conditions and the No Action Alternative, for the entire period modeled (Appendix 8M, *Selenium*, Table M-~~10A~~9a). These decreases in long-term average ~~These changes in~~ selenium concentrations in water ~~are reflected in small (10% or less) to moderate (between 11% and 50%) changes~~ would result in increases in available assimilative capacity for selenium at these pumping plants of 8–16%, relative to the 1.3 µg/L ecological benchmark~~for all years~~ (Figures 8-59a and 8-60a). ~~Relative to Existing Conditions and the No Action Alternative, Alternative 8 would result in increases in assimilative capacity at Jones PP (14% and 15%, respectively) and at Banks PP (7%) (Figures 8-59 and 8-60) and would have a positive effect at the Export Service Area locations.~~ Furthermore, ~~T~~the ~~ranges of modeled~~ long-term average selenium concentrations in water ~~(Appendix 8M, Table M-10Ae)~~ for Alternative 8 (range 0.~~32~~09–0.3~~7~~9 µg/L)~~, Existing Conditions (range 0.37–0.58 µg/L), and the No Action Alternative (range 0.37–0.59 µg/L) are similar, and all~~ would be well below the ~~ecological risk benchmark~~USEPA draft water quality criterion of 1.3~~(2~~ µg/L (Appendix 8M, Table M-9a).

Relative to Existing Conditions and the No Action Alternative, Alternative 8 would result in small changes (less than ~~5~~4%) in estimated selenium concentrations in biota (whole-body fish, bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets) at SWP/CVP service areas (Figures 8-61a through 8-64b; Appendix 8M, *Selenium*, Table M-~~19~~28). ~~Relative to Existing Conditions and the No Action Alternative, the largest increase of selenium concentrations in biota would be at Banks PP for drought years (except for bird eggs [assuming a fish diet] at Banks PP for all years), and the largest decrease would be at Jones PP for drought years.~~ Concentrations in biota would not exceed any selenium benchmarks for Alternative 8 (Figures 8-61a through 8-64b).

~~Thus, relative to Existing Conditions and the No Action Alternative, Alternative 8 would result in small to moderate changes in selenium concentrations in water and minimal changes in selenium concentrations in biota at the Export Service Area locations. Selenium concentrations in water and biota generally would decrease under Alternative 8 and would not exceed ecological benchmarks at either location, whereas the lower benchmark for bird eggs (fish diet) would be exceeded under~~

Existing Conditions and the No Action Alternativeat Jones PP under drought conditions. This small positive change in selenium concentrations under Alternative 8 would be expected to slightly decrease the frequency with which applicable benchmarks would be exceeded or slightly improve the quality of water at the Export Service Area locations, with regard to selenium.

NEPA Effects: Based on the discussion above, the effects on selenium from Alternative 8 are considered to be adverse. This determination is reached because selenium concentrations in whole-body sturgeon modeled at two western Delta locations would increase by an estimated 20average of 30%, which may represent a measurable increase in the environment. Because both low and high toxicity benchmarks are already exceeded under the No Action Alternative, tThese potentially measurable increases represent an adverse impact.

***CEQA Conclusion*:** Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for selenium. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

There are no substantial point sources of selenium in watersheds upstream of the Delta, and no substantial nonpoint sources of selenium in the watersheds of the Sacramento River and the eastern tributaries. Nonpoint sources in the San Joaquin Valley that contribute selenium to the Delta will be controlled through a TMDL developed by the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the Grassland Bypass Project, and Basin Plan objectives (Central Valley Water Board [2010cd)] and State Water Board ([2010db, 2010ec]) that are expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta. Consequently, any modified reservoir operations and subsequent changes in river flows under Alternative 8, relative to Existing Conditions, are expected to cause negligible changes in selenium concentrations in water. Any negligible changes in selenium concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies as related to selenium.

Relative to Existing Conditions, modeling estimates indicate that Alternative 8 would increase selenium concentrations in whole-body sturgeon modeled at two western Delta locations by an estimated 20%, which may represent a measurable increase in the environment. Because both low and high toxicity benchmarks are already exceeded under Existing Conditions, these potentially measurable increases represent a potential impact to aquatic life beneficial uses.

Relative to Existing Conditions, modeling estimates indicate that Alternative 8 would result in essentially no small changes in selenium concentrations in water or most biota throughout the Delta, with no exceedances of benchmarks for biological effects. Relative to Existing Conditions, modeling estimates indicate that Alternative 8 would increase selenium concentrations in whole-body sturgeon modeled at two western Delta locations by an estimated 21%, which may represent a measureable increase in the environment. Because both low and high toxicity benchmarks are exceeded, these potentially measureable increases represent a potential impact to aquaticfish and wildlife life beneficial uses.

Assessment of effects of selenium in the SWP/ and CVP Export Service Areas is based on effects on selenium concentrations at the Banks and Jones pumping plants. Relative to Existing Conditions, Alternative 8 would slightly decrease cause no change increase in the frequency with which applicable benchmarks would be exceeded~~, (there would be none) or~~ and would slightly improve the quality of water in selenium concentrations at the Banks and Jones pumping plants locations.

Based on the above, although waterborne selenium concentrations would not exceed applicable water quality objectives/criteria, however, significant impacts on some beneficial uses of waters in the Delta could occur because ~~both low and high toxicity benchmarks are already exceeded under Existing Conditions, and~~ uptake of selenium from water to biota may measurably increase such that high toxicity benchmarks may be exceeded. In comparison to Existing Conditions, water quality conditions under this alternative would increase levels of selenium (a bioaccumulative pollutant) by frequency, magnitude, and geographic extent such that the affected environment may have measurably higher body burdens of selenium in aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish); however, impacts to humans consuming those organisms are not expected to occur. Water quality conditions under this alternative with respect to selenium would cause long-term degradation of water quality in the western Delta. Except in the vicinity of the western Delta for sturgeon, water quality conditions under this alternative would not increase levels of selenium by frequency, magnitude, and geographic extent such that the affected environment would be expected to have measurably higher body burdens of selenium in aquatic organisms. The greater level of selenium bioaccumulation in the western Delta would further degrade water quality by measurable levels, on a long-term basis, for selenium and, thus, cause the CWA Section 303(d)-listed impairment of beneficial use to be made discernibly worse. This impact is considered significant. Environmental Commitment: Selenium Management (AMM27), which affords for site-specific measures to reduce effects, would be available to reduce BDCP-related effects associated with selenium. The effectiveness of AMM27 is uncertain and, therefore implementation may not reduce the identified impact to a level that would be less than significant, and therefore it is significant and unavoidable.

The need for, and the feasibility and effectiveness of, post-operation mitigation for the predicted level of selenium bioaccumulation is uncertain. The first step shall be to determine the reliability of the model in predicting biota selenium concentrations in the affected environment where effects are predicted but selenium data are lacking. For that reason, the model shall be validated with site-specific sampling before extensive mitigation measures relative to CM1 operations are developed and evaluated for feasibility, as the measures and their evaluation for feasibility are likely to be complex. Specifically, it remains to be determined whether the available existing data for transfer of selenium from water to particulates and through different trophic levels of the food chain are representative of conditions that may occur from implementation of Alternative 8. Therefore, the proposed mitigation measure requires that sampling be conducted to characterize each step of data inputs needed for the model, and then the refined model be validated for local conditions. This impact is considered significant and unavoidable.

Impact WQ-26: Effects on Selenium Concentrations Resulting from Implementation ofCM2–~~CM22~~CM21

NEPA Effects: Effects of CM2–CM21 on selenium under Alternative 8 are the same as those discussed for Alternative 1A and are considered not to be adverse.

CEQA Conclusion: CM2–CM21 proposed under Alternative 8 would be similar to those proposed under Alternative 1A. As such, effects on selenium resulting from the implementation of CM2–CM21 would be similar to that previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

NEPA Effects: In general, with the possible exception of changes in Delta hydrodynamics resulting from habitat restoration, CM2–CM11 would not substantially increase selenium concentrations in the water bodies of the affected environment. Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, and thus such effects of these restoration measures were included in the assessment of CM1 facilities operations and maintenance (see Impact WQ-25).

However, iImplementation of these conservation measures may increase water residence time within the restoration areas. Increased restoration area water residence times could potentially increase the bioaccumulation of selenium in biota, thereby potentially increasing fish tissue and bird egg concentrations of selenium, but m.Models are not available to quantitatively estimate the level of changes in residence time and the associated selenium bioavailability, but the effects of residence time are incorporated in the bioaccumulation modeling for selenium that was based on higher Kd values (the ratio of selenium concentrations in particulates [as the lowest level of the food chain] relative to the water-borne concentration) for drought years in comparison to wet, normal, or all years; see Appendix 8M, Selenium. If increases in fish tissue or bird egg selenium were to occur, the increases would likely be of concern only where fish tissues or bird eggs are already elevated in selenium to near or above thresholds of concern. That is, where biota concentrations are currently low and not approaching thresholds of concern, changes in residence time alone would not be expected to cause them to then approach or exceed thresholds of concern. In consideration of this factor, although the Delta as a whole is a 303(d)-listed water body for selenium, and although monitoring data of fish tissue or bird eggs in the Delta are sparse, the most likely areas in which biota tissues would be at levels high enough that additional bioaccumulation due to increased residence time from restoration areas would be a concern are the western Delta and Suisun Bay, and the South Delta in areas that receive San Joaquin River water.

The western Delta and Suisun Bay receive elevated selenium loads from North San Francisco Bay (including San Pablo Bay, Carquinez Strait, and Suisun Bay) and from the San Joaquin River. Point sources of selenium in North San Francisco Bay (i.e., refineries) that contribute selenium to Suisun Bay are expected to be reduced through a TMDL under development by the San Francisco Bay Water Board (San Francisco Bay Water Board 2012) that is expected to result in decreasing discharges of selenium. Nonpoint sources of selenium in the San Joaquin Valley that contribute selenium to the San Joaquin River, and thus the Delta and Suisun Bay, will be controlled through a TMDL developed by the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the Grassland Bypass Project, and Basin Plan objectives (Central Valley Water Board 2010c, d) that are expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta. If selenium levels are not sufficiently reduced via these efforts, it is expected that the State Water Board and the San Francisco Bay and Central Valley Water Boards would initiate additional actions to further control sources of selenium.

The South Delta receives elevated selenium loads from the San Joaquin River. In contrast to Suisun Bay and possibly the western Delta in the future, the South Delta lacks the overbite clam (Corbula [Potamocorbula] amurensis), which is considered a key driver of selenium bioaccumulation in Suisun Bay, due to its high bioaccumulation of selenium and its role in the benthic food web that includes long-lived sturgeon. The South Delta does have Corbicula fluminea, another bivalve that bioaccumulates selenium, but it is not as invasive as the overbite clam and thus likely makes up a smaller fraction of sturgeon diet. Also, as mentioned above, nonpoint sources of selenium in the San Joaquin Valley that contribute selenium to the Delta will be controlled through a TMDL developed by the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the

~~Grassland Bypass Project, and Basin Plan objectives (Central Valley Water Board 2010c, d) that are expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta. Further, if selenium levels in the San Joaquin River are not sufficiently reduced via these efforts, it is expected that the State Water Board and Central Valley Water Board would initiate additional TMDLs to further control nonpoint sources of selenium.~~

~~Wetland restoration areas will not be designed such that water flows in and does not flow out. Exchange of water between the restoration areas and existing Delta channels is an important design factor, since one goal of the restoration areas is to export food produced in these areas to the rest of the Delta (see BDCP Chapter 3, Conservation Strategy, Section 3.3, Biological Goals and Objectives). Thus, these areas can be thought of as "flow-through" systems. Consequently, althoughwater residence times associated with BDCP restoration could increase, they are not expected toincrease without bound. and selenium concentrations in the water column would not continue to build up and be recycled in sediments and organisms as may be the case within a closed system.~~

~~However, because increases in bioavailable selenium in the habitat restoration areas are uncertain, proposed avoidance and minimization measureswould require evaluating risks of selenium exposure at a project level for each restoration area, minimizing to the extent practicable potential risk of additional bioaccumulation, and monitoring selenium levels in fish and/or wildlife to establish whether, or to what extent, additional bioaccumulation is occurring. See Appendix 3B, Environmental Commitments for a description of the environmental commitment BDCP proponents are making with respect to Selenium Management; and Appendix 3.C. of the BDCP for additionaldetail on this avoidance and minimization measure (AMM27). Data generated as part of the avoidance and minimization measures will assist the State and Regional Water Boards in determining whether beneficial uses are being impacted by selenium, and thus will provide the data necessary to support regulatory actions (including additional TMDL development), should such actions be warranted.~~

~~Given the factors discussed in the assessment above, any increases in bioaccumulation rates from water-borne selenium that could occur in some areas as a result of increased water residence time would not be of sufficient magnitude and geographic extent that any portion of the Delta would be expected to have measurably higher body burdens of selenium in aquatic organisms and, therefore, would not substantially increase risk for adverse effects to beneficial uses. Furthermore, although the Delta is a 303(d)-listed water body for selenium, given the discussion in the assessment above, it is unlikely that restoration areas would result in measurable increases in selenium in fish tissues or bird eggs such that the beneficial use impairment would be made discernibly worse.~~

~~Because it is unlikely that substantial increases in selenium in fish tissues or bird eggs would occur such that effects on aquatic life beneficial uses would be anticipated, and because of the avoidance and minimization measures that are designed to further minimize and evaluate the risk of such increases, the effects of WQ-26 are considered not adverse.~~

~~***CEQA Conclusion:*** There would be no substantial, long-term increase in selenium concentrations in water in the rivers and reservoirs upstream of the Delta, water in the Delta, or the waters exported to the CVP and SWP service areas due to implementation of CM2–CM22CM21 relative to Existing Conditions. Waterborne selenium concentrations under this alternative would not exceed applicable water quality objectives/criteria.~~

~~Given the factors discussed in the assessment above, any increases in bioaccumulation rates from water-borne selenium that could occur in some areas as a result of increased water residence times~~

~~would not be of sufficient magnitude and geographic extent that any portion of the Delta wouldbe expected to have measurably higher body burdens of selenium in aquatic organisms, and therefore would not substantially increase risk for adverse effects to beneficial uses. CM2-22 would not cause long-term degradation of water quality resulting in sufficient use of available assimilative capacity such that occasionally exceeding water quality objectives/criteria would be likely. Also, CM2-22 would not result in substantially increased risk for adverse effects to any beneficial uses. Furthermore, although the Delta is a 303(d)-listed water body for selenium, given the discussion in the assessment above, it is unlikely that restoration areas would result in measurable increases in selenium in fish tissues or bird eggs such that the beneficial use impairment would be made discernibly worse.~~

~~Since it is unlikely that substantial increases in selenium in fish tissues or bird eggs would occur such that effects on aquatic life beneficial uses would be anticipated, and because of the avoidance and minimization measures that are designed to further minimize and evaluate the risk of such increases (see Appendix 3.C. of the BDCP for more detail on AMM27) as well as the Selenium Management environmental commitment (see Appendix 3B, Environmental Commitments), this impact is considered less than significant. No mitigation is required.~~

Impact WQ-32. Effects on *Microcystis* Bloom Formation Resulting from Facilities Operations and Maintenance (CM1).

Effects of facilities and operations (CM1) on *Microcystis* abundance, and thus microcystins concentrations, in water bodies of the affected environment under Alternative 8 would be very similar (i.e., nearly the same) to those discussed for Alternative 1A. This is because factors that affect *Microcystis* abundance in waters upstream of the Delta, in the Delta, and in the SWP/CVP Export Services Areas under Alternative 1A would similarly change under Alternative 8, relative to Existing Conditions and the No Action Alternative. For the Delta in particular, there are differences in the direction and magnitude of water residence time changes during the *Microcystis* bloom period among the six Delta sub-regions under Alternative 8 compared to Alternative 1A, relative to Existing Conditions and No Action Alternative. However, under Alternative 8, relative to Existing Conditions and No Action Alternative, water residence times during the *Microcystis* bloom period in various Delta sub-regions are expected to increase to a degree that could, similar to Alternative 1A, lead to an increase in the frequency, magnitude, and geographic extent of *Microcystis* blooms throughout the Delta.

Similar to Alternative 1A, elevated ambient water temperatures relative to Existing Conditions would occur in the Delta under Alternative 8, which could lead to earlier occurrences of *Microcystis* blooms in the Delta, and increase the overall duration and magnitude of blooms. However, the degradation of water quality from *Microcystis* blooms due to the expected increases in Delta water temperatures is driven entirely by climate change, not effects of CM1. While *Microcystis* blooms have not occurred in the Export Service Areas, conditions in the Export Service Areas under Alternative 8 may become more conducive to *Microcystis* bloom formation, relative to Existing Conditions, because water temperatures will increase in the Export Service Areas due to the expected increase in ambient air temperatures resulting from climate change.

NEPA Effects: Effects of water facilities and operations (CM1) on Microcystis in water bodies of the affected environment under Alternative 8 would be very similar to (i.e., nearly the same) to those discussed for Alternative 1A. In summary, Alternative 8 operations and maintenance, relative to the No Action Alternative, would result in long-term increases in hydraulic residence time of various

Delta sub-regions during the summer and fall Microcystis bloom period. During this period, the increased residence time could result in a concurrent increase in the frequency, magnitude, and geographic extent of Microcystis blooms, and thus microcystin levels, in affected areas of the Delta. As a result, Alternative 8 operation and maintenance activities would cause further degradation to water quality with respect to Microcystis in the Delta. Under Alternative 8, relative to No Action Alternative, water exported to the SWP/CVP Export Service Area will be a mixture of Microcystis-affected source water from the south Delta intakes and unaffected source water from the Sacramento River, diverted at the north Delta intakes. It cannot be determined whether operations and maintenance under Alternative 8 will result in increased or decreased levels of Microcystis and microcystins in the mixture of source waters exported from Banks and Jones pumping plants. Mitigation Measure WQ-32a and WQ-32b are available to reduce the effects of degraded water quality in the Delta. Although there is considerable uncertainty regarding this impact, the effects on Microcystis from implementing CM1 is determined to be adverse.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Under Alternative 8, additional impacts from *Microcystis* in the reservoirs and watersheds upstream of the Delta are not expected, relative to Existing Conditions. Operations and maintenance occurring under Alternative 8 is not expected to change nutrient levels in upstream reservoirs or hydrodynamic conditions in upstream rivers and streams such that conditions would be more conductive to *Microcystis* production.

