

## 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

1 alternatives and followed by a general summary in some instances and cross reference to  
2 appropriate analysis located elsewhere in the chapter.

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

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

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

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

- 39 • Ammonia
- 40 • Boron
- 41 • Bromide
- 42 • Chloride

- 1 • Dissolved Oxygen
- 2 • Electrical Conductivity
- 3 • Mercury
- 4 • Nitrate
- 5 • Organic Carbon
- 6 • Pathogens
- 7 • Pesticides and Herbicides
- 8 • Phosphorus
- 9 • Selenium
- 10 • Trace Metals
- 11 • TSS and Turbidity
- 12 • Construction-related Activities
- 13 • Microcystis
- 14 • San Francisco Bay

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

## 18 **8.1 Environmental Setting/Affected Environment**

### 19 **8.1.1 Affected Environment**

#### 20 **8.1.1.7 Water Quality Impairments**

##### 21 **Water Quality–Limited Water Bodies, Watershed Monitoring Programs, and Total** 22 **Maximum Daily Loads**

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

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

32 Under CWA Section 303(d), states, territories, and authorized tribes are required to develop a  
 33 ranked list of water quality–limited segments of rivers and other water bodies under their  
 34 jurisdiction. Listed waters are those that do not meet water quality standards even after point

1 sources of pollution have installed the minimum required levels of pollution control technology. The  
 2 law requires that action plans, or TMDLs, be developed to monitor and improve water quality. TMDL  
 3 is defined as the sum of the individual waste load allocations from point sources, load allocations  
 4 from nonpoint sources and background loading, plus an appropriate margin of safety. A TMDL  
 5 defines the maximum amount of a pollutant that a water body can receive and still meet water  
 6 quality standards. TMDLs can lead to more stringent National Pollutant Discharge Elimination  
 7 System (NPDES) permits (CWA Section 402).

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

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

25 **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 <sup>a</sup>	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 <sup>b</sup>	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.

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

<sup>b</sup> 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.

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

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

1  
2**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.

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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.

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

Pollutant	Regional Water Board				
	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.

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## 4 **8.1.3 Existing Surface Water Quality**

### 5 **8.1.3.3 Bromide**

#### 6 **Existing Conditions in the Study Area**

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

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

19 There are presently no regulatory water quality objectives for bromide in the Delta. Bromide is not a  
 20 priority pollutant; thus, the CTR has no criteria for bromide. There are no state or federal regulatory  
 21 water quality objectives/criteria for bromide, or any USEPA-recommended criteria. The state  
 22 drinking water primary MCL for bromate is 0.01 mg/L. To reduce the potential for DBP formation in  
 23 municipal water supplies, the CALFED Drinking Water Quality Program has the goal of achieving

1 either a bromide concentration of 0.05 mg/L at the southern and ~~western-central~~ Delta water export  
 2 locations, along with an average TOC concentration of 3 mg/L (CALFED Bay-Delta Program 2000),  
 3 or an “Equivalent Level of Public Health protection” for municipal water supply purveyors.  
 4 Specifically, the goal of the CALFED Drinking Water Program is to:

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

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

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

13 In 1998, a panel of three water quality and treatment experts, engaged by the California Urban Water  
 14 Agencies (CUWA), produced a report titled “Bay-Delta Water Quality Evaluation, Draft Final Report”.  
 15 CUWA had charged the panel with developing potential regulatory scenarios, defining appropriate  
 16 treatment process criteria, and estimating the Delta source water quality required to achieve  
 17 compliance under the anticipated regulatory scenarios...The panel identified two regulatory  
 18 scenarios for their evaluation, a near-term scenario consisting of the then current treatment rules  
 19 governing pathogen inactivation and disinfection and a long-term scenario which included the  
 20 anticipated more stringent versions of these rules then under development.

21 The long term scenario...were regulatory levels of 40 µg/L total trihalomethanes (TTHMs), 30 µg/L  
 22 haloacetic acids (HAA5s), and 5 µg/L bromate (as running annual averages) as well as an additional 1  
 23 to 2-log inactivation of *Giardia* and 1-log inactivation of *Cryptosporidium*. The panel focused on  
 24 inactivation requirements and the DBP precursors TOC and bromide as the constituents in Delta  
 25 water that would be most likely to drive treatment technology decisions. Their basic finding was that,  
 26 under the more stringent long-term scenario, it would be necessary to keep Delta water diverted for  
 27 municipal use to no more than 3 mg/L TOC and 50 µg/L bromide to give users flexibility in their  
 28 choice of treatment method (enhanced coagulation or ozone disinfection)...For the less stringent  
 29 near-term regulatory scenario, TOC from 4 to 7 mg/L and bromide from 100 to 300 µg/L was  
 30 determined to be acceptable. (CALFED Water Quality Program 2007).

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

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



1 [possible the bromate MCL will be lowered to the 5 µg/L value assumed in the derivation of the](#)  
 2 [50 µg/L CALFED bromide goal.](#)

### 3 **8.1.3.4 Chloride**

#### 4 **Existing Conditions in the Study Area**

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

12 Chloride mean concentrations in the north-of-Delta locations were very low (water years 2001–  
 13 2006), ranging from 1 to 5 mg/L (Table 8-9). South-of-Delta locations had mean values of 69 mg/L,  
 14 which were higher than that reported at the Banks headworks (59 mg/L, Figure 8-17).

15 **Table 8-9. Chloride Concentrations at Selected North of Delta and South-of-Delta Stations, Water**  
 16 **Years 2001–2006<sup>a</sup>**

Location	Chloride (dissolved, mg/L)				
	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

<sup>a</sup> 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.

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

20 The Bay-Delta WQCP contains chloride objectives for municipal and industrial water supply  
 21 beneficial uses protection, including a maximum mean daily concentration of 250 mg/L year-round  
 22 at the five major municipal water supply diversion locations—Contra Costa Canal at pumping plant  
 23 #1, West Canal at mouth of Clifton Court Forebay, Jones pumping plant, Barker Slough at North Bay  
 24 Aqueduct, and Cache Slough at the City of Vallejo intake (abandoned). [Table 8-9a summarizes the](#)  
 25 [record of compliance with the Delta chloride objectives that are specified in the Bay-Delta WQCP.](#)  
 26 [These 250 mg/L standard has been exceeded at the CCWD pumping plant #1 on several occasions](#)  
 27 [and, on rare occasions, at the Delta Mendota Canal headworks in four of the past 20 years.](#)

28 Additionally, the Bay-Delta WQCP contains a chloride objective for Contra Costa Canal at pumping  
 29 plant #1 or the San Joaquin River at Antioch Water Works intake that specifies the number of days  
 30 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)**

Location	Objective <sup>a, b</sup>		Exceedances of Objective		
	Applicable Period (and narrative description)	Days/year <sup>c</sup>	Years (#) With Objective Exceeded	Maximum Days Exceeded	Median Days Exceeded <sup>d</sup>
<b>Municipal and Industrial Water Supply Objectives</b>					
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

<sup>a</sup> This table also includes objectives/standards set by Water Rights Orders 95-6 and 98-6.

<sup>b</sup> Only partial description of objective provided; refer to Bay-Delta WQCP for full text of objective.

<sup>c</sup> Total number of days in year that requirement is applicable.

<sup>d</sup> 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).

### 1 8.1.3.5 Dioxins, Furans, and Polychlorinated Biphenyls

#### 2 Background

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

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

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

33 Dioxins may enter the environment through air, water, and land pathways. Because the majority of  
 34 dioxin releases are to the atmosphere, some dioxins can be transported very long distances and can  
 35 be found in most places in the world (National Research Council 2006; U.S. Food and Drug  
 36 Administration 2009). In water, dioxins tend to settle into sediments where they can move up the  
 37 food chain. Dioxins can also be deposited on plants and enter the food chain. Animals tend to  
 38 accumulate dioxins in fatty tissues.

39 USEPA (2006a) estimated that the primary pathway of dioxin releases to the environment is  
 40 atmospheric (92.4%), with 5.7% to the land and 1.8% to water. It is important to note that this  
 41 estimate did not include natural sources of dioxins, which exceed those produced by human  
 42 activities (Centers for Disease Control 2005). Dioxins are ubiquitous, and all living organisms have  
 43 had some form of low-level exposure. Natural brush and forest fires produce dioxins, so it is

1 reasonable to assume that organisms have been exposed to dioxins for centuries. For example, 54%  
 2 of global dioxin emissions were from natural forest fires in 2004, with the remainder coming from  
 3 anthropogenic sources (Figure 8-20).

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

## 9 **Importance in the Study Area**

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

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

## 19 **Existing Conditions in the Study Area**

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

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

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

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

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

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

9 Analytes examined in the present effort for the Banks and Barker Slough pumping plants included  
 10 ~~the PCB mixtures (i.e., PCB-1016, PCB-1221, PCB-1232, PCB-1242, PCB-1248, PCB-1254, and PCB-~~  
 11 ~~1260)~~. The monitoring program sampled for each of these analytes approximately 16 times during  
 12 the water years 2001 to 2006 for each location. No detections were found.

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

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

Sum of all PCBs	Samples	Minimum (pg/L)	Maximum (pg/L)	Mean (pg/L)	Median (pg/L)
<b>Sacramento River above Point Sacramento</b>					
Dissolved	7	35	70	52	50
Total	6	67	138	99	95
<b>San Joaquin River at Antioch Ship Channel</b>					
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

22  
 23 The samples were taken between late July and late August, which does not allow examination of wet  
 24 versus dry season effects. The results indicate that ~~all selected~~ PCBs are still present in the  
 25 Sacramento and San Joaquin River outflows during summer conditions, albeit at low concentrations.  
 26 Values for ~~the sum of all~~ PCBs were comparable at the two locations.

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

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

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

9 With regard to Basin Plan narrative objectives, any of the compounds above might be considered  
10 toxic at high concentrations. There are no numerical water quality objectives for the San Francisco  
11 Bay Water Board or Central Valley Water Board Basin Plans. The California drinking water standard  
12 MCL for 2,3,7,8-TCDD is 0.00000003 mg/L; the MCL for carbofuran is 0.018 mg/L. The CTR for  
13 2,3,7,8-TCDD is 0.000000013 µg/L for Human Health: Water and Organisms, and 0.000000014 µg/L  
14 for Human Health: Organisms Only. Data are inadequate to assess whether the sites examined in this  
15 SFEI monitoring exceeded this standard.

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

### 20 **8.1.3.7 Salinity and Electrical Conductivity**

#### 21 **Existing Conditions in the Study Area**

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

32 Mean values for the north-of-Delta area were lower than in the Delta region, ranging from  
33 65 µmhos/cm at the American River at the WTP to 120 µmhos/cm at the Sacramento River at  
34 Verona (Table 8-13). South-of-Delta mean values were higher than those for the north-of-Delta  
35 stations examined (439 to 460 µmhos/cm), and slightly higher than the mean at the Banks  
36 headworks (393 µmhos/cm) (Figure 8-24).

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

Location	Electrical Conductivity ( $\mu\text{mhos/cm}$ )				
	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:  $\mu\text{mhos/cm}$  = micro mhos per centimeter; WTP = water treatment plant.

<sup>a</sup> Sample size represents water quality samples having values at or greater than the reporting limit.

Sources: California Department of Water Resources 2009b.

3  
 4 Time series data indicate that EC concentrations at the examined stations generally fluctuate on an  
 5 annual basis (Figures 8-25a, 8-25b, and Figure 8-26). However, peak values occurred at different  
 6 times of the year for the various locations. Factors influencing this variability may include  
 7 hydrology, water operations, watershed sources, and hydrodynamics in the Delta.

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

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

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

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



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

Notes:

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

<sup>a</sup> This table also includes objectives/standards set by Water Rights Orders 95-6 and 98-6.

<sup>b</sup> Only partial description of objective provided; refer to Bay-Delta WQCP for full text of objective.

<sup>c</sup> Total number of days in year that requirement is applicable.

<sup>d</sup> Median calculated using only years when exceedances occurred.

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

1

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

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

19 CV-SALTS prepared an updated strategy and workplan in February 2012 that identified necessary  
20 studies to develop the SNMP. CEQA scoping meetings were held in late 2013 to solicit comments on

1 potential components of the Central Valley SNMP. CV-SALTS has completed many studies identified  
 2 in the early planning stages for CV-SALTS, including review and evaluations of applicable and  
 3 potential alternative salinity and nutrient regulatory policies and water quality objectives for  
 4 beneficial use protection. Many more studies, including economic and environmental review of  
 5 proposed SNMP alternatives, are underway. A Strategic Salt Accumulation Land and Transport  
 6 Study (SSALTS) is being prepared to identify the range of viable salt disposal methods for the  
 7 Central Valley (taking into account regulatory, institutional, economic, and technological issues) and  
 8 inclusion in the SNMP. The SSALTS study will evaluate existing salt disposal areas, establishment of  
 9 new salt disposal areas within the Central Valley, export or transport of salt out of the Central Valley,  
 10 or some combination of the above. Two parts of the study have been completed to date including a  
 11 “Phase 1” report in December 2013 of potential study areas, and a “Phase 2” report in September  
 12 2014 that identifies potential salt disposal options. The final report (scheduled for late 2014) will  
 13 identify and prioritize acceptable salt disposal alternatives.

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

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

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

### 36 **8.1.3.8 Emerging Pollutants: Endocrine-Disrupting Compounds,** 37 **Pharmaceutical and Personal Care Products, and Nitrosamines**

#### 38 **Background**

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

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

### 5 **Endocrine-Disrupting Chemicals**

6 EDCs interfere with hormone (endocrine) systems in animals. Hormones are released by body  
 7 organs (e.g., thyroid, ovaries, testes) and act as chemical messengers to other organs and tissues.  
 8 Hormones bind with receptor sites in a way similar to how a key fits into a lock. Upon binding, the  
 9 receptor carries out the hormone's instructions by either altering the cell's existing proteins or  
 10 turning on genes that will build a new protein (U.S. Environmental Protection Agency 2009b). Both  
 11 of these actions create reactions throughout the body. The hormone system operates from  
 12 conception through old age, affecting development, reproduction, metabolism, and other crucial  
 13 body functions.

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

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

27 Examples of EDCs include natural plant and animal compounds, metals (e.g., arsenic, cadmium, lead,  
 28 mercury), dioxins, polycyclic aromatic hydrocarbons (PAHs), pesticides, PPCPs, and PCBs (Snyder  
 29 2008). Sources of anthropogenic EDCs include WTPs, private septic systems, urban stormwater  
 30 runoff, industrial effluents, landfill leachates, discharges from fish hatcheries and dairy facilities,  
 31 runoff from agricultural fields and livestock enclosures, and land amended with biosolids or manure.

32 WTPs are [not specifically designed to treat and remove CECs, and the WTP industry is](#) just beginning  
 33 to examine their ability to treat for EDCs, with [an encouraging](#) degree of success (e.g., Snyder  
 34 2008; Benotti et al. 2009; Contra Costa Water District 2009); [however, our understanding of](#)  
 35 [treatability for CECs is incomplete](#). Related research suggests that estrogen compounds can be  
 36 biodegraded in the stream sediments below plant outfalls (Bradley et al. 2009).

### 37 **Pharmaceuticals and Personal Care Products**

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

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

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

5 According to the USEPA (2009c), people contribute PPCPs to the environment when medication  
 6 residues pass out of the body and into sewer lines, when externally applied drugs and personal care  
 7 products they use wash down the shower drain, and when unused or expired medications are  
 8 placed in the trash or flushed down a toilet. ~~WTP operators are just beginning to examine their~~  
 9 ~~ability to treat for PPCPs, with an encouraging degree of success (e.g., Snyder 2008; Benotti et al.~~  
 10 ~~2009; Contra Costa Water District 2009).~~

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

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

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

#### 42 **Nitrosamines**

43 Nitrosamines are a family of semi-volatile organic chemicals containing a nitroso and an amine  
 44 functional group. N-Nitrosodimethylamine (NDMA) is the best-known nitrosamine, although there

1 are several others of importance, including N-Nitrosodiethylamine (NDEA) and N-Nitrosodi-n-  
 2 propylamine (NDPA). Chlorination or chloramination of water containing organic-nitrogen, such as  
 3 occurs during water and wastewater treatment, can lead to the production of NDMA and other  
 4 nitrosamines. NDMA and other nitrosamines also can form or be leached during treatment of water  
 5 by anion exchange resins. NDMA and other nitrosamines are not easily removed during treatment,  
 6 as they do not readily biodegrade, adsorb, or volatilize. (Najm and Trussell 2001). “NDMA Formation  
 7 in Water and Wastewater”)

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

### 15 **8.1.3.10 Nitrate/Nitrite and Phosphorus**

#### 16 **Background and Importance in the Study Area**

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

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

34 There are presently no applicable water quality standards for P. Drinking water standards have  
 35 been set for nitrate (10 mg/L) and nitrite (1 mg/L) because nitrate and nitrite can compete with  
 36 oxygen for receptor sites on hemoglobin in the bloodstream, thereby interfering with normal  
 37 respiration and causing effects in humans such as blue-baby syndrome. [The USEPA in 1998](#)  
 38 [published the “National Strategy for the Development of Regional Nutrient Criteria” where it](#)  
 39 [identified that, due to the highly variable relationships of nutrient levels to biostimulatory responses](#)  
 40 [across the county, it would not develop national recommended nutrient criteria. Instead, USEPA](#)  
 41 [expects states and tribes to develop water quality standards for nutrients, or nutrient numeric](#)  
 42 [endpoints \(NNEs\), in their geographic regions. The primary goal of NNEs is to establish nutrient](#)  
 43 [levels that support the health of aquatic systems and also limit excessive growth of macrophytes or](#)

1 phytoplankton, public health threats, and general degradation of aquatic resources. The NNE  
 2 framework has two components: a) response indicators and regulatory endpoints that specify how  
 3 to assess water body condition, and b) nutrient-response models that can be used to link response  
 4 indicators to nutrients and other management controls (e.g., hydrology) on a water body-specific  
 5 basis.

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

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

31 Aquatic life depends on the availability of nutrients; however, elevated concentrations of nutrients  
 32 such as nitrate can cause eutrophication, in which high algal and bacterial growth and subsequent  
 33 microbial respiration deplete oxygen, producing anoxic waters and sediments. Waters of the Delta  
 34 are not considered nutrient-limited; that is, algal growth rates are limited by availability of light, and  
 35 thus increases or decreases in nutrient levels are, in general, expected to have little effect on  
 36 productivity (Jassby et al. 2002). However, when waters of the Delta are exported into conveyance  
 37 canals, algae may no longer be light-limited, and thus increases in nutrient levels in Delta export  
 38 waters may increase phytoplankton growth in the canals. Algal blooms are problematic in that they  
 39 create biomass that can obstruct water conveyance facilities and clog filters, and they may also lead  
 40 to taste and odor problems for municipal supplies (State Water Project Contractors Authority  
 41 2007:3-69).

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

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

6 This is important in that benthic and attached algae are potentially more important for taste and  
 7 odor concerns than is planktonic biomass generally (Juttner and Watson 2007:1-2, Taylor et al.  
 8 2006).

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

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

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

### 35 **8.1.3.11 Organic Carbon**

#### 36 **Existing Conditions in the Study Area**

37 The lowest observed mean concentrations of DOC in the Delta during the waters years 2001–2006  
 38 ranged from 1.9 to 2.2 mg/L, with the lowest concentrations occurring in the Sacramento River at  
 39 Hood (Figure 8-38). Higher mean concentrations of DOC occurred in the southern Delta, ranging  
 40 from 3.3 mg/L at the Banks headworks location to 3.8 mg/L at the San Joaquin River near Vernalis.  
 41 The highest observed mean DOC concentration occurred at the North Bay Aqueduct pumping plant  
 42 on Barker Slough (5.7 mg/L). The quality of water in Barker Slough is substantially influenced by  
 43 local sources located in its immediate upland watershed. These local sources contribute a significant

1 organic carbon load to Barker Slough, particularly during winter months when concentrations of  
2 DOC often exceed 10 mg/L (State Water Project Contractors Authority 2007: 3-19, 3-26).

3 DOC measured in the Sacramento River shows a trend of gradually increasing DOC with distance  
4 from Shasta Dam, where median concentrations of about 1 to 1.5 mg/L increase to about 1.5 mg/L  
5 to 2 mg/L at Hood (CALFED Bay-Delta Program 2007b:5-58). Major tributaries such as the Feather  
6 and American Rivers contain relatively low DOC as well, with median measured concentrations of  
7 1.5 mg/L–2 mg/L. DOC on the lower San Joaquin River is comparatively greater but generally  
8 decreases with downstream distance, where median concentrations at Stevinson are nearly 6 mg/L  
9 and median concentrations at Vernalis are about 3 mg/L (CALFED Bay-Delta Program 2007b:5-49).  
10 This decrease in DOC can be attributed to inputs from tributaries such as the Merced, Tuolumne, and  
11 Stanislaus Rivers, with median DOC concentrations of 2 mg/L. Mean values for the north-of-Delta  
12 area during water years 2001–2006 ranged from 1.5 mg/L at the Feather River at Oroville to  
13 2.0 mg/L at the Sacramento River at Veterans Bridge (Table 8-21). South-of-Delta mean values were  
14 higher than north-of-Delta stations examined (3.2 to 3.4 mg/L), and comparable to the mean at the  
15 Banks headworks (3.3 mg/L, Figure 8-38).