Relative to Existing Conditions, water temperatures and hydraulic residence times in the Delta are expected to increase under Alternative 8, resulting in an increase in the frequency, magnitude and geographic extent of *Microcystis* blooms in the Delta. However, the degradation of water quality from *Microcystis* blooms due to the expected increases in Delta water temperatures is driven entirely by climate change, not effects of CM1. Increases in Delta residence times are expected throughout the Delta during the summer and fall bloom period, due in small part to climate change and sea level rise, but due more proportionately to CM1 and the hydrodynamic impacts of restoration included in CM2 and CM4. The precise change in local residence times and *Microcystis* production expected within any Delta sub-region is unknown because conditions will vary across the complex networks of intertwining channels, shallow back water areas, and submerged islands that compose the Delta. Nonetheless, Delta residence times are, in general, expected to increase due to Alternative 8. Consequently, it is possible that increases in the frequency, magnitude, and geographic extent of *Microcystis* blooms in the Delta will occur due to the operations and maintenance of Alternative 8 and the hydrodynamic impacts of restoration (CM2 and CM4).

The assessment of effects of *Microcystis* on SWP/CVP Export Service Areas is based on the assessment of changes in *Microcystis* levels in export source waters, as well as the effects of temperature and residence time changes within the Export Service Areas on *Microcystis* production. Under Alternative 8, relative to Existing Conditions, the potential for *Microcystis* to occur in the Export Service Area is expected to increase due to increasing water temperature, but this impact is driven entirely by climate change and not Alternative 8. Water exported from the Delta to the Export Service Area is expected to be a mixture of *Microcystis*-affected source water from the south Delta intakes and unaffected source water from the Sacramento River. Because of this, it cannot be determined whether operations and maintenance under Alternative 8, relative to existing conditions, will result in increased or decreased levels of *Microcystis* and microcystins in the mixture of source waters exported from Banks and Jones pumping plants.

Based on the above, this alternative would not be expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause significant impacts on any beneficial uses of waters in the affected environment. *Microcystis* and microcystins are not 303(d) listed within the affected environment and thus any increases that could occur in some areas would not make any existing *Microcystis* impairment measurably worse because no such impairments currently exist. Because *Microcystis* and microcystins are not bioaccumulative, increases that could occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. However, because it is possible that increases in the frequency, magnitude, and geographic extent of *Microcystis* blooms in the Delta will occur due to the operations and maintenance of Alternative 8 and the hydrodynamic impacts of restoration (CM2 and CM4), long-term water quality degradation may occur and, thus, significant impacts on beneficial uses could occur. Although there is considerable uncertainty regarding this impact, the effects on *Microcystis* from implementing CM1 is determined to be significant.

Implementation of Mitigation Measure WQ-32a and WQ-32b may reduce degradation of Delta water quality due to *Microcystis*. However, because the effectiveness of these mitigation measures to result in feasible measures for reducing water quality effects is uncertain, this impact is considered to remain significant and unavoidable.

Mitigation Measure WQ-32a: Design Restoration Sites to Reduce Potential for Increased *Microcystis* Blooms

Please see Mitigation Measure WQ-32a under Impact WQ-32 in the discussion of Alternative 1A.

Mitigation Measure WQ-32b: Investigate and Implement Operational Measures to Manage Water Residence Time

Please see Mitigation Measure WQ-32b under Impact WQ-32 in the discussion of Alternative 1A.

Impact WQ-33. Effects on *Microcystis* Bloom Formation Resulting from Other Conservation Measures (CM2-–CM21).

The effects of CM2–CM21 on *Microcystis* under Alternative ~~9~~8 are the same as those discussed for Alternative 1A. In summary, potential environmental effects related to CM2 and CM4 could result in an increase in the frequency, magnitude, and geographic extent of *Microcystis* blooms in the Delta, relative to Existing Conditions and the No Action Alternative, as a result of increased residence times for Delta waters from implementing CM2 and CM4 restoration areas. -Because the hydrodynamic effects associated with implementing CM2 and CM4 were incorporated into the modeling used to assess CM1, a detailed assessment of the effects of implementing CM2 and CM4 on *Microcystis* blooms in the Delta via their~~e~~ effects on Delta water residence time is provided under CM1 (above). The effects of ~~CM 2~~CM2 and ~~CM 4~~CM4 on *Microcystis* may be reduced by implementation of Mitigation Measures WQ-32A and WQ-32b. The effectiveness of these mitigation measures to result in feasible measures for reducing water quality effects is uncertain. Conservation Measures 3 (CM3) and CM5-CM21 would not result in an increase in the frequency, magnitude, and geographic extent of *Microcystis* blooms in the Delta.

NEPA Effects: .

CEQA Conclusion: Based on the above, this alternative would not be expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause significant impacts on any beneficial uses of waters in the affected environment. Microcystis and microcystins are not 303(d) listed within the affected environment and thus any increases that could occur in some areas would not make any existing Microcystis impairment measurably worse because no such impairments currently exist. Because Microcystis and microcystins are not bioaccumulative, increases that could occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. Because restoration actions implemented under CM2 and CM4 will increase residence time throughout the Delta and create local areas of warmer water during the bloom season, it is possible that increases in the frequency, magnitude, and geographic extent of Microcystis blooms, and thus long-term water quality degradation and significant impacts on beneficial uses, could occur. Although there is considerable uncertainty regarding this impact, the effects on Microcystis from implementing CM2–CM21 are determined to be significant.

Impact WQ-34: Effects on San Francisco Bay Water Quality Resulting from Facilities Operations and Maintenance (CM1) and Implementation of CM2–CM21

The effects analysis presented in the preceding impacts (Impact WQ-1 through WQ-33) concluded that Alternative 8 would have a less than significant impact/no adverse effect on the following constituents in the Delta:

- Boron
- Dissolved Oxygen
- Pathogens
- Pesticides
- Trace Metals
- Turbidity and TSS

Elevated concentrations of boron are of concern in drinking and agricultural water supplies. However, waters in the San Francisco Bay are not designated to support municipal water supply (MUN) and agricultural supply (AGR) beneficial uses. Changes in Delta dissolved oxygen, pathogens, pesticides, and turbidity and TSS are not anticipated to be of a frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of the Delta. Thus, changes in boron, dissolved oxygen, pathogens, pesticides, and turbidity and TSS in Delta outflow are not anticipated to be of a frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of the of San Francisco Bay.

The effects of Alternative 8 on bromide, chloride, and DOC, in the Delta were determined to be significant/adverse. Increases in bromide, chloride, and DOC concentrations are of concern in drinking water supplies; however, as described previously, the San Francisco Bay does not have a designated MUN use. Thus, changes in bromide, chloride, and DOC in Delta outflow would not adversely effect any beneficial uses of San Francisco Bay.

Elevated EC, as assessed for this alternative, is of concern for its effects on the agricultural beneficial use (AGR) and fish and wildlife beneficial uses. As discussed above, San Francisco Bay does not have an AGR beneficial use designation. Further, as discussed for the No Action Alternative, changes in Delta salinity would not contribute to measurable changes in Bay salinity, as the change in Delta outflow, which would be the primary driver of salinity changes, would two to three orders of magnitude lower than (and thus minimal compared to) the Bay's tidal flow.

Also, as discussed for the No Action Alternative, adverse changes in Microcystis levels that could occur in the Delta would not cause adverse Microcystis blooms in San Francisco Bay, because Microcystis are intolerant of the Bay's high salinity and, thus not have not been detected downstream of Suisun Bay.

While effects of Alternative 8 on the nutrients ammonia, nitrate, and phosphorus were determined to be less than significant/not adverse, these constituents are addressed further below because the response of the seaward bays to changed nutrient concentrations/loading may differ from the response of the Delta. Selenium and mercury are discussed further, because they are bioaccumulative constituents where changes in load due to both changes in Delta concentrations and exports are of concern.

Nutrients: Ammonia, Nitrate, and Phosphorus

Total nitrogen loads in Delta outflow to Suisun and San Pablo Bays under Alternative 8 would be dominated almost entirely by nitrate, because planned upgrades to the SRWTP will result in >95% removal of ammonia in its effluent. Total nitrogen loads to Suisun and San Pablo Bays would decrease by 9%, relative to Existing Conditions, and increase by 33%, relative to the No Action Alternative (Appendix 8O, Table O-1). The change in nitrogen loading to Suisun and San Pablo Bays under Alternative 8 would not adversely impact primary productivity in these embayments because light limitation and grazing current limit algal production in these embayments. To the extent that algal growth increases in relation to a change in ammonia concentration, this would have net positive benefits, because current algal levels in these embayments are low. Nutrient levels and ratios are not considered a direct driver of *Microcystis* and cyanobacteria levels in the North Bay.

The phosphorus load exported from the Delta to Suisun and San Pablo Bays for Alternative 8 is estimated to increase by 14%, relative to Existing Conditions, and increase by 9% relative to the No Action Alternative (Appendix 8O, Table O-1)). The only postulated effect of changes in phosphorus loads to Suisun and San Pablo Bays is related to the influence of nutrient stoichiometry on primary productivity. However, there is uncertainty regarding the impact of nutrient ratios on phytoplankton community composition and abundance. Any effect on phytoplankton community composition would likely be small compared to the effects of grazing from introduced clams and zooplankton in the estuary (Senn and Novick 2014; Kimmerer and Thompson 2014). Therefore, the projected change in total nitrogen and phosphorus loading that would occur in Delta outflow to San Francisco Bay is not expected to result in degradation of water quality with regard to nutrients that would result in adverse effects to beneficial uses.

Mercury

The estimated long-term average mercury and methylmercury loads in Delta exports are shown in Appendix 8O, Table O-2. Loads of mercury and methylmercury from the Delta to San Francisco Bay are estimated to change relatively little due to changes in source water fractions and net Delta outflow that would occur under Alternative 8. Mercury load to the Bay, relative to Existing Conditions, is estimated to increase by 16 kg/yr (6%), relative to Existing Conditions, and 13 kg/yr (5%), relative to the No Action Alternative. Methylmercury load is estimated to increase by 0.40

kg/yr (11%), relative to Existing Conditions, and increase by 0.31 kg/yr (8%) relative to the No Action Alternative. The estimated total mercury load to the Bay is 276 kg/yr, which would be less than the San Francisco Bay mercury TMDL WLA for the Delta of 330 kg/yr. The estimated changes in mercury and methylmercury loads would be within the overall uncertainty associated with the estimates of long-term average net Delta outflow and the long-term average mercury and methylmercury concentrations in Delta source waters. The estimated changes in mercury load under the alternative would also be substantially less than the considerable differences among estimates in the current mercury load to San Francisco Bay (SFBRWQCB 2006; David et al. 2009). Similar uncertainty is expected in the existing methylmercury load in net Delta exports, for which the best available current load estimate is based on approximately one year of monitoring data (Foe et al. 2008).

Given that the estimated incremental ~~decreases~~increases of mercury and methylmercury loading to San Francisco Bay would fall within the uncertainty of current mercury and methylmercury load estimates, the estimated changes in mercury and methylmerucy loads in Delta exports to San Francisco Bay due to Alternative 8 are not expected to result in adverse effects to beneficial uses or substantially degrade the water quality with regard to mercury, or make the existing CWA Section 303(d) impairment measurably worse.

Selenium

Changes in source water fraction and net Delta outflow under Alternative 8, relative to Existing Conditions, are projected to cause the total selenium load to the North Bay to increase by 24%, relative to Existing Conditions, and increase by 20%, relative to the No Action Alternative (Appendix 8O, Table O-3). Changes in long-term average selenium concentrations of the North Bay are assumed to be proportional to changes in North Bay selenium loads. Under Alternative 8, the long-term average total selenium concentration of the North Bay is estimated to be 0.16μg/L and the dissolved selenium concentration is estimated to be 0.14 μg/L, which would be a 0.03 μg/L increase relative to Existing Conditions and the No Action Alternative (Appendix 8O, Table O-3). The dissolved selenium concentration would be below the target of 0.202 μg/L developed by Presser or Luoma (2013) to coincide with a white sturgeon whole-body fish tissue selenium concentration not greater than 8 mg/kg in the North Bay.

The incremental increase in dissolved selenium concentrations projected to occur under Alternative 8, relative to Existing Conditions and the No Action Alternative, would be higher than under Alternatives 1–5, but still low (0.03 μg/L). The increased dissolved selenium concentration would be within the overall uncertainty of the analytical methods used to measure selenium in water column samples; however, it also would be within the uncertainty associated with estimating numeric water column selenium thresholds (Pressor and Luoma 2013). As described in Section 8.3.1.8, there have been improvements in selenium concentrations in the tissue of diving ducks and muscle of white sturgeon since the initial CWA Section 303(d) listing of the North Bay for selenium impairments, and selenium concentrations in white sturgeon muscle have also generally been below the USEPA's draft recommended fish muscle tissue concentration of 11.8 mg/kg dry weight (SFEI 2014). However, as described under Impact WQ-25, though there is some uncertainty in the estimate of sturgeon concentrations at western Delta locations, the predicted increases for Alternative 8 are high enough that they may represent measurably higher body burdens of selenium in aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish). Because the projected incremental increases in dissolved selenium could cause measurable changes in water column concentrations, and these incremental increases would be within the uncertainty in the target water column threshold for dissolved selenium for protection against adverse bioaccumulative effects in the North Bay ecosystem, and modeling predicts concentrations in the western Delta may represent a measurable increase in body burdens of sturgeon, there is potential that the incremental increase in dissolved selenium concentration projected to occur in the North Bay under Alternative 8 could result in adverse effects beneficial uses.

Based on the discussion above, Alternative 8, relative to the No Action Alternative, would not cause further degradation to water quality with respect to boron, bromide, chloride, dissolved oxygen, DOC, EC, mercury, pathogens, pesticides, nutrients (ammonia, nitrate, phosphorus), trace metals, or turbidity and TSS in the San Francisco Bay. Further, changes in these constituent concentrations in Delta outflow would not be expected to cause changes in Bay concentrations of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses. In summary, based on the discussion above, effects on the San Francisco Bay from implementation of CM1–CM21 are considered to be not adverse with respect to boron, bromide, chloride, dissolved oxygen, DOC, EC, mercury, pathogens, pesticides, nutrients (ammonia, nitrate, phosphorus), trace metals, or turbidity and TSS. However, Alternative 8 could result in increases in selenium concentrations in the North San Francisco Bay that could result in adverse effects to fish and wildlife beneficial uses. This effect is considered to be adverse.

CEQA Conclusion: Based on the above, Alternative 8 would not be expected to cause long-term degradation of water quality in San Francisco Bay resulting in sufficient use of available assimilative capacity such that occasionally exceeding water quality objectives/criteria would be likely and would result in substantially increased risk for adverse effects to one or more beneficial uses with respect to boron, bromide, chloride, dissolved oxygen, DOC, EC, mercury, pathogens, pesticides, nutrients (ammonia, nitrate, phosphorus), trace metals, or turbidity and TSS. Further, based on the above, this alternative would not be expected to cause additional exceedance of applicable water quality objectives/criteria in the San Francisco Bay by frequency, magnitude, and geographic extent that would cause significant impacts on any beneficial uses of waters in the affected environment with respect to boron, bromide, chloride, dissolved oxygen, DOC, EC, mercury, pathogens, pesticides, nutrients (ammonia, nitrate, phosphorus), trace metals, or turbidity and TSS. Any changes in boron, bromide, chloride, and DOC in the San Francisco Bay would not adversely affect beneficial uses, because the uses most affected by changes in these parameters, MUN and AGR, are not beneficial uses of the Bay. Further, no substantial changes in dissolved oxygen, pathogens, pesticides, trace metals or turbidity or TSS are anticipated in the Delta, relative to Existing Conditions, therefore, no substantial changes these constituents levels in the Bay are anticipated. Changes in Delta salinity would not contribute to measurable changes in Bay salinity, as the change in Delta outflow would two to three orders of magnitude lower than (and thus minimal compared to) the Bay's tidal flow. Adverse changes in Microcystis levels that could occur in the Delta would not cause adverse Microcystis blooms in the Bay, because Microcystis are intolerant of the Bay's high salinity and, thus not have not been detected downstream of Suisun Bay. The 9% decrease in total nitrogen load and 14% increase in phosphorus load, relative to Existing Conditions, are expected to have minimal effect on water quality degradation, primary productivity, or phytoplankton community composition. The estimated increase in mercury load (16 kg/yr; 6%) and methylmercury load (0.40 kg/yr; 11), relative to Existing Conditions, is within the level of uncertainty in the mass load estimate and not expected to contribute to water quality degradation, make the CWA section 303(d) mercury impairment measurably worse or cause mercury/methylmercury to bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans.

hough there is some uncertainty in the estimate of sturgeon concentrations at western Delta locations, the predicted increases are high enough that they may represent measurably higher body burdens of selenium in aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish). Environmental Commitment: Selenium Management (AMM27), which affords for site-specific measures to reduce effects, would be available to reduce BDCP-related effects associated with selenium. The effectiveness of AMM27 is uncertain and, therefore implementation may not reduce the identified impact to a level that would be less than significant, and therefore it is significant and unavoidable.

8.3.3.16 Alternative 9—Through Delta/Separate Corridors (15,000 cfs; Operational Scenario G)

Impact WQ-5: Effects on Bromide Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of ~~CM2-**22**~~**CM2**–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for ~~CM2-22~~CM2–CM21. See section 8.3.1.3 for more information.

Using the mass-balance modeling approach for bromide (see Section 8.3.1.3), relative to Existing Conditions, Alternative 9 would result in increases in long-term average bromide concentrations at Buckley Cove (for the modeled drought period only), Emmaton, and Barker Slough, while long-term average concentrations would decrease at the other assessment locations (Appendix 8E, *Bromide*, Table 20). With regard to bromide, Emmaton is a suitable source of raw drinking water on a seasonal basis. While the relative change in long-term average bromide concentration at Emmaton is considerable (≤32%), the increase in the average would be due to more frequent seasonal peak concentrations in excess of 1,000 µg/L relative to Existing Conditions (Appendix 8E, *Bromide*, Figure 2). At Emmaton the predicted 50 µg/L exceedance frequency would increase only slightly from 82% under Existing Conditions to 86% under Alternative 9 (98% to 100% for the modeled drought period), and the predicted 100 µg/L exceedance frequency would increase from 72% under Existing Conditions to 81% under Alternative 9 (93% to 97% for the modeled drought period), indicative of very small changes during seasonally suitable periods of potential use. At Barker Slough, predicted long-term average bromide concentrations would increase from 51 µg/L to 61 µg/L (19% relative increase) for the modeled 16-year hydrologic period and 54 µg/L to 100 µg/L (88% relative increase) for the modeled drought period. At Barker Slough, the predicted 50 µg/L exceedance frequency would decrease from 49% under Existing Conditions to 41% under Alternative 9, but would increase from 55% to 80% during the drought period. At Barker Slough, the predicted 100 µg/L exceedance frequency would increase from 0% under Existing Conditions to 16% under Alternative 9, and would increase from 0% to 42% during the drought period. At Buckley Cove, predicted long-term average bromide concentrations would remain the same (i.e., 259 µg/L), but would increase from 272 µg/L to 330 µg/L (21% relative increase) for the modeled drought period. At Buckley Cove, the predicted 50 µg/L exceedance frequency would not change (i.e., 100%

exceedance), but the modeled 100 μg/L exceedance frequency would decrease from 100% under Existing Conditions to 90% under Alternative 9 (100% to 87% for the modeled drought period). This comparison to Existing Conditions reflects changes in bromide due to both Alternative 9 operations (including use of operable barriers and numerous other operational components of Scenario G) and climate change/sea level rise.

Due to the relatively small differences between modeled Existing Conditions and No Action baselines, changes in long-term average bromide concentrations and changes in exceedance frequencies relative to the No Action Alternative are generally of similar magnitude to those previously described for the existing condition comparison (Appendix 8E, *Bromide*, Table 20). Modeled long-term average bromide concentration at Emmaton would increase by as much as 36%, but change in 50 and 100 μg/L exceedance thresholds would be smaller than that described for the existing condition comparison, indicative of very small changes during seasonally suitable periods of potential use. Modeled long-term average bromide concentration at Barker Slough is predicted to increase by 23% (87% for the modeled drought period) relative to the No Action Alternative. Modeled long-term average bromide concentration increases at Buckley Cove are predicted to increase by 7% (36% for the modeled drought period) relative to the No Action Alternative. Unlike the comparison to Existing Conditions, this comparison to the No Action Alternative reflects changes in bromide due only to Alternative 9operations.

At Barker Slough, modeled long-term average bromide concentrations for the various baseline conditions are very similar (≤4%) (Appendix 8E, *Bromide*, Table 20). Such similarity demonstrates that the modeled Alternative 9 change in bromide is almost entirely due to Alternative 9 operations, and not climate change/sea level rise. Therefore, operations are the primary driver of effects on bromide at Barker Slough, regardless whether Alternative 9 is compared to Existing Conditions, or compared to the No Action Alternative.

Results of the modeling approach which used relationships between EC and chloride and between chloride and bromide (see Section 8.3.1.3) differed somewhat from what is presented above for the mass-balance approach (see Appendix 8E,*Boron,* Table 21).For most locations, the frequency of exceedance of the 50 μg/L and 100 μg/L were similar. The greatest difference between the methods was predicted for Barker Slough. The increases in frequency of exceedance of the 100 μg/L threshold, relative to Existing Conditions and the No Action Alternative, were not as great using this alternative EC to chloride and chloride to bromide relationship modeling approach as compared to that presented above from the mass-balance modeling approach. However, there were still substantial increases, resulting in 9% exceedance over the modeled period under Alternative 9, as compared to 1% under Existing Conditions and 2% under the No Action Alternative. For the drought period, exceedance frequency increased from 0% under Existing Conditions and the No Action Alternative, to 23% under Alternative 9.Furthermore, concentrations predicted at Buckley Cove also differed. The EC to chloride and chloride to bromide relationship modeling approach predicted that concentrations at Buckley cove would decrease under Alternative 9 on both a long term basis and under the modeled drought period, relative to Existing Conditions and the No Action Alternative. This is in contrast to the mass-balance approach presented above, which predicted an increase in concentrations under the drought period. Because the mass-balance approach predicts a greater level of impact at Barker Slough, determination of impacts was based on the mass-balance results.

While the increase in long-term average bromide concentrations at Buckley Cove are relatively small when modeled over a representative 16-year hydrologic period, increases during the modeled drought period, principally the long-term average bromide concentration greater than 300 μg/L, would represent a substantial change in source water quality to the City of Stockton during a season of drought. Additionally, the increase in long-term average bromide concentrations predicted at Barker Slough, principally the relative increase in 100 µg/L exceedance frequency, would result in a substantial change in source water quality for existing drinking water treatment plants drawing water from the North Bay Aqueduct. While the implications of such modeled changes in bromide concentrations at Buckley Cove and Barker Slough is difficult to predict, the substantial modeled increases could lead to adverse changes in the formation of disinfection byproducts such that considerable treatment plant upgrades may be necessary in order to achieve equivalent levels of health protection. Because many of the other modeled locations already frequently exceed the 100 µg/L threshold under Existing Conditions and the No Action Alternative, these locations likely already require treatment plant technologies to achieve equivalent levels of health protection, and thus no additional treatment technologies would be triggered by the small increases in the frequency of exceeding the 100 µg/L threshold. Hence, no further impact on the drinking water beneficial use would be expected at these locations.

The seasonal intakes at Mallard Slough and City of Antioch are infrequently used due to water quality constraints related to sea water intrusion. On a long-term average basis, bromide at these locations is in excess of 3,000 µg/L, but during seasonal periods of high Delta outflow can be <300 µg/L. Based on modeling using the mass-balance approach, use of the seasonal intakes at Mallard Slough and City of Antioch under Alternative 9 would experience a period average increase in bromide during the months when these intakes would most likely be utilized. For those wet and above normal water year types where mass balance modeling would predict water quality typically suitable for diversion, predicted long-term average bromide would increase from 103 µg/L to 140 µg/L (37% increase) at City of Antioch and would decrease from 150 µg/L to 146 µg/L (3% decrease) at Mallard Slough relative to Existing Conditions (Appendix 8E, *Bromide*, Table 23). Changes would be similar for the No Action Alternative comparison. Modeling results using the EC to chloride and chloride to bromide relationships show increases during these months, but the relative magnitude of the increases is much lower (Appendix 8E, *Bromide*, Table 24).Regardless of the differences in the data between the two modeling approaches, the decisions surrounding the use of these seasonal intakes is largely driven by acceptable water quality, and thus have historically been opportunistic. Opportunity to use these intakes would remain, and the predicted increases in bromide concentrations at the City of Antioch and Mallard Slough intake would not be expected to adversely affect MUN beneficial uses, or any other beneficial use, at these locations.

Based on modeling using the mass-balance approach, relative to existing and No Action Alternative conditions, Alternative 9 would lead to predicted improvements in long-term average bromide concentrations at Staten Island, Franks Tract, Rock Slough, and Contra Costa PP No. 1, in addition to Banks and Jones (discussed below). At Staten Island and Franks Tract, long-term average bromide concentrations would be predicted to decrease by 4–21% depending on baseline comparison, while at Rock Slough and Contra Costa PP No.1, long-term average bromide concentrations would be predicted to decrease by 40–45%, depending on baseline comparison. Modeling results using the EC to chloride and chloride to bromide relationships generally do not show similar decreases for Rock Slough and Contra Costa PP No. 1, but rather, predict small increases. Based on the small magnitude of increases predicted, these increases would not adversely affect beneficial uses at those locations.

Important to the results presented above is the assumed habitat restoration footprint on both the temporal and spatial scales incorporated into the modeling. Modeling sensitivity analyses have indicated that habitat restoration (which are reflected in the modeling—see Section 8.3.1.3), not operations covered under CM1, are the driving factor in the modeled bromide increases. The timing, location, and specific design of habitat restoration will have effects on Delta hydrodynamics, and any deviations from modeled habitat restoration and implementation schedule will lead to different outcomes. Although habitat restoration near Barker Slough is an important factor contributing to modeled bromide concentrations at the North Bay Aqueduct, BDCP habitat restoration elsewhere in the Delta can also have large effects. Because of these uncertainties, and the possibility of adaptive management changes to BDCP restoration activities, including location, magnitude, and timing of restoration, the estimates are not predictive of the bromide levels that would actually occur in Barker Slough or elsewhere in the Delta.

Impact WQ-7: Effects on Chloride Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Delta

303(d) Listed Water Bodies

With respect to the 303(d) listing for chloride in Tom Paine Slough, the monthly average chloride concentrations for the 16-year period modeled at Old River at Tracy Road would generally be similar compared to Existing Conditions, and thus, would not be further degraded on a long-term basis (Appendix 8G, Figure Cl-14). With respect to Suisun Marsh, the monthly average chloride concentrations for the 16-year period modeled would generally increase compared to Existing Conditions and No Action Alternative in some months during October through May at the Sacramento River at Collinsville (Appendix 8G, Figure Cl-15), Mallard Island (Appendix 8G, Figure Cl-13), and increase substantially at Montezuma Slough at Beldon's Landing (i.e., over a doubling of concentration in December through February) (Appendix 8G, Figure Cl-16)., However, modeling of Alternative 9 assumed no operation of the Montezuma Slough Salinity Control Gates, but the project description assumes continued operation of the Salinity Control Gates, consistent with assumptions included in the No Action Alternative. A sensitivity analysis modeling run conducted for Alternative 4 with the gates operational consistent with the No Action Alternative resulted in substantially lower EC levels than indicated in the original Alternative 4 modeling results for Suisun Marsh, but EC levels were still somewhat higher than EC levels under Existing Conditions for several locations and months. Although chloride was not specifically modeled in these sensitivity analyses, it is expected that chloride concentrations would be nearly proportional to EC levels in Suisun Marsh. Another modeling run with the gates operational and restoration areas removed resulted in EC levels nearly equivalent to Existing Conditions, indicating that design and siting of restoration areas has notable bearing on EC levels at different locations within Suisun Marsh (see Appendix 8H Attachment 1 for more information on these sensitivity analyses). These analyses also indicate that increases in salinity are related primarily to the hydrodynamic effects of CM4, not operational components of CM1. Based on the sensitivity analyses, optimizing the design and siting of restoration areas may limit the magnitude of long-term chloride increases in the Marsh. However, the chloride concentration increases at certain locations could be substantial, depending on siting and design of restoration areas. Thus, these increased chloride levels in Suisun Marsh are considered to contribute to additional, measureable long-term degradation that potentially would adversely affect the necessary actions to reduce chloride loading for any TMDL that is developed.

~~thereby contributing to additional, measureable long-term degradation that potentially would adversely affect the necessary actions to reduce chloride loading for any TMDL that is developed.~~

NEPA Effects: In summary, relative to the No Action Alternative conditions, Alternative 9 would result in additional exceedances of the 150 mg/L Bay-Delta WCCP objective at Contra Costa Pumping Plant #1 and Antioch, substantial seasonal use of assimilative capacity at Contra Costa Pumping Plant #1, Rock Slough and Franks Tract, and potentially measureable water quality degradation relative to the 303(d) impairment in Suisun Marsh. The predicted chloride increases constitute an adverse effect on water quality(see Mitigation Measure WQ-7 below; implementation of this measure along with a separate, non-environmental commitment relating to the potential increased chloride treatment costs would reduce these effects).Additionally, the predicted changes relative to the No Action Alternative conditions indicate that in addition to the effects of climate change/sea level rise, implementation of CM1 and CM4 under Alternative 9 would contribute substantially to the adverse water quality effects.

Impact WQ-9: Effects on Dissolved Oxygen Resulting from Facilities Operations and Maintenance (CM1)

NEPA Effects: Effects of CM1 on dissolved oxygen under Alternative 9 are the same as those discussed for Alternative 1A and are determined to be not adverse.

CEQA Conclusion: Effects of CM1 on DO under Alternative 9would be similar to those discussed for Alternative 1A, and are summarized here, then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion under Alternative 1A.

~~River flow rate and r~~Reservoir storage reductions that would occur under Alternative 9, relative to Existing Conditions, would not be expected to result in a substantial adverse change in DO levels in the reservoirs, because oxygen sources (surface water aeration, aerated inflows, vertical mixing) would remain. Similarly, river flow rate reductions that would occur would not be expected to result in a substantial adverse change in DO levels in the ~~and~~ rivers upstream of the Delta, given that mean monthly flows would remain within the ranges historically seen under Existing Conditions and the affected river are large and turbulent. Any reduced DO saturation level that may be caused by increased water temperature would not be expected to cause DO levels to be outside of the range seen historically. Finally, amounts of oxygen demanding substances and salinity would not be expected to change sufficiently to affect DO levels.

It is expected there would be no substantial change in Delta DO levels in response to a shift in the Delta source water percentages under this alternative or substantial degradation of these water bodies, with regard to DO. DO levels would be affected by nutrient loading, which the state has begun to aggressively regulate the discharges of, and this loading would not be expected to lower DO levels relative to Existing Conditions based on historical DO levels. Further, the anticipated changes in salinity would have relatively minor effects on DO levels, and tidal exchange, which contribute to the reaeration of Delta waters would not be expected to change substantially.

There is not expected to be substantial, if even measurable, changes in DO levels in the SWP/CVP Export Service Areas waters under Alternative 9, relative to Existing Conditions, because the biochemical oxygen demand of the exported water would not be expected to substantially differ from that under Existing Conditions (due to ever increasing water quality regulations), canal turbulence and exposure of the water to the atmosphere and the algal communities that exist within the canals would establish an equilibrium for DO levels within the canals. The same would occur in downstream reservoirs.

Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would result in significant impacts on any beneficial uses within affected water bodies. Because no substantial changes in DO levels are expected, long-term water quality degradation would not be expected to occur, and, thus, beneficial uses would not be adversely affected. Various Delta waterways are 303(d)-listed for low DO, but because no substantial decreases in DO levels would be expected, greater degradation and DO-related impairment of these areas would not be expected. This impact would be less than significant. No mitigation is required.

Impact WQ-11: Effects on Electrical Conductivity Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of ~~CM2-22~~CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for ~~CM2-22~~CM2–CM21. See section 8.3.1.3 for more information.

Relative to Existing Conditions, Alternative 9 would result in an increase in the number of days the Bay-Delta WQCP EC objectives would be exceeded in the Sacramento River at Emmaton, and the San Joaquin River at San Andreas Landing and Jersey Point (Appendix 8H, *Electrical Conductivity*, Table EC-9).

The percent of days the Emmaton EC objective would be exceeded for the entire period modeled (1976–1991) would increase from 6% under Existing Conditions to 1~~7~~8% under Alternative 9, and the percent of days out of compliance would increase from 11% under Existing Conditions to ~~28~~31% under Alternative 9.

The percent of days the Jersey Point EC objective would be exceeded and the percent of days out of compliance would increase from 0% under Existing Conditions to 2% under Alternative 9. The increase in percent of days the San Andreas Landing EC objective would be exceeded ~~would be 1% under Existing Conditions and Alternative 9,~~ and the percent of days out of compliance ~~with the EC objective~~ would ~~increase from~~ be <1%~~ under Existing Conditions to 2% under Alternative 9~~. These increases are minimal, and are not considered substantial, in light of overall modeling uncertainty.

Average EC levels at the western and southern Delta compliance locations, except at Emmaton in the western Delta, and S. Fork Mokelumne River at Terminous (an interior Delta location) would decrease from 1–33% for the entire period modeled and 2–33% during the drought period modeled (1987–1991) (Appendix 8H, *Electrical Conductivity*, Table EC-20). In the Sacramento River at Emmaton, average EC would increase 22% for the entire period modeled and 36% during the drought period modeled. In the San Joaquin River at San Andreas Landing, average EC would increase 16% for the entire period modeled and 33% during the drought period modeled. Average EC in the Sacramento River at Emmaton and San Joaquin River at San Andreas Landing would increase during all months (Appendix 8H, Table EC-20). In the San Joaquin River at Prisoners Point, average EC would increase 2% for the entire period modeled and 16% during the drought period modeled. Average EC at Prisoners Point would increase in September through December (Appendix

8H, Table EC-20). The western portion of the Delta–—which is Clean Water Act section 303(d) listed as impaired due to elevated EC–—would have an increased frequency of exceedance of the Bay-Delta WQCP objectives (Appendix 8H, Table EC-9) and long-term average EC levels at compliance locations in this region would increase relative to Existing Conditions (Appendix 8H, Table EC-20). Thus, Alternative 9 could contribute to additional impairment and potentially adversely affect beneficial uses for section 303(d) listed Delta waterways, relative to Existing Conditions. The comparison to Existing Conditions reflects changes in EC due to both Alternative 9 operations (including use of operable barriers and numerous other operational components of Scenario G) and climate change/sea level rise.

Relative to the No Action Alternative, the change in percent compliance with Bay-Delta WQCP EC objectives under Alternative 9 would be similar to that described above relative to Existing Conditions, except there would not be an increase in objective exceedance in the San Joaquin River at Jersey Point. For the entire period modeled, average EC levels would increase in the Sacramento River at Emmaton, and San Joaquin River at San Andreas Landing and Prisoners Point. The greatest average EC increase would occur in the San Joaquin River at San Andreas Landing (22%); the increase at Emmaton would be 21% and at Prisoners Point would be 12% (Appendix 8H, *Electrical Conductivity*, Table EC-20). Similarly, during the drought period modeled, average EC would increase at these locations. The greatest average EC increase during the drought period modeled also would occur in the San Joaquin River at San Andreas Landing (33%); the average EC increase at Emmaton would be 24% and at Prisoners Point would be 25% (Appendix 8H, Table EC-20). The western portion of the Delta–which is Clean Water Act section 303(d) listed as impaired due to elevated EC–would have an increased frequency of exceedance of the Bay-Delta WQCP objectives (Appendix 8H, Table EC-9) and long-term average EC levels at this compliance location would increase relative to the No Action Alternative (Appendix 8H, Table EC-20). Thus, Alternative 9 could contribute to additional impairment and potentially adversely affect beneficial uses for section 303(d) listed Delta waterways, relative to the No Action Alternative. The comparison to the No Action Alternative reflects changes in EC due only to Alternative 9 operations (including use of operable barriers and numerous other operational components of Scenario G).