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

21 **Table 8-21. Dissolved Organic Carbon Concentrations at Selected North- and South-of-Delta**  
22 **Stations, Water Years 2001–2006<sup>a</sup>**

Location	Dissolved Organic Carbon (mg/L as C)				
	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.

<sup>a</sup> 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.

23  
24 The lowest observed mean concentrations of TOC in the Delta during the water years 2001–2006  
25 ranged from 2.7 to 3.0 mg/L, occurring at the Sacramento River at Hood and in the Delta export  
26 region (Figure 8-41). Higher mean concentrations of TOC occurred in the southern Delta region,  
27 ranging from 3.8 mg/L at CCWD pumping plant #1 to 5.1 mg/L at the San Joaquin River near  
28 Vernalis. The highest observed mean TOC concentration occurred at the Barker Slough pump  
29 (7.8 mg/L).

30 Mean values for the north-of-Delta area ranged from 1.5 mg/L at the Sacramento River at Keswick to  
31 2.1 mg/L at the Sacramento River at Veterans Bridge (Table 8-22). South-of-Delta mean values were



1 higher than north-of-Delta stations examined (3.9 to 4.2 mg/L) and slightly lower than the mean at  
2 the Banks headworks (4.3 mg/L, Figure 8-41).

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

6 **Table 8-22. Total Organic Carbon Concentrations at Selected North- and South-of-Delta Stations,**  
7 **Water Years 2001–2006<sup>a</sup>**

Location	Total Organic Carbon (mg/L as C)				
	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.

<sup>a</sup> 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.

8  
9 Organic carbon is not a priority pollutant; thus, the CTR has no criteria. There are no state or federal  
10 regulatory numerical water quality objectives/criteria for organic carbon or any USEPA-  
11 recommended criteria. As a consequence, none of the water bodies in the affected environment are  
12 listed as impaired on the state's CWA Section 303(d) list because of elevated organic carbon.

13 However, The Central Valley Water Board recently (July 2013) amended the Drinking Water Policy  
14 in the Basin Plan to include new directives to ensure that risks to drinking water quality associated  
15 with organic carbon from Delta source water does not increase over current levels. The Basin Plan  
16 narrative chemical objective (i.e., "Waters shall not contain chemical constituents in concentrations  
17 that adversely affect beneficial uses.") was amended to include a new footnote stating "This includes  
18 drinking water chemical constituents of concern, such as organic carbon." The revised policy requires  
19 the Central Valley Water Board to consider the necessity for inclusion of monitoring of organic  
20 carbon, salinity, and nutrients when renewing waste discharge requirements based on the discharge  
21 loading, proximity to drinking water intakes, and trends in ambient conditions for these  
22 constituents.

23 Under USEPA's Disinfectants and Disinfection Byproducts Rule (63 FR 69390), municipal drinking  
24 water treatment facilities are required to remove specific percentages of TOC in their source water  
25 through enhanced treatment methods, unless the drinking water treatment system can meet  
26 alternative criteria. USEPA's action thresholds begin at 2–4 mg/L TOC and, depending on source  
27 water alkalinity, may require a drinking water utility to employ treatment to achieve as much as a  
28 35% reduction in TOC. Where source water TOC is between 4 and 8 mg/L TOC, drinking water  
29 utilities may be required to achieve a 45% reduction in TOC. Existing Delta water quality regularly  
30 exceeds 2 mg/L TOC, and existing treatment plants already are obligated to remove some amount of  
31 TOC. Nevertheless, changes in source water quality at municipal intakes may trigger additional  
32 enhanced TOC removal, and associated increased treatment costs.

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

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

12 The USEPA promulgated the Stage 1 Disinfectants and Disinfection Byproducts (D/DBP) Rule in  
 13 1998 and the Stage 2 D/DBP Rule in 2006 under the Safe Drinking Water Act (SDWA) which  
 14 collectively establish the treatment standards for DBPs, tightened compliance monitoring  
 15 requirements for DBPs, and strengthened public health protection related to DBP exposure in  
 16 municipal water distribution systems. The Long Term 2 Enhanced Surface Water Treatment Rule  
 17 focuses on reducing illness from cryptosporidium and other disease-causing microorganisms in  
 18 drinking water distribution systems and requires water utilities to balance long-term and short-  
 19 term health concerns posed by DBPs and pathogens, respectively. The compliance challenge for  
 20 WTP operators is to provide adequate disinfection to protect against pathogens without forming  
 21 DBPs. Development of the Delta Drinking Water Policy by the Central Valley Water Board was  
 22 identified as a future need during the 1998 and 2001 triennial reviews of the Basin Plan, and by the  
 23 CALFED process, with a goal of completing the policy and associated Basin Plan amendments in  
 24 2013.

### 25 **8.1.3.12 Pathogens**

#### 26 **Existing Conditions in the Study Area**

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

38 Of the known sources of coliform discharges into the waters of the Central Valley, it was found that  
 39 wastewater total coliform concentrations for most plants were fairly low (<1,000 most probable  
 40 number per 100 milliliters [MPN/100 ml]), whereas the highest total coliform concentrations in  
 41 water (>10,000 MPN/100 ml) were observed near samples influenced by urban areas (Tetra Tech  
 42 2007). In fact, the regional water boards limit publicly owned treatment works discharges to  
 43 <23 MPN/100 ml in NPDES permits, with most plants limited to <2.2 MPN/100 ml. In the San  
 44 Joaquin River valley, comparably high concentrations of E. coli were observed for waters affected by

1 urban environments and intensive agriculture in the San Joaquin Valley (Tetra Tech 2007). Fecal  
 2 indicator data showed minimal relationships with flow rates, although most of the high  
 3 concentrations were observed during the wet months of the years, possibly indicating the  
 4 contribution of stormwater runoff (Tetra Tech 2007).

5 Regulatory criteria with respect to pathogens are as follows. The Central Valley Water Board Basin  
 6 Plan specifies numerical water contact recreation criteria for fecal coliform bacteria not to exceed a  
 7 geometric mean of 200 organisms/100 ml in any 30-day period (based on a minimum of five  
 8 samples), nor more than 10% of the total number of samples taken during any 30-day period to  
 9 exceed 400 organisms/100 ml. The Central Valley Water Board Basin Plan numerical water quality  
 10 objectives for pathogens are detailed in Appendix 8A. The Central Valley Water Board recently (July  
 11 2013) amended the Drinking Water Policy in the Basin Plan to include new directives to ensure that  
 12 risks to drinking water quality associated with pathogens from Delta source water does not increase  
 13 over current levels. A new narrative objective was added stating, "Waters shall not contain  
 14 Cryptosporidium and Giardia in concentrations that adversely affect the public water system  
 15 component of the MUN beneficial use." The new objective applies to the Delta and tributaries below  
 16 the first major dams, and allows utilities to request assistance from the state to conduct source  
 17 evaluations and implement potential control actions if the drinking water utility monitoring at  
 18 intakes indicates increased risks to treatment from these constituents. The Stockton Deep Water  
 19 Ship Channel and various sloughs and creeks in the western and eastern Delta are on the state's  
 20 CWA Section 303(d) list as impaired because of pathogens, with sources identified as recreational  
 21 and tourism activities [nonboating] and urban runoff/storm sewers (State Water Resources Control  
 22 Board 2011). A TMDL for the Stockton Urban Waterbodies was approved by EPA on 13 May 2008.  
 23 TMDLs for other listed water bodies in the affected environment are proposed for completion in  
 24 2021(State Water Resources Control Board 2011).

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

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

### 37 **8.1.3.14 Polycyclic Aromatic Hydrocarbons**

#### 38 **Background**

39 PAHs are toxic compounds formed primarily as products of incomplete combustion (burning) of  
 40 substances such as gasoline, coal, oil, wood, garbage, grilled meat, and tobacco (Agency for Toxic  
 41 Substances and Disease Registry 1995). Some PAHs are manufactured for specific uses such as  
 42 asphalt, creosote, roofing tar, medicines, dyes, pesticides, and plastics. Mahler et al. (2005) suggest

1 that parking lot sealcoat can be a major source of PAHs to urban water bodies. PAHs in oil products  
2 also may exist in a watershed from spills and leaking vehicle fluids, which can then enter the aquatic  
3 environment from pavement runoff. PAHs in the environment tend to be found together as complex  
4 mixtures rather than single compounds (Oros et al. 2007).

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

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

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

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

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

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

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

## 1 **8.1.3.15 Selenium**

### 2 **Importance in the Study Area**

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

18 Selenium concentrations in whole-body fish or fish eggs are most useful for evaluating risks to fish,  
 19 and concentrations in bird eggs are most useful for evaluating risks to birds (Skorupa and Ohlendorf  
 20 1991; Department of the Interior 1998; Ohlendorf 2003). Analyses of dietary items (such as benthic  
 21 [sediment-associated] or water-column invertebrates) also can be used for evaluating risks through  
 22 dietary exposure, although with less certainty than when using concentrations measured in fish or  
 23 birds. When data are not available for the target receptors (fish and birds) or for their diets,  
 24 concentrations can be estimated from selenium in water and suspended particulates. However, such  
 25 modeling further increases the uncertainties in predictions of risk.

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

### 30 **Existing Conditions in the Study Area**

#### 31 **Water Concentrations**

32 Selenium has been monitored most consistently at the mouth of the San Joaquin River at Vernalis  
 33 (Table 8-28) mainly because agricultural drainage in the San Joaquin Valley is the primary source of  
 34 selenium to the Delta (Cutter and Cutter 2004; Presser and Luoma 2006; Bureau of Reclamation  
 35 2006; Entrix 2008; Tetra Tech 2008).

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

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

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

15 Much less sampling has been conducted for selenium analysis in the Sacramento River. The most  
16 recent available data for locations in or near the Delta are from Freeport (Table 8-28). A mean  
17 concentration of 0.072 µg/L was reported for Freeport in 1984 to 1988 and 1997 to 2000 (years  
18 combined, with no apparent difference between the two periods) (Cutter and Cutter 2004), but the  
19 detailed data (e.g., min-max values and sample numbers) are not available for comparison to the  
20 USGS data shown in the table. Because of the limited data from Freeport, additional values are  
21 provided from the Sacramento River at Verona and [below](#) Knights Landing (upstream from  
22 Sacramento but reflecting quality of water that may enter the Yolo Bypass during flooding). The  
23 maximum selenium concentration at those locations was ~~1.00~~[0.39](#) µg/L, and the mean concentrations  
24 were all less than [0.25](#) µg/L. Only limited selenium data are available for other major tributaries to  
25 the eastern Delta.  
26

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

Site	No. of Samples	Selenium Concentration (µg/L)			Years	Source
		Min.	Max.	Mean		
<b>Selenium Concentrations North of the Delta</b>						
Sacramento River at Keswick	86	0.061	0.40	0.21	2003–2008	DWR 2010
Sacramento River at Keswick <sup>a</sup>	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 <sup>a</sup>	30	0.052	0.28	0.16	2003–2008	DWR 2010
<b>Selenium Concentrations for Inflows to the Delta</b>						
Sacramento River at Verona	24	0.061	0.39	0.21	2003–2009	DWR 2010
Sacramento River at Verona <sup>a</sup>	21	0.15	0.29	0.20	2004–2009	DWR 2010
Sacramento River <del>at</del> below Knights Landing	<del>135</del>	0.19	<del>1.00</del> 0.30	<del>0.45</del> 0.23	<del>2003</del> , 2004, 2007, 2008	DWR 2009
Sacramento River at Freeport <sup>a</sup>	<del>6288</del>	0.044	<del>1.00</del> 0.23	<del>0.32</del> 0.09	<del>1996–2001</del> , 11/2007– 07/2014 <del>0</del>	USGS <del>2010</del> 2014
San Joaquin River at Vernalis (Airport Way) <sup>eb</sup>	<del>105</del> <sup>d</sup> 105 <sup>c</sup>	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) <sup>eb</sup>	453	0.40	2.8	0.84	1999–2007	SWAMP 2009
<u>San Joaquin River at Vernalis</u>	<u>93</u>	<u>0.070</u>	<u>1.5</u>	<u>0.45</u>	<u>11/2007–08/2014</u>	<u>USGS 2014</u>
<b>Selenium Concentrations within/near the Delta</b>						
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 <sup>a</sup>	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) <sup>a</sup>	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) <sup>a</sup>	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 <sup>a</sup>	38	0.02	0.44	0.10	2000–2008	SFEI 2010
<b>Selenium Concentrations for the Delta's Major Outputs</b>						
<u>Banks Pumping Plant<sup>a</sup></u>	<u>71</u>	<u>1.0</u>	<u>2.0</u>	<u>1.0</u>	<u>2001–2007</u>	<u>MWQI 2003, 2005, 2006, 2008</u>

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

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

<sup>a</sup> Dissolved selenium concentration.

~~<sup>b</sup> Includes data collected from Colusa Basin Drain near Knights Landing and Sacramento River below Knights Landing.~~

<sup>eb</sup> Not specified whether total or dissolved selenium.

<sup>ec</sup> 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 20102014.

2

1 **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 <sup>a</sup>	0.52	1.01	0.73	0.005	0.04	0.02	0.55	1.03	0.76
Calaveras River	2 <sup>a</sup>	0.55	0.72	0.63	0.005	0.03	0.01	0.56	0.75	0.65
Fourteen Mile Slough	6 <sup>a</sup>	0.35	0.94	0.59	0.01	0.03	0.01	0.36	0.95	0.61
McDonald-Empire	5 <sup>a</sup>	0.09	0.91	0.17	0.005	0.03	0.01	0.10	0.94	0.18
Mildred Island South	1 <sup>a</sup>	0.12	0.12	0.12	0.02	0.02	0.02	0.14	0.14	0.14
Mildred Island Center	1 <sup>a</sup>	0.11	0.11	0.11	0.01	0.01	0.01	0.13	0.13	0.13
Mildred Island North	1 <sup>a</sup>	0.09	0.09	0.09	0.01	0.01	0.01	0.10	0.10	0.10
Venice	1 <sup>a</sup>	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 <sup>a</sup>	0.12	0.12	0.12	0.01	0.01	0.01	0.14	0.14	0.14
Mokelumne River	6 <sup>a</sup>	0.09	0.22	0.13	0.01	0.01	0.01	0.10	0.23	0.14
Three Mile Slough	6 <sup>a</sup>	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.

<sup>a</sup> One sample each station was collected during July 2000; all other data are from January 2003 to January 2004.

Source: Lucas and Stewart 2007.

2



1 Sporadic sampling has been conducted at a few locations in the Delta (Tables 8-~~26-28~~ and 8-~~27-29~~).  
2 The only two locations at which sampling was conducted over several recent years are in the  
3 Sacramento and San Joaquin Rivers just upstream of Mallard Island (near the western limit of the  
4 Delta). Observed total selenium concentrations at these stations are considered more representative  
5 of generalized Delta concentrations than of the individual rivers (Tetra Tech 2008). Total and dissolved  
6 selenium concentrations were somewhat lower at those locations during low flow in a dry year  
7 (<0.1 µg/L in August 2001) than during high flow (>0.1 µg/L in February 2001) (Tetra Tech 2008).  
8 Cutter and Cutter (2004) reported similar flow-related patterns for those locations. The maximum  
9 selenium concentration found in the Delta was 2 µg/L at an Old/Middle River location in the south  
10 subarea of the Delta. Except for that location, the available data show mean concentrations well  
11 below 1 µg/L.

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

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

32 The water quality objective for the lower San Joaquin River at Vernalis is 5 µg/L as a 4-day average  
33 for ~~above-normal~~ and wet water-year types, and 5 µg/L as a monthly mean for dry and below  
34 normal water-year types (Central Valley Water Board 2001, 2007). Selenium criteria were  
35 promulgated for all San Francisco Bay and Delta waters in the NTR (San Francisco Bay Water Board  
36 2007). The NTR criteria specifically apply to San Francisco Bay upstream to and including Suisun  
37 Bay and the Delta. The NTR values are 5.0 µg/L (4-day average) and 20 µg/L (1-hour average). By  
38 comparison, the available data show that the maximum concentration at Vernalis has not exceeded  
39 3 µg/L since implementation of the Grassland Bypass Project, and the mean is less than 1 µg/L for  
40 the period from 1999 through ~~2007~~2014. The CTR criteria for aquatic life protection in saltwater  
41 are substantially higher than the freshwater criteria (i.e., chronic = 71 µg/L; acute = 290 µg/L).

42 Selenium concentrations in water exported from the Delta via Banks pumping plant ranged from 1  
43 to 2 µg/L, with a mean of 1.02 µg/L for 2003–2007. Drinking water standards for selenium are  
44 average concentrations of 50 µg/L, both as the MCL—the enforceable standard that defines the

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

## 12 Sediment and Fish Tissue Concentrations

13 Very little information is available for selenium concentrations in sediment or biota from in the  
 14 Delta (Table 8-30, Table 8-31, and Table 8-32) that would be useful for evaluating risks for fish,  
 15 wildlife, or the people consuming them. Selenium concentrations in sediment usually are not closely  
 16 related to effects on fish or wildlife resources, although screening-level values such as those  
 17 provided by the U.S. Department of the Interior (DOI) are sometimes used for comparison to  
 18 background or potential effect levels (U.S. Department of the Interior 1998). Background selenium  
 19 concentrations in freshwater [environments-sediments](#) are typically <1 mg/kg dry weight.  
 20 Consequently, the concentrations reported for the Sacramento and San Joaquin Rivers near Mallard  
 21 Island and in Suisun Bay (Table 8-[3130](#)) are consistent with background levels. They are well below  
 22 the concentrations associated with effects on fish and bird populations (2.5 mg/kg). Selenium  
 23 analyses of clams from the Mallard Island locations ([Table 8-31](#)) are consistent with other bivalves  
 24 in the Bay-Delta (Linville et al. 2002; Stewart et al. 2004). Whole-body fish from the San Joaquin  
 25 River near Manteca had selenium concentrations within the range of background (<1–4 mg/kg,  
 26 typically <2 mg/kg), although the mean was slightly higher than typical background (Table 8-32).  
 27 Selenium concentrations in delta smelt from Chipps Island also were consistent with background.

28 **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.

29

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

Site	Number of Samples	Selenium Concentration (mg/kg)			Common Name	Year Collected	Source
		Min.	Max.	Mean			
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
Chippis Island <sup>a</sup>	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 <sup>b</sup>	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.

<sup>a</sup> Most of the fish were collected at Chippis Island but included some fish (fewer than 5) from Garcia Bend (near Sacramento).

<sup>b</sup> Near Manteca.

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

2

3 **Table 8-32. Selenium Concentrations in Largemouth Bass**

Site	Number of Samples	Selenium Concentrations in Fish Fillets (mg/kg, wet weight)			Selenium Concentrations in Whole-Body Fish (mg/kg, dry weight)			Years
		Min.	Max.	Mean	Min.	Max.	Mean	
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 <sup>a</sup>	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.

<sup>a</sup> Near Clarksburg.

Source: Foe 2010.

1

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

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

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

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

29 Selenium concentrations in the livers of ~~two~~ 2 of 86 Sacramento splittail collected from Big Break,  
 30 Nurse Slough, and Sherman Island exceeded the concentration (>27 mg/kg) (Teh et al. 2004) at  
 31 which growth, survival, and histopathology effects were observed in long-term laboratory studies of  
 32 juvenile splittail (Greenfield et al. 2008). Mean selenium concentrations ranged from 11.8 to  
 33 16.3 mg/kg in 2001 and from 8.36 to 8.84 mg/kg in 2002, with the highest mean concentrations  
 34 occurring in fish from Nurse Slough (in Suisun Marsh). Other field and laboratory studies have been  
 35 conducted with splittail (Deng et al. 2007, 2008) and with white sturgeon (Tashjian and Hung 2006;  
 36 Tashjian et al. 2006, 2007) and other fish (Linville et al. 2002; Stewart et al. 2004), but no other  
 37 analytical data for field-collected fish from in the Delta were found.

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

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

8 **Table 8-33. Draft Water Quality Criteria for Selenium**

Media Type	Fish Tissue		Water Column <sup>c</sup>	
	Egg/Ovary <sup>a</sup>	Fish Whole-Body or Muscle <sup>b</sup>	Monthly Average Exposure	Intermittent Exposure <sup>d</sup>
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 <sup>e</sup>	Instantaneous measurement <sup>e</sup>	30 days	Number of days/month with an elevated concentration

Source: U.S. Environmental Protection Agency 2014

<sup>a</sup> Overrides any whole-body, muscle, or water column elements when fish egg/ovary concentrations are measured.

<sup>b</sup> Overrides any water column element when both fish tissue and water concentrations are measured.

<sup>c</sup> Water column values are based on dissolved total selenium in water.

<sup>d</sup> Where  $WQC_{30-day}$  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  $\geq 0.033$  (corresponding to 1 day).

<sup>e</sup> 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.

9  
 10 a draft ambient water quality criterion for selenium in 2004 that was based on selenium  
 11 concentrations in whole-body fish (U.S. Environmental Protection Agency 2009g; State Water  
 12 Resources Control Board 2010a). The recommendations were intended to protect aquatic life under  
 13 the CWA. They incorporated the latest scientific information available to the agency at that time and  
 14 reflect an improved approach to measuring this bioaccumulative pollutant in the aquatic  
 15 environment. In October 2008, USEPA released a technical report describing the results from  
 16 additional testing of the toxicity of selenium to juvenile bluegill sunfish under winter temperature  
 17 conditions and also provided references for data obtained since 2004 (73 FR 63706).