For Suisun Marsh, October–May is the period when Bay-Delta WQCP EC objectives for protection of fish and wildlife apply. Long-term average EC would increase under Alternative 9, relative to Existing Conditions, during the months of December through May by 0.2–0.4 mS/cm in the Sacramento River at Collinsville (Appendix 8H, *Electrical Conductivity*, Table EC-21). In Montezuma Slough at National Steel during January and February, long-term average EC would increase 0.1–0.2 mS/cm (Appendix 8H, Table EC-22). The most substantial increase would occur near Beldon Landing, with long-term average EC levels increasing by 1.5–6.3 mS/cm, depending on the month, nearly doubling and tripling during some months the long-term average EC relative to Existing Conditions (Appendix 8H, Table EC-23). Sunrise Duck Club and Volanti Slough also would have long-term average EC increases during February–May of 1.5–3.9 mS/cm (Appendix 8H, Tables EC-24 and EC-25). Modeling of this alternative assumed no operation of the Montezuma Slough Salinity Control Gates, but the project description assumes continued operation of the Salinity Control Gates, consistent with assumptions included in the No Action Alternative. A sensitivity analysis modeling run conducted for Alternative 4 scenario H3 with the gates operational consistent with the No Action Alternative resulted in substantially lower EC levels than indicated in the original Alternative 4 modeling results, but EC levels were still somewhat higher than EC levels under Existing Conditions and the No Action Alternative for several locations and months. Another modeling run with the gates operational and restoration areas removed resulted in EC levels nearly equivalent to

Existing Conditions and the No Action Alternative, indicating that design and siting of restoration areas has notable bearing on EC levels at different locations within Suisun Marsh (see Appendix 8H Attachment 1 for more information on these sensitivity analyses). These analyses also indicate that increases are related primarily to the hydrodynamic effects of CM4, not operational components of CM1. Based on the sensitivity analyses, optimizing the design and siting of restoration areas may limit the magnitude of long-term EC increases to be on the order of 1 mS/cm or less. Due to similarities in the nature of the EC increases between alternatives, the findings from these analyses can be extended to this alternative as well.

The degree to which the long-term average EC increases in Suisun Marsh would cause exceedance of Bay-Delta WQCP objectives is unknown, because these objectives are expressed as a monthly average of daily high tide EC, which does not have to be met if it can be demonstrated "equivalent or better protection will be provided at the location" (State Water Resources Control Board 2006:14). The described long-term average EC increase may, or may not, contribute to adverse effects on beneficial uses, depending on how and when wetlands are flooded, soil leaching cycles, and how agricultural use of water is managed, and future actions taken with respect to the marsh. However, the EC increases at certain locations would could be substantial, depending on siting and design of restoration areas, and it is uncertain the degree to which current management plans for the Suisun Marsh would be able to address these substantially higher EC levels and protect beneficial uses. Thus, these increased EC levels in Suisun Marsh are considered to have a potentially adverse effect on marsh beneficial uses. Long-term average EC increases in Suisun Marsh under Alternative 9 relative to the No Action Alternative would be similar to the increases relative to Existing Conditions. Suisun Marsh is section 303(d) listed as impaired due to elevated EC, and the potential increases in long-term average EC concentrations could contribute to additional impairment., because the increases would be double or triple that relative to Existing Conditions and the No Action Alternative.

NEPA Effects: In summary, the increased frequency of exceedance of EC objectives and increased long-term and drought period average EC levels that would occur in the San Joaquin River at San Andreas Landing (interior Delta),and the increased frequency of exceedance of EC objectives in the Sacramento River at Emmaton under Alternative 9, relative to the No Action Alternative, would contribute to adverse effects on the agricultural beneficial uses. Given that the western Delta is Clean Water Act section 303(d) listed as impaired due to elevated EC, the increased frequency of exceedance of the Bay-Delta WQCP objectives and long-term average EC levels at this compliance location could contribute to additional impairment and potentially adversely affect beneficial uses for section 303(d) listed Delta waterways, relative to the No Action Alternative. The increases in long-term average EC levels that would could occur in Suisun Marsh would further degrade existing EC levels and could contribute additional to adverse effects on the fish and wildlife beneficial uses. Suisun Marsh is section 303(d) listed as impaired due to elevated EC, and the potential increases in long-term average EC levels could contribute to additional beneficial use impairment. These increases in EC constitute an adverse effect on water quality. Mitigation Measure WQ-11 would be available to reduce these effects (implementation of this measure along with a separate, non-environmental commitment as set forth in EIR/EIS Appendix 3B, *Environmental Commitments*, relating to the potential EC-related changes would reduce these effects).

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the

effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

River flow rate and reservoir storage reductions that would occur under Alternative 9, relative to Existing Conditions, would not be expected to result in a substantial adverse change in EC levels in the reservoirs and rivers upstream of the Delta, given that: changes in the quality of watershed runoff and reservoir inflows would not be expected to occur in the future; the state's aggressive regulation of point-source discharge effects on Delta salinity-elevating parameters and the expected further regulation as salt management plans are developed; the salt-related TMDLs adopted and being developed for the San Joaquin River; and the expected improvement in lower San Joaquin River average EC levels commensurate with the lower EC of the irrigation water deliveries from the Delta.

Relative to Existing Conditions, Alternative 9 would not result in any substantial increases in long-term average EC levels in the SWP/CVP Export Service Areas. There would be no exceedance of the EC objective at the Jones and Banks pumping plants. Average EC levels for the entire period modeled would decrease at both plants and, thus, this alternative would not contribute to additional beneficial use impairment related to elevated EC in the SWP/CVP Export Service Areas waters. Rather, this alternative would improve long-term EC levels in the SWP/CVP Export Service Areas, relative to Existing Conditions.

In the Plan Area, Alternative 9 would result in an1~~1~~2% increase in the frequency with which the Bay-Delta WQCP EC objectives are exceeded at Emmaton (western Delta), a 2% increase in the frequency with which fish and wildlife EC objectives are exceeded in the San Joaquin River at Jersey Point ~~, and a <1% increase in the frequency with which EC objectives are exceeded in the San Joaquin River at San Andreas Landing (interior Delta)~~ for the entire period modeled (1976–1991). Further, average EC levels at Emmaton would increase by 22% for the entire period modeled and 36% during the drought period modeled, and EC levels at San Andreas Landing would increase by 16% for the entire period modeled and 33% during the drought period modeled. Because EC is not bioaccumulative, the increases in long-term average EC levels would not directly cause bioaccumulative problems in aquatic life or humans. The interior Delta is not Clean Water Act section 303(d) listed for elevated EC, however, the western Delta is. The increases in long-term and drought period average EC levels and increased frequency of exceedance of EC objectives that would occur in the Sacramento River at Emmaton and San Joaquin River at San Andreas would potentially contribute to adverse effects on the agricultural beneficial uses in the interior Delta. This impact is considered to be significant.

Further, relative to Existing Conditions, Alternative 9 ~~would~~ could result in substantial increases in long-term average EC during the months of October through May in Suisun Marsh~~, such that EC levels would be double or triple that occurring under Existing Conditions~~. The increases in long-term average EC levels that would occur in Suisun Marsh could further degrade existing EC levels and thus contribute additionally to adverse effects on the fish and wildlife beneficial uses. Because EC is not bioaccumulative, the increases in long-term average EC levels would not directly cause bioaccumulative problems in wildlife. Suisun Marsh is Clean Water Act section 303(d) listed for elevated EC and the increases in long-term average EC that would occur in the marsh could make beneficial use impairment measurably worse. This impact is considered to be significant.

Implementation of Mitigation Measure WQ-11 along with a separate, non-environmental commitment relating to the potential increased costs associated with EC-related changes would reduce these effects. While mitigation measures to reduce these water quality effects in affected water bodies to less than significant levels are not available, implementation of Mitigation Measure WQ-11 is recommended to attempt to reduce the effect that increased EC concentrations may have on Delta beneficial uses. However, because the effectiveness of this mitigation measure to result in feasible measures for reducing water quality effects is uncertain, this impact is considered to remain significant and unavoidable. Please see Mitigation Measure WQ-11 under Impact WQ-11 in the discussion of Alternative 1A.

In addition to and to supplement Mitigation Measure WQ-11, the BDCP proponents have incorporated into the BDCP, as set forth in EIR/EIS Appendix 3B, Environmental Commitments, a separate, non-environmental commitment to address the potential increased water treatment costs that could result from EC concentration effects on municipal, industrial and agricultural water purveyor operations. Potential options for making use of this financial commitment include funding or providing other assistance towards acquiring alternative water supplies or towards modifying existing operations when EC concentrations at a particular location reduce opportunities to operate existing water supply diversion facilities. Please refer to Appendix 3B, Environmental Commitments, for the full list of potential actions that could be taken pursuant to this commitment in order to reduce the water quality treatment costs associated with water quality effects relating to chloride, electrical conductivity, and bromide.

Impact WQ-13: Effects on Mercury Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of ~~CM2-22~~CM2–CM21 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for ~~CM2-22~~CM2–CM21. See section 8.3.1.3 for more information.

The water quality impacts of waterborne concentrations of mercury and methylmercury and fish tissue mercury concentrations were evaluated for 9 Delta locations. The analysis of percentage change in assimilative capacity of waterborne total mercury of Alternative 9relative to the 25 ng/L ecological risk benchmark as compared to Existing Conditions showed the greatest decrease of 10.2% at Old River at Rock Slough, and a 10.1% reduction relative to the No Action Alternative at that location (Figures 8-53 and 8-54).Similarly, increases in long term annual average methylmercury concentration are expected to be greatest (approximately 30%) at the Contra Costa Pumping Plant as compared to Existing Conditions and the No Action Alternative (Appendix 8I,*Mercury,* Figure ~~8~~I-9, Table I-6).The concentration of methylmercury is estimated to be 0.163 ng/L at that location, which is greater than Existing Conditions (0.121 ng/L) and the No Action Alternative (0.122 ng/L).All modeled input concentrations exceeded the methylmercury TMDL guidance objective of 0.06 ng/L, therefore percentage change in assimilative capacity was not evaluated for methylmercury.

Fish tissue estimates show some substantial percentage increases in concentration and exceedance quotients for mercury at some Delta locations. The greatest change in exceedance quotients are expected for Old River at Rock Slough with changes of 66% over Existing Conditions, and 59% over the No Action Alternative (Figure 8-558-55a,b, Appendix 8I,*Mercury*, Table I-16b). The Contra Costa Pumping Plant values shows a 62% increase in fish tissue concentrations over Existing Conditions, and 59% over the No Action Alternative (Appendix 8I, Table I-16b). Because these increases are substantial, and it is evident that substantive increases are expected at numerous locations throughout the Delta, these changes may be measurable in the environment. See Appendix 8I for a discussion of the uncertainty associated with the fish tissue estimates.

NEPA Effects: Based on the above discussion, the effects of mercury and methylmercury in comparison of Alternative 9 to the No Action Alternative (as waterborne and bioaccumulated forms) are considered to be adverse for the case of fish tissue bioaccumulation at some locations.

***CEQA Conclusion*:** Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Under Alternative 9, greater water demands and climate change would alter the magnitude and timing of reservoir releases and river flows upstream of the Delta in the Sacramento River watershed and east-side tributaries, relative to Existing Conditions. Concentrations of mercury and methylmercury upstream of the Delta will not be substantially different relative to Existing Conditions due to the lack of important relationships between mercury/methylmercury concentrations and flow for the major rivers.

Methylmercury concentrations exceed criteria at all locations in the Delta and no assimilative capacity exists. However, mMonthly average waterborne concentrations of total and methylmercury, over the period of record, are very similar to Existing Conditions, but showed notable increases at some locations. .Similarly, eEstimates of fish tissue mercury concentrations show almost nosubstantial increases differences would occur among for several sites for Alternative 9 as compared to Existing Conditions for Delta sites.

Assessment of effects of mercury in the SWP and CVP Export Service Areas were based on effects on mercury concentrations and fish tissue mercury concentrations at the Banks and Jones pumping plants. The Banks and Jones pumping plants are expected to show increased assimilative capacity for waterborne mercury and decreased fish tissue concentrations of mercury for Alternative 9 as compared to Existing Conditions.

As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. However, increases in fish tissue mercury concentrations are substantial, and changes in fish tissue mercury concentrations would make existing mercury-related impairment in the Delta measurably worse. In comparison to Existing Conditions, Alternative 9 would increase levels of mercury by frequency, magnitude, and geographic extent such that the affected environment would be expected to have measurably higher body burdens of mercury in aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish) or humans consuming those organisms. This impact is considered to be significant. Feasible or effective actions to reduce the effects on mercury resulting from CM1 are unknown. General mercury management measures through CM12, or actions taken by other entities or programs such as TMDL implementation, may minimize or reduce sources and inputs of mercury to the Delta and methylmercury formation. However, it is uncertain whether this impact would be reduced to a level that would be less than significant as a result of CM12 or other future actions. Therefore, the impact would be significant and unavoidable.

Impact WQ-25: Effects on Selenium Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics~~,~~. To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of ~~CM2-22~~CM2–CM21 not attributable to hydrodynamics, ~~for example,~~such as additional loading of a constituent to the Delta, are discussed within the impact header for ~~CM2-22~~CM2–CM21. See ~~section~~ Section 8.3.1.3 for more information.

Selenium concentrations and threshold comparisons for each of the 11 modeled Delta assessment locations under Alternative 9, relative to Existing Conditions and the No Action Alternative, are presented in Appendix 8M, Selenium, Table M-9a for water, Tables M-19 and M-29 for most biota (whole-body fish ~~(~~[excluding sturgeon~~)~~], bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets) throughout the Delta, and Tables M-30 through M-32 for sturgeon at the two western Delta locations. Figures 8-59a and 8-60a present graphical distributions of predicted selenium concentration changes (shown as changes in available assimilative capacity based on 1.3 µg/L) in water at each modeled assessment location for all years. Appendix 8M, Figure M-24 provides more detail in the form of monthly patterns of selenium concentrations in water during the modeling period.

Alternative 9 would result in small to moderate changes in average selenium concentrations in water at modeled Delta assessment locations relative to Existing Conditions and the No Action Alternative (Appendix 8M, Selenium, Table M-~~10A~~9a). Long-term average concentrations at some interior and western Delta locations would increase by 0.01–0.21 µg/L for the entire period modeled (1976–1991). ~~The various changes in selenium concentrations in water are reflected in small (10% or less) to moderate (between 11% and 50%) changes in available assimilative capacity for selenium (based on 2 µg/L ecological risk benchmark) for all years. Relative to Existing Conditions, Alternative 9 would result in the largest modeled increase in assimilative capacity at Buckley Cove (32%) and the three largest decreases would be at Franks Tract (13%), Rock Slough (19%), and Contra Costa PP (18%) (Figure 8-59). Relative to the No Action Alternative, the largest modeled increase in assimilative capacity would be at Buckley Cove (26%) and the three largest decreases would be at Franks Tract (13%), Rock Slough (19%), and Contra Costa PP (18%) (Figure 8-60). Although there would be moderate (greater than 10%) negative changes in assimilative capacity at three locations (Franks Tract, Rock Slough, and Contra Costa PP), the changes would be minimal (10% or less decrease) at the other locations and the available assimilative capacity at all locations would remain substantial; overall, the effect of Alternative 9 would be generally moderate for portions of the Delta represented by Franks Tract, Rock Slough, and Contra Costa PP. However~~These increases in selenium concentrations in water would result in reductions in available assimilative capacity of 1–19%, relative to the 1.3 µg/L ~~ecological risk benchmark~~USEPA draft water quality criterion (Figures 8-59a and 8-60a). T~~, t~~he ~~ranges of modeled~~ long-term average selenium concentrations in water ~~(Appendix 8M, Table M-10A)~~ for Alternative 9 (range 0.~~23~~09–0.37~~0~~ µg/L) would be similar to, Existing Conditions (range 0.2109–0.7641 μg/L), and the No Action Alternative (range 0.2109–0.6938 μg/L) are similar, and all would be below the ecological risk benchmarkUSEPA draft water quality criterion of 1.3(2 μg/L Appendix 8M, Table M-9a).

Relative to Existing Conditions and the No Action Alternative, Alternative 9 would generally result in minimal small to moderate changes (less than 54%) in estimated selenium concentrations in most biota (whole-body fish (excluding sturgeon), bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets) (Figures 8-61a through 8-64b; Appendix 8M, Table M-20 29and Table 8M-2 in the sturgeon addendum to Appendix 8MAddendum M.A, Selenium in Sturgeon, to Appendix 8M, Table M.A-2).). Despite the small changes in selenium concentrations in biota, Level of Concern Exceedance Quotients (i.e., modeled tissue divided by Level of Concern benchmarks) for selenium concentrations in those biota for all years and for drought years are less than 1.0 (indicating low probability of adverse effects). Similarly, Advisory Tissue Level Exceedance Quotients for selenium concentrations in fish fillets for all years and drought years also are less than 1.0. Estimated selenium concentrations in sturgeon for the San Joaquin River at Antioch are predicted to increase by about 35 percent relativeRelative to Existing Conditions and to the No Action Alternative in all years (from about 4.7 to 6.4 mg/kg dry weight [dw]). Likewise, those for sturgeon in the Sacramento River at Mallard Island are predicted to increase by about 17 percent in all years (from about 4.4 to 5.2 mg/kg dw) (Figure 8-65; Appendix 9M, Tables M-30 and M-31). Selenium concentrations in sturgeon during drought years are expected to increase by about 35 percent at Antioch and 17 percent at Mallard Island. Detection of changes in whole-body sturgeon such as those estimated for the western Delta may require large sample sizes because of the inherent variability in fish tissue selenium concentrations. Low Toxicity Threshold Exceedance Quotients for selenium concentrations in sturgeon in the western Delta would exceed 1.0 for drought years at both locations (as they do for Existing Conditions and the No Action Alternative; Figure 8-65 and Appendix 8M, Table M-32) and for all years at both locaitonsAntioch, whereas Existing Conditions and the No Action Alternative do not (quotient increases from 0.94 to 1.3 at Antioch and from 0.88 at Sacramento River at Mallard Island to 1.0) (Appendix 8M, Table M-32). High Toxicity Threshold Exceedance Quotients for selenium concentrations in sturgeon in the western Delta would exceed 1.0 for drought years at Antioch (where quotient increases from 0.85 to 1.2), and at Mallard Island (where quotient increases from 0.85 to 1.0) unlike Existing Conditions and the No Action Alternative (Appendix 8M, Table M-32).and the No Action Alternative, the largest increase of selenium concentrations in biota would be at Rock Slough and Contra Costa PP for drought years and in sturgeon at the two western Delta locations in all as well as drought years, and the largest decrease would be at Buckley Cove for drought years. Except for sturgeon in the western Delta, concentrations of selenium in whole-body fish and in bird eggs (invertebrate and fish diets) would exceed the lower benchmarks (4 and 6 mg/kg dry weight, respectively, indicating a low potential for effects), under drought conditions, at Buckley Cove for Existing Conditions and the No Action Alternative, and at Rock Slough and Contra Costa PP for Alternative 9 (Figures 8-61 through 8-63). Exceedance Quotients quotients for these comparisons to the lower benchmarks are between 1.0 and 1.5, indicating a low risk to biota in the Delta, but modeled selenium concentrations in whole-body fish and in bird eggs (invertebrate and fish diets) exceed those benchmarks at two locations where they do not exceed under Existing Conditions and the No Action Alternative. Selenium concentrations in fish fillets would not exceed the screening value for protection of human health (Figure 8-64). For sturgeon in the western Delta, whole-body selenium concentrations would increase from 12.3 mg/kg under Existing Conditions and the No Action Alternative to 15.1 mg/kg under Alternative 9, a 23% increase (Table 8M-2 in the sturgeon addendum to Appendix 8MAddendum M.A, Selenium in Sturgeon, Table M.A-2). All of these values exceed both the low and high toxicity benchmarks. The predicted increases are high enough that they may represent a measurable increase in body burdens of sturgeon, which would constitute an adverse impact (see also the discussion of results provided in the sturgeonaddendum M.A, Selenium in Sturgeon,to Appendix 8M).

The disparity between larger estimated changes for sturgeon and smaller changes for other biota are attributable largely to differences in modeling approaches, as described in Appendix 8M, Selenium. The model for most biota was calibrated to encompass the varying concentration-dependent uptake from waterborne selenium concentrations (expressed as the Kd, which is the ratio of selenium concentrations in particulates [as the lowest level of the food chain] relative to the waterborne concentration) that was exhibited in data for largemouth bass in 2000, 2005, and 2007 at various locations across the Delta. In contrast, the modeling for sturgeon could not be similarly calibrated at the two western Delta locations and used literature-derived uptake factors and trophic transfer factors for the estuary from Presser and Luoma (2013). As noted in the appendix, there was a significant negative log-log relationship of Kd to waterborne selenium concentration that reflected the greater bioaccumulation rates for bass at low waterborne selenium than at higher concentrations. (There was no difference in bass selenium concentrations in the Sacramento River at Rio Vista in comparison to the San Joaquin River at Vernalis in 2000, 2005, and 2007 [Foe 2010], despite a nearly 10-fold difference in waterborne selenium.) Thus, there is more confidence in the site-specific modeling based on the Delta-wide model that was calibrated for bass data than in the estimates for sturgeon based on "fixed" Kds for all years and for drought years without regard to waterborne selenium concentration at the two locations in different time periods.

Increased water residence times could increase the bioaccumulation of selenium in biota, thereby potentially increasing fish tissue and bird egg concentrations of selenium (see residence time discussion in Appendix 8M, *Selenium*, and Presser and Luoma [2010b]). Thus, residence time was assessed for its relevance to selenium bioaccumulation. Table 60a (presented originally in Section 8.3.1.7 in the *Microcystis* subsection) shows the time for neutrally buoyant particles to move through the Delta (surrogate for flow and residence time). Although an increase in residence time throughout the Delta is expected under the No Action Alternative, relative to Existing Conditions (because of climate change and sea level rise), the change is fairly small in most areas of the Delta. Thus, the changes in residence times between Alternative 9 and the No Action Alternative are very similar to the changes in residence times between Alternative 9 and the Existing Conditions.

Relative to Existing Conditions and the No Action Alternative, increases in residence times for Alternative 9 would be greater in the South Delta than in other sub-regions. Relative to Existing Conditions, annual average residence times for Alternative 9 in the South Delta are expected to increase by more than 18 days (Table 60a) and by more than 16 days relative to the No Action Alternative. Increases in residence times for other sub-regions would be smaller, especially as compared to Existing Conditions and the No Action Alternative As mentioned above, these results incorporate hydrodynamic effects of both CM1 and CM2 and CM4, and the effects of CM1 cannot be distinguished from the effects of CM2 and CM4. However, it is expected that CM2 and CM4 are substantial drivers of the increased residence time.

Presser and Luoma (2010b) summarized and discussed selenium uptake in the Bay-Delta (including hydrologic conditions [e.g., Delta outflow and residence time for water], K_ds [the ratio of selenium concentrations in particulates, as the lowest level of the food chain, relative to the water-borne concentration], and associated tissue concentrations [especially in clams and their consumers, such as sturgeon]). When the Delta Outflow Index (daily average flow per month) decreased by five-fold (73,732 cubic feet per second [cfs] in June 1998 to 12, 251 cfs in October 1998), residence time doubled (from 11 to 22 days) and the calculated mean K_d also doubled (from 3,198 to 6,501). However, when daily average Delta outflow in November 1999 was only 6,951 cfs (i.e., about one-half that in October 1998) and residence time was 70 days, the calculated mean K_d (7,614) did not increase proportionally.

Models are not available to quantitatively estimate the level of changes in selenium bioaccumulation as related to residence time, but the effects of residence time are incorporated in the bioaccumulation modeling for selenium that was based on higher K_d values for drought years in comparison to wet, normal, or all years; see Appendix 8M, *Selenium*. If increases in fish tissue or bird egg selenium were to occur, the increases would likely be of concern only where fish tissues or bird eggs are already elevated in selenium to near or above thresholds of concern. That is, where biota concentrations are currently low and not approaching thresholds of concern (which, as discussed above, is the case throughout the Delta, except for sturgeon in the western Delta), changes in residence time alone would not be expected to cause them to then approach or exceed thresholds of concern. In consideration of this factor, although the Delta as a whole is a CWA Section 303(d)-listed water body for selenium, and although monitoring data of fish tissue or bird eggs in the Delta are sparse, the most likely area in which biota tissues would be at levels high enough that additional bioaccumulation due to increased residence time from restoration areas would be a concern is the western Delta and Suisun Bay for sturgeon, as discussed above. As shown in Table 60a, the overall increase in residence time estimated in the western Delta is 3 days relative to Existing Conditions, and 1 day relative to the No Action Alternative. Given the available information, these increases are small enough that they are not expected to substantially affect selenium bioaccumulation in the western Delta. Because CM2 and CM4 are expected to be substantial drivers of the increased residence times, further discussion is included in Impact WQ-26 below.

In summary, ~~R~~relative to Existing Conditions and the No Action Alternative, Alternative 9 would result in small changes in selenium concentrations throughout the Delta for most biota (less than ~~5~~4%), although larger increases in selenium concentrations are predicted for sturgeon in the western Delta. Concentrations of selenium in sturgeon would only exceed the lower benchmark for both western Delta locations for all years and drought years, indicating a low potential for effects. ~~with the exception of San Joaquin River at Antioch and Sacramento River at Mallard Island for drought years. The High Toxicity Threshold Exceedance Quotient for selenium concentrations for sturgeon in the western Delta in drought years at Antioch would increase from about 0.85 for Exsiting Conditions and the No Action Alternativce to 1.1 and at Mallard Island from 0.87 to 1.0.~~ Concentrations of selenium in sturgeon would exceed the higher benchmark for Antioch only in drought years, indicating a high potential for effects. The modeling of bioaccumulation for sturgeon is less calibrated to site-specific conditions than that for other biota, which was calibrated on a robust dataset for modeling of bioaccumulation in largemouth bass as a representative species for the Delta. Overall, the predicted increase for Alternative 9 are high enough that they may represent a measureable increase in body burdens of sturgeon, which would constitute an adverse impact.

~~Under Alternative 9, the most notable effect on selenium concentrations in water would be the increase at Rock Slough, Franks Tract, and Contra Costa PP, decreasing the available assimilative capacity and increasing the selenium concentrations in biota at those locations. Alternative 9 is the only action alternative that would exceed benchmarks for biota that are not exceeded under Existing Conditions and the No Action Alternative (and only at Rock Slough and Contra Costa PP); this level of bioaccumulation is predicted despite the conclusion that selenium concentrations in water would not exceed ecological benchmarks at any location and the assimilative capacity would remain substantial. The foremost difference between Alternative 9 and the other alternatives is the~~

~~exceedances of risk-based benchmarks for biota at Rock Slough and Contra Costa PP (and a large increase in tissue concentrations predicted at Franks Tract, although the tissue benchmarks would not be exceeded) compared to the exceedances at Buckley Cove for Existing Conditions and the No Action Alternativeand the other alternatives. In essence, the location where selenium bioaccumulation is highest would be displaced from Buckley Cove to Rock Slough, Franks Tract, and Contra Costa PP. Therefore, selenium concentrations in water and biota within the Delta would also differ spatially for Alternative 9 compared to Existing Conditions and the No Action Alternative and the other action alternatives, and under Alternative 9 could increase the frequency with which applicable benchmarks would be exceeded in some regions of the Delta or substantially degrade the quality of water with respect to beneficial uses in the Delta.~~

SWP/CVP Export Service Areas

Alternative 9 would result in ~~small to~~ moderate ~~changes~~ decreases in average selenium concentrations in water at the Banks and Jones pumping plants, relative to Existing Conditions and the No Action Alternative, for the entire period modeled (Appendix 8M, *Selenium*, Table M-~~10A~~9a). ~~These changes are reflected in the small (10% or less) to moderate (between 11% and 50%) changes in available assimilative capacity for selenium for all years. Relative to Existing Conditions and the No Action Alternative, Alternative 9 would result in increases in assimilative capacity at Jones PP (12% and 13%, respectively) and at Banks PP (5%) (Figures 8-59 and 8-60), so it would have a positive effect at the Export Service Area locations.~~ These decreases in long-term average selenium concentrations in water would result in increases in available assimilative capacity for selenium at these pumping plants of 5–12%, relative to the 1.3 µg/L ~~ecological risk benchmark~~USEPA draft water quality criterion (Figures 8-59a and 8-60a). Furthermore, ~~T~~the ~~ranges of modeled~~ long-term average selenium concentrations in water ~~(Appendix 8M, Table M-10A)~~ for Alternative 9 (range 0.~~32~~16–0.~~40~~17 µg/L)~~, Existing Conditions (range 0.37–0.58 µg/L), and the No Action Alternative (range 0.37–0.59 µg/L) are similar, and all~~ would be well below the ~~ecological risk benchmark~~USEPA draft water quality criterion ~~(~~of ~~2~~1.3 µg/L (Appendix 8M, Table M-9a).

Relative to Existing Conditions and the No Action Alternative, Alternative 9 would result in ~~minimal~~ small changes (less than ~~5~~3%) in estimated selenium concentrations in biota (whole-body fish, bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets) at export service areas (Figures 8-61a through 8-64b; Appendix 8M, Table M-~~20~~29). ~~Relative to Existing Conditions and the No Action Alternative, the largest increase of selenium concentrations in biota would be at Banks PP for all years. Relative to all Existing Conditions and the No Action Alternative, the largest decrease of selenium concentrations in biota would be at Jones PP for drought years. Selenium c~~Concentrations in biota would not exceed any selenium benchmarks for Alternative 9 (Figures 8-61a through 8-64b).

~~Thus, relative to Existing Conditions and the No Action Alternative, Alternative 9 would result in small to moderate changes in selenium concentrations in water and minimal changes in selenium concentrations in biota at the Export Service Area locations. Selenium concentrations in water and biota generally would decrease under Alternative 9 and would not exceed ecological benchmarks at either location, whereas the lower benchmark for bird eggs (fish diet) would be exceeded under Existing Conditions and the No Action Alternativeat Jones PP under drought conditions. This small positive change in selenium concentrations under Alternative 9 would be expected to slightly decrease the frequency with which applicable benchmarks would be exceeded or slightly improve the quality of water at the Export Service Area locations, with regard to selenium.~~

NEPA Effects: Based on the discussion above, the effects on selenium from Alternative 9 are considered to be adverse. This determination is reached because ~~1) modeled selenium concentrations in water would increase at Rock Slough, Franks Tract, and Contra Costa PP, decreasing the available assimilative capacity by more than 10 percent at each of those locations; 2) selenium concentrations in whole-body fish and in bird eggs (invertebrate and fish diets) at those locations would increase so that Level of Concern benchmarks for biota that are not exceeded under the No Action Alternative would be exceeded at Rock Slough and Contra Costa PP (and approach exceedance at Franks Tract); and~~ selenium concentrations in whole-body sturgeon modeled at two western Delta locations would increase by an ~~estimated~~ average of ~~23~~26%, which may represent a measurable increase in the environment. ~~Because both low and high toxicity benchmarks are already exceeded under the No Action Alternative, t~~These potentially measurable increases represent an adverse impact.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for selenium. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

There are no substantial point sources of selenium in watersheds upstream of the Delta, and no substantial nonpoint sources of selenium in the watersheds of the Sacramento River and the eastern tributaries. Nonpoint sources in the San Joaquin Valley that contribute selenium to the Delta will be controlled through a TMDL developed by the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the Grassland Bypass Project, and Basin Plan objectives (Central Valley Water Board 2010~~c~~d) and State Water Board (2010~~d~~b, 2010~~e~~c) that are expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta. Consequently, any modified reservoir operations and subsequent changes in river flows under Alternative 9, relative to Existing Conditions, are expected to cause negligible changes in selenium concentrations in water. Any negligible changes in selenium concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies as related to selenium.

Relative to Existing Conditions, modeling estimates indicate that Alternative 9 would result in ~~essentially no~~ small changes in selenium concentrations in water or most biota through the Delta, ~~which~~with no exceedances of benchmarks for biological effects. Relative to Existing Conditions, modeling estimates indicate that Alternative 9 would ~~result in essentially no change in~~ increase selenium concentrations in whole-body sturgeon modeled at two western Delta locations by an average of 26% , which may represent a measurable increase in the environment. Because both low and high toxicity benchmarks are exceeded, these poten~~eitl~~ially measurable increases represent a potential impact to ~~aquatic life~~ fish and wildlife beneficial uses. ~~Relative to Existing Conditions, modeling estimates indicate that selenium concentrations in water and biota within the Delta would differ spatially for Alternative 9 compared to Existing Conditions, and the differences would be substantial. Under Alternative 9, modeled selenium concentrations in water would increase at Rock Slough, Franks Tract, and Contra Costa PP, decreasing the available assimilative capacity by more than 10 percent at each of those locations; consequently, selenium concentrations in whole-body fish and in bird eggs (invertebrate and fish diets) at those locations would increase so that Level of Concern benchmarks for biota that are not exceeded under Existing Conditions would be exceeded at Rock Slough and Contra Costa PP (and approach exceedance at Franks Tract). Additionally,~~

~~relative to Existing Conditions, modeling estimates indicate that Alternative 9 would increase selenium concentrations in whole-body sturgeon modeled at two western Delta locations by an estimated 23%, which may represent a measurable increase in the environment. Because both low and high toxicity benchmarks are already exceeded under Existing Conditions, these potentially measurable increases represent a potential impact to aquatic life beneficial uses.~~

The a~~A~~ssessment of effects of selenium in the SWP/~~ and~~ CVP Export Service Areas is based on effects on selenium concentrations at the Banks and Jones pumping plants. Relative to Existing Conditions, Alternative 9 would ~~slightly decrease~~ cause no ~~change~~ increase in the frequency with which applicable benchmarks would be exceeded, and would ~~(there would be none) or~~ slightly improve the quality of water in selenium concentrations at the Banks and Jones pumping plants~~ locations~~.

Based on the above, although waterborne selenium concentrations would not exceed applicable water quality objectives/criteria, however, significant impacts on some beneficial uses of waters in the Delta could occur because uptake of selenium from water to biota would be expected to increase above potential effects levels at some locations, and in the western Delta where concentrations in sturgeon exceed both low and high toxicity benchmarks under Existing Conditions, uptake of selenium from water to sturgeon may measurably increase. In comparison to Existing Conditions, water quality conditions under this alternative would increase levels of selenium (a bioaccumulative pollutant) by frequency, magnitude, and geographic extent such that the affected environment would be expected to have measurably higher body burdens of selenium in aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish); however, impacts to humans consuming those organisms are not expected to occur. Water quality conditions under this alternative with respect to selenium would cause long-term degradation of water quality in the western Delta~~, and conditions at Rock Slough and Contra Costa PP (and the regions of the Delta they represent) are expected to result in exceedance of selenium thresholds in some biota, indicating a level of risk greater than under Existing Conditions~~. Except in the vicinity of the western Delta, ~~Rock Slough, and Contra Costa PP (and the region of the Delta they represent),~~ water quality conditions under this alternative would not increase levels of selenium by frequency, magnitude, and geographic extent such that the affected environment would be expected to have measurably higher body burdens of selenium in aquatic organisms. The greater level of selenium bioaccumulation in the ~~vicinities of the~~ western Delta~~, Rock Slough, and Contra Costa PP~~ would further degrade water quality by measurable levels, on a long-term basis, for selenium and, thus, cause the CWA Section 303(d)-listed impairment of beneficial use to be made discernibly worse. This impact is considered significant. Environmental Commitment: Selenium Management (AMM27), which affords for site-specific measures to reduce effects, would be available to reduce BDCP-related effects associated with selenium. The effectiveness of AMM27 is uncertain and, therefore implementation may not reduce the identified impact to a level that would be less than significant, and therefore it is significant and unavoidable.

The need for, and the feasibility and effectiveness of, post-operation mitigation for the predicted level of selenium bioaccumulation is uncertain. The first step shall be to determine the reliability of the model in predicting biota selenium concentrations in the affected environment where effects are predicted but selenium data are lacking. For that reason, the model shall be validated with site-specific sampling before extensive mitigation measures relative to CM1 operations are developed and evaluated for feasibility, as the measures and their evaluation for feasibility are likely to be complex. Specifically, it remains to be determined whether the available existing data for transfer of selenium from water to particulates and through different trophic levels of the food chain are representative of conditions that may occur from implementation of Alternative 9. Therefore, the proposed mitigation measure requires that sampling be conducted to characterize each step of data inputs needed for the model, and then the refined model be validated for local conditions. This impact is considered significant and unavoidable.

Impact WQ-26: Effects on Selenium Concentrations Resulting from Implementation of CM2–~~CM22~~CM21

NEPA Effects**:** Effects of CM2–CM21 on selenium under Alternative 9 are the same as those discussed for Alternative 1A and are considered not to be adverse.