18 Recent preliminary information concerning USEPA's pending revision of the draft chronic ambient  
 19 water quality criterion suggests that the agency will propose a two-part criterion: selenium  
 20 concentration in fish egg/ovary coupled with a water screening value (Delos pers. comm.). If the  
 21 latter is exceeded, the former either must be measured or may be estimated using whole-body  
 22 concentrations. It is expected the water screening value will be conservative (so that if the value is  
 23 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<sub>10</sub> 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 Agency 2012a) 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 Agency 2012a). 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

1 and adsorption (i.e., chemical coagulation and filtration systems), and all surface waters require a  
 2 minimum of coagulation and filtration to conform to federal SDWA regulations.

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

## 12 Existing Conditions in the Study Area

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

28 There was a large monitoring effort from 1988 to 1993 to assess metals in the Delta. Results for San  
 29 Joaquin River at Buckley Cove, Sacramento River at Hood (actually collected at Greene’s Landing),  
 30 Sacramento River above Point Sacramento, San Joaquin River at Antioch Ship Channel, Old River at  
 31 Rancho Del Rio, Suisun Bay at Bulls Head Point near Martinez, and Franks Tract are shown in Table  
 32 8-33. Analysis of the monitoring results indicated that most metal median values were similar  
 33 between locations, with zinc median values being the highest of all the metals.

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

1 0.005 mg/L at several locations during the 1988–1993 study, but there were no detections at either  
2 the Banks or Barker Slough pumping plants during water years 2001–2006.

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

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

13 Arsenic, cadmium, chromium, copper, lead, nickel, silver and zinc are among the 126 priority  
14 pollutants identified by the USEPA. Iron and manganese are identified as non-priority pollutants by  
15 USEPA. Federal water quality criteria contained in the CTR, state water quality objectives contained  
16 in the Region 2 and Region 5 Water Quality Control Plans, and drinking water MCLs are listed in  
17 Appendix 8A. Based on water quality criteria and objectives, and typical levels in surface waters, it is  
18 generally the case that [aluminum](#), arsenic, iron, and manganese are of primary concern for drinking  
19 water, while [aluminum](#), cadmium, chromium, copper, lead, nickel, silver, and zinc are of concern  
20 because of potential toxicity to aquatic organisms.  
21



1 **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.

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

Metal	Harvey O. Banks Pumping Plant (µg/L)				Barker Slough Pumping Plant (µg/L)					
	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.

3  
4

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

Metal	Fraction	Sacramento River above Point Sacramento (µg/L)					San Joaquin River at Antioch Ship Channel (µg/L)				
		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.

2

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

Metal	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)				
	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.

2



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

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

### 14 **8.1.3.18 Microcystis**

#### 15 **Background and Importance in the Study Area**

16 This section provides a brief summary of the background and importance of *Microcystis* in the study  
 17 area. A detailed discussion of the importance of *Microcystis* in the Delta, its biology, and potential  
 18 adverse effects due to bloom formation is provided in Appendix 5F of the BDCP, section 5.F.7. The  
 19 occurrence of *Microcystis aeruginosa* (*Microcystis*), a harmful species of cyanobacteria (also  
 20 referred to as a blue-green algal species), in the Delta was first observed in 1999 (Lehman et al.  
 21 2005). In addition to producing surface scums that interfere with recreation and cause aesthetic  
 22 problems, it also produces taste and odor compounds and toxic microcystins that are associated  
 23 with liver cancer in humans and wildlife. Microcystin-LR is the most widely studied congener of the  
 24 known microcystins, and it has been associated with most incidents of toxicity involving  
 25 microcystins. *Microcystis* blooms can cause toxicity to phytoplankton, zooplankton, and fish, and  
 26 also can affect feeding success or food quality for zooplankton and fish. Blooms of *Microcystis*  
 27 require high levels of nutrients and low turbidity, but also require high water temperature (i.e.,  
 28 above 19°C) and long residence time, since the species is fairly slow growing (Lehman et al. 2008;  
 29 Lehman et al. 2013). In addition, low vertical mixing associated with high residence time allows  
 30 *Microcystis* colonies to float to the surface of the water column, where they out compete other  
 31 species for light.

#### 32 **Existing Conditions in the Study Area**

33 Since its first observance in the Delta in 1999, annual *Microcystis* blooms have occurred at varying  
 34 levels throughout the Delta, with blooms typically beginning in the central Delta and spreading  
 35 seaward into saline environments (Lehman et al. 2008; Lehman et al. 2013). Section 5.F.7.4 of  
 36 Appendix 5F cites numerous studies showing that *Microcystis* blooms produce adverse effects on  
 37 phytoplankton, zooplankton and fish populations in the Delta. Water temperatures greater than  
 38 19°C, low water velocities, and high water clarity are necessary for *Microcystis* levels to reach  
 39 bloom-forming scale (Paerl 1988; Lehman et al. 2008; Lehman et al. 2013). The water temperature  
 40 requirement is considered the primary factor that restricts bloom development to the months of  
 41 June through September (Lehman et al. 2013). Sufficiently high water temperature (i.e., 19°C), low  
 42 flow and thus sufficiently long residence time, and increased clarity enable bloom formation, which

1 occurs in the San Joaquin River, Old River, and Middle River earlier, and to a greater extent, than  
 2 other areas of the Delta. Likewise, the Delta's shallow, submerged islands sustain high levels of  
 3 *Microcystis* during the growing season because the physical drivers of bloom formation are  
 4 amplified in these areas due to low flushing rates (Lehman et al. 2008). Although elevated pH is  
 5 tolerated by *Microcystis*, pH is not currently thought to be a primary driver of seasonal and  
 6 interannual variation in bloom formation (Lehman et al. 2013).

7 Nutrients have historically been sufficiently high to support *Microcystis* growth in the Delta, yet  
 8 there is currently little evidence that levels of nitrogen, phosphorus, or their ratio control the  
 9 seasonal or inter-annual variation in the bloom (Lehman 2005; Lehman et al. 2008; Lehman et al.  
 10 2013; Lehman et al. 2015). This is likely because nutrient concentrations in the Delta are above the  
 11 thresholds that limit *Microcystis* growth (Lehman et al. 2008; Lehman et al. 2013). However, blooms  
 12 of *Microcystis* in the Delta have been shown to utilize ammonia from the Sacramento River over  
 13 other forms of nitrogen (Lehman et al. 2015).

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

## 23 **8.3 Environmental Consequences**

### 24 **8.3.1 Methods for Analysis**

#### 25 **8.3.1.1 Models Used and Their Linkages**

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

#### 33 **CALSIM II**

34 The CALSIM II model, which has been jointly developed and maintained by DWR and Reclamation to  
 35 provide hydrologic-based information for planning, managing, and operating the integrated SWP  
 36 and CVP system, was used to simulate system operations and resulting hydrologic conditions under  
 37 the Alternatives. CALSIM II operates on a monthly time step from water year 1922 through 2003  
 38 using historical rainfall and runoff data which have been adjusted for changes in water and land use  
 39 that have occurred or are projected to occur in the future. In the model, the reservoirs and pumping

1 facilities of the SWP and CVP are operated to ensure the flow and water quality requirements for  
 2 these systems are met. The model assumes that facilities, land uses, water supply contracts, and  
 3 regulatory requirements are constant throughout the 82-year hydrologic period of record, thus  
 4 providing a simulation representing a fixed level of development.

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

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

### 16 **Artificial Neural Network for Flow-Salinity Relationship**

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

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

35 ~~The ANN model approximates DSM2 model-generated salinity at the following key locations for the~~  
 36 ~~purpose of modeling Delta water quality standards: X2, Sacramento River at Emmaton, San Joaquin~~  
 37 ~~River at Jersey Point, Sacramento River at Collinsville, and Old River at Rock Slough. In addition, the~~  
 38 ~~ANN is capable of providing salinity estimates for Clifton Court Forebay, CCWD Alternate Intake~~  
 39 ~~Project (AIP) and Los Vaqueros diversion locations. The ANN may not fully capture the dynamics of~~  
 40 ~~the Delta under conditions other than those for which it was trained. It is possible that the ANN will~~  
 41 ~~exhibit errors in flow regimes beyond those for which it was trained. Therefore, a new ANN was~~  
 42 ~~developed for scenarios with sea level rise and/or restoration areas in the Delta which result in~~  
 43 ~~changed flow--salinity relationships in the Delta. A more complete description of the ANNs~~  
 44 ~~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 to~~ To better represent the sub-monthly flow variability, particularly in early winter, a monthly-to-daily flow mapping-patterning technique ~~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



1 simply a technique to incorporate representative daily variability into the flows resulting from  
2 CALSIM II's monthly operational decisions.

### 3 **Calibration and Validation**

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

### 14 **Corroboration**

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

### 27 **Modeling Limitations and Uncertainty**

28 Because DSM2 is a ~~1D~~ one-dimensional model, it has ~~with~~ inherent limitations in simulating  
29 hydrodynamic and transport processes in a complex estuarine environment such as the ~~Sacramento~~  
30 ~~–San Joaquin~~ Delta. DSM2 assumes that velocity in a channel can be adequately represented by a  
31 single average velocity over the channel cross-section, meaning that variations both across the  
32 width of the channel and through the water column are negligible. DSM2 does not have the ability to  
33 model short-circuiting of flow through a reach, where a majority of the flow in a cross-section is  
34 confined to a small portion of the cross-section. DSM2 does not conserve momentum at the channel  
35 junctions and does not model the secondary currents in a channel. DSM2 also does not explicitly  
36 account for dispersion due to flow accelerating through channel bends. It cannot model the vertical  
37 salinity stratification in the channels. It has inherent limitations in simulating the hydrodynamics  
38 related to the open water areas. Since a reservoir surface area is constant in DSM2, it impacts the  
39 stage in the reservoir and thereby impacting the flow exchange with the adjoining channel. Due to  
40 the inability to change the cross-sectional area of the reservoir inlets with changing water surface  
41 elevation, the final entrance and exit coefficients were fine tuned to match a median flow range. This  
42 causes errors in the flow exchange at breaches during the extreme spring and neap tides. Using an  
43 arbitrary bottom elevation value for the reservoirs representing the proposed marsh areas to get

1 around the wetting-drying limitation of DSM2 may increase the dilution of salinity in the reservoirs.  
 2 Accurate representation of RMA's tidal marsh areas, bottom elevations, location of breaches, breach  
 3 widths, cross-sections, and boundary conditions in DSM2 is critical to the agreement of  
 4 corroboration with RMA results for tidal marsh areas.

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

### 13 Use of CALSIM II and DSM2 for Assessment of Meeting of ~~D1641~~ Bay-Delta WQCP 14 Water Quality Objectives

#### 15 Section 3.4 Water Quality Objectives Incorporated into CALSIM II

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

- 28 ● Municipal and Industrial Use:
  - 29 ○ Old River at Rock Slough Chloride
  - 30 ○ Banks/Jones Chloride Pumping Plants
- 31 ● Agricultural Beneficial Use:
  - 32 ○ Sacramento River at Emmaton or Threemile Slough<sup>‡</sup>
  - 33 ○ San Joaquin River at Jersey Point
- 34 ● Fish and Wildlife Beneficial Uses:
  - 35 ○ Sacramento River at Collinsville

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

39 Note that the ~~project A~~ Alternatives contain an important element regarding the Sacramento River at  
 40 Emmaton water quality objective. All ~~project A~~ Alternatives included, 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 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 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 objective 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 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 3.2b. 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

- 1           ● San Joaquin River at Airport Way Bridge, Vernalis
- 2           ● San Joaquin River at Brandt Bridge Site
- 3           ● Old River near Middle River
- 4           ● Old River at Tracy Road Bridge
- 5           ● West Canal at mouth of Clifton Court Forebay
- 6           ● Delta-Mendota Canal at Tracy Pumping Plant
- 7           ● Fish and Wildlife Beneficial Uses:
  - 8           ○ San Joaquin River at and between Jersey Point and Prisoners Point
  - 9           ○ Suisun Marsh
    - 10           ● Sacramento River at Collinsville
    - 11           ● Montezuma Slough at National Steel
    - 12           ● Montezuma Slough near Beldon Landing
    - 13           ● Chadbourne Slough at Sunrise Duck Club
    - 14           ● Suisun Slough, 300 feet south of Volanti Slough
    - 15           ● Cordelia Slough at Ibis Club
    - 16           ● Goodyear Slough at Morrow Island Clubhouse

17           Section 3.3 ● Water supply intakes for waterfowl management areas on Van Sickle and  
 18           Chippis Islands

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

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

26           Section 3.42. The system operations that CALSIM II simulated were incidentally sufficient to  
 27           meet the water quality objective on a monthly average basis, but the monthly-to-daily  
 28           patterning discussed above resulted in a pattern of flows at the DSM2 boundary conditions that  
 29           resulted in the objective being exceeded.

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

1 among alternatives for impact assessment purposes. Additionally, because DSM2 accounts for  
 2 hydrodynamic conditions in the Delta, the effects of some of the habitat restoration actions (i.e., CM2  
 3 and CM4) on EC and DOC are evaluated quantitatively. Restoration actions that resulted in water  
 4 quality changes associated with altered hydrodynamics, which were captured in the DSM2  
 5 modeling, are discussed in constituent-specific impact assessment sections as operations-related  
 6 water quality changes. Restoration actions that could result in a potential increase in constituent  
 7 loading (e.g., increased nutrient, organic carbon, or suspended solids) to the Delta region were  
 8 assessed qualitatively.

9 ~~As described above, these~~ The approach ~~methodes~~ described in the following sections were used to  
 10 calculate values/levels/concentrations for water quality parameters on a daily or monthly average  
 11 basis for the DSM2 period of record (1976–1991). Results were generally compiled and presented  
 12 based on two averaging periods: all water years, and the drought period (water years 1987–1991).  
 13 The drought period was chosen to represent water quality in “worst-case” conditions, as it includes  
 14 several dry and critical years in sequence. This was done in lieu of calculating water quality effects  
 15 on a water year type basis (using the Sacramento River Water Year Hydrologic Classification Index).  
 16 The reasons for this included simplicity of presenting and discussing results, and also because the  
 17 1987–1991 drought period represents truly worst-case conditions, whereas discussion of dry or  
 18 critical year water types s-results lumped together would includess individual years that when  
 19 water supply and quality were would not be significantly affected because they were preceded by  
 20 and succeeded by wet or above normal water years (e.g., 1981, 1985). However, when necessary,  
 21 analysis of effects during certain water year types was conducted (for example, for chloride and EC,  
 22 whose water quality standards depend on the water year type).

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

#### 34 Mass-Balance Method

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

$$44 \quad f_{SAC,i}(C_{SAC}) + f_{SJR,i}(C_{SJR}) + f_{EST,i}(C_{EST}) + f_{BAY,i}(C_{BAY}) + f_{AGR,i}(C_{AGR}) = C_i \quad (1)$$

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

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

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

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

35 This is because

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

1 component CM4 increases tidal exchange volume, the value used for  $C_{BAY}$  would underestimate  
2 concentrations associated with San Francisco Bay water (as measured at Martinez).

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

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

#### 24 Regression Method for Chloride and Bromide

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

$$29 \quad Cl = \max \left( \begin{array}{l} 0.15 * EC - 12 \\ 0.285 * EC - 50 \end{array} \right) \quad (2)$$

30 In the equation above, Cl is the chloride concentration in mg/L, and EC is in  $\mu\text{S}/\text{cm}$ .

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

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



$$Br = 0.0035 * Cl \quad (3)$$

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.

- 1       • **Literature-based regression models or bioaccumulation factors.** These resources provide a  
2       basis for estimating tissue concentrations for mercury and selenium from concentrations in  
3       surface water or sediment.
- 4       • **Site-specific linkages.** Methods were developed to describe existing relationships between  
5       waterborne concentrations of mercury and selenium at the nearest modeling nodes, existing  
6       sediment (for mercury), and fish tissue concentrations in an attempt to create predictive  
7       relationships for impact analysis and alternatives comparisons.
- 8       • **Delta methylmercury.** The TMDL translation equation for mercury (Central Valley Water  
9       Quality Board 2011b) was used to estimate fish tissue concentrations from waterborne  
10      concentrations. In addition, DSM2 water quality model predictions were investigated separately  
11      for their ability to predict measured fish tissue concentrations at discrete locations. The two  
12      translation models were compared for their predictive ability.
- 13      • ~~**Delta U.S. Geological Survey Bioaccumulation and Trophic Transfer Factors for selenium.**~~  
14      U.S. Geological Survey bioaccumulation and trophic transfer factors for ~~Values for~~ uptake of  
15      selenium from water to the lowest trophic levels (e.g., suspended particulates or algae) and  
16      ~~transfer factors~~ from that level to invertebrates and then to fish and bird eggs developed by  
17      Presser and Luoma (2009, 2010) were used initially to estimate uptake from water to fish and to  
18      bird eggs. In calibrating the Delta-wide bioaccumulation model for largemouth bass, the  
19      particulate selenium concentration initially was estimated using a default  $K_d$  of 1,000 ( $K_d =$   
20      particulate/water ratio; Presser and Luoma 2010). Because this first step in selenium  
21      bioaccumulation typically is much more variable than other steps in the bioaccumulation model,  
22      the  $K_d$  was then adjusted to calibrate the model so that the modeled concentrations for fish  
23      approximated the measured concentrations in bass for normal and wet years (2000 and 2005)  
24      and for dry years (2007), as described in Appendix 8M, Section 8M.4. Initial modeling for fish  
25      was based on a model calibrated for largemouth bass as the representative species because of  
26      the available data for bass across the Delta (~~Appendix 8M~~). However, because there would be  
27      more bioaccumulation of selenium by species such as sturgeon that feed in part on clams that  
28      are known to bioaccumulate selenium readily in Suisun Bay, additional modeling was conducted  
29      for sturgeon in the western Delta (~~sturgeon addendum M.A for~~ ~~Appendix 8M~~).
- 30      Adverse effects on ecological and human receptors were quantified through comparisons of  
31      measured and modeled surface water, and tissue (fish [fillets for mercury; whole body and fillets for  
32      selenium] and bird eggs [selenium only]) data to established benchmarks, including the following.
- 33      • Water quality objectives, criteria, and drinking water standards for mercury, methylmercury,  
34      and selenium.
- 35      • Literature-derived effect levels for mercury, methylmercury, and selenium in fish fillets for  
36      species most representative of the Delta.
- 37      • Literature-derived effect levels for selenium in whole-body fish for species most representative  
38      of the Delta.
- 39      • Literature-derived effect levels for selenium in eggs of bird species most representative of the  
40      Delta.
- 41      • State of California Office of Environmental Health Hazard Assessment's fish contaminant goals  
42      and advisory tissue levels for mercury, methylmercury, and selenium.

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

### 15 **8.3.1.7 Constituent-Specific Considerations Used in the Assessment**

#### 16 **Bromide**

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

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

1 As demonstrated in Table 8-43, achieving the CALFED goal of 50 µg/L bromide at drinking water  
2 intakes is severely challenged by the ~~quality bromide concentrations in two main of at least three of~~  
3 ~~the five primary~~ source waters ~~to the Delta, the San Joaquin River and San Francisco Bay (seawater),~~  
4 where long-term average concentrations exceed this goal many fold ~~in the source waters~~  
5 ~~themselves~~. In establishing its source water goal for bromide, CALFED assumed more stringent DBP  
6 criteria for treated drinking water than are currently in place. Source water with bromide between  
7 100 µg/L and 300 µg/L is believed sufficient to meet currently established drinking water criteria  
8 for DBPs, depending on the amount of *Giardia* inactivation required (California Urban Water  
9 Agencies 1998, ES2). This assessment of alternatives evaluates how each alternative would affect  
10 the frequency with which predicted future bromide concentrations would exceed 50 µg/L (based  
11 directly on the CALFED goal) and 100 µg/L (based on the lower limit of the range considered  
12 sufficient for meeting currently established drinking water criteria) on a long-term average basis at  
13 the assessment locations. Because, in many cases, the existing condition is one already exceeding 50  
14 µg/L, the frequency with which bromide would exceeds 100 µg/L becoames a key focus of the  
15 assessment, as well as the change in long-term average bromide concentration.

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

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

1 **Table 8-43. Source Water Concentrations for Dissolved Bromide ( $\mu\text{g/L}$ )**

Source Water	Sacramento River	San Joaquin River	San Francisco Bay <sup>a</sup>	Eastside Tributaries	Agriculture in the Delta
Mean ( $\mu\text{g/L}$ )	15	251	13,149–32,951	16	456
Minimum ( $\mu\text{g/L}$ )	1	20	28–17,465	14	20
Maximum ( $\mu\text{g/L}$ )	100	650	33,985–44,100	17	2,720
75th Percentile ( $\mu\text{g/L}$ )	20	345	22,313–38,500	N/A	580
99th Percentile ( $\mu\text{g/L}$ )	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	<sup>b</sup>	Mokelumne River at Sacto Road	<sup>c</sup>
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 <sup>d</sup>
No. of Data Points	560	547	26–27	2	991

## Notes:

<sup>a</sup> 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.

<sup>b</sup> 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.

<sup>c</sup> 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.

<sup>d</sup> 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  $\mu\text{g/L}$  and 46,800  $\mu\text{g/L}$ . In total, 2 data points were omitted and 991 were retained.

2

## 1 Chloride

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

9 In addition, the implementation CM4 would restore substantial areas of tidal habitat that would  
10 increase the magnitude of daily tidal water exchange at the restoration areas, and could alter other  
11 hydrodynamic conditions in adjacent Delta channels. San Francisco Bay water is a major source of  
12 chloride, thus, the increased tidal exchange resulting from tidal habitat restoration may increase  
13 chloride concentrations in the portion of the Bay water that enters the western Delta. The DSM2  
14 modeling included assumptions regarding possible locations of tidal habitat restoration areas, and  
15 how restoration would affect Delta hydrodynamic conditions and source water flow fractions.  
16 However, the magnitude of increased chloride concentrations in Bay source water in the western  
17 Delta as a result of increased tidal exchange is uncertain. Consequently, the potential effects of tidal  
18 restoration on chloride concentrations in the Bay source water was assessed qualitatively based on  
19 predicted changes in the Bay source water fraction. The effects of other conservation measures (i.e.,  
20 CM2, CM3, and CM5-CM~~2221~~) which do not substantially affect flows or Delta hydrodynamic  
21 conditions also were assessed qualitatively.

22 Applicable chloride objectives for the affected environment utilized in this assessment are  
23 summarized in ~~(Table 8-44)~~. The mass-balance modeling results were used to compare predicted  
24 changes in assessment variables (e.g., exceedances of objectives/criteria, amount of water quality  
25 degradation relative to chloride) based on averaging periods appropriate for each relevant  
26 beneficial use. Results of a second modeling approach utilizing relationships between EC and  
27 chloride were used to supplement those results (see Section 8.3.1.3). The assessment of effects  
28 relative to designated beneficial uses and associated water quality objectives/criteria was based on  
29 changes in long-term average concentrations modeled for all water year types for the 16-year  
30 (1976–1991) hydrologic period of record and for the drought years only (i.e., 1987–1991).  
31 Compliance for some applicable objectives/criteria are based on short-term averaging period  
32 concentrations; e.g., daily data for Bay-Delta WQCP objectives for municipal and industrial water  
33 supply for specific locations in the Delta (e.g., daily data) ~~and the U.S. EPA aquatic life criteria (i.e., 4-~~  
34 ~~day chronic and 1-hour acute criteria)~~. The available monitoring data for source water chloride  
35 concentrations are not adequate to characterize daily variability, and the channel flows modeled in  
36 CALSIM, which provides the hydrologic input to the DSM2 model, ~~is are~~ on a monthly time-step.  
37 Therefore, the mass-balance approach can only be used for monthly average assessment, and thus  
38 for the chloride assessment cannot be used to evaluate exceedances of the 150 mg/L objective, and  
39 can only evaluate exceedances of the 250 mg/L objective on a monthly average basis instead of a  
40 daily average basis. Consequently, the assessment of potential effects of alternatives relative to the  
41 150 mg/L objective was based only on daily chloride data obtained via the EC to chloride  
42 relationships and DSM2 EC output (as described in Section 8.3.1.3). Relative to the 250 mg/L  
43 objective, assessment was based on both monthly average concentrations from the mass-balance  
44 approach and daily average concentrations from the EC to chloride relationship approach.

1 **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
<i>All Receiving Waters Other Than the Delta</i>	--		250 <sup>a, b</sup> 500 <sup>a, c</sup> 600 <sup>a, d</sup>	142/355 <sup>e</sup> 250 <sup>a, b</sup> 500 <sup>a, c</sup> 600 <sup>a, d</sup>	250 <sup>b</sup> 500 <sup>c</sup> 600 <sup>d</sup>	230/860 <sup>f</sup>
<i>Delta-Specific</i>						
Contra Costa Canal @ Pumping Plant No. 1 or San Joaquin River @ Antioch Water Works Intake	Year Type	Objective <sup>g</sup>	--	--	--	--
	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%)				
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.) <sup>h</sup>		--	--	--	--
<p>Notes: A = Annual, etc.</p> <p><sup>a</sup> 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.</p> <p><sup>b</sup> 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.</p> <p><sup>c</sup> 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.</p> <p><sup>d</sup> 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.</p> <p><sup>e</sup> Objectives for agricultural water supply identified in Basin Plan as a “threshold value/limit value”; no averaging period is defined for assessment of compliance.</p> <p><sup>f</sup> U.S. EPA National Recommended Water Quality Criteria specified as Criterion Continuous Concentration (CCC)/Criteria Maximum Concentration (CMC).</p> <p><sup>g</sup> 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).</p> <p><sup>h</sup> 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.</p>						

2

1 Understanding the uncertainties and limitations in the modeling and assessment approach is  
2 important for interpreting the results and effects analysis, including assessment of compliance with  
3 water quality objectives. Please refer to Section 8.3.1.1, *Models Used and Their Linkages*, and Section  
4 8.3.1.3, *Plan Area*, for a description of these limitations. In light of these limitations, the assessment  
5 of compliance is conducted in terms of assessing the overall direction and degree to which Delta  
6 chloride would be affected relative to a baseline, and discussion of compliance does not imply that  
7 the alternative would literally cause Delta chloride to be out of compliance a certain period of time.  
8 In other words, the model results are used in a comparative mode, not a predictive mode.

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

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



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

Source Water	Sacramento River	San Joaquin River	San Francisco Bay <sup>a</sup>	East Side Tributaries	Delta Agriculture Return Waters <sup>b</sup>
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	<sup>b</sup>
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:

<sup>a</sup> 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.

<sup>b</sup> 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.

2

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

12 **Dissolved Oxygen**

13 DO levels in the reservoirs and rivers upstream of the Delta are primarily affected by water  
14 temperature, flow velocity, turbulence, amounts of oxygen demanding substances present (e.g.,  
15 ammonia, organics), and rates of photosynthesis (which is influenced by nutrient levels),  
16 respiration, and decomposition. Water temperature and salinity affect the maximum DO saturation  
17 level (i.e., the highest amount of oxygen the water can dissolve). Flow velocity affects the turbulence  
18 and re-aeration of the water (i.e., the rate at which oxygen from the atmosphere can be dissolved in

1 water). High nutrient content can support aquatic plant and algae growth, which in turn generates  
 2 oxygen through photosynthesis and consumes oxygen through respiration and decomposition.

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

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

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

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

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

### 23 **Electrical Conductivity**

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

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

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

38 The assessment of hydrodynamic effects of the BDCP alternatives' CM1, CM2, and CM4 on EC in the  
 39 Plan Area relied on DSM2 output. Because implementation CM4 would restore substantial areas of  
 40 tidal habitat that would increase the magnitude of daily tidal water exchange at the restoration  
 41 areas, and could alter other hydrodynamic conditions in adjacent Delta channels, the DSM2  
 42 modeling included assumptions regarding possible locations of tidal habitat restoration areas, and

1 how restoration would affect Delta hydrodynamic conditions and source water flow fractions. The  
 2 effects of other conservation measures (i.e., CM3 and CM5–CM~~22~~21) which do not substantially  
 3 affect Delta hydrodynamic conditions were assessed qualitatively.

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

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

11 For the assessment of Alternatives 1-34 and 5-9, the Sacramento River at Emmaton compliance  
 12 location is relocated to Three~~m~~-Mile Slough near the Sacramento River. For comparing effects of the  
 13 alternatives on EC in this portion of the Delta, two comparisons were made:

- 14 • changes in EC in the Sacramento River at Emmaton under the alternatives are compared to EC at  
 15 Emmaton under Existing Conditions and the No Action Alternative, and
- 16 • changes in EC in Three-Mile Slough under the alternatives are compared to EC at Emmaton  
 17 under Existing Conditions and the No Action Alternative.

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

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

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

1 **Table 8-46. Applicable State Objectives and Other Relevant Effects Thresholds for Electrical Conductivity ( $\mu\text{mhos/cm}$  [at 25°C] unless specified)**

Location	Bay-Delta WQCP	Region 5 Basin Plan	Region 2 Basin Plan	Drinking Water MCL
<i>All Receiving Waters Other than the Delta</i>	--	900 <sup>a, b</sup> 1,600 <sup>a, c</sup> 2,200 <sup>a, d</sup>	200-3,000 <sup>e</sup> 900 <sup>f</sup>	900 <sup>a, b</sup> 1,600 <sup>a, c</sup> 2,200 <sup>a, d</sup>
<i>Delta-Specific</i>	<u>Year Type</u>	<u>Objective <sup>g</sup> for Agricultural Beneficial Uses</u>		
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 @ Terminus	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	<u>Objective for Agricultural Beneficial Uses</u>	--	--	-
	700 (Apr. 1–Aug. 31)			
	1,000 (Sep. 1–Mar. 31) <sup>h</sup>			
Export Area	<u>Objective for Agricultural Beneficial Uses</u>	--	--	--
	1,000 (Oct. 1–Sep. 30) <sup>i</sup>			
SJR at and between Prisoners Point and Jersey Point	<u>Objective for Fish and Wildlife Beneficial Uses</u>	--	--	--
	440 (Apr. 1–May 31) <sup>j</sup>			
Eastern Suisun Marsh (Sacramento @ Collinsville; Montezuma Slough @ National Steel; Montezuma Slough near Beldon Landing)	<u>Month</u> <u>Objective <sup>k</sup> for Fish and Wildlife Beneficial Uses</u>	--	--	--
	Oct	19,000		
	Nov–Dec	15,500		
	Jan	12,500		
	Feb–Mar	8,000		
	Apr–May	11,000		
Western Suisun Marsh (Cadbourn 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.)	<u>Month</u> <u>Objective <sup>l</sup></u> <u>Month</u> <u>Objective <sup>m</sup> for Fish and Wildlife Beneficial Uses</u>	--	--	--
	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		

1

## 1 Notes for Table 8-46

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### Notes:

- <sup>a</sup> 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.
  - <sup>b</sup> Recommended Contaminant Level. Constituent concentrations lower than the recommended contaminant level are desirable for a higher degree of consumer acceptance.
  - <sup>c</sup> 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.
  - <sup>d</sup> 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.
  - <sup>e</sup> 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.
  - <sup>f</sup> Objective for municipal supply.
  - <sup>g</sup> Agricultural objective is a 14-day running average of mean daily EC.
  - <sup>h</sup> 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).
  - <sup>i</sup> 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.
  - <sup>j</sup> Fish and wildlife objective is a maximum 14-day running average of mean daily EC.
  - <sup>k</sup> 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.
  - <sup>l</sup> 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.
  - <sup>m</sup> 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.
- 

## 2

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

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

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

30 Furthermore, there are several factors related to the modeling approach that may result in modeling  
 31 artifacts that show objective exceedance, when in reality no such exceedance would occur in reality.  
 32 Sensitivity analyses and further other analyses were performed to evaluate whether exceedances  
 33 were indeed modeling artifacts or were potential project related impacts that may actually occur.  
 34 The sensitivity analysis modeling runs were limited to the Existing Conditions, No Action  
 35 Alternative, and Alternative 4 Scenario H3, but the findings from these analyses can generally be  
 36 extended to other scenarios of Alternative 4 and the other project alternatives. These analyses  
 37 included modeling runs investigating the impact of: changing the Emmaton electrical conductivity  
 38 compliance location to Threemile Slough, monthly-daily patterning at the Delta boundary locations,  
 39 including the Montezuma Slough Salinity Control Gates under the Alternatives, removing 65,000  
 40 acres of Delta restoration (as a means of understanding the contribution to exceedances of  
 41 restoration vs. CM1), and revising head of Old River Barrier operations during April-May.  
 42 Additionally, evaluation of individual exceedances at Emmaton was conducted to determine the  
 43 most likely cause of each exceedance. A complete discussion of the sensitivity analysis modeling  
 44 runs performed and the results for EC is included in Appendix XX8H, Attachment 1.

## 1 Nitrate

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

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

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

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

<sup>b</sup> Ayers and Westcot (1994). Recommended goals for sensitive crops.

<sup>c</sup> For the consumption of water and organisms.

13  
 14 Table 8-51 characterizes nitrate concentrations in source waters to the Delta. Data indicate that the  
 15 San Joaquin River and agriculture within the Delta contain the highest nitrate concentrations, while  
 16 concentrations in the Sacramento River, San Francisco Bay, and East Side Tributaries are  
 17 considerably lower. Both the Sacramento and San Joaquin Rivers exhibit seasonal patterns in nitrate  
 18 concentration.

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

Source Water	Sacramento River <sup>a</sup>	San Joaquin River <sup>a</sup>	San Francisco Bay	East Side Tributaries	Agriculture within the Delta <sup>a, b</sup>
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 <sup>b</sup>
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 <sup>a</sup>	San Joaquin River <sup>a</sup>	San Francisco Bay	East Side Tributaries	Agriculture within the Delta <sup>a, b</sup>
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

<sup>a</sup> 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.

<sup>b</sup> 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.

1

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

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

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

## 1 Phosphorus

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

16 **Table 8-53. Summary of Dissolved Ortho-Phosphate Concentrations (mg/L-P) in Delta Source**  
 17 **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

18  
 19 Phosphorus does not behave conservatively in the environment. It can be taken up and metabolized  
 20 by organisms or lost to or supplied by sediment. Because phosphorus concentrations do not vary  
 21 considerably between the major source waters (as discussed above), phosphorus was assessed  
 22 qualitatively. While at times phosphorus in the Delta and its source waters can be bound primarily  
 23 in suspended sediment, we have limited ability to predict changes in total phosphorus  
 24 concentrations because there are no sediment transport models for the Delta. Because our modeling  
 25 tools assume dissolved, conservative constituents, we assumed conservative mixing to predict  
 26 changes in ortho-phosphate concentrations based on the mixing of different water sources. The  
 27 primary way in which the BDCP alternatives could affect phosphorus levels is by increasing the

1 fraction of San Joaquin River water at point in the Plan Area during January through March. Thus,  
2 source water fractions for the San Joaquin River were analyzed for that period to determine if the  
3 changes would be expected to substantially affect phosphorus concentrations. As unpredictable as  
4 they may be, levels of total phosphorus could be directly influenced by changes in suspended  
5 sediment-bound phosphorus. Therefore, changes in phosphorus levels were qualitatively assessed  
6 on the basis of changes in TSS and turbidity levels.

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

## 18 **Selenium**

19 Potential impacts may occur from project-related changes to concentrations of selenium in water as  
20 well as changes to concentrations in fish tissues (whole-body and fillets) and bird eggs.

21 Bioaccumulation models were developed linking selenium concentrations in water to  
22 concentrations in fish tissue and bird eggs, which were estimated for each assessment location and  
23 alternative based on the modeled selenium concentration estimates for water from DSM2 (as  
24 described in Appendix 8M), and from water to whole-body sturgeon in the western Delta (as  
25 described in ~~sturgeon addendum M.A to~~ Appendix 8M). Because of differences in bioaccumulation  
26 among water-year types, one model was used for all water years and a modified model was  
27 developed for drought years (when bioaccumulation was higher for fish). Detailed results are  
28 presented in Appendix 8M ~~and Addendum sturgeon addendum M.A to Appendix 8M.~~

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

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

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

<sup>a</sup> 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).

<sup>b</sup> 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).

<sup>c</sup> 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).

<sup>d</sup> 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.

<sup>e</sup> 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).

<sup>f</sup> Concentration as total recoverable selenium identified as a Level of Concern for the Grassland Bypass Project (Beckon et al. 2008).

3

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

	Whole-Body Fish <sup>a</sup>		Bird Eggs <sup>a</sup>		Fish Fillets <sup>b</sup>
	Low <sup>c</sup>	High <sup>d</sup>	Low <sup>e</sup>	High <sup>f</sup>	
Selenium	4	<u>98.1</u>	6	10	2.5

<sup>a</sup> mg/kg, dry-weight basis.

<sup>b</sup> mg/kg, wet-weight basis; Advisory Tissue Level (OEHHA 2008).

<sup>c</sup> 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).

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

<sup>e</sup> Level of Concern for bird eggs (lower end of range) (Beckon et al. 2008).

<sup>f</sup> Toxicity Level for bird eggs (Beckon et al. 2008).

6

7 The State Water Board lists the western Delta as having impaired water quality for selenium and  
 8 several other constituents under Clean Water Act Section 303(d) (State Water Resources Control  
 9 Board 2011). The Central Valley Water Board completed a TMDL for selenium in the lower San  
 10 Joaquin River (downstream of the Merced River) in 2001, and USEPA approved this in 2002 (Central  
 11 Valley Water Board 2001, 2009d). Historical selenium concentrations in source waters to the Delta  
 12 are shown in Table 8-56. DSM2 modeling for other constituents considered five sources of water to  
 13 the Delta, as described in Section 8.3.1.3. However, for selenium, the Sacramento River mean

1 concentration upstream of the American River (as measured ~~bat-elow~~ Knights Landing, upstream of  
 2 the Yolo Bypass) was somewhat higher than that at Freeport (representing the main flow of the  
 3 river to the Delta). Consequently, the value for Knights Landing was used as the input through the  
 4 Yolo Bypass and the value for Freeport was used to represent the main flow of the Sacramento River  
 5 to the Delta.

6 **Table 8-56. Historical Selenium Concentrations in the Six Delta Source Waters for the Period 1996–**  
 7 **2014~~0~~**

Source Water	Sacramento River <sup>a</sup>	San Joaquin River <sup>b</sup>	San Francisco Bay <sup>a</sup>	East Side Tributaries <sup>c</sup>	Agriculture within the Delta <sup>a</sup>	Yolo Bypass <sup>d</sup>
Mean (µg/L) <sup>e</sup>	<del>0.3209</del>	<del>0.4584</del>	<del>0.0910</del>	<del>0.10</del>	0.11	<del>0.4523</del>
Minimum (µg/L)	0.04	<del>0.4007</del>	<del>0.0306</del>	<del>0.10</del>	0.11	0.19
Maximum (µg/L)	<del>0.1.2300</del>	<del>1.52-80</del>	0.45	<del>0.10</del>	0.11	<del>1.050.30</del>
75th percentile (µg/L)	<del>1.0.1100</del>	<del>1.200.76</del>	<del>0.124</del>	<del>0.10</del>	0.11	<del>0.6529</del>
99th percentile (µg/L)	<del>1.000.23</del>	<del>2.601.50</del>	<del>0.441</del>	<del>0.10</del>	0.11	<del>1.040.30</del>
Data Source	USGS <del>20102014</del>	USGS <del>2014SWAMP</del> <del>2009</del>	SFEI <del>20102014</del>	None	Lucas and Stewart 2007	DWR 2009b
Station(s)	Sacramento River at Freeport	San Joaquin River at Vernalis <del>(Airport Way)</del>	Central-West; San Joaquin River near Mallard Is. (BG30)	None	Mildred Island, Center	Sacramento River at <del>below</del> Knights Landing
Date Range	<del>11/2007-7/2014</del> <del>1996-2001, 2007-2010</del>	<del>11/2007-8/2014</del> <del>1999-2007</del>	<del>2/2000-8/2008</del> <del>2013</del>	None	2000	<del>2003-2004, 2007, 2008</del>
ND Replaced with RL	<del>Not applicable</del> Yes	<del>Not applicable</del> Yes	<del>Yes</del> No	Not applicable	No	Yes
Data Omitted	None	<del>Pending Data</del> None	None	Not applicable	None	None
No. of Data Points	<del>6288</del>	<del>45293</del>	<del>1114</del>	None	1	<del>135</del>

<sup>a</sup> Dissolved selenium concentration.

<sup>b</sup> Not specified whether total or dissolved selenium.

<sup>c</sup> 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.

<sup>d</sup> Total selenium concentration.

<sup>e</sup> Means are geometric means.

SFEI = San Francisco Estuary Institute

SWAMP = Surface Water Ambient Monitoring Program

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

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

Year	Sacramento River <sup>a</sup>		San Joaquin River <sup>b</sup>		Suisun Bay <sup>c</sup>	
	Measured	Modeled	Measured	Modeled	Measured	Modeled
2000	2.6	1.54 <sup>d</sup>	1.7	1.98 <sup>e</sup>	No Data	10.5 <sup>9af</sup>
2005	1.5	1.54 <sup>d</sup>	1.9	1.98 <sup>e</sup>	No Data	1.6 <sup>0af</sup>
2007 <sup>g</sup>	1.8	2.53 <sup>fg</sup>	2.4	2.4 <sup>4h</sup>	No Data	21.52 <sup>fi</sup>

<sup>a</sup> Sacramento River Mile (RM) 44.

<sup>b</sup> Vernalis.

<sup>c</sup> 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.

<sup>d</sup> Concentration of selenium estimated from Model 84: Trophic level 4 (TL-4) fish eating TL-3 fish, using  $K_d = 17604909$  to  $4997$  (varying by year and quarter in 2000 [4910 to 4997] and 2005 [4909 to 4910]),  $TTF_{invertebrate} = 2.48$ , and  $TTF_{fish} = 1.1$ .

<sup>e</sup> Concentration of selenium estimated from Model 8a4: Trophic level 4 (TL-4) fish eating TL-3 fish, using  $K_d = 850665$  in 2000 and  $651$  in 2005,  $TTF_{invertebrate} = 2.48$ , and  $TTF_{fish} = 1.1$ .

<sup>f</sup> Concentration of selenium estimated from Model 94: 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,  $TTF_{invertebrate} = 2.48$ , and  $TTF_{fish} = 1.1$ .

<sup>g</sup> Concentration of selenium estimated from Model 9a5: Trophic level 4 (TL-4) fish eating TL-3 fish, using  $K_d = 11308061$  to  $8064$  (varying by quarter),  $TTF_{invertebrate} = 2.48$ , and  $TTF_{fish} = 1.1$ .

<sup>h</sup> 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  $TTF_{fish} = 1.1$ .

<sup>i</sup> 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.