CEQA Conclusion**:** CM2–CM21 proposed under Alternative 9 would be similar to those proposed under Alternative 1A. As such, effects on selenium resulting from the implementation of CM2–CM21 would be similar to that previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

~~***NEPA Effects*****:** In general, with the possible exception of changes in Delta hydrodynamics resulting from habitat restoration, CM2–CM11 would not substantially increase selenium concentrations in the water bodies of the affected environment. Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, and thus such effects of these restoration measures were included in the assessment of CM1 facilities operations and maintenance (see Impact WQ-25).~~

~~However, iImplementation of these conservation measures may increase water residence time within the restoration areas. Increased restoration area water residence times could potentially increase the bioaccumulation of selenium in biota, thereby potentially increasing fish tissue and bird egg concentrations of selenium, but m. Models are not available to quantitatively estimate the level of changes in residence time and the associated selenium bioavailability, but the effects of residence time are incorporated in the bioaccumulation modeling for selenium that was based on higher K_d values (the ratio of selenium concentrations in particulates [as the lowest level of the food chain] relative to the water-borne concentration) for drought years in comparison to wet, normal, or all years; see Appendix 8M, *Selenium*. If increases in fish tissue or bird egg selenium were to occur, the increases would likely be of concern only where fish tissues or bird eggs are already elevated in selenium to near or above thresholds of concern. That is, where biota concentrations are currently low and not approaching thresholds of concern, changes in residence time alone would not be expected to cause them to then approach or exceed thresholds of concern. In consideration of this factor, although the Delta as a whole is a 303(d)-listed water body for selenium, and although monitoring data of fish tissue or bird eggs in the Delta are sparse, the most likely areas in which biota tissues would be at levels high enough that additional bioaccumulation due to increased residence time from restoration areas would be a concern are the western Delta and Suisun Bay, and the South Delta in areas that receive San Joaquin River water.~~

~~The western Delta and Suisun Bay receive elevated selenium loads from North San Francisco Bay (including San Pablo Bay, Carquinez Strait, and Suisun Bay) and from the San Joaquin River. Point sources of selenium in North San Francisco Bay (i.e., refineries) that contribute selenium to Suisun Bay are expected to be reduced through a TMDL under development by the San Francisco Bay Water Board (San Francisco Bay Water Board 2012) that is expected to result in decreasing discharges of selenium. Nonpoint sources of selenium in the San Joaquin Valley that contribute selenium to the San Joaquin River, and thus the Delta and Suisun Bay, will be controlled through a TMDL developed by the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the Grassland Bypass Project, and Basin Plan objectives (Central Valley Water Board 2010c, d) that are~~

expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta. If selenium levels are not sufficiently reduced via these efforts, it is expected that the State Water Board and the San Francisco Bay and Central Valley Water Boards would initiate additional actions to further control sources of selenium.

The South Delta receives elevated selenium loads from the San Joaquin River. In contrast to Suisun Bay and possibly the western Delta in the future, the South Delta lacks the overbite clam (*Corbula* [*Potamocorbula*] *amurensis*), which is considered a key driver of selenium bioaccumulation in Suisun Bay, due to its high bioaccumulation of selenium and its role in the benthic food web that includes long-lived sturgeon. The South Delta does have *Corbicula fluminea*, another bivalve that bioaccumulates selenium, but it is not as invasive as the overbite clam and thus likely makes up a smaller fraction of sturgeon diet. Also, as mentioned above, nonpoint sources of selenium in the San Joaquin Valley that contribute selenium to the Delta will be controlled through a TMDL developed by the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the Grassland Bypass Project, and Basin Plan objectives (Central Valley Water Board 2010c, d) that are expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta. Further, if selenium levels in the San Joaquin River are not sufficiently reduced via these efforts, it is expected that the State Water Board and Central Valley Water Board would initiate additional TMDLs to further control nonpoint sources of selenium.

Wetland restoration areas will not be designed such that water flows in and does not flow out. Exchange of water between the restoration areas and existing Delta channels is an important design factor, since one goal of the restoration areas is to export food produced in these areas to the rest of the Delta (see BDCP Chapter 3, *Conservation Strategy*, Section 3.3, Biological Goals and Objectives). Thus, these areas can be thought of as “flow-through” systems. Consequently, althoughwater residence times associated with BDCP restoration could increase, they are not expected toincrease without bound. and selenium concentrations in the water column would not continue to build up and be recycled in sediments and organisms as may be the case within a closed system.

However, because increases in bioavailable selenium in the habitat restoration areas are uncertain, proposed avoidance and minimization measureswould require evaluating risks of selenium exposure at a project level for each restoration area, minimizing to the extent practicable potential risk of additional bioaccumulation, and monitoring selenium levels in fish and/or wildlife to establish whether, or to what extent, additional bioaccumulation is occurring. See Appendix 3B, *Environmental Commitments* for a description of the environmental commitment BDCP proponents are making with respect to Selenium Management; and Appendix 3.C. of the BDCP for additionaldetail on this avoidance and minimization measure (AMM27). Data generated as part of the avoidance and minimization measures will assist the State and Regional Water Boards in determining whether beneficial uses are being impacted by selenium, and thus will provide the data necessary to support regulatory actions (including additional TMDL development), should such actions be warranted.

Given the factors discussed in the assessment above, any increases in bioaccumulation rates from water-borne selenium that could occur in some areas as a result of increased water residence time would not be of sufficient magnitude and geographic extent that any portion of the Delta would be expected to have measurably higher body burdens of selenium in aquatic organisms and, therefore, would not substantially increase risk for adverse effects to beneficial uses. Furthermore, although the Delta is a 303(d)-listed water body for selenium, given the discussion in the assessment above, it is unlikely that restoration areas would result in measurable increases in selenium in fish tissues or bird eggs such that the beneficial use impairment would be made discernibly worse.

Because it is unlikely that substantial increases in selenium in fish tissues or bird eggs would occur such that effects on aquatic life beneficial uses would be anticipated, and because of the avoidance and minimization measures that are designed to further minimize and evaluate the risk of such increases, the effects of WQ-26 are considered not adverse.

***CEQA Conclusion*:** There would be no substantial, long-term increase in selenium concentrations in water in the rivers and reservoirs upstream of the Delta, water in the Delta, or the waters exported to the CVP and SWP service areas due to implementation of CM2–CM22CM21 relative to Existing Conditions. Waterborne selenium concentrations under this alternative would not exceed applicable water quality objectives/criteria.

Given the factors discussed in the assessment above, any increases in bioaccumulation rates from water-borne selenium that could occur in some areas as a result of increased water residence times would not be of sufficient magnitude and geographic extent that any portion of the Delta wouldbe expected to have measurably higher body burdens of selenium in aquatic organisms, and therefore would not substantially increase risk for adverse effects to beneficial uses. CM2-22 would not cause long-term degradation of water quality resulting in sufficient use of available assimilative capacity such that occasionally exceeding water quality objectives/criteria would be likely. Also, CM2-22CM2 through CM22CM2–CM21 would not result in substantially increased risk for adverse effects to any beneficial uses. Furthermore, although the Delta is a 303(d)-listed water body for selenium, given the discussion in the assessment above, it is unlikely that restoration areas would result in measurable increases in selenium in fish tissues or bird eggs such that the beneficial use impairment would be made discernibly worse.

Since Because it is unlikely that substantial increases in selenium in fish tissues or bird eggs would occur such that effects on aquatic life beneficial uses would be anticipated, and because of the avoidance and minimization measures that are designed to further minimize and evaluate the risk of such increases (see Appendix 3.C. of the BDCP for more detail on AMM27) as well as the Selenium Management environmental commitment (see Appendix 3B, *Environmental Commitments*), this impact is considered less than significant. No mitigation is required.

Impact WQ-32. Effects on *Microcystis* Bloom Formation Resulting from Facilities Operations and Maintenance (CM1).

Effects of facilities and operations (CM1) on *Microcystis* abundance, and thus microcystins concentrations, in water bodies of the affected environment under Alternative 9 would be very similar (i.e., nearly the same) to those discussed for Alternative 1A. This is because factors that affect *Microcystis* abundance in waters upstream of the Delta, in the Delta, and in the SWP/CVP Export Services Areas under Alternative 1A would similarly change under Alternative 9, relative to Existing Conditions and the No Action Alternative. For the Delta in particular, there are differences in the direction and magnitude of water residence time changes during the *Microcystis* bloom period among the six Delta sub-regions under Alternative 9 compared to Alternative 1A, relative to Existing Conditions and No Action Alternative. However, under Alternative 9, relative to Existing Conditions and No Action Alternative, water residence times during the *Microcystis* bloom period in various Delta sub-regions are expected to increase to a degree that could, similar to Alternative 1A, lead to an increase in the frequency, magnitude, and geographic extent of *Microcystis* blooms throughout the Delta.

Similar to Alternative 1A, water exported from the Delta to the SWP/CVP Export Service Areas will consist of a mixture of water from the south Delta that is affected by *Microcystis* and Sacramento River water diverted from the north Delta that is unaffected by *Microcystis*. Sacramento River water will be conveyed through existing Delta channels under Alternative 9, in contrast to pipelines or tunnels which will be constructed to convey this water under Alternative 1A. Under Alternative 9, Delta channels, gates and barriers will be operated and maintained to convey Sacramento River water to the south Delta pump intakes in manner to maintain the water quality of this source water. Thus, it is expected that diverted Sacramento River water will remain relatively unaffected by *Microcystis* until it mixes with *Microcystis*-affected water from the south Delta at Banks and Jones pumping plants. For the same reasons described for Alternative 1A, it cannot be determined whether operations and maintenance under Alternative 9, relative to existing conditions, will result in increased or decreased levels of *Microcystis* and microcystins in the mixture of source waters exported from Banks and Jones pumping plants.

Similar to Alternative 1A, elevated ambient water temperatures relative to Existing Conditions would occur in the Delta under Alternative 9, which could lead to earlier occurrences of *Microcystis* blooms in the Delta, and increase the overall duration and magnitude of blooms. However, the degradation of water quality from *Microcystis* blooms due to the expected increases in Delta water temperatures is driven entirely by climate change, not effects of CM1. While *Microcystis* blooms have not occurred in the Export Service Areas, conditions in the Export Service Areas under Alternative 9 may become more conducive to *Microcystis* bloom formation, relative to Existing Conditions, because water temperatures will increase in the Export Service Areas due to the expected increase in ambient air temperatures resulting from climate change.

NEPA Effects: Effects of water facilities and operations (CM1) on Microcystis in water bodies of the affected environment under Alternative 9 would be very similar to (i.e., nearly the same) to those discussed for Alternative 1A. In summary, Alternative 9 operations and maintenance, relative to the No Action Alternative, would result in long-term increases in hydraulic residence time of various Delta sub-regions during the summer and fall Microcystis bloom period. During this period, the increased residence time could result in a concurrent increase in the frequency, magnitude, and geographic extent of Microcystis blooms, and thus microcystin levels, in affected areas of the Delta. As a result, Alternative 9 operation and maintenance activities would cause further degradation to water quality with respect to Microcystis in the Delta. Under Alternative 9, relative to No Action Alternative, water exported to the SWP/CVP Export Service Area will be a mixture of Microcystis-affected source water from the south Delta intakes and unaffected source water from the Sacramento River, diverted at the north Delta intakes. It cannot be determined whether operations and maintenance under Alternative 9 will result in increased or decreased levels of Microcystis and microcystins in the mixture of source waters exported from Banks and Jones pumping plants. Mitigation Measure WQ-32a and WQ-32b are available to reduce the effects of degraded water quality in the Delta. Although there is considerable uncertainty regarding this impact, the effects on Microcystis from implementing CM1 is determined to be adverse.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Under Alternative 9, additional impacts from *Microcystis* in the reservoirs and watersheds upstream of the Delta are not expected, relative to Existing Conditions. Operations and maintenance occurring under Alternative 9 is not expected to change nutrient levels in upstream reservoirs or hydrodynamic conditions in upstream rivers and streams such that conditions would be more conductive to *Microcystis* production.

Relative to Existing Conditions, water temperatures and hydraulic residence times in the Delta are expected to increase under Alternative 9, resulting in an increase in the frequency, magnitude and geographic extent of *Microcystis* blooms in the Delta. However, the degradation of water quality from *Microcystis* blooms due to the expected increases in Delta water temperatures is driven entirely by climate change, not effects of CM1. Increases in Delta residence times are expected throughout the Delta during the summer and fall bloom period, due in small part to climate change and sea level rise, but due more proportionately to CM1 and the hydrodynamic impacts of restoration included in CM2 and CM4. The precise change in local residence times and *Microcystis* production expected within any Delta sub-region is unknown because conditions will vary across the complex networks of intertwining channels, shallow back water areas, and submerged islands that compose the Delta. Nonetheless, Delta residence times are, in general, expected to increase due to Alternative 9. Consequently, it is possible that increases in the frequency, magnitude, and geographic extent of *Microcystis* blooms in the Delta will occur due to the operations and maintenance of Alternative 9 and the hydrodynamic impacts of restoration (CM2 and CM4).

The assessment of effects of *Microcystis* on SWP/CVP Export Service Areas is based on the assessment of changes in *Microcystis* levels in export source waters, as well as the effects of temperature and residence time changes within the Export Service Areas on *Microcystis* production. Under Alternative 9, relative to Existing Conditions, the potential for *Microcystis* to occur in the Export Service Area is expected to increase due to increasing water temperature, but this impact is driven entirely by climate change and not Alternative 9. Water exported from the Delta to the Export Service Area is expected to be a mixture of *Microcystis*-affected source water from the south Delta intakes and unaffected source water from the Sacramento River. Because of this, it cannot be determined whether operations and maintenance under Alternative 9, relative to existing conditions, will result in increased or decreased levels of *Microcystis* and microcystins in the mixture of source waters exported from Banks and Jones pumping plants.

Based on the above, this alternative would not be expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause significant impacts on any beneficial uses of waters in the affected environment. *Microcystis* and microcystins are not 303(d) listed within the affected environment and thus any increases that could occur in some areas would not make any existing *Microcystis* impairment measurably worse because no such impairments currently exist. Because *Microcystis* and microcystins are not bioaccumulative, increases that could occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. However, because it is possible that increases in the frequency, magnitude, and geographic extent of *Microcystis* blooms in the Delta will occur due to the operations and maintenance of Alternative 9 and the hydrodynamic impacts of restoration (CM2 and CM4), long-term water quality degradation may occur and, thus, significant impacts on beneficial uses could occur. Although there is considerable uncertainty regarding this impact, the effects on *Microcystis* from implementing CM1 is determined to be significant.

Implementation of Mitigation Measure WQ-32a and WQ-32b may reduce degradation of Delta water quality due to *Microcystis*. However, because the effectiveness of these mitigation measures to result in feasible measures for reducing water quality effects is uncertain, this impact is considered to remain significant and unavoidable.

Impact WQ-33. Effects on *Microcystis* Bloom Formation Resulting from Other Conservation Measures (CM2-–CM21).

The effects of CM2–CM21 on Microcystis under Alternative 9 are the same as those discussed for Alternative 1A. In summary, potential environmental effects related to CM2 and CM4 could result in an increase in the frequency, magnitude, and geographic extent of Microcystis blooms in the Delta, relative to Existing Conditions and the No Action Alternative, as a result of increased residence times for Delta waters from implementing CM2 and CM4 restoration areas. -Because the hydrodynamic effects associated with implementing CM2 and CM4 were incorporated into the modeling used to assess CM1, a detailed assessment of the effects of implementing CM2 and CM4 on Microcystis blooms in the Delta via theire effects on Delta water residence time is provided under CM1 (above). The effects of CM-2 and CM-4 on Microcystis may be reduced by implementation of Mitigation Measures WQ-32A and WQ-32b. The effectiveness of these mitigation measures to result in feasible measures for reducing water quality effects is uncertain. Conservation Measures 3 (CM3) and CM5-CM21 would not result in an increase in the frequency, magnitude, and geographic extent of Microcystis blooms in the Delta.

NEPA Effects: Effects of CM2–CM21on Microcystis under Alternative 9 are the same as those discussed for Alternative 1A and are considered to be adverse.

CEQA Conclusion: Based on the above, this alternative would not be expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause significant impacts on any beneficial uses of waters in the affected environment. Microcystis and microcystins are not 303(d) listed within the affected environment and thus any increases that could occur in some areas would not make any existing Microcystis impairment measurably worse because no such impairments currently exist. Because Microcystis and microcystins are not bioaccumulative, increases that could occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. Because restoration actions implemented under CM2 and CM4 will increase residence time throughout the Delta and create local areas of warmer water during the bloom season, it is possible that increases in the frequency, magnitude, and geographic extent of Microcystis blooms, and thus long-term water quality degradation and significant impacts on beneficial uses, could occur. Although there is considerable uncertainty regarding this impact, the effects on Microcystis from implementing CM2–CM21 are determined to be significant.

Impact WQ-34: Effects on San Francisco Bay Water Quality Resulting from Facilities Operations and Maintenance (CM1) and Implementation of CM2–CM21

The effects analysis presented in the preceding impacts (Impact WQ-1 through WQ-33) concluded that Alternative 9 would have a less than significant impact/no adverse effect on the following constituents in the Delta:

- Boron
- Dissolved Oxygen

- Pathogens
- Pesticides
- Trace Metals
- Turbidity and TSS

Elevated concentrations of boron are of concern in drinking and agricultural water supplies. However, waters in the San Francisco Bay are not designated to support municipal water supply (MUN) and agricultural supply (AGR) beneficial uses. Changes in Delta dissolved oxygen, pathogens, pesticides, and turbidity and TSS are not anticipated to be of a frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of the Delta. Thus, changes in boron, dissolved oxygen, pathogens, pesticides, and turbidity and TSS in Delta outflow are not anticipated to be of a frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of the of San Francisco Bay.

The effects of Alternative 9 on bromide, chloride, and DOC, in the Delta were determined to be significant/adverse. Increases in bromide, chloride, and DOC concentrations are of concern in drinking water supplies; however, as described previously, the San Francisco Bay does not have a designated MUN use. Thus, changes in bromide, chloride, and DOC in Delta outflow would not adversely effect any beneficial uses of San Francisco Bay.

Elevated EC, as assessed for this alternative, is of concern for its effects on the agricultural beneficial use (AGR) and fish and wildlife beneficial uses. As discussed above, San Francisco Bay does not have an AGR beneficial use designation. Further, as discussed for the No Action Alternative, c

While effects of Alternative 9 on the nutrients ammonia, nitrate, and phosphorus were determined to be less than significant/not adverse, these constituents are addressed further below because the response of the seaward bays to changed nutrient concentrations/loading may differ from the response of the Delta. Selenium and mercury are discussed further, because they are bioaccumulative constituents where changes in load due to both changes in Delta concentrations and exports are of concern.