10

## 11 Trace Metals

12 Water quality criteria used in the assessment of trace metals are presented in Table 8-5158. The  
 13 CTR criteria for cadmium, chromium (III), copper, lead, nickel, silver, and zinc are promulgated as  
 14 equations that contain three adjustments: 1) the water-effect ratio (WER), 2) the conversion factor  
 15 (CF) from total to dissolved fraction, and 3) hardness (freshwater criteria only), which are used to  
 16 adjust the criteria based on site-specific water quality conditions in order to provide the level of  
 17 protection intended by U.S. EPA. Table 8-52-59 presents hardness adjusted CTR criteria for the  
 18 primary Delta source waters, including the Sacramento and San Joaquin Rivers. Criteria were  
 19 calculated based on each source waters average and 5<sup>th</sup> percentile hardness (See Appendix 8N).

1 Trace Metals, for hardness data). Due to lower average and 5<sup>th</sup> percentile hardness on the  
 2 Sacramento River, calculated hardness-based metals aquatic life criteria are lowest on the  
 3 Sacramento River.

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

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

Metal	Freshwater		Saltwater		Human Health		Region 5 Basin Plan	California Drinking Water MCLs <sup>e</sup>
	Acute <sup>a</sup>	Chronic <sup>a</sup>	Acute <sup>a</sup>	Chronic <sup>a</sup>	Water & Organisms	Organisms Only		
<u>Aluminum</u>	<u>87<sup>f</sup></u>	<u>750<sup>f</sup></u>	<u>n/a</u>	<u>n/a</u>	<u>n/a</u>	<u>n/a</u>	<u>n/a</u>	<u>200</u>
Arsenic	340	150	69	36	n/a	n/a	10 <sup>b</sup>	10
Cadmium	4.3/3.9 <sup>c</sup>	2.2/1.1 <sup>c</sup>	42	9.3	n/a	n/a	0.22 <sup>d</sup>	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 <sup>d</sup> /10 <sup>b</sup>	1,000
Iron	n/a	1,000 <sup>f</sup>	n/a	n/a	n/a	n/a	300 <sup>b</sup>	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 <sup>b</sup>	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 <sup>b</sup>	100
Zinc	120	120	90	81	n/a	n/a	100 <sup>b</sup> /16 <sup>d</sup>	5,000

All values in micrograms per liter (µg/L) and expressed as dissolved metal, unless otherwise noted.  
 n/a = non-applicable.

<sup>a</sup> 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-hour average 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<sub>3</sub>).

<sup>b</sup> 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.

<sup>c</sup> First value is the CTR cadmium criterion, second value is Region 2 Basin Plan criterion.

<sup>d</sup> Applies to the Sacramento River and its tributaries above State Hwy 32 bridge at Hamilton City.

<sup>e</sup> Expressed as total recoverable metal.

<sup>f</sup> EPA 304(a) national recommended criteria.

11

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

1 a substantial load of suspended matter (i.e., TSS). Therefore, assessment of aquatic life and drinking  
 2 water effects utilizes the dissolved fraction of trace metals in the environment.

3 **Table 8-59. Hardness-Based Dissolved Freshwater Aquatic Life Criteria by Primary Source Water ( $\mu\text{g/L}$ )**

Metal	Criteria for Sacramento Source Water Based on 5 <sup>th</sup> Percentile Hardness		Criteria for Sacramento Source Water Based on Average Hardness	
	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
Metal	Criteria for San Joaquin Source Water Based on 5 <sup>th</sup> Percentile Hardness		Criteria for San Joaquin Source Water Based on Average Hardness	
	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
Metal	Criteria for Bay Source Water Based on 5 <sup>th</sup> Percentile Hardness		Criteria for Bay Source Water Based on Average Hardness	
	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 5<sup>th</sup> percentile hardness.

4

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



1 adjusted copper criteria presented in Table 8-59. Therefore, the calculated hardness-based CTR  
2 copper criteria are found to be adequately protective of fish olfaction.

3 **Table 8-60. BLM-Based Criteria For Dissolved Copper ( $\mu\text{g/L}$ )**

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

4  
5 There is currently no single program or effort for the coordinated and comprehensive measurement  
6 of trace metals in the Delta and its primary source waters. Moreover, analytical techniques for trace  
7 metals measurement have improved considerably over time, often resulting in substantially lower  
8 detection limits and at time showing earlier techniques to be prone to analytical error. Nevertheless,  
9 local monitoring efforts such as the San Francisco Bay Regional Monitoring Program (RMP) and the  
10 Sacramento Coordinated Regional Monitoring Program have collected trace metals on the  
11 Sacramento River and the San Francisco Bay for more than a decade, resulting in an adequate long-  
12 term characterization of these waters. Unfortunately, there has been no equivalent effort on the San  
13 Joaquin River, east-side tributaries, or within the Delta itself. This imbalance in available data limits  
14 the effects assessment approach. Effects are qualitatively assessed.

15 Summaries of trace metals data compiled for this qualitative assessment are provided in Appendix  
16 8N, *Trace Metals*. Data of sufficient quality were available for the Bay, Sacramento River and San  
17 Joaquin River source waters, although data for the San Joaquin are very few. These data used to  
18 inform the qualitative assessment on trace metal effects upstream of the Delta, within the Delta, and  
19 the SWP and CVP service areas. Due to the relatively short exposure durations related to aquatic life  
20 acute and chronic effects, long-term trace metals effects are evaluated on a 95<sup>th</sup> percentile  
21 concentration basis. Due to the relatively long exposure durations related to drinking water effects,  
22 long-term trace metals effects are evaluated on an average concentration basis.

### 23 **Microcystis**

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

28 Regarding nutrients, as mentioned above, the maintenance of *Microcystis* blooms in the Delta  
29 requires the availability of the nitrogen and phosphorus. However, the body of science produced by  
30 scientists studying *Microcystis* blooms in the Delta and elsewhere does not indicate that the specific  
31 levels of these nutrients, or their ratio, currently control the seasonal or inter-annual variation in the  
32 bloom. A large fraction of ammonia in the Sacramento River will be removed due to planned  
33 upgrades to the Sacramento Regional County Sanitation District's Sacramento Regional Wastewater  
34 Treatment Plant (SRWTP) which will result in >99.95% removal of ammonia from the effluent  
35 discharge from this facility. Following the SRWTP upgrades, levels of ammonia in Sacramento River  
36 are expected to be similar to background ammonia concentrations in the San Joaquin River and San

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

8 Nutrient ratios in excess of the Redfield N:P ratio of 16 have also been hypothesized to favor  
9 *Microcystis* growth in the Delta (Glibert et al. 2011). However, considerable doubt has been cast on  
10 this hypothesis because median N:P molar ratios in the Delta during peak bloom periods are usually  
11 near or a little lower than the Redfield ratio of 16 needed for optimum phytoplankton growth, and  
12 when ammonia is considered the sole N source, the N:P ratio drops substantially to a median of  
13 1.31:1 (Lehman et al. 2013). Based on this information, there is no evidence as to what type of effect  
14 small changes in nutrient concentrations and ratios would have on *Microcystis* blooms, given that  
15 such blooms are largely influenced by a host of other physical factors including water temperature  
16 and water residence time within channels.

17 High water clarity is also considered a pre-requisite for *Microcystis* bloom formation (Lehman et al.  
18 2013). As described under WQ-29 (Effects on TSS and Turbidity from CM1), changes in TSS and  
19 turbidity levels within the Delta under the project alternatives could not be quantified, but are  
20 expected to be similar under the project alternatives to Existing Conditions and the No Action  
21 Alternative. Minimal changes in water clarity would result in minimal changes in light availability  
22 for *Microcystis* under the project Alternatives. As such, the project alternatives' influence on  
23 *Microcystis* production in the Delta, as influenced by the project alternatives' effects on Delta water  
24 clarity, is considered to be negligible.

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

31 Changes to water operations and creation of tidal and floodplain restoration areas that change water  
32 residence times within Delta channels, and 2) increases in Delta water temperatures.

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

1 and fall are most relevant for the Microcystis assessment, but all seasons are presented for  
 2 completeness.

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

Subregion	Season	Average Residence Time (days)										
		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

4

### 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).

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

12 Harmful algal blooms are considered a stressor of Suisun Bay. Summer-fall blooms of *Microcystis*  
13 aeruginosa have occurred with increasing frequency and intensity in the Delta and Suisun Bay since  
14 2000. While blooms of *Microcystis* have not been documented in embayments downstream of  
15 Suisun Bay, the toxin produced by some *Microcystis* strains, microcystin, was detected in pilot  
16 monitoring measurements throughout the low salinity zone and in the central and southern  
17 embayments of San Francisco Bay (Senn and Novick 2014). In the San Francisco Estuary, nutrient  
18 levels are not considered a primary driver *Microcystis* bloom formation (Lehman et al. 2013),  
19 however there is evidence that *Microcystis* tends to prefer an ammonia nitrogen source compared  
20 to other forms of nitrogen (Senn and Novick 2014).

## 21 Load Estimates

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

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

### 34 Ammonia:

- 35 ● Existing Conditions: The ammonia-nitrogen load was assumed to be equivalent to the current  
36 average ammonia load discharged from SRWTP (28.7 mg/L-N at 141 MGD; EchoWater FEIR  
37 2014) plus the ammonia load of the Delta tributaries unaffected by the SRWTP discharge,  
38 calculated from the long-term average ambient ammonia concentration (0.04 mg/L-N; Central  
39 Valley Water Board 2010a:5) and the Delta outflow (provided in Appendix 5A, Section C.7).
- 40 ● Project Alternative: Ammonia-nitrogen loads at Mallard Island were calculated from the long-  
41 term annual ammonia concentration downstream of the SRWTP calculated in the Impact WQ-1  
42 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

1 web of San Francisco Bay is the internal net production of methylmercury bay sediments (Davis et  
2 al. 2012). Historically, millions of pounds of inorganic mercury were used in gold mining operations  
3 within the San Francisco Bay watershed, and a large fraction of this mercury was washed  
4 downstream and accumulated in Bay sediment. The large pool of inorganic mercury currently  
5 contained in Bay sediments dominates the fraction converted to methylmercury and that  
6 accumulating the Bay's aquatic food web.

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

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

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

### 25 Load Estimates

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

42 The long-term average mercury and methylmercury loads under the project alternatives were  
43 calculated as the sum of 1) the existing mercury and methylmercury loads from existing literature,  
44 and 2) the net change in the mercury and methylmercury load associated with changes in the source

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

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

## 21 **Selenium**

### 22 **Constituent-specific Considerations**

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

35 Selenium is a constituent of concern in San Francisco Bay for potential effects on aquatic and  
36 terrestrial resources, and (indirectly) human health. The State Water Board listed San Francisco Bay  
37 as having impaired water quality for selenium under CWA Section 303(d) in 1998 (State Water  
38 Resources Control Board 2011). Currently, North, Lower, and South San Francisco Bay are Section  
39 303(d) listed for impairments from selenium due to reduced hatchability in nesting diving birds.  
40 Historical monitoring of selenium in ducks, fish, and invertebrates in the northern part of San  
41 Francisco Bay revealed concentrations that could cause health risks to people and wildlife. More  
42 recent monitoring has shown that selenium tissue concentrations of diving ducks have declined to  
43 be within the normal background range and white sturgeon muscle concentrations are substantially  
44 lower than observed before the North Bay was Section 303(d) listed (SFBRWQCB 2011; SFEI 2014).



1 Selenium levels in the North Bay have declined gradually since the early 1990s before the North Bay  
2 was first 303(d) listed (Tetra Tech 2008). This was due in part to the petroleum refineries, which  
3 were a major source of dissolved selenium to the North Bay at that time, implemented controls by  
4 1999 that decreased selenium in their discharges by up to 66% (Tetra Tech 2008).

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

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

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

30 Selenium criteria were promulgated for all San Francisco Bay and Delta waters in the NTR  
31 (SFBRWQCB 2013). The NTR criteria specifically apply to San Francisco Bay upstream to and  
32 including Suisun Bay and the Delta. The NTR values are 5.0 µg/L (4-day average) and 20 µg/L (1-  
33 hour average). By comparison, the available data show that the maximum concentration in the  
34 North Bay has not exceeded 0.44 µg/L since 2002. However, the NTR criteria are not considered  
35 protective of aquatic life in the San Francisco Bay because the current scientific information shows  
36 that selenium toxicity is driven by dietary exposures that are amplified through biomagnification of  
37 selenium through the aquatic food chain (USEPA 2014). The USEPA has published draft aquatic life  
38 ambient water quality criteria for selenium (USEPA 2014) that account for dietary exposure that  
39 recommend fish and fish egg/ovary tissue concentrations that are protective of aquatic life. The  
40 USEPA draft criterion for selenium is 15.2 mg/kg (dry weight) in fish eggs or ovaries, and 8.1 mg/kg  
41 (dry weight) in fish whole-body (or 11.8 mg/kg in fish muscle). Selenium concentrations in white  
42 sturgeon muscle throughout the entire San Francisco Bay, including fish from the North Bay, have  
43 mostly been below 10 mg/kg (dry weight) in the most recent fish surveys conducted by the RMP  
44 (2006 and 2009) (SFEI 2014). Because obtaining fish tissues is challenging, USEPA (2014) also  
45 recommends water column dissolved selenium criteria of 1.3 µg/L for lentic aquatic systems and 4.8

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

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

15 Annual average dissolved selenium concentrations in the North Bay as measured by the RMP (0.05–  
16 0.17 µg/L) have been below the 0.202 µg/L dissolved selenium water column target since 2002. The  
17 low long-term average dissolved selenium concentration of the North Bay (0.11 µg/L) and data from  
18 recent fish tissue surveys have led to the suggestion that the North Bay may ~~have assimilative~~  
19 ~~capacity with regard to selenium~~ not currently be impaired with respect to selenium, and this  
20 suggestion has led to continued efforts as part of the North Bay TMDL development to determine the  
21 current effects to aquatic life from selenium in the North Bay (SFBRWQCB 2011).

22 Existing annual average selenium loads for the entire North Bay have been calculated based on  
23 measured concentrations of the major source waters to the North Bay, with concentrations  
24 measured in samples from Mallard Island used to estimate the load of total selenium exported from  
25 the Delta (SFBRWQCB 2011). The Preliminary Project Report for the North Bay selenium TMDL has  
26 reported the existing load of total selenium to the North Bay is 5,605 kg/yr (assuming an average  
27 urban and non-urban runoff load of 595 kg/year). The existing total selenium load to the North Bay  
28 from the Delta is 3,940 kg/yr, which comprises 70.3% of the entire North Bay load (SFBRWQCB  
29 2011). While the entire North Bay load of dissolved selenium was not determined, the dissolved  
30 selenium load to the North Bay from the Delta has been estimated as 2,700 kg/yr (SFBRWQCB 2011;  
31 Tetra Tech 2014).

### 32 Load Estimates

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

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

11 The incremental change in selenium load in net Delta outflow under the project alternatives (item 2,  
 12 above) was estimated as follows, assuming that loads to the North Bay besides those from the Delta  
 13 would remain unchanged. First, the percent change in selenium load in net Delta outflow was  
 14 calculated using modeling results. Long-term average concentrations of dissolved selenium in water  
 15 were modeled for the Delta using a quantitative mass-balance approach (as described in Appendix  
 16 8M). Concentration data represent the concentration expected at a given location due to  
 17 conservative mixing (i.e., no uptake, loss or transformation) of the various source water fractions  
 18 under the alternative. Thus, the estimated concentrations do not account for other sources or sinks  
 19 of selenium to Delta waters, including mobilization of sediment, flux from sediment, and sediment  
 20 deposition. Given its seaward location, the modeled long-term average concentration data for the  
 21 Mallard Island station (Appendix 8M, Tables M-9a and M-9b) were assumed to represent the  
 22 concentration of dissolved selenium in Delta outflow due to conservative mixing of the various  
 23 source waters under the alternative. Mallard Island concentration data were converted to selenium  
 24 loads using the long-term annual average flow (as shown in Appendix 5A of the EIR/EIS, Section C.7)  
 25 at Mallard Island. The percent change of the modeled selenium load (“modeled percent change”)  
 26 under the alternative relative to the modeled selenium load in Delta outflow under Existing  
 27 Conditions was then calculated. The incremental change in total selenium load of net Delta outflow  
 28 under the alternative (item 2, above) was calculated as the product of 1) the modeled percent  
 29 change in selenium load, and 2) the current estimate for existing long-term average total selenium  
 30 loads from the Delta to the North Bay (3,940 kg/yr).

## 31 **8.3.2 Effects and Mitigation Approaches**

### 32 **8.3.2.1 No Action Alternative**

#### 33 **Impact WQ-9: Effects on Dissolved Oxygen Resulting from Facilities Operations and** 34 **Maintenance**

##### 35 *Upstream of the Delta*

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

1 support aquatic plant and algae growth, which in turn generates oxygen through photosynthesis and  
2 consumes oxygen through respiration and decomposition.

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

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

31 The changes in the magnitude and timing of water releases from reservoirs upstream of the Delta,  
32 relative to Existing Conditions, could affect downstream river temperatures, depending on month  
33 and year. Water temperature affects the maximum DO saturation level; as temperature increases,  
34 the DO saturation level decreases. When holding constant for barometric pressure (e.g., 760 mm  
35 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)  
36 (Tchobanoglous and Schroeder 1987:735). As described in the affected environment section, DO in  
37 the Sacramento River at Keswick, Feather River at Oroville, and lower American River ranged from  
38 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  
39 oxygenated and experience periods of supersaturation (i.e., when DO level exceeds the saturation  
40 concentration). Because these are large, turbulent rivers, any reduced DO saturation level that  
41 would be caused by an increase in temperature under the No Action Alternative would not be  
42 expected to cause DO levels to be outside of the range seen historically. This is because sufficient  
43 turbulence and interaction of river water with the atmosphere would continue to occur under this  
44 alternative to maintain saturation levels.

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

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

### 11 **Delta**

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

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

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

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

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

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

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

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

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

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

### 26 ***SWP/CVP Export Service Areas***

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

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

42 ***CEQA Conclusion:*** Key findings discussed in the effects assessment provided above are summarized  
 43 here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the

1 purpose of making the CEQA impact determination for this constituent. For additional details on the  
 2 effects assessment findings that support this CEQA impact determination, see the effects assessment  
 3 discussion that immediately precedes this conclusion.

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

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

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

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

### 38 **Impact WQ-23: Effects on Phosphorus Concentrations Resulting from Facilities Operations** 39 **and Maintenance**

40 As described under Impact WQ-29, facilities operations and maintenance is not expected to result in  
 41 substantial changes in TSS and Turbidity under the project alternative relative to Existing  
 42 Conditions in surface waters upstream of the Delta, in the Delta, and in the SWP/CVP Export Service  
 43 Areas. Thus in these areas, long-term changes in the levels of suspended sediment-bound

1 ~~phosphorus are not expected. Additional factors that may effect phosphorus levels are discussed~~  
 2 ~~below.~~

### 3 **Impact WQ-25: Effects on Selenium Concentrations Resulting from Facilities Operations and** 4 **Maintenance**

#### 5 *Upstream of the Delta*

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

12 Substantial point sources of selenium do not exist upstream in the Sacramento River watershed, in  
 13 the watersheds of the eastern tributaries (Cosumnes, Mokelumne, and Calaveras Rivers), or  
 14 upstream of the Delta in the San Joaquin River watershed. Nonpoint sources of selenium within the  
 15 watersheds of the Sacramento River and the eastern tributaries also are relatively low, resulting in  
 16 generally low selenium concentrations in the reservoirs and rivers of those watersheds.

17 Consequently, any modified reservoir operations and subsequent changes in river flows under the  
 18 No Action Alternative, relative to Existing Conditions, are expected to have negligible, if any, effects  
 19 on reservoir and river selenium concentrations upstream of Freeport in the Sacramento River  
 20 watershed or in the eastern tributaries upstream of the Delta.

21 Non-point sources of selenium in the San Joaquin River watershed are associated with discharges of  
 22 subsurface agricultural drainage to the river or its tributaries. Selenium concentrations in the San  
 23 Joaquin River upstream of the Delta comply with NTR criteria and Basin Plan objectives at Vernalis  
 24 under Existing Conditions, and they are expected to do so under the No Action Alternative. This is  
 25 because a TMDL has been developed by the Central Valley Water Board (2001), the Grassland  
 26 Bypass Project has established limits that will result in reduced inputs of selenium to the Delta, and  
 27 the Central Valley Water Board (2010a) and State Water Board (2010d, 2010e) have established  
 28 Basin Plan objectives that are expected to result in decreasing discharges of selenium from the San  
 29 Joaquin River to the Delta, as previously discussed in 8.1.13.150.

30 Selenium concentrations at Vernalis are generally higher during lower San Joaquin River flows, with  
 31 considerable variability in concentrations below about 3,000 cubic feet per second (cfs), as shown in  
 32 Appendix 8M, *Selenium*, (Table M-31-33 and Figures M-47 through M-2017). ~~The only three monthly~~  
 33 ~~average selenium concentrations greater than 2 µg/L were in March 2002 (2.3 µg/L) and February~~  
 34 ~~and March 2003 (2.1 and 2.3 µg/L), when monthly average flows were 1,879 to 2,193 cfs.~~ Modeling  
 35 of flows for the San Joaquin River at Vernalis indicates that average annual flows under the No  
 36 Action Alternative ~~will~~ ~~would~~ vary by less than 10 percent from Existing Conditions (Appendix 5A).  
 37 Given these relatively small decreases in flows and the considerable variability in the relationship  
 38 between selenium concentrations and flows in the San Joaquin River, it is expected that selenium  
 39 concentrations in the San Joaquin River would be minimally affected, if at all, by anticipated changes  
 40 in flow rates under the No Action Alternative.

41 Thus, available information indicates selenium concentrations are well below the Basin Plan  
 42 objective and are likely to remain so ~~under the No Action Alternative. Any~~ ~~The~~ negligible changes in  
 43 selenium concentrations that may occur in the water bodies of the affected environment located



1 upstream of the Delta would not be of frequency, magnitude, and geographic extent that would  
 2 adversely affect any beneficial uses or substantially degrade the quality of these water bodies as  
 3 related to selenium.

#### 4 **Delta**

5 Selenium concentrations and threshold comparisons for each of the 11 modeled Delta assessment  
 6 locations under Existing Conditions and the No Action Alternative, ~~and all action alternatives~~, are  
 7 presented in Appendix 8M, Selenium, Table M-10A9Aa/B for water, Tables M-11-10 through M-20  
 8 29 for most biota (whole-body fish (excluding sturgeon), bird eggs [invertebrate diet], bird eggs  
 9 [fish diet], and fish fillets) throughout the Delta, and Tables ~~M.AM-300 through through M-32 8M-2~~  
 10 in the sturgeon addendum to Appendix 8M for sturgeon at the two western Delta locations. Figures  
 11 8-59a and 8-59b ~~and Figures 8-60a and b~~ present graphical distributions of predicted selenium  
 12 concentration changes (shown as changes in available assimilative capacity based on 21.3 µg/L) in  
 13 water at each modeled assessment location for all years. Appendix 8M, ~~(Figures 8M-421 through~~  
 14 ~~8M-6)~~ provides more detail in the form of monthly patterns of selenium concentrations in water  
 15 during the modeling period.

16 Relative to Existing Conditions, the No Action Alternative would result in little to no small changes in  
 17 average selenium concentrations in water at all modeled Delta assessment locations. Long-term  
 18 average concentrations at most locations would be the same or lower, with the exception of Old  
 19 River at Rock Slough and North Bay Aqueduct during the drought period modeled (1987–1991) and  
 20 Jones pumping plant for the entire (1976–1991) and drought periods modeled (Appendix 8M, Table  
 21 M-9a). Long-term average concentrations at these locations would increase negligibly (0.01–0.02  
 22 µg/L) at these locations, resulting in a reduction of assimilative capacity of <1%, relative to the 1.3  
 23 µg/L ecological risk benchmark USEPA draft water quality criterion (Figure 8-59a) with the largest  
 24 increase being at the Contra Costa Pumping Plant #1 (hereafter Contra Costa PP) for drought years  
 25 and largest decrease being in the San Joaquin River at Buckley Cove (Buckley Cove) for all and  
 26 drought years (Table M-10A). These small changes in selenium concentrations in water are reflected  
 27 in small percent changes in available assimilative capacity (10% or less) for selenium (based on 2  
 28 µg/L ecological risk benchmark). Relative to Existing Conditions, the No Action Alternative would  
 29 result in the largest modeled increase in available assimilative capacity at Buckley Cove (5%) and  
 30 the largest decrease at Contra Costa PP (0.4%) (Figure 8-59). Although some small negative changes  
 31 in selenium concentrations in water are expected, the effect of the No Action Alternative would  
 32 generally be minimal for the Delta locations. Furthermore, †The long-term average selenium  
 33 concentrations in water (Table M-10A) for Existing Conditions (range 0.21–0.76 µg/L) and under  
 34 the No Action Alternative would (range from 0.2109–0.6938 µg/L (Appendix 8M, Table 9a)), well  
 35 would be below the ecological risk benchmark USEPA draft water quality criterion of (21.3 µg/L).

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

42 Modeled selenium concentrations in fish and bird eggs were compared with effect benchmarks to  
 43 evaluate the potential for selenium to exceed levels of concern for toxicity or health advisories.  
 44 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 years period 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 b through 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 8M Table 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 PP Buckley Cove for drought years, and the largest decrease at Buckley Cove for drought years but 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 for During 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 years~~, but there would be essentially no change relative to Existing Conditions (Table ~~8M.A-2M-32 in the sturgeon addendum to Appendix 8M and Figure 8-65).~~~~

~~R~~relative 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 P ~~pumping~~ 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 benchmark USEPA 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 lower any 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 Alternative ~~for biota~~ (Figures 8-61a through 8-64b, Appendix 8M, Table M63). However, Exceedance Quotients ~~exceedance quotients~~ for these exceedances of the lower benchmarks are between 1.0 and 1.1, indicating a low risk to biota in the

1 ~~Export Service Areas, and they do not differ substantially among Existing Conditions and the No~~  
 2 ~~Action Alternative. Selenium concentrations in whole body fish, bird eggs (invertebrate diet), and~~  
 3 ~~fish fillets would not exceed the screening value of the lower benchmarks (Figures 8-61, 8-62, and 8-~~  
 4 ~~64).~~

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

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

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

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

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

39 Based on the above, selenium concentrations that would occur in water under this alternative would  
 40 not cause additional exceedances of applicable state or federal numeric or narrative water quality  
 41 objectives/criteria, or other relevant water quality effects thresholds identified for this assessment  
 42 (Table 8-54), by frequency, magnitude, and geographic extent that would result in adverse effects to  
 43 one or more beneficial uses within affected water bodies. In comparison to Existing Conditions,  
 44 water quality conditions under this alternative would not increase levels of selenium by frequency,

1 magnitude, and geographic extent such that the affected environment would be expected to have  
 2 measurably higher body burdens of selenium in aquatic organisms, thereby substantially increasing  
 3 the health risks to wildlife (including fish) or humans consuming those organisms. Water quality  
 4 conditions under this alternative with respect to selenium would not cause long-term degradation of  
 5 water quality in the affected environment, and therefore would not result in use of available  
 6 assimilative capacity such that exceedances of water quality objectives/criteria would be likely and  
 7 would result in substantially increased risk for adverse effects to one or more beneficial uses. This  
 8 alternative would not further degrade water quality by measurable levels, on a long-term basis, for  
 9 selenium and, thus, cause the [CWA Section](#) 303(d)-listed impairment of beneficial uses to be made  
 10 discernibly worse. This impact is considered to be less than significant.

## 11 **Impact WQ-27: Effects on Trace Metal Concentrations Resulting from Facilities Operations** 12 **and Maintenance**

### 13 *Delta*

14 For metals of primarily aquatic life concern (copper, cadmium, chromium, lead, nickel, silver, and  
 15 zinc), average and 95<sup>th</sup> percentile trace metal concentrations of the primary source waters to the  
 16 Delta are very similar, with difference typically not greater than a factor of 2 to 5 (Appendix 8N,  
 17 [Trace Metals](#), Tables 1--7). For example, average dissolved copper concentrations on the Sacramento  
 18 River, San Joaquin River, and Bay (Martinez) are 1.7 µg/L, 2.4 µg/L, and 1.7 µg/L, respectively. The  
 19 95<sup>th</sup> percentile dissolved copper concentrations on the Sacramento River, San Joaquin River, and  
 20 Bay (Martinez) are 3.4 µg/L, 4.5 µg/L, and 2.4 µg/L, respectively. Given this similarity, very large  
 21 changes in source water fraction would be necessary to effect a relatively small change in trace  
 22 metal concentration at a particular Delta location. Moreover, average and 95<sup>th</sup> percentile trace metal  
 23 concentrations for these primary source waters are all below their respective water quality criteria,  
 24 including those that are hardness-based without a WER adjustment (Tables 8-51-58 and 8-52-59). No  
 25 mixing of these three source waters could result in a metal concentration greater than the highest  
 26 source water concentration, and given that the average and 95<sup>th</sup> percentile source water  
 27 concentrations for copper, cadmium, chromium, lead, nickel, silver, and zinc do not exceed their  
 28 respective criteria, more frequent exceedances of criteria in the Delta would not occur under the  
 29 operational scenario for this alternative.

30 [Based on comments received during public review of the initial draft EIR/EIS, further evaluation of](#)  
 31 [aluminum data and potential effects are included herein. Aluminum has potential to result in aquatic](#)  
 32 [toxicity effects as well as nuisance aesthetic concerns in potable water. Regarding potential aquatic](#)  
 33 [life effects, monthly DWR data collected in 2013-2014 indicate that the maximum and 95<sup>th</sup>](#)  
 34 [percentile dissolved aluminum in the Sacramento River exceed the USEPA's default chronic criterion](#)  
 35 [of 87 µg/L, whereas the San Joaquin River concentrations are well below the criterion, and no data](#)  
 36 [were identified for the Bay source water. However, the USEPA national recommended criteria](#)  
 37 [developed in 1988 is recognized as a highly conservative value based on limited toxicity test data](#)  
 38 [and very low water hardness levels. A recent study evaluated aluminum criteria with the USEPA](#)  
 39 [recalculation procedure using an updated and comprehensive toxicity test database that determined](#)  
 40 [a hardness-based relationship for aluminum \(Pima County Wastewater Management Department](#)  
 41 [2006\). The Pima County study hardness-dependent equation for dissolved aluminum indicates that](#)  
 42 [a chronic criteria of 287 µg/L \(at 25 mg/L hardness as CaCO<sub>3</sub>\) better represents potential aluminum](#)  
 43 [toxicity in ambient water. Similar to the analysis for the other trace metals above, based on the](#)  
 44 [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 95<sup>th</sup> 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-18-60a), 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

1 change is relatively small, it is unknown whether the increase in modeled residence times expected  
2 under the No Action Alternative relative to Existing Conditions will result in measurable increases in  
3 the frequency, magnitude, and geographic extent of *Microcystis* blooms throughout the Delta.

4 The relationship between Delta water temperatures, climate change, and changes in water  
5 deliveries from upstream reservoirs is discussed in Appendix 29C. In short, ambient meteorological  
6 conditions are the primary driver of Delta water temperatures, meaning that climate warming and  
7 not water operations will determine future water temperatures in the Delta. Climate projections for  
8 the Central Valley, California discussed in Appendix 5A-D indicate substantial warming of ambient  
9 air temperatures with a median increase in annual temperature of about 1.1°C (2.0°F) by 2025 and  
10 2.2°C (4.0°F) by 2060. The projected water temperature change ranges from 0.7 to 1.4°C (1.3 to  
11 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  
12 earlier attainment of the water temperature threshold of 19°C required to initiate *Microcystis* bloom  
13 formation, and thus earlier occurrences of *Microcystis* blooms in the Delta, relative to Existing  
14 Conditions. Elevated ambient water temperatures in the Delta, and thus an increase in *Microcystis*  
15 bloom duration and magnitude, are expected under the No Action Alternative, relative to Existing  
16 Conditions.

#### 17 **CVP/SWP Export Service Area**

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

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

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

37 **CEQA Conclusion:** Based on the above, the No Action Alternative would not be expected to cause  
38 additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and  
39 geographic extent that would cause significant impacts on any beneficial uses of waters in the  
40 affected environment. *Microcystis* and microcystins are not 303(d) listed within the affected  
41 environment and thus any increases that could occur in some areas would not make any existing  
42 *Microcystis* impairment measurably worse because no such impairments currently exist. Because  
43 *Microcystis* and microcystins are not bioaccumulative, increases that could occur in some areas  
44 would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial

1 health risks to fish, wildlife, or humans. However, because it is possible that increases in the  
 2 frequency, magnitude, and geographic extent of Microcystis blooms in the Delta will occur due to  
 3 increased water temperatures from climate change under the No Action Alternative, long-term  
 4 water quality degradation may occur in the Delta and water exported from the Delta to the SWP and  
 5 CVP Export Service Areas. Thus, impacts on beneficial uses could occur. This impact is considered to  
 6 be significant.

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

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

- 12 ● Boron
- 13 ● Bromide
- 14 ● Dissolved Oxygen
- 15 ● Dissolved Organic Carbon (DOC)
- 16 ● Pathogens
- 17 ● Pesticides
- 18 ● Trace Metals
- 19 ● Turbidity and TSS

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

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

40 While effects of the No Action Alternative on the nutrients ammonia, nitrate, and phosphorus were  
 41 determined to be less than significant/not adverse, these constituents are addressed further below



1 because the response of the seaward bays to changed nutrient concentrations/loading may differ  
2 from the response of the Delta. Because the potential change in *Microcystis* levels were found to be  
3 significant in the Delta, potential effects on *Microcystis* levels and microcystin concentrations in San  
4 Francisco Bay are discussed. Selenium and mercury are discussed further, because they are  
5 bioaccumulative constituents where changes in load due to both changes in Delta concentrations  
6 and exports are of concern.

### 7 **Nutrients: Ammonia, Nitrate, and Phosphorus**

8 Total nitrogen loads in Delta outflow to Suisun and San Pablo Bays under the No Action Alternative  
9 would be dominated almost entirely by nitrate, because planned upgrades to the SRWTP will result  
10 in >95% removal of ammonia in its effluent. Relative to Existing Conditions, total nitrogen loads to  
11 Suisun and San Pablo Bays would decrease by 32% (Appendix 80, Table O-1). The change in  
12 nitrogen loading to Suisun and San Pablo Bays under the No Action Alternative would not adversely  
13 impact primary productivity in these embayments because light limitation and grazing current limit  
14 algal production in these embayments. To the extent that algal growth increases in relation to a  
15 change in ammonia concentration, this would have net positive benefits, because current algal levels  
16 in these embayments are low. Nutrient levels and ratios are not considered a direct driver of  
17 *Microcystis* and cyanobacteria levels in the North Bay.

18 The phosphorus load exported from the Delta to Suisun and San Pablo Bays for the No Action  
19 Alternative is estimated to increase by 5% relative to Existing Conditions (Appendix 80, Table O-1).  
20 . The only postulated effect of changes in phosphorus loads to Suisun and San Pablo Bays is related  
21 to the influence of nutrient stoichiometry on primary productivity. However, there is uncertainty  
22 regarding the impact of nutrient ratios on phytoplankton community composition and abundance.  
23 Any effect on phytoplankton community composition would likely be small compared to the effects  
24 of grazing from introduced clams and zooplankton in the estuary (Senn and Novick 2014; Kimmerer  
25 and Thompson 2014). Therefore, the projected decrease in total nitrogen loading and increase in  
26 phosphorus loading that would occur in Delta outflow to San Francisco Bay are not expected to  
27 result in adverse effects to beneficial uses or substantially degrade the water quality with regard to  
28 nutrients.

### 29 **Mercury**

30 The estimated long-term average mercury and methylmercury loads in Delta exports are shown in  
31 Appendix 80, Table O-2. Loads of mercury and methylmercury from the Delta to San Francisco Bay  
32 are estimated to change relatively little due to changes in source water fractions and net Delta  
33 outflow that would occur under the No Action Alternative. Mercury load to the Bay, relative to  
34 Existing Conditions, is estimated to increase by 3 kg/yr (1%). Methylmercury load, relative to  
35 Existing Conditions, is estimated to increase by 0.09 kg/yr (3%). The estimated total mercury load  
36 to the Bay is 263 kg/yr, which would be less than the San Francisco Bay mercury TMDL WLA for the  
37 Delta of 330 kg/yr. The estimated changes in mercury and methylmercury loads would be within the  
38 overall uncertainty associated with the estimates of long-term average net Delta outflow and the  
39 long-term average mercury and methylmercury concentrations in Delta source waters. The  
40 estimated changes in mercury load under the alternative would also be substantially less than the  
41 considerable differences among estimates in the current mercury load to San Francisco Bay  
42 (SFBRWQCB 2006; David et al. 2009). Similar uncertainty is expected in the existing methylmercury  
43 load in net Delta exports, for which the best available current load estimate is based on  
44 approximately one year of monitoring data (Foe et al. 2008).

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

### 7 Salinity

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

### 18 Selenium

19 Changes in source water fraction and net Delta outflow under the No Action Alternative, relative to  
20 Existing Conditions, are projected to cause the total selenium load to the North Bay to increase by  
21 3% (Appendix 80, Table O-3). Changes in long-term average selenium concentrations of the North  
22 Bay are assumed to be proportional to changes in North Bay selenium loads. Under the No Action  
23 Alternative, the long-term average total selenium concentration of the North Bay is estimated to be  
24 0.13 µg/L and the dissolved selenium concentration is estimated to be 0.11 µg/L, which would be the  
25 same as Existing Conditions (Appendix 80, Table O-3). The dissolved selenium concentration would  
26 be below the target of 0.202 µg/L developed by Presser or Luoma (2013) to coincide with a white  
27 sturgeon whole-body fish tissue selenium concentration not greater than 8 mg/kg in the North Bay.  
28 The incremental increase in dissolved selenium concentrations in the North Bay, relative to Existing  
29 Conditions, would be negligible (0.00 µg/L) under this alternative. Thus, the estimated changes in  
30 selenium loads in Delta exports to San Francisco Bay due to the No Action Alternative are not  
31 expected to result in adverse effects to beneficial uses or substantially degrade the water quality  
32 with regard to selenium, or make the existing CWA Section 303(d) impairment measurably worse.

### 33 Microcystis

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

1 transport of Delta-derived microcystins are not expected to result in measurable changes in the  
2 microcystin levels of San Francisco Bay.

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

16 **CEQA Conclusion:** Based on the above, the No Action Alternative would not be expected to cause  
17 long-term degradation of water quality in San Francisco Bay resulting in sufficient use of available  
18 assimilative capacity such that occasionally exceeding water quality objectives/criteria would be  
19 likely and would result in substantially increased risk for adverse effects to one or more beneficial  
20 uses. Further, based on the above, this alternative would not be expected to cause additional  
21 exceedance of applicable water quality objectives/criteria in the San Francisco Bay by frequency,  
22 magnitude, and geographic extent that would cause significant impacts on any beneficial uses of  
23 waters in the affected environment. Any changes in boron, bromide, chloride, and DOC in the San  
24 Francisco Bay would not adversely affect beneficial uses, because the uses most affected by changes  
25 in these parameters, MUN and AGR, are not beneficial uses of the Bay. Further, no substantial  
26 changes in dissolved oxygen, pathogens, pesticides, trace metals or turbidity or TSS are anticipated  
27 in the Delta, relative to Existing Conditions, therefore, no substantial changes these constituents  
28 levels in the Bay are anticipated. Changes in Delta salinity would not contribute to measurable  
29 changes in Bay salinity, as the change in Delta outflow would two to three orders of magnitude  
30 lower than (and thus minimal compared to) the Bay's tidal flow. Adverse changes in *Microcystis*  
31 levels that could occur in the Delta would not cause adverse *Microcystis* blooms in the Bay, because  
32 *Microcystis* are intolerant of the Bay's high salinity and, thus not have not been detected  
33 downstream of Suisun Bay. The 32% reduction in total nitrogen load and 5% increase in  
34 phosphorus load, relative to Existing Conditions, are expected to have minimal effect on water  
35 quality degradation, primary productivity, or phytoplankton community composition. The estimated  
36 increase in mercury load (3 kg/yr; 1%) and methylmercury load (0.09 kg/yr; 3%), relative to  
37 Existing Conditions, is within the level of uncertainty in the mass load estimate and not expected to  
38 contribute to water quality degradation, make the CWA section 303(d) mercury impairment  
39 measurably worse or cause mercury/methylmercury to bioaccumulate to greater levels in aquatic  
40 organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. The  
41 estimated increase in selenium load would be 3%, but estimated total and dissolved selenium  
42 concentrations under the No Action Alternative would be the same as Existing Conditions, and less  
43 than the target associated with white sturgeon whole-body fish tissue levels for the North Bay. Thus,  
44 the small increase in selenium load is not expected to contribute to water quality degradation, or  
45 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 ~~CM2-22CM2–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.

Using the mass-balance modeling approach for bromide (see Section 8.3.1.3), relative to Existing Conditions, Alternative 1A would 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

1 would be less than 27% at the remaining assessment locations. Due to the relatively small  
2 differences between modeled Existing Conditions and No Action Alternative, changes in the  
3 frequency with which concentration thresholds of 50 µg/L and 100 µg/L are exceeded are of similar  
4 magnitude to those previously described for the existing condition comparison (Appendix 8E,  
5 *Bromide*, Table 4). Unlike the comparison to Existing Conditions, the comparison to the No Action  
6 Alternative reflects changes in bromide due only to operations.

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

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

1 increases in the frequency of exceeding the 100 µg/L threshold. Hence, no further impact on the  
2 drinking water beneficial use would be expected at these locations.