Nutrients: Ammonia, Nitrate, and Phosphorus

Total nitrogen loads in Delta outflow to Suisun and San Pablo Bays under Alternative 9 would be dominated almost entirely by nitrate, because planned upgrades to the SRWTP will result in >95% removal of ammonia in its effluent. Total nitrogen loads to Suisun and San Pablo Bays would decrease by 17%, relative to Existing Conditions, and increase by 21%, relative to the No Action Alternative (Appendix 8O, Table O-1). The change in nitrogen loading to Suisun and San Pablo Bays under Alternative 9 would not adversely impact primary productivity in these embayments because light limitation and grazing current limit algal production in these embayments. To the extent that algal growth increases in relation to a change in ammonia concentration, this would have net positive benefits, because current algal levels in these embayments are low. Nutrient levels and ratios are not considered a direct driver of *Microcystis* and cyanobacteria levels in the North Bay.

The phosphorus load exported from the Delta to Suisun and San Pablo Bays for Alternative 9 is estimated to increase by 5%, relative to Existing Conditions, and there would be no change relative to the No Action Alternative (Appendix 8O, Table O-1)). The only postulated effect of changes in phosphorus loads to Suisun and San Pablo Bays is related to the influence of nutrient stoichiometry on primary productivity. However, there is uncertainty regarding the impact of nutrient ratios on phytoplankton community composition and abundance. Any effect on phytoplankton community composition would likely be small compared to the effects of grazing from introduced clams and zooplankton in the estuary (Senn and Novick 2014; Kimmerer and Thompson 2014). Therefore, the projected change in total nitrogen and phosphorus loading that would occur in Delta outflow to San Francisco Bay is not expected to result in degradation of water quality with regard to nutrients that would result in adverse effects to beneficial uses.

Mercury

The estimated long-term average mercury and methylmercury loads in Delta exports are shown in Appendix 8O, Table O-2. Loads of mercury and methylmercury from the Delta to San Francisco Bay are estimated to change relatively little due to changes in source water fractions and net Delta outflow that would occur under Alternative 9. Mercury load to the Bay, relative to Existing Conditions, is estimated to increase by 8 kg/yr (3%), relative to Existing Conditions, and 5 kg/yr (2%), relative to the No Action Alternative. Methylmercury load is estimated to increase by 0.14 kg/yr (4%), relative to Existing Conditions, and increase by 0.05 kg/yr (1%) relative to the No Action Alternative. The estimated total mercury load to the Bay is 268 kg/yr, which would be less than the San Francisco Bay mercury TMDL WLA for the Delta of 330 kg/yr. The estimated changes in mercury and methylmercury loads would be within the overall uncertainty associated with the estimates of long-term average net Delta outflow and the long-term average mercury and methylmercury concentrations in Delta source waters. The estimated changes in mercury load under the alternative would also be substantially less than the considerable differences among estimates in the current mercury load to San Francisco Bay (SFBRWQCB 2006; David et al. 2009). Similar uncertainty is expected in the existing methylmercury load in net Delta exports, for which the best available current load estimate is based on approximately one year of monitoring data (Foe et al. 2008).

Given that the estimated incremental ~~decreases~~increases of mercury and methylmercury loading to San Francisco Bay would fall within the uncertainty of current mercury and methylmercury load estimates, the estimated changes in mercury and methylmerucy loads in Delta exports to San Francisco Bay due to Alternative 9 are not expected to result in adverse effects to beneficial uses or substantially degrade the water quality with regard to mercury, or make the existing CWA Section 303(d) impairment measurably worse.

Selenium

Changes in source water fraction and net Delta outflow under Alternative 9, relative to Existing Conditions, are projected to cause the total selenium load to the North Bay to increase by 16%, relative to Existing Conditions, and increase by 13%, relative to the No Action Alternative (Appendix 8O, Table O-3). Changes in long-term average selenium concentrations of the North Bay are assumed to be proportional to changes in North Bay selenium loads. Under Alternative 9, the long-term average total selenium concentration of the North Bay is estimated to be 0.15 µg/L and the dissolved selenium concentration is estimated to be 0.13 µg/L, which would be a 0.02 µg/L increase relative to Existing Conditions and the No Action Alternative (Appendix 8O, Table O-3). The dissolved selenium concentration would be below the target of 0.202 µg/L developed by Presser or Luoma (2013) to coincide with a white sturgeon whole-body fish tissue selenium concentration not greater than 8 mg/kg in the North Bay.

The incremental increase in dissolved selenium concentrations projected to occur under Alternative 9, relative to Existing Conditions and the No Action Alternative, would be higher than under

Alternatives 1–5, but still low (0.02 µg/L). The increased dissolved selenium concentration would be within the overall uncertainty of the analytical methods used to measure selenium in water column samples; however, it also would be within the uncertainty associated with estimating numeric water column selenium thresholds (Pressor and Luoma 2013). As described in Section 8.3.1.8, there have been improvements in selenium concentrations in the tissue of diving ducks and muscle of white sturgeon since the initial CWA Section 303(d) listing of the North Bay for selenium impairments, and selenium concentrations in white sturgeon muscle have also generally been below the USEPA's draft recommended fish muscle tissue concentration of 11.8 mg/kg dry weight (SFEI 2014). However, as described under Impact WQ-25, though there is some uncertainty in the estimate of sturgeon concentrations at western Delta locations, the predicted increases for Alternative 9 are high enough that they may represent measurably higher body burdens of selenium in aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish). Because the projected incremental increases in dissolved selenium could cause measurable changes in water column concentrations, and these incremental increases would be within the uncertainty in the target water column threshold for dissolved selenium for protection against adverse bioaccumulative effects in the North Bay ecosystem, and modeling predicts concentrations in the western Delta may represent a measurable increase in body burdens of sturgeon, there is potential that the incremental increase in dissolved selenium concentration projected to occur in the North Bay under Alternative 9 could result in adverse effects beneficial uses.

NEPA Effects: Based on the discussion above, Alternative 9, relative to the No Action Alternative, would not cause further degradation to water quality with respect to boron, bromide, chloride, dissolved oxygen, DOC, EC, mercury, pathogens, pesticides, nutrients (ammonia, nitrate, phosphorus), trace metals, or turbidity and TSS in the San Francisco Bay. Further, changes in these constituent concentrations in Delta outflow would not be expected to cause changes in Bay concentrations of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses. In summary, based on the discussion above, effects on the San Francisco Bay from implementation of CM1–CM21 are considered to be not adverse with respect to boron, bromide, chloride, dissolved oxygen, DOC, EC, mercury, pathogens, pesticides, nutrients (ammonia, nitrate, phosphorus), trace metals, or turbidity and TSS. However, Alternative 9 could result in increases in selenium concentrations in the North San Francisco Bay that could result in adverse effects to fish and wildlife beneficial uses. This effect is considered to be adverse.

CEQA Conclusion: Based on the above, Alternative 9 would not be expected to cause long-term degradation of water quality in San Francisco Bay resulting in sufficient use of available assimilative capacity such that occasionally exceeding water quality objectives/criteria would be likely and would result in substantially increased risk for adverse effects to one or more beneficial uses with respect to boron, bromide, chloride, dissolved oxygen, DOC, EC, mercury, pathogens, pesticides, nutrients (ammonia, nitrate, phosphorus), trace metals, or turbidity and TSS. Further, based on the above, this alternative would not be expected to cause additional exceedance of applicable water quality objectives/criteria in the San Francisco Bay by frequency, magnitude, and geographic extent that would cause significant impacts on any beneficial uses of waters in the affected environment with respect to boron, bromide, chloride, dissolved oxygen, DOC, EC, mercury, pathogens, pesticides, nutrients (ammonia, nitrate, phosphorus), trace metals, or turbidity and TSS. Any changes in boron, bromide, chloride, and DOC in the San Francisco Bay would not adversely affect beneficial uses, because the uses most affected by changes in these parameters, MUN and AGR, are not beneficial uses of the Bay. Further, no substantial changes in dissolved oxygen, pathogens, pesticides, trace metals or turbidity or TSS are anticipated in the Delta, relative to Existing Conditions, therefore, no substantial changes these constituents levels in the Bay are anticipated. Changes in Delta salinity would not contribute to measurable changes in Bay salinity, as the change in Delta outflow would two to three orders of magnitude lower than (and thus minimal compared to) the Bay's tidal flow. Adverse changes in Microcystis levels that could occur in the Delta would not cause adverse Microcystis blooms in the Bay, because Microcystis are intolerant of the Bay's high salinity and, thus not have not been detected downstream of Suisun Bay. The 17% decrease in total nitrogen load and 5% increase in phosphorus load, relative to Existing Conditions, are expected to have minimal effect on water quality degradation, primary productivity, or phytoplankton community composition. The estimated increase in mercury load (8 kg/yr; 3%) and methylmercury load (0.14 kg/yr; 4%), relative to Existing Conditions, is within the level of uncertainty in the mass load estimate and not expected to contribute to water quality degradation, make the CWA section 303(d) mercury impairment measurably worse or cause mercury/methylmercury to bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans.

In regard to selenium, the estimated increase in selenium load would be 16% and the estimated increase in dissolved selenium concentrations would be 0.02 µg/L. Though there is some uncertainty in the estimate of sturgeon concentrations at western Delta locations, the predicted increases are high enough that they may represent measurably higher body burdens of selenium in aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish). Thus, the increase in selenium load may make the CWA section 303(d) selenium impairment measurably worse and cause selenium to bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish and wildlife. This impact is considered to be significant. Environmental Commitment: Selenium Management (AMM27), which affords for site-specific measures to reduce effects, would be available to reduce BDCP-related effects associated with selenium. The effectiveness of AMM27 is uncertain and, therefore implementation may not reduce the identified impact to a level that would be less than significant, and therefore it is significant and unavoidable.

8.3.3.17 Cumulative Analysis

No Action Alternative

The cumulative effect of the No Action Alternative is as follows. Water quality conditions upstream of the Delta, in the Delta Region, and in the SWP/CVP export service areas of the affected environment are expected to change as a result of past, present, and reasonably foreseeable future projects, population growth, climate change, and changes in water quality regulations (e.g., completion of TMDLs, adoption of new or more restrictive criteria/objectives). Many past, present, and reasonably foreseeable future projects are identified and described in Appendix 3D, and specific projects or regulatory programs that are either ongoing or proposed for future implementation, and thus, could affect future cumulative water quality conditions, are listed in Table 8-73. The combined water quality effects of projects considered in the cumulative condition will vary, including potential contribution to the degradation of various water quality parameters, whereas others will function to improve constituent-specific water quality in certain areas. Future population growth may produce increased constituent loadings to the water bodies of the affected environment through increased urban stormwater runoff, increased POTW discharges, and changes in land uses. Climate change is anticipated to cause salinity increases in the western and southern Delta due to sea level rise. This is evidenced by the increase in violations of the D-1641 salinity standard in the Sacramento River at Emmaton under the No Action Alternative, relative to Existing Conditions, as described in section

8.3.3.1 above. Conversely, changes in water quality regulations generally are in a direction that results in improvements in water quality (e.g., increased monitoring and restrictions on urban stormwater runoff, completion of TMDLs to lessen or eliminate existing beneficial use impairments through improved water quality, more restrictive regulations on POTW discharges, new and/or more restrictive water quality criteria/objectives in Basin Plans).

Some water quality constituents are at levels under Existing Conditions that cause some impact to beneficial uses. These include:

- Bromide
- Chloride
- Electrical Conductivity
- Mercury
- Organic Carbon
- Pesticides and Herbicides
- Selenium

Under the cumulative No Action Alternative, even with consideration of the factors that will affect water quality discussed above, these constituents are expected to remain at levels that cause some impact to beneficial uses. In addition, the frequency, magnitude, and geographic extent of *Microcystis* blooms in Delta waters may increase in the future as Delta water temperatures increase due to climate change. Thus, for the purposes of NEPA, water quality conditions for the~~se~~ constituents listed above, and possibly for ~~-~~*Microcystis* blooms in Delta waters as well, under the cumulative No Action Alternative constitute an adverse environmental condition. The cumulative effect of the No Action Alternative for all other water quality constituents is not adverse.

Although the constituents listed above are at levels under Existing Conditions that cause some impact to beneficial uses, the only constituents for which the cumulative effects of the No Action Alternative are expected to adversely affect beneficial uses, relative to Existing Conditions, ~~is~~ are electrical conductivity, chloride, and possibly *Microcystis* blooms in Delta waters, due to the effects of climate change and sea level rise. Thus, for the purposes of CEQA, water quality conditions for electrical conductivity chloride, and *Microcystis* blooms in Delta waters under the cumulative No Action Alternative constitute a significant environmental condition. The cumulative effect of the No Action Alternative for all other water quality constituents is less than significant, relative to Existing Conditions.

Alternatives 1A through 9

Chloride

The cumulative condition for chloride is considered adverse in the Delta, because of marked increases in chloride concentrations anticipated to occur in the western Delta~~,~~ and ~~including~~ potentially Suisun Marsh, ~~and the interior Delta~~, but not in the SWP/CVP Export Service Areas south of the Delta due to greater source fraction of Sacramento River water on an annual average basis at the south Delta pumps under all alternatives.

~~Alternatives 1A–5 and 9 would substantially increase chloride levels in Suisun Marsh relative to Existing Conditions, primarily during the October through May period, whereas alternatives 6A–8~~

~~would result in somewhat lesser (but still substantial) increases in Suisun Marsh.~~ With regards to the frequency of exceeding the 150 mg/L Bay-Delta WQCP objective at Antioch and Contra Costa Canal Pumping Plant #1, the modeling and assessment approach indicated that Alternatives ~~1A–9~~1A, 3, and 7-9 would result in a substantial increase in the frequency of objective exceedance. With regards to the frequency of exceeding the 250 mg/l chloride objective at Antioch, the modeling and assessment approach indicated that Alternatives ~~1A–5~~1A, 3, and 5 would result in a substantial increase in the frequency of exceeding this objective, relative to Existing Conditions, whereas Alternative 9 would cause only a minor increase in frequency of exceedance and Alternatives 6A–8 would result in a reduction in frequency of exceeding the 250 mg/L chloride objective (Appendix 8G, *Chloride*). Regarding exceedance of Bay Delta WQCP water quality objectives for chloride, staff from DWR and Reclamation constantly monitor Delta water quality conditions and adjust operations of the SWP and CVP in real time as necessary to meet water quality objectives. These decisions take into account real-time conditions and are able to account for many factors that the best available models cannot simulate. DWR and Reclamation have a good history of compliance with water quality objectives (see section 8.3.1.4 and 8.3.1.7 for more detail). Considering these real-time actions, the good history of compliance with objectives, and the uncertainty inherent in the modeling approach (as discussed in section 8.3.1.1 and 8.3.1.3), it is likely that any objective exceedance could be avoided through real-time operation of the SWP and CVP. Nevertheless, water quality degradation could occur that may not be addressed through real-time operations.

Depending on siting and design of tidal restoration areas proposed under CM4, Alternatives 1A–9 could substantially increase chloride levels in some areas of Suisun Marsh relative to Existing Conditions, primarily during the October through May period.

Hence, based on their respective effects on increased chloride levels in Suisun Marsh and the increased ~~frequency of exceeding Bay-Delta WQCP objectives at Antioch and Contra Costa Canal Pumping Plant #1~~water quality degradation in the western Delta, implementation of facilities operations and maintenance (CM1) under Alternatives 1A–9 would contribute substantially to this adverse cumulative condition for chloride. Additionally, implementation of tidal habitat restoration under CM4 would increase the tidal exchange volume in the Delta, and thus may contribute to increased chloride concentrations in the Bay source water as a result of increased salinity intrusion. As such, CM4 is expected to contribute to this adverse cumulative condition. Implementation of CM2, CM3, and CM5–~~CM22~~CM21 would not contribute substantially to this adverse cumulative condition.

Electrical Conductivity

The cumulative condition for EC is considered to be adverse, at various Delta locations and Suisun Marsh, depending on BDCP alternative implemented. EC levels at the south Delta export pumps would improve under all alternatives and thus the cumulative EC condition at the export pumps would not be adverse. As such, cumulative EC levels in the SWP/CVP Export Service Areas would not be adverse.

Alternatives 1A-3 and 5-9 are expected to result in more frequent exceedances of the Bay Delta WQCP EC objective in the Sacramento River at Emmaton, relative to Existing Conditions. This is due in part to the definition of these alternatives, in which the compliance point is moved to Threemile Slough. Although modeling of Alternative 4 indicated more frequent exceedance of the Emmaton objective as well, these results were for modeling that was originally performed for Alternative 4 assuming the Emmaton compliance point shifted to Threemile Slough, but Alternative 4 now does not include a change in compliance point from Emmaton to Threemile Slough. Sensitivity analyses performed indicated that Alternative 4 is not expected to result in more frequent exceedances of the Emmaton objective, but that water supply and water quality conditions could be either under greater stress or under stress earlier in the year, and salinity EC levels at Emmaton and in the western Delta may increase as a result, leading to EC water quality degradation and increased possibility of impacts adverse effects to agricultural beneficial uses. Similarly, water quality degradation is expected to occur at Emmaton and other areas of the western Delta under all alternatives during parts of the summer, and on an annual average basis for Alternatives 1, 3, 4 scenarios H1 and H2, and 9. To the extent that exceedances of this objective or substantial water quality degradation is expected, these impacts could lead to effects on agricultural beneficial uses. Increases in EC in the San Joaquin River at San Andreas Landing are expected for parts of the summer under all Alternatives, and depending on the nature of the increases, may result in water quality degradation that could lead to effects on agricultural beneficial uses.

~~Alternatives 1A–5 and 9 would substantially increase EC levels in Suisun Marsh relative to Existing Conditions, primarily during the October through May period, whereas Alternatives 6A–8 would result in somewhat lesser (but still substantial) increases in Suisun Marsh.~~ Moreover, in the central Delta at Prisoner's Point, Alternatives 2A–C, 4 (including all operational scenarios H1 through H4), and 6A–8 would result in substantially increased frequency of exceedance of the EC objective, whereas Alternative 5 would cause a lesser increase in frequency of exceedance, and Alternatives 1A–C, 3, and 9 would have little to no effect on frequency of exceedance of the EC objective at Prisoner's Point (Appendix 8H). These exceedances could contribute to adverse effects on fish and wildlife beneficial uses (specifically, indirect adverse effects on striped bass spawning), though there is a high degree of uncertainty associated with this impact.