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

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

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

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

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

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

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

## 28 **Impact WQ-7: Effects on Chloride Concentrations Resulting from Facilities Operations and** 29 **Maintenance (CM1)**

### 30 ***Delta***

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

38 Relative to Existing Conditions, modeling predicts that Alternative 1A would result in decreased  
 39 long-term average chloride concentration at some assessment locations for the 16-year period  
 40 modeled (i.e., 1976–1991), in particular at interior and south Delta assessment locations (i.e., San  
 41 Joaquin River at Buckley Cove, Franks Tract, and Old River at Rock Slough) (Appendix 8G, *Chloride*,  
 42 Table CI-7 and Table CI-8) Long-term average chloride concentrations would remain relatively  
 43 unchanged at the San Joaquin River at Antioch and Contra Costa Canal at Pumping Plant #1

1 locations, and, depending on modeling approach (see Section 8.3.1.3), would increase at the  
 2 Sacramento River at Emmaton (i.e.,  $\leq 18\%$ ), Sacramento River at Mallard Island (i.e.,  $\leq 6\%$ ), North  
 3 Bay Aqueduct at Barker Slough (i.e.,  $\leq 32\%$ ), and ~~San Joaquin River~~ ~~SF Mokelumne~~ at Staten Island  
 4 (i.e.,  $\leq 21\%$ ). Additionally, implementation of tidal habitat restoration under CM4 would increase the  
 5 tidal exchange volume in the Delta, and thus may contribute to increased chloride concentrations in  
 6 the Bay source water as a result of increased salinity intrusion. More discussion of this the  
 7 assessment methods for changes in source water concentrations caused by project-related  
 8 hydrodynamic changes is included in Section 8.3.1.3. Consequently, while uncertain, the magnitude  
 9 of chloride increases may be greater than indicated herein and would have the greatest effect on the  
 10 western Delta assessment locations which are influenced to the greatest extent by the Bay source  
 11 water. The comparison to Existing Conditions reflects changes in chloride due to both Alternative 1A  
 12 operations (including north Delta intake capacity of 15,000 cfs and numerous other operational  
 13 components of Scenario A) and climate change/sea level rise.

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

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

### 23 *Municipal and Industrial Beneficial Uses—Relative to Existing Conditions*

24 Estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output  
 25 (see Section 8.3.1.3) were used to evaluate the 150 mg/L Bay-Delta WQCP objective for municipal  
 26 and industrial beneficial uses on a basis of the percent of years the chloride objective is exceeded for  
 27 the modeled 16-year period. The objective is exceeded if chloride concentrations exceed 150 mg/L  
 28 for a specified number of days in a given water year at both the Antioch and Contra Costa Pumping  
 29 Plant #1 locations. For Alternative 1A, the modeled frequency of objective exceedance would  
 30 ~~approximately double~~ ~~increase~~ from 67% of modeled years under Existing Conditions, to 13% of  
 31 modeled years under Alternative 1A (Appendix 8G, Table Cl-64).

32 Similarly, estimates of chloride concentrations generated using EC-chloride relationships and DSM2  
 33 EC output (see Section 8.3.1.3) were also used to evaluate the 250 mg/L Bay-Delta WQCP objective  
 34 for chloride at Contra Costa Pumping Plant #1 where daily average objectives apply. The basis for  
 35 the evaluation was the predicted number of days the objective was exceeded for the modeled 16-  
 36 year period. For Alternative 1A, the modeled frequency of objective exceedance would decrease by  
 37 approximately one half, from 6% of modeled days under Existing Conditions, to 3% of modeled days  
 38 under Alternative 1A (Appendix 8G, *Chloride*, Table Cl-63). Given the limitations inherent to  
 39 estimating future chloride concentrations (see Section 8.3.1.3), estimation of chloride  
 40 concentrations through both a mass balance approach and an EC-chloride relationship approach was  
 41 used to evaluate the 250 mg/L Bay-Delta WQCP objectives in terms of both frequency of exceedance  
 42 and use of assimilative capacity. When utilizing the mass balance approach to model monthly  
 43 average chloride concentrations for the 16-year period, the predicted frequency of exceeding the  
 44 250 mg/L objective would increase at the San Joaquin River at Antioch location from 66% under



1 Existing Conditions to 74%, and would increase by 2% at the Sacramento River at Mallard Island  
2 location (i.e., from 85% under Existing Conditions to 87%) (Appendix 8G, Table Cl-9). The increased  
3 chloride concentrations at the Antioch and Mallard Slough locations would occur during the months  
4 of January through June, thus reducing water quality during the period of seasonal freshwater  
5 diversions (Appendix 8G, Figure Cl-1). The available assimilative capacity would decrease  
6 substantially at the Antioch location in the months of March and April (i.e., maximum reduction of  
7 66% for the 16-year period modeled, and 100% reduction, or elimination of assimilative capacity,  
8 during the drought period modeled) (Appendix 8G, Table Cl-9). Similar to modeling results that  
9 predicted daily exceedance frequency, the frequency of monthly average exceedances at the Contra  
10 Costa Canal at Pumping Plant #1 would decrease (Appendix 8G, Table Cl-9); however, available  
11 assimilative capacity would be reduced compared to the Existing Conditions up to 100% in October  
12 (i.e., eliminated) (Appendix 8G, Table Cl-11). Additional long-term degradation at the Antioch and  
13 Contra Costa Canal at Pumping Plant #1 locations would occur when chloride concentrations would  
14 be near, or exceed, the objectives, thus increasing the risk of exceeding objectives.

15 In comparison, when utilizing the chloride-EC relationship to model monthly average chloride  
16 concentrations for the 16-year period, trends in frequency of exceedance and use of assimilative  
17 capacity would be similar to that discussed when utilizing the mass balance modeling approach  
18 (Appendix 8G, *Chloride*, Table Cl-10 and Table Cl-12). However, the predicted magnitude change at  
19 western Delta locations are substantially different when the predictions from both modeling  
20 approaches are compared. For example, both modeling approaches indicated that the frequency of  
21 exceeding the 250 mg/L objective at Contra Costa Canal at Pumping Plant #1 on a monthly average  
22 basis would decrease relative to Existing Conditions, but their predictions of the magnitude use of  
23 assimilative capacity varied substantially. Modeling using the mass balance approach predicted that  
24 100% of assimilative capacity would be utilized in October, but modeling using the chloride-EC  
25 relationship approach predicted that only 20% of assimilative capacity would be utilized. As  
26 discussed in Section 8.3.1.3, in cases of such disagreement, the approach that yielded the more  
27 conservative predictions was used as the basis for determining adverse impacts.

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

### 33 *303(d) Listed Water Bodies—Relative to Existing Conditions*

34 With respect to the 303(d) listing for chloride in Tom Paine Slough, the monthly average chloride  
35 concentrations for the 16-year period modeled at Old River at Tracy Road would generally be  
36 similar or lower compared to Existing Conditions, and thus, would not be further degraded on a  
37 long-term basis (Appendix 8G, Figure Cl-2). With respect to Suisun Marsh, the long-term average  
38 chloride concentration at the Sacramento River at Mallard Island for the 16-year period modeled  
39 would increase by 91 mg/L (4%) compared to Existing Conditions (Appendix 8G, Table Cl-7) and  
40 chloride concentrations would increase in some months during October through May at Mallard  
41 Island (Appendix 8G, Figure Cl-1) and in the Sacramento River at Collinsville (Appendix 8G, Figure  
42 Cl-3). Monthly average chloride concentrations at the Montezuma Slough at Beldon's Landing would  
43 increase substantially compared to Existing Conditions in October through May, with over a  
44 doubling of concentrations in December through February (Appendix 8G, Figure Cl-4). **However,**  
45 **[modeling of Alternative 1A assumed no operation of the Montezuma Slough Salinity Control Gates.](#)**

1 but the project description assumes continued operation of the Salinity Control Gates, consistent  
 2 with assumptions included in the No Action Alternative. A sensitivity analysis modeling run  
 3 conducted for Alternative 4 with the gates operational consistent with the No Action Alternative  
 4 resulted in substantially lower EC levels than indicated in the original Alternative 4 modeling results  
 5 for Suisun Marsh, but EC levels were still somewhat higher than EC levels under Existing Conditions  
 6 for several locations and months. Although chloride was not specifically modeled in these  
 7 sensitivity analyses, it is expected that chloride concentrations would be nearly proportional to EC  
 8 levels in Suisun Marsh. Another modeling run with the gates operational and restoration areas  
 9 removed resulted in EC levels nearly equivalent to Existing Conditions, indicating that design and  
 10 siting of restoration areas has notable bearing on EC levels at different locations within Suisun  
 11 Marsh (see Appendix 8H Attachment 1 for more information on these sensitivity analyses). These  
 12 analyses also indicate that increases in salinity are related primarily to the hydrodynamic effects of  
 13 CM4, not operational components of CM1. Based on the sensitivity analyses, optimizing the design  
 14 and siting of restoration areas may limit the magnitude of long-term chloride increases in the Marsh.  
 15 However, the chloride concentration increases at certain locations could be substantial, depending  
 16 on siting and design of restoration areas. Thus, these increased chloride levels in Suisun Marsh are  
 17 considered to contribute to additional, measureable long-term degradation that potentially would  
 18 adversely affect the necessary actions to reduce chloride loading for any TMDL that is developed.

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

#### 22 *Municipal Beneficial Uses—Relative to No Action Alternative*

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

28 Similarly, estimates of chloride concentrations generated using EC-chloride relationships and DSM2  
 29 EC output (see Section 8.3.1.3) were also used to evaluate the 250 mg/L Bay-Delta WQCP objective  
 30 for chloride at Contra Costa Pumping Plant #1 where daily average objectives apply. For Alternative  
 31 1A, the modeled frequency of objective exceedance would decrease from 5% of modeled days under  
 32 the No Action Alternative to 3% of modeled days under Alternative 1A (Appendix 8G, Table CI-63).

33 Similar to Existing Conditions, a comparative assessment of modeling approaches was utilized to  
 34 evaluate the 250 mg/L Bay-Delta WQCP objectives in terms of both frequency of exceedance and use  
 35 of assimilative capacity on a monthly average basis. When utilizing the mass balance approach to  
 36 model monthly average chloride concentrations for the 16-year period, the exceedance frequency of  
 37 the 250 mg/L objective is predicted relative to the No Action Alternative would increase slightly by  
 38 1% at the Antioch location (i.e., from 73% to 74%), by 7% at the Contra Costa Canal at Pumping  
 39 Plant #1 (i.e., from 14% to 21%), and by 1% at Mallard Island (i.e., from 86% to 87%) (Appendix 8G,  
 40 *Chloride*, Table CI-9). The available assimilative capacity for the 16-year period modeled would be  
 41 reduced at the Antioch location during the months of February and March by approximately 28%  
 42 and 44%, respectively, compared to the No Action Alternative (Appendix 8G, Table CI-11). The  
 43 available assimilative capacity would be reduced at the Contra Costa Canal at Pumping Plant #1 in  
 44 September through April compared to the No Action Alternative (i.e., reduction ranging from 18% in

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

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

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

#### 21 *303(d) Listed Water Bodies—Relative to No Action Alternative*

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

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

37 **NEPA Effects:** In summary, relative to the No Action Alternative, Alternative 1A would result in  
 38 increased water quality degradation and frequency of exceedance of the 150 mg/L objective at  
 39 Contra Costa Pumping Plant #1 and Antioch, the 250 mg/L municipal and industrial objective at  
 40 interior and western Delta locations on a monthly average chloride basis, and could contribute  
 41 measureable water quality degradation relative to the 303(d) impairment in Suisun Marsh. The  
 42 predicted chloride increases constitute an adverse effect on water quality (see Mitigation Measure  
 43 WQ-7 below; implementation of this measure along with a separate, non-environmental  
 44 commitment relating to the potential increased chloride treatment costs would reduce these

1 effects). Additionally, the predicted changes relative to the No Action Alternative indicate that  
 2 implementation of CM1 and CM4 under Alternative 1A would contribute substantially to the adverse  
 3 water quality effects (i.e., impacts are not wholly attributable to the effects of climate change/sea  
 4 level rise).

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

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

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

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

36 Chloride is not a bioaccumulative constituent, thus any increased concentrations under Alternative  
 37 1A would not result in substantial chloride bioaccumulation impacts on aquatic life or humans.  
 38 Alternative 1A maintenance would not result in any substantial changes in chloride concentration  
 39 upstream of the Delta or in the SWP/CVP Export Service Areas. However, based on these findings,  
 40 this impact would be significant due to increased chloride concentrations and degradation at  
 41 western Delta locations and its impacts on municipal and industrial water supply and fish and  
 42 wildlife beneficial uses.

43 ~~While mitigation measures to reduce these water quality effects in affected water bodies to less than  
 44 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~~

1 operations only. Development of mitigation actions for the incremental chloride effects  
2 attributable to climate change/sea level rise are not required because these changed conditions  
3 would occur with or without implementation of Alternative 1A.

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

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

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

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

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

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

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

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

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

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

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

33 **Mitigation Measure WQ-7a: Conduct Additional Evaluation and Modeling of Increased**  
 34 **Chloride Levels Following Initial Operations of CM1**

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

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

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

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

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

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

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

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

38 ~~River flow rate and r~~eservoir storage reductions that would occur under Alternative 1A, relative to  
39 Existing Conditions, would not be expected to result in a substantial adverse change in DO levels in  
40 the reservoirs, because oxygen sources (surface water aeration, aerated inflows, vertical mixing)  
41 would remain. Similarly, river flow rate reductions that would occur would not be expected to  
42 result in a substantial adverse change in DO levels in the -and rivers upstream of the Delta, given that



1 mean monthly flows would remain within the ranges historically seen under Existing Conditions  
 2 and the affected river are large and turbulent. Any reduced DO saturation level that may be caused  
 3 by increased water temperature would not be expected to cause DO levels to be outside of the range  
 4 seen historically. Finally, amounts of oxygen demanding substances and salinity would not be  
 5 expected to change sufficiently to affect DO levels.

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

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

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

## 28 **Impact WQ-11: Effects on Electrical Conductivity Concentrations Resulting from Facilities** 29 **Operations and Maintenance (CM1)**

### 30 ***Delta***

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

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

1 The percent of days the Emmaton EC objective would be exceeded for the entire period modeled  
 2 (1976–1991) would increase from 6% under Existing Conditions to 2731% under Alternative 1A.  
 3 Further, the percent of days out of compliance at Emmaton would increase from 11% under Existing  
 4 Conditions to 3945% under Alternative 1A.

5 The percent of days the San Andreas Landing EC objective would be exceeded would increase from  
 6 1% under Existing Conditions to 23% under Alternative 1A. Further, the percent of days out of  
 7 compliance with the EC objective would increase from 1% under Existing Conditions to 56% under  
 8 Alternative 1A. Sensitivity analyses were performed for Alternative 4 scenario H3, and indicated  
 9 that many similar exceedances were modeling artifacts, and the small number of remaining  
 10 exceedances were small in magnitude, lasted only a few days, and could be addressed with real time  
 11 operations of the SWP and CVP (see Section 8.3.1.1 for a description of real time operations of the  
 12 SWP and CVP). Due to similarities in the nature of the exceedances between alternatives, the  
 13 findings from these analyses can be extended to this alternative as well.

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

18 At Brandt Bridge, the increase in days of EC objective exceedance and days out of compliance would  
 19 be <1%. Average EC levels at the western and southern Delta compliance locations, except at  
 20 Emmaton in the western Delta, would decrease from 1–27% for the entire period modeled and 2–  
 21 28% during the drought period modeled (1987–1991) (Appendix 8H, Table EC-12). At Emmaton,  
 22 average EC would increase 16% for both the entire period modeled and the drought period  
 23 modeled. Also, at the two interior Delta compliance locations, there would be increases in average  
 24 EC: the S. Fork Mokelumne River at Terminous average EC would increase 4% for the entire period  
 25 modeled and 3% during the drought period modeled; and San Joaquin River at San Andreas Landing  
 26 average EC would increase 12% for the entire and drought periods modeled. On average, EC would  
 27 increase at Emmaton during all months except October and November. Average EC would increase  
 28 at San Andreas Landing during all months except November. Average EC in the S. Fork Mokelumne  
 29 River at Terminous would increase during all months. Average EC at Jersey Point during the months  
 30 of April–May, when the fish and wildlife objective applies in all but critical water year types, would  
 31 increase from 15% for the entire period modeled (Appendix 8H, Table EC-12;) further discussion of  
 32 EC increases relative to this objective can be found in Appendix 8H Attachment 2). Of the Clean  
 33 Water Act section 303(d) listed sections of the Delta–western, northwestern, and southern–the  
 34 Sacramento River at Emmaton would have a modest increase in exceedance of the Bay-Delta WQCP  
 35 EC objectives (245%) and the San Joaquin River at Brandt Bridge in the southern Delta would have a  
 36 slight increase (<1%) in the exceedance of the Bay-Delta WQCP EC objectives (Appendix 8H, Table  
 37 EC-1). Further, long-term average EC at Emmaton would increase by 16%, whereas the long-term  
 38 average EC at the San Joaquin River-Brandt Bridge would decrease by 2%, relative to Existing  
 39 Conditions, for the entire period modeled (Appendix 8H, Table EC-12). Thus, Alternative 1A is not  
 40 expected to contribute to additional impairment and adversely affect beneficial uses for section  
 41 303(d) listed southern Delta waterways, relative to Existing Conditions. However, the increase in  
 42 incidence of exceedance of EC objectives and increases in long-term and drought period average EC  
 43 at Emmaton in the western Delta, relative to Existing Conditions, has the potential to contribute to  
 44 additional impairment and potentially adversely affect beneficial uses. The comparison to Existing  
 45 Conditions reflects changes in EC due to both Alternative 1A operations (including north Delta

1 intake capacity of 15,000 cfs and numerous other operational components of Scenario A) and  
 2 climate change/sea level rise.

3 Relative to the No Action Alternative, the percent of days exceeding EC objectives and percent of  
 4 days out of compliance would increase at: Sacramento River at Emmaton, San Joaquin River at  
 5 Jersey Point, San Andreas Landing, Brandt Bridge, and Prisoners Point; and Old River near Middle  
 6 River at Tracy Bridge (Appendix 8H, Electrical Conductivity, Table EC-1). The increase in percent of  
 7 days exceeding the EC objective would be 2% or less and the increase in percent of days out of  
 8 compliance would be 45% or less, with the exception of Emmaton, which would have a 157%  
 9 increase in percent of days exceeding the EC objective and 4720% increase in percent of days out of  
 10 compliance. Regarding exceedances at Old River at Middle River and at Tracy Bridge, as noted in  
 11 Section 8.1.3.7, SWP and CVP operations have relatively little influence on salinity levels at these  
 12 locations, and the elevated salinity in south Delta channels is affected substantially by local salt  
 13 contributions discharged into the San Joaquin River downstream of Vernalis. Thus, the modeling  
 14 has limited ability to estimate salinity accurately in this region. Average EC would increase at some  
 15 compliance locations for the entire period modeled: Sacramento River at Emmaton (15%), San  
 16 Joaquin River at Jersey Point (3%), S. Fork Mokelumne River at Terminous (5%), San Joaquin River  
 17 at San Andreas Landing (18%), and San Joaquin River at Prisoners Point (9%) (Appendix 8H, Table  
 18 EC-12). For the drought period modeled, the locations with an average EC increase would be:  
 19 Sacramento River at Emmaton (5%), S. Fork Mokelumne River at Terminous (4%), San Joaquin  
 20 River at San Andreas Landing (13%), San Joaquin River at Brandt Bridge (1%), Old River at Tracy  
 21 Bridge (1%), and San Joaquin River at Prisoners Point (4%) (Appendix 8H, Table EC-12). The  
 22 western and southern Delta are CWA section 303(d) listed for elevated EC and the increased  
 23 incidence of exceedance of EC objectives and EC degradation that could occur in the western Delta  
 24 could make beneficial use impairment measurably worse. Since there would be very little change in  
 25 EC levels in the southern Delta and there is not expected to be an increase in frequency of  
 26 exceedances of objectives, this alternative is not expected to make beneficial use impairment  
 27 measurably worse in the southern Delta. Given that the western and southern Delta are Clean Water  
 28 Act section 303(d) listed as impaired due to elevated EC, the increase in the incidence of exceedance  
 29 of EC objectives and increases in long-term and drought period average EC at the western and  
 30 southern Delta locations under Alternative 1A, relative to the No Action Alternative, has the  
 31 potential to contribute to additional impairment and potentially adversely affect beneficial uses. The  
 32 comparison to the No Action Alternative reflects changes in EC due only to Alternative 1A  
 33 operations (including north Delta intake capacity of 15,000 cfs and numerous other operational  
 34 components of Scenario A).

35 For Suisun Marsh, October–May is the period when Bay-Delta WQCP EC objectives for protection of  
 36 fish and wildlife apply. Average EC for the entire period modeled would increase under Alternative  
 37 1A, relative to Existing Conditions, during the months of February through May by 0.1–0.8 mS/cm in  
 38 the Sacramento River at Collinsville (Appendix 8H, Table EC-21). Long-term average EC would  
 39 decrease relative to Existing Conditions in Montezuma Slough at National Steel during October–May  
 40 (Appendix 8H, Table EC-22). The most substantial increase would occur near Beldon Landing, with  
 41 long-term average EC levels increasing by 1.8–6.1 mS/cm, depending on the month, which would be  
 42 a doubling or tripling of long-term average EC relative to Existing Conditions (Appendix 8H, Table  
 43 EC-23). Sunrise Duck Club and Volanti Slough also would have long-term average EC increases  
 44 during all months of 1.9–4.0 mS/cm (Appendix 8H, Tables EC-24 and EC-25). Modeling of this  
 45 alternative assumed no operation of the Montezuma Slough Salinity Control Gates, but the project  
 46 description assumes continued operation of the Salinity Control Gates, consistent with assumptions

1 included in the No Action Alternative. A sensitivity analysis modeling run conducted for Alternative  
 2 4 scenario H3 with the gates operational consistent with the No Action Alternative resulted in  
 3 substantially lower EC levels than indicated in the original Alternative 4 modeling results, but EC  
 4 levels were still somewhat higher than EC levels under Existing Conditions and the No Action  
 5 Alternative for several locations and months. Another modeling run with the gates operational and  
 6 restoration areas removed resulted in EC levels nearly equivalent to Existing Conditions and the No  
 7 Action Alternative, indicating that design and siting of restoration areas has notable bearing on EC  
 8 levels at different locations within Suisun Marsh (see Appendix 8H Attachment 1 for more  
 9 information on these sensitivity analyses). These analyses also indicate that increases are related  
 10 primarily to the hydrodynamic effects of CM4, not operational components of CM1. Based on the  
 11 sensitivity analyses, optimizing the design and siting of restoration areas may limit the magnitude of  
 12 long-term EC increases to be on the order of 1 mS/cm or less. Due to similarities in the nature of the  
 13 EC increases between alternatives, the findings from these analyses can be extended to this  
 14 alternative as well.