Alternatives 1A–5 and 9 could substantially increase EC levels in Suisun Marsh relative to Existing Conditions, primarily during the October through May period, whereas Alternatives 6A–8 would result in somewhat lesser (but still substantial) increases in Suisun Marsh.

Based on their adverse effects on EC levels in Suisun Marsh as well as the adverse effects in the western and~~,~~ interior~~, and/or south~~ Delta, Alternatives 1A–9 would all contribute substantially to the adverse cumulative conditions for EC in the Delta ~~and in Suisun Marsh~~. Additionally, implementation of tidal habitat restoration under CM4 would increase the tidal exchange volume in the Delta, and thus may contribute to increased EC concentrations in the Bay source water as a result of increased salinity intrusion. As such, CM4 is expected to contribute to this adverse cumulative condition. Implementation of CM2, CM3, and CM5–~~CM22~~CM21 would not contribute substantially to this adverse cumulative condition.

Mercury

Numerous regulatory efforts have been implemented or are under development to control and reduce mercury loading to the Delta, Upstream of the Delta and in the SWP/CVP Export Service Areas, which include a Delta mercury TMDL, methylmercury TMDL, and their implementation strategies (e.g., methylmercury control studies), increased restrictions on point-source discharges such as POTWs, greater restrictions on suction dredging in Delta tributary watersheds, and continued clean-up actions on mine drainage in the upper watersheds. A key challenge surrounds the pool of mercury deposited in the sediments of the Delta which cannot be readily or rapidly reduced, despite efforts to reduce future loads in Delta tributaries, and serves as a source for continued methylation and bioaccumulation of methylmercury by Delta biota. Consequently, mercury levels in Delta waters are considered to be an adverse cumulative condition. Facilities operations and maintenance (CM1) of Alternatives 1A–~~9~~ 5 would not be expected to substantially alter the cumulative condition for mercury and the mercury impairment in the Delta or contribute substantially to the cumulative mercury condition in the SWP/CVP Export Service Areas. Facilities operations and maintenance (CM1) of Alternatives 6-9~~with the exception of Alternative 8~~ would be expected to contribute substantially to the cumulative condition for mercury in the Delta, since fish tissue concentrations are expected to increase measurably at several locations throughout the Delta. ~~, at selected locations, where fish tissue mercury is expected to increase.~~ Implementation of CM4 (tidal wetland habitat), CM5 (floodplain habitat), CM10 (freshwater marsh habitat), and ~~possibly~~ CM2 (Yolo Bypass fisheries enhancements) could create conditions resulting in increased methylation of mercury within the Delta per unit time, increased biotic exposure to and uptake of methylmercury, and resulting increased mercury bioaccumulation in fish tissues. The methylation of mercury in these restored wetland habitats would contribute substantially to the cumulative condition for mercury in the Delta.

***Microcystis* Blooms**

Alternatives 1A–9, including their implementation of CM2 and CM4, would increase water residence times in the Delta during the summer period, relative to Existing Conditions and the No Action Alternative. An increase in residence time throughout the Delta is also expected due to climate change and sea level rise, although this change is believed to be fairly small in most areas of the Delta. Longer residence times in portions of the Delta may potentially increase the frequency, magnitude, and geograp~~g~~hic extent of *Microcystis* blooms in Delta waters, relative to Existing Conditions and the No Action Alternative. *Microcystis* blooms can occur in the Delta during the June through September period of the year. Siting and design of restoration areas has substantial influence on the magnitude of residence time increases that would occur under Alternatives 1A-9. However, the expected residence time changes under Alternatives 1A-9, compared to Existing Conditions and the No Action Alternative, are in a direction and of magnitude that could lead to an increase in Delta *Microcystis* blooms.

Climate change projected for the future is expected to cause an increase in average Delta water temperatures during the summer and early fall period of the year. Increased water temperatures could lead to earlier attainment of the water temperature threshold of 19°C required to initiate *Microcystis* bloom formation in the Delta, and thus earlier occurrences of *Microcystis* blooms, relative to Existing Conditions. Warmer water temperatures could also increase bloom duration and magnitude, relative to Existing Conditions. Nevertheless, it should be noted that projected Delta water temperature increases ~~are~~would be due entirely to climate change, and ~~are~~ not due to the implementation of Alternatives 1A-9. Because climate change is assumed under the No Action Alternative, potential water temperature-driven increases in *Microcystis* blooms in the Delta, relative to Existing Conditions, also would occur under the No Action Alternative. Therefore, no water temperature-driven increases in *Microcystis* blooms would occur in the Delta under Alternatives 1A-9, relative to the No Action Alternative.

Water diverted from the Sacramento River in the North Delta is expected to be unaffected by Microcystis and microcystins. However, the fraction of water flowing through the Delta that reaches the existing south Delta intakes is expected to be influenced by an increase in the frequency, magnitude, and geographic extent of Microcystis blooms as discussed above. Therefore, relative to Existing Conditions and the No Action Alternative, the addition of Sacramento River water from the North Delta under Alternatives 1A-9 serves to dilute Microcystis and microcystins in water diverted from the South Delta with water that is not expected to contain them. Because the degree to which

Microcystis blooms, and thus microcystins concentrations, will increase in source water from the South Delta is unknown, it cannot be determined whether Alternatives 1A-9 will result in increased or decreased levels of microcystins in the mixture of source waters exported from Banks and Jones pumping plants, relative to Existing Conditions and the No Action Alternative.

Implementation of Alternatives 1A-9 (including CM2 and CM4) would contribute substantially to the adverse cumulative condition for *Microcystis* through their effects on residence time. Conversely, because projected Delta water temperature increases are due entirely to climate change, and are not due to the implementation of Alternatives 1A-9 , implementation of Alternatives 1A-9 would not contribute substantially to the adverse cumulative condition for *Microcystis* via changes to Delta water temperature.

Selenium

The lower San Joaquin River and the western Delta are listed as impaired in accordance with section 303(d) of the Clean Water Act for exceeding selenium water quality objectives or bioaccumulation in biota. The San Joaquin River impairment is listed as extending from the Mud Slough confluence to the Airport Way Bridge near Vernalis, a reach distance of about 43 river miles. Selenium occurs naturally throughout the lower San Joaquin River watershed, with elevated concentrations of selenium occurring in the shallow groundwater within the Grassland Watershed. Subsurface agricultural drainage discharges from this area are the major source of selenium to the San Joaquin River and Delta. Load allocations for agricultural subsurface drainage discharges from the Grassland Drainage Area have been developed through completion of the lower San Joaquin River selenium TMDL and the Grassland Bypass Project. The Grassland Bypass Project prevents discharge of subsurface agricultural drainage water into wildlife refuges and wetlands. The Grassland Area Farmers have been successful in meeting TMDL wasteload allocations and continue to utilize and expand the San Joaquin River Water Quality Improvement Project. Moreover, the Grassland Area Farmers continue to work closely with the Central Valley Water Board and U.S. Bureau of Reclamation to further develop and improve their drainage solutions for the Grassland Drainage Area. Despite these improvements in reducing selenium loading to the San Joaquin River and Delta, it is anticipated that the cumulative condition for selenium in the lower San Joaquin River and Delta will remain adverse.

Facilities operations and maintenance (CM1) of Alternatives 1A–5 would not be expected to substantially alter the cumulative condition for selenium and selenium impairment in the Delta. Modeled selenium concentrations in sturgeon in the western Delta, in the San Joaquin River at Antioch and the Sacramento River at Mallard Island, would increased under Alternatives 6A-–9 by 1720-–2342%, which may represent a measurable increase in the environment. These increases would contribute to low toxicity benchmarks being exceeded on average, in all years, and to high toxicity benchmarks being approached or exceeded during drought years. Because both low and high toxicity benchmarks are already exceeded under the No Action Alternative, tThese increases would further degrade water quality by measurable levels, on a long-term basis, for selenium and, thus, cause the CWA Section 303(d)-listed impairment of beneficial uses to be made discernibly worse. These potentially measurable increases would contribute substantially to the adverse cumulative condition for selenium in the Delta. Under Alternative 9, modeled selenium concentrations in water would increase at Rock Slough, Franks Tract, and Contra Costa PP, decreasing the available assimilative capacity by more than 10 percent at each of those locations; consequently, selenium concentrations in whole-body fish and in bird eggs (invertebrate and fish diets) at those locations would increase so that Level of Concern benchmarks for biota would be

~~exceeded at Rock Slough and Contra Costa PP (and approach exceedance at Franks Tract). The greater level of selenium bioaccumulation in the vicinities of Rock Slough and Contra Costa PP would further degrade water quality by measurable levels, on a long-term basis, for selenium and, thus, cause the 303(d)-listed impairment of beneficial use to be made discernibly worse.~~ However, the greater Sacramento River flow fraction at the south Delta pumps under all alternatives would be expected to result in reduced selenium concentrations in the SWP/CVP Export Service Areas and thus would not contribute to the adverse cumulative condition. Implementation of CM4 (tidal wetland habitat), CM5 (floodplain habitat), and CM10 (freshwater marsh habitat) could create conditions resulting in increased flow residence time at the restored Delta locations, which could increase biotic exposure to and uptake of selenium, potentially resulting in increased selenium bioaccumulation in fish tissues. The potential for increased biotic exposure in and near these restored wetland habitats would contribute substantially to the adverse cumulative condition for selenium in the Delta. However, Environmental Commitment: Selenium Management (AMM27), which affords for site-specific measures to reduce effects, would be available to reduce BDCP-related effects associated with selenium.

NEPA Effects: The cumulative water quality conditions are considered to be adverse for bromide, chloride, electrical conductivity, mercury, *Microcystis* blooms, organic carbon, pesticides and herbicides, and selenium in areas of the Delta, and thus may adversely affect beneficial uses of the Delta such as domestic, agricultural, municipal and industrial water supply and recreation, aesthetic, and fish and wildlife resources. The implementation of BDCP Alternatives 1A–9 would contribute substantially to these adverse cumulative water quality conditions. With respect to bromide, chloride, and electrical conductivity, implementation of Alternatives 1A~~-~~–9 would improve water quality conditions for these constituents at the Banks and Jones pumping plants in the south Delta and thus in the SWP/CVP Export Service Areas. Mitigation measures (described below) and environmental commitments have been developed to mitigate the alternatives' contributions to the adverse cumulative water quality conditions elsewhere in the Delta for bromide (WQ-5), chloride (WQ-7), electrical conductivity (WQ-11), mercury (see mitigation measure below), *Microcystis* blooms (WQ-32a and WQ-32b), organic carbon (WQ-17 and WQ-18), pesticides and herbicides (WQ-21 and WQ-22) and selenium (Environmental Commitment: Selenium Management (AMM27)).

CEQA Conclusion: The cumulative Delta water quality conditions are anticipated to be significant for bromide, chloride, electrical conductivity, mercury, *Microcystis* blooms, organic carbon, pesticides and herbicides, and selenium.

The incremental effects of Alternatives 1A–9 would be cumulatively considerable with respect to significant cumulative bromide, chloride, Microcystis, and electrical conductivity conditions at various western and interior Delta locations. However, implementation of Alternatives 1A-9 would not contribute considerably, and would, in fact, improve conditions for these constituents (except *Microcystis*) at the Banks and Jones pumping plants in the south Delta and thus in the SWP/CVP Export Service Areas. It cannot be determined whether Alternatives 1A~~-~~–9 will result in increased or decreased levels of microcystins in the mixture of source waters exported from Banks and Jones pumping plants, relative to Existing Conditions.

Implementation of WQ-5 may reduce impacts on bromide relative to municipal and industrial beneficial uses in Barker Slough, but it is not known whether actions to reduce this impact under the mitigation measures are feasible. Implementation of Mitigation Measures WQ-7a, WQ-7b, WQ-11a, and WQ-11b may reduce impacts on chloride relative to municipal and industrial beneficial uses and EC relative to agricultural beneficial uses in the western Delta, but it is not known whether actions to reduce this impact under the mitigation measures are feasible. Implementation of Mitigation measure WQ-11c may reduce potential impacts of EC on fish and wildlife beneficial uses in the interior Delta, but it is not known whether actions to reduce this impact under the mitigation measure are feasible. Thus, for these impacts, the contribution to the adverse cumulative condition is expected to remain significant. Implementation of Mitigation Measure WQ-7d and WQ-11d is expected to reduce the contribution of impacts on chloride and EC water quality degradation in Suisun Marsh to a less than significant level. Implementation of WQ-32 may reduce potential impacts on Microcystis in the Delta, but it is not known whether actions to reduce this impact under the mitigation measure are feasible; thus, the contribution to the adverse cumulative condition is expected to remain significant.

Regarding mercury and selenium, facilities operations and maintenance (CM1) would not be expected to contribute considerably to the significant cumulative mercury and selenium conditions in the Delta for Alternatives 1A-–5, but would be expected to contribute to these conditions for Alternatives 6-–9. ~~(with the exception of Alternative 8 for mercury and Alternative 9 for selenium), but i~~Implementation of CM4, CM5, and CM10 would be expected to contribute considerably to certain localized areas (i.e., near where the wetland restoration areas are planned) within the Delta through the potential for increased mercury methylation and selenium bioaccumulation in these restored wetland habitats. Although CM12 is designed to reduce these effects for mercury, it is not known if these actions would be feasible and could effectively reduce the incremental contribution to the adverse cumulative condition to a less than significant level. However, with implementation of Environmental Commitment: Selenium Management (AMM27), which affords for site-specific measures to reduce effects, the incremental effects of ~~BDCP of~~ these CMs on selenium would not be expected to be cumulatively considerable. Likewise, CM2 would create greater localized source loading of methylmercury to Delta waters, to the degree that the Yolo Bypass is inundated more frequently and/or to a greater geographic extent under the alternatives, relative to the existing condition. Conversely, CM2 is not expected to contribute considerably to future Delta selenium levels and thus would not be expected to affect future bioaccumulation of selenium in Delta fish tissues.

For organic carbon, implementation of facilities operations and maintenance (CM1) for Alternatives 6A–9 would contribute considerably to the significant cumulative organic carbon condition in the Delta, but Alternatives 1A–C, 2A–C, and 3–5 would not contribute considerably to this cumulative condition. Conservation Measures 4, 5, and 10, through the ability of these new wetlands to load additional organic carbon to Delta waters, would contribute considerably to the significant adverse cumulative organic carbon condition in the Delta. In addition, CM2 would create greater localized source loading of DOC to Delta waters for all alternatives, to the degree that the Yolo Bypass is inundated more frequently and/or to a greater geographic extent under the alternatives, relative to the existing condition. Implementation of Mitigation Measure WQ-17 and WQ-18 may reduce these contributions, but it is unknown whether these actions would be feasible and would effectively reduce the incremental contribution to the adverse cumulative condition to a less than significant level. These cumulative effects are not expected to extend to the south Delta pumps or the SWP/CVP Export Service Areas~~, but to the extent that they do, the mitigation measure proposed also would address such effects.~~.

Implementation of facilities operations and maintenance (CM1) for Alternatives ~~2A–C and 4~~6–9 would contribute considerably to the adverse cumulative pesticide and herbicide condition in the Delta, but Alternatives ~~1A–C and 3~~ 1-5would not contribute considerably to this significant cumulative condition. Also, implementation of CM13 (nonnative aquatic vegetation control) is the only conservation measure identified that would contribute considerably to the cumulative pesticide and herbicide condition in the Delta. However, with implementation of Mitigation Measure WQ-22, the contribution to the cumulative condition of CM13 is expected to be less than significant. The cumulative effects for pesticides and herbicides are not expected to extend to the SWP/CVP Export Service Areas due to the increases in Sacramento River source fraction at Banks and Jones pumping plants under all alternatives and its generally lower levels of pesticides relative to the San Joaquin River source water.

Mitigation Measures:

The following conservation measures, mitigation measures, and environmental commitments have been developed to mitigate the alternatives' contributions to the adverse cumulative water quality conditions described above: for bromide (WQ-5), chloride (WQ-7), electrical conductivity (WQ-11), mercury (~~see mitigation measure below~~Conservation Measure 12), organic carbon (WQ-17 and WQ-18), pesticides and herbicides (~~WQ-21 and~~ WQ-22) and selenium (Environmental Commitment: Selenium Management (AMM27)).

~~To mitigate the alternatives' contribution to adverse mercury effects, implementation of conservation measures (CM 2CM2, CM4, CM5, and CM10) associated with wetland/floodplain habitat shall conform to the relevant requirements of the Delta Mercury Control Strategy of the Central Valley Water Board Basin Plan. Requirements of the Delta Mercury Control Strategy include the following.~~

- ~~Required participation in efforts to evaluate and minimize health risk associated with eating mercury contaminated fish.~~
- ~~Required participation in monitoring methylmercury loading from wetlands.~~
- ~~Implementation of appropriate and site-specific methylmercury control measures.~~

~~It is anticipated that these same, or similar, measures can be utilized to address and mitigate wetland-related bioaccumulation issues for selenium, as well.~~

~~Appropriate mercury and methylmercury selenium control measures shall be developed at the time of formal restoration planning and design. All practicable measures (i.e., those that are both feasible and reasonable from a cost-benefit perspective) to reduce methylmercury formation shall be considered for implementation. Appropriate strategies and control measures may include the following.~~

- ~~Conservation measure design features, such as use of seasonal inundation periods, hydraulic residence time, sediment basins and vegetation traps to control mercury inputs and exports, inundation depths and related vegetation type and density selection so as to control oxidation-reduction conditions.~~
- ~~Appropriate consideration of conservation measure location, preferably not in the direct path of large mercury loading sources such as the Sacramento River, Yolo Bypass, Cosumnes River, or San Joaquin River.~~
- ~~Prioritization of conservation measures that minimize trophic level transfer of mercury through active or passive operation and maintenance controls, such as targeted control and/or removal of hyperaccumulating plant or animal species.~~

- ~~Pre- and post-restoration monitoring of water and biota (sentinel species) for mercury content in the context of a targeted adaptive management strategy whereby new or modified mercury/methylmercury controls would be implemented in order to, at the minimum, maintain methylmercury formation and fish tissue accumulation at baseline conditions.~~

~~These mitigation measures may not completely eliminate the contributions identified to the adverse cumulative water quality conditions, but would be expected to lessen the contributions to the degree feasible. Hence, some level of contribution to adverse cumulative conditions are anticipated to remain after mitigation.~~

8.4 References

8.4.1 Printed References

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