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

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

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

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

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

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

31 In the Plan Area, Alternative 1A would result in an increase in the frequency with which Bay-Delta  
 32 WQCP EC objectives for agricultural beneficial use protection are exceeded in the ~~San Joaquin River~~  
 33 ~~at San Andreas Landing (12%; interior Delta) and~~ Sacramento River at Emmaton (215%; western  
 34 Delta) for the entire period modeled (1976–1991). ~~Further, for the entire and drought periods~~  
 35 modeled, average EC levels would increase by 12% at San Andreas Landing and by 16% at  
 36 Emmaton. ~~In addition, there would be an increase in the frequency with which the EC objective for~~  
 37 ~~fish and wildlife beneficial uses protection is exceeded in the San Joaquin River at Jersey Point, and~~  
 38 ~~an increase in the average EC at Jersey Point of 15% (for the entire period modeled) during the~~  
 39 ~~months of April–May, when the fish and wildlife objective applies.~~ Because EC is not  
 40 bioaccumulative, the increases in long-term average EC levels would not directly cause  
 41 bioaccumulative problems in aquatic life or humans. The interior Delta is not Clean Water Act  
 42 section 303(d) listed for elevated EC, however, the western Delta is. The increases in long-term and  
 43 drought period average EC levels and increased frequency of exceedance of EC objectives that would  
 44 occur ~~in the San Joaquin River at San Andreas Landing and~~ in the Sacramento River at Emmaton  
 45 would potentially contribute to adverse effects on the agricultural beneficial uses in the ~~interior and~~

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

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

20 Implementation of Mitigation Measure WQ-11 along with a separate, non-environmental  
 21 commitment relating to the potential increased costs associated with EC-related changes would  
 22 reduce these effects. ~~Although it is not known whether implementation of WQ-11 will be able to~~  
 23 ~~feasibly reduce water quality degradation in the western Delta, implementation of Mitigation~~  
 24 ~~Measure WQ-11 is recommended to attempt to reduce the effect that increased EC may have on~~  
 25 ~~Delta beneficial uses. However, because the effectiveness of this mitigation measure to result in~~  
 26 ~~feasible measures for reducing these water quality effects is uncertain, this impact is considered to~~  
 27 ~~remain significant and unavoidable. As mentioned above, it is expected that implementation of WQ-~~  
 28 ~~11d will be able to reduce impacts on EC in Suisun Marsh to a less than significant level.~~

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

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

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

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

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

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

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

41 ~~BDCP proponents shall consider effects of site-specific restoration areas proposed under CM4~~  
 42 ~~on EC levels in the western Delta. Design and siting of restoration areas shall attempt to reduce~~  
 43 ~~water quality degradation in the western Delta to the extent possible without compromising~~  
 44 ~~proposed benefits of the restoration areas. These evaluations will be conducted concurrently~~

1 with Mitigation Measure WQ-11a. Together, findings from WQ-11a and WQ-11b will indicate  
 2 whether sufficient flexibility to prevent or offset EC increases is feasible under Alternative 1A.  
 3 These actions are identical to the actions discussed in Mitigation Measure WQ-7b regarding  
 4 levels of chloride in the western Delta.

5 **Mitigation Measure WQ-11a11c: Design Restoration Sites to Reduce Effects on**  
 6 **Compliance with the Fish and Wildlife EC Objective between Prisoners Point and Jersey**  
 7 **Point, Evaluate Striped Bass Monitoring Data, and Consult with CDFW/USFWS/NMFS to**  
 8 **Determine Whether Additional Actions are Warranted**  
 9 **Conduct Additional Evaluation and Modeling of Increased EC Levels Following Initial Operations of CM1**

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

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

34 **Mitigation Measure WQ-11b11d: Site and Design Restoration Sites and consult with**  
 35 **CDFW/USFWS, and Suisun Marsh Stakeholders to Identify Potential Actions to Avoid or**  
 36 **Reduce EC Level Increases in the Marsh**  
 37 **Consult with CDFW/USFWS, and Suisun**  
 38 **Marsh Stakeholders, to Identify Potential Actions to Avoid or Minimize EC Level Increases**  
 39 **in the Marsh**

39 BDCP proponents shall consider effects of site-specific restoration areas proposed under CM4  
 40 on EC levels and compliance with the fish and wildlife EC objectives for Suisun Marsh. Design  
 41 and siting of restoration areas shall attempt to reduce potential effects to the extent possible  
 42 without compromising proposed benefits of the restoration areas. BDCP proponents will also  
 43 consult with CDFW/USFWS, and Suisun Marsh stakeholders, to identify potential actions to  
 44 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 feasible actions 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 ~~CM2-22CM2–through CM22CM21~~ 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.

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 ~~8-558-55a,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 ~~CM2-22CM2 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 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-10A9a). 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 (~~402%~~ or less) in available assimilative capacity for selenium, relative to the ~~21.3~~ 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

1 assimilative capacity would be at Mokelumne River (South Fork) at Staten Island (Staten Island)  
 2 (1%) and the largest decrease would be at Franks Tract (2%) (Figure 8-60). Although there are  
 3 some small negative changes in selenium concentrations in water, the effect of Alternative 1A is  
 4 generally minimal for the Delta locations. Furthermore, ~~the~~ long-term average selenium  
 5 concentrations in water (Appendix 8M, Table M-11) for Alternative 1A (range 0.2109–0.7038 µg/L)  
 6 ~~are would be~~ similar to those for Existing Conditions (range 0.2109–0.7641 µg/L), and the No Action  
 7 Alternative (range 0.2109–0.6938 µg/L), and all would be below the ~~ecological risk~~  
 8 ~~benchmark~~ USEPA draft water quality criterion of (21.3 µg/L) (Appendix 8M, Table 9a).

9 Relative to Existing Conditions and the No Action Alternative, Alternative 1A would result in very  
 10 small changes ~~(less than 1% or less)~~ in estimated selenium concentrations in most biota (whole-  
 11 body fish, bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets) throughout the Delta,  
 12 with little difference among locations (Figures 8-61a through 8-64b; Appendix 8M, Selenium, Table  
 13 M-12-21 and addendum M.A., Selenium in Sturgeon, to Appendix 8M, Table M.A.8M-2 in the sturgeon  
 14 addendum to Appendix 8M). Level of Concern Exceedance Quotients (i.e., modeled tissue divided by  
 15 Level of Concern benchmarks) for selenium concentrations in those biota for all years and for  
 16 drought years are less than 1.0 (indicating low probability of adverse effects). Similarly, Advisory  
 17 Tissue Level Exceedance Quotients for selenium concentrations in fish fillets for all years and  
 18 drought years also are less than 1.0. Estimated selenium concentrations in sturgeon for the San  
 19 Joaquin River at Antioch are predicted to increase by about 12 percent relative Relative to Existing  
 20 Conditions and to the No Action Alternative in all years (from about 4.7 to 5.3 mg/kg dry weight  
 21 {dw}), and those for sturgeon in the Sacramento River at Mallard Island are predicted to increase by  
 22 about 7 percent in all years (from about 4.4 to 4.7 mg/kg dw) (Figure 8-65; Appendix 8M, Tables M-  
 23 30 and M-31). Selenium concentrations in sturgeon during drought years are expected to increase  
 24 by only 2 or 3 percent at those locations (Appendix 8M, Tables M-30 and M-31). Detection of small  
 25 changes in whole-body sturgeon such as those estimated for the western Delta would require very  
 26 large sample sizes because of the inherent variability in fish tissue selenium concentrations. Low  
 27 Toxicity Threshold Exceedance Quotients for selenium concentrations in sturgeon in the western  
 28 Delta would exceed 1.0 (indicating a higher probability for adverse effects) for drought years at both  
 29 locations (as they do for Existing Conditions and the No Action Alternative; Figure 8-65), and would  
 30 increase slightly, from 0.94 to 1.1, for all years in the San Joaquin River at Antioch (where quotients  
 31 increasees from 0.94 to 1.1) (Appendix 8M, Table M-32).

32 The disparity between larger estimated changes for sturgeon and smaller changes for other biota  
 33 are is attributable largely to differences in modeling approaches, as described in Appendix 8M,  
 34 Selenium. The model for most biota was calibrated to encompass the varying concentration-  
 35 dependent uptake from waterborne selenium concentrations (expressed as the  $K_d$ , which is the ratio  
 36 of selenium concentrations in particulates [as the lowest level of the food chain] relative to the  
 37 waterborne concentration) that was exhibited in data for largemouth bass in 2000, 2005, and 2007  
 38 at various locations across the Delta. In contrast, the modeling for sturgeon could not be similarly  
 39 calibrated at the two western Delta locations and used literature-derived uptake factors and trophic  
 40 transfer factors for the estuary from Presser and Luoma (2013). As noted in the appendix, there was  
 41 a significant negative log-log relationship of  $K_d$  to waterborne selenium concentration that reflected  
 42 the greater bioaccumulation rates for bass at low waterborne selenium than at higher  
 43 concentrations. (There was no difference in bass selenium concentrations in the Sacramento River  
 44 at Rio Vista in comparison to the San Joaquin River at Vernalis in 2000, 2005, and 2007 [Foe 2010],  
 45 despite a nearly 10-fold difference in waterborne selenium.) Thus, there is more confidence in the  
 46 site-specific modeling based on the Delta-wide model that was calibrated for bass data than in the

1 estimates for sturgeon based on “fixed”  $K_d$ s for all years and for drought years without regard to  
2 waterborne selenium concentration at the two locations in different time periods.

3 Increased water residence times could increase the bioaccumulation of selenium in biota, thereby  
4 potentially increasing fish tissue and bird egg concentrations of selenium (see residence time  
5 discussion in Appendix 8M, *Selenium*, and Presser and Luoma [2010b]). Thus, residence time was  
6 assessed for its relevance to selenium bioaccumulation. Table 60a (presented originally in Section  
7 8.3.1.7 in the *Microcystis* subsection) shows the time for neutrally buoyant particles to move through  
8 the Delta (surrogate for flow and residence time). Although an increase in residence time  
9 throughout the Delta is expected under the No Action Alternative, relative to Existing Conditions  
10 (because of climate change and sea level rise), the change is fairly small in most areas of the Delta.  
11 Thus, the changes in residence times between Alternative 1A and the No Action Alternative are very  
12 similar to the changes in residence times between Alternative 1A and the Existing Conditions.

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

23 Presser and Luoma (2010b) summarized and discussed selenium uptake in the Bay-Delta (including  
24 hydrologic conditions [e.g., Delta outflow and residence time for water],  $K_d$ s [the ratio of selenium  
25 concentrations in particulates, as the lowest level of the food chain, relative to the water-borne  
26 concentration], and associated tissue concentrations [especially in clams and their consumers, such  
27 as sturgeon]). When the Delta Outflow Index (daily average flow per month) decreased by five-fold  
28 (73,732 cubic feet per second [cfs] in June 1998 to 12, 251 cfs in October 1998), residence time  
29 doubled (from 11 to 22 days) and the calculated mean  $K_d$  also doubled (from 3,198 to 6,501).  
30 However, when daily average Delta outflow in November 1999 was only 6,951 cfs (i.e., about one-  
31 half that in October 1998) and residence time was 70 days, the calculated mean  $K_d$  (7,614) did not  
32 increase proportionally.

33 Models are not available to quantitatively estimate the level of changes in selenium bioaccumulation  
34 as related to residence time, but the effects of residence time are incorporated in the  
35 bioaccumulation modeling for selenium that was based on higher  $K_d$  values for drought years in  
36 comparison to wet, normal, or all years; see Appendix 8M, *Selenium*. If increases in fish tissue or bird  
37 egg selenium were to occur, the increases would likely be of concern only where fish tissues or bird  
38 eggs are already elevated in selenium to near or above thresholds of concern. That is, where biota  
39 concentrations are currently low and not approaching thresholds of concern (which, as discussed  
40 above, is the case throughout the Delta, except for sturgeon in the western Delta), changes in  
41 residence time alone would not be expected to cause them to then approach or exceed thresholds of  
42 concern. In consideration of this factor, although the Delta as a whole is a CWA Section 303(d)-listed  
43 water body for selenium, and although monitoring data of fish tissue or bird eggs in the Delta are  
44 sparse, the most likely area in which biota tissues would be at levels high enough that additional  
45 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 (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 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

1 ~~two modeled Export Service Area assessment locations Banks and Jones pumping plants~~, relative to  
 2 Existing Conditions and the No Action Alternative, ~~for the entire period modeled~~ (Appendix 8M,  
 3 Table M-10A9a). These ~~small changes decreases~~ in selenium concentrations in water ~~are reflected in~~  
 4 ~~small percent changes (10% or less) in available assimilative capacity for selenium (based on 2 µg/L~~  
 5 ~~ecological risk benchmark) for all years. Relative to Existing Conditions and the No Action~~  
 6 ~~Alternative, Alternative 1A would result in small increases in available assimilative capacity for~~  
 7 ~~selenium at these pumping plants Jones PP (of 6-7%, relative to the 1.3 µg/L benchmark and 7%,~~  
 8 ~~respectively) and at Banks PP (6% and 5%, respectively), and have a small positive effect on the~~  
 9 ~~Export Service Area locations~~ (Figures 8-59a and 8-60a). Furthermore, the ~~modeled long-term~~  
 10 ~~average~~ selenium concentrations in water ~~(Table 8.3-E- SeTable M-10A in Appendix 8M) for~~  
 11 Alternative 1A (range 0.3715-0.502 µg/L) ~~are would similar to those for Existing Conditions (range~~  
 12 ~~0.37-0.58 µg/L) and the No Action Alternative (range 0.37-0.59 µg/L), and all would be well below~~  
 13 ~~the ecological risk benchmark USEPA draft water quality criterion (of 21.3 µg/L) (Table M-9a in~~  
 14 ~~Appendix 8M).~~

15 Relative to Existing Conditions and the No Action Alternative, Alternative 1A would result in very  
 16 small changes (less than 1%) in estimated selenium concentrations in biota (whole-body fish, bird  
 17 eggs [invertebrate diet], bird eggs [fish diet], and fish fillets) (Figures 8-61a through 8-64b;  
 18 Appendix 8M, *Selenium*, Table M-1221) ~~at export service areasthe Banks and Jones pumping plants.~~  
 19 ~~Relative to Existing Conditions and the No Action Alternative, the largest increase of selenium~~  
 20 ~~concentrations in biota under Alternative 1A would be at Banks PP for drought years, and the~~  
 21 ~~largest decrease would be at Jones PP for all years (except for bird eggs [assuming a fish diet] at~~  
 22 ~~Jones PP for drought years). Relative to the No Action Alternative, the largest increase under~~  
 23 ~~Alternative 1A would be at Banks PP for drought years (except for bird eggs [assuming a fish diet] at~~  
 24 ~~Banks PP for all years), and the largest decrease would be at Jones PP for all years (except for bird~~  
 25 ~~eggs [assuming a fish diet] at Jones PP for drought years). However, c~~Concentrations in biota would  
 26 not exceed any selenium benchmarks for Alternative 1A (Figures 8-61a through 8-64b).

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

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

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

43 There are no substantial point sources of selenium in watersheds upstream of the Delta, and no  
 44 substantial nonpoint sources of selenium in the watersheds of the Sacramento River and the eastern

1 tributaries. Nonpoint sources in the San Joaquin Valley that contribute selenium to the Delta will be  
 2 controlled through a TMDL developed by the Central Valley Water Board (2001) for the lower San  
 3 Joaquin River, established limits for the Grassland Bypass Project, and Basin Plan objectives (Central  
 4 Valley Water Board [2010ed]) and State Water Board [(2010db, 2010ec)] that are expected to result  
 5 in decreasing discharges of selenium from the San Joaquin River to the Delta. Consequently, any  
 6 modified reservoir operations and subsequent changes in river flows under Alternative 1A, relative  
 7 to Existing Conditions, are expected to cause negligible changes in selenium concentrations in water.  
 8 Any negligible changes in selenium concentrations that may occur in the water bodies of the affected  
 9 environment located upstream of the Delta would not be of frequency, magnitude, and geographic  
 10 extent that would adversely affect any beneficial uses or substantially degrade the quality of these  
 11 water bodies as related to selenium.

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

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

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

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

3 **NEPA Effects:** In general, with the possible exception of changes in Delta hydrodynamics resulting  
 4 from habitat restoration, CM2-CM~~4~~1 would not substantially increase selenium concentrations in  
 5 the water bodies of the affected environment. Modeling scenarios included assumptions regarding  
 6 how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, and  
 7 thus such effects of these restoration measures were included in the assessment of CM1 facilities  
 8 operations and maintenance (see Impact WQ-25).

9 ~~As discussed in Impact WQ-25, However,~~ implementation of these conservation measures may  
 10 increase water residence time within the restoration areas. Increased restoration area water  
 11 residence times could ~~potentially~~ increase the bioaccumulation of selenium in biota, thereby  
 12 potentially increasing fish tissue and bird egg concentrations of selenium ~~(see residence time~~  
 13 ~~discussion in Appendix 8M, Selenium, and Presser and Luoma [2010b]),~~ ~~but no~~ Models are not  
 14 ~~available to quantitatively estimate the level of changes in selenium bioaccumulation as related to~~  
 15 ~~residence time, but the effects of residence time are incorporated in the bioaccumulation modeling~~  
 16 ~~for selenium that was based on higher  $K_d$  values for drought years in comparison to wet, normal, or~~  
 17 ~~all years; see Appendix 8M, Selenium. If increases in fish tissue or bird egg selenium were to occur,~~  
 18 ~~the increases would likely be of concern only where fish tissues or bird eggs are already elevated in~~  
 19 ~~selenium to near or above thresholds of concern. That is, where biota concentrations are currently~~  
 20 ~~low and not approaching thresholds of concern (which, as discussed above, is the case throughout~~  
 21 ~~the Delta, except for sturgeon in the western Delta), changes in residence time alone would not be~~  
 22 ~~expected to cause them to then approach or exceed thresholds of concern. In consideration of this~~  
 23 ~~factor, although the Delta as a whole is a CWA Section 303(d)-listed water body for selenium, and~~  
 24 ~~although monitoring data of fish tissue or bird eggs in the Delta are sparse, the most likely area in~~  
 25 ~~which biota tissues would be at levels high enough that additional bioaccumulation due to increased~~  
 26 ~~residence time from restoration areas would be a concern is the western Delta and Suisun Bay for~~  
 27 ~~sturgeon, as discussed above. As shown in Table 60a, the overall increase in residence time~~  
 28 ~~estimated in the western Delta is 2 days relative to Existing Conditions, and 5 days relative to the No~~  
 29 ~~Action Alternative. Given the available information, these increases are small enough that they are~~  
 30 ~~not expected to substantially affect selenium bioaccumulation in the western Delta.~~Models are not  
 31 ~~available to quantitatively estimate the level of changes in residence time and the associated~~  
 32 ~~selenium bioavailability, but the effects of residence time are incorporated in the bioaccumulation~~  
 33 ~~modeling for selenium that was based on higher  $K_d$  values (the ratio of selenium concentrations in~~  
 34 ~~particulates [as the lowest level of the food chain] relative to the water borne concentration) for~~  
 35 ~~drought years in comparison to wet, normal, or all years; see Appendix 8M, Selenium. If increases in~~  
 36 ~~fish tissue or bird egg selenium were to occur, the increases would likely be of concern only where~~  
 37 ~~fish tissues or bird eggs are already elevated in selenium to near or above thresholds of concern.~~  
 38 ~~That is, where biota concentrations are currently low and not approaching thresholds of concern,~~  
 39 ~~changes in residence time alone would not be expected to cause them to then approach or exceed~~  
 40 ~~thresholds of concern. In consideration of this factor, although the Delta as a whole is a CWA Section~~  
 41 ~~303(d)-listed water body for selenium, and although monitoring data of fish tissue or bird eggs in~~  
 42 ~~the Delta are sparse, the most likely areas in which biota tissues would be at levels high enough that~~  
 43 ~~additional bioaccumulation due to increased residence time from restoration areas would be a~~  
 44 ~~concern are the western Delta and Suisun Bay, and the South Delta in areas that receive San Joaquin~~  
 45 ~~River water.~~



1 The western Delta and Suisun Bay receive elevated selenium loads from North San Francisco Bay  
 2 (including San Pablo Bay, Carquinez Strait, and Suisun Bay) and from the San Joaquin River. The San  
 3 Francisco Bay Water Board is conducting a TMDL project to address selenium toxicity in the North  
 4 San Francisco Bay (North Bay), defined to include a portion of the Delta, Suisun Bay, Carquinez  
 5 Strait, San Pablo Bay, and the Central Bay (State Water Resources Control Board 2011). The North  
 6 Bay selenium TMDL will identify and characterize selenium sources to the North Bay and the  
 7 processes that control the uptake of selenium by wildlife. The TMDL will quantify selenium loads,  
 8 develop and assign waste load and load allocations among sources, and include an implementation  
 9 plan designed to achieve the TMDL and protect beneficial uses. Point sources of selenium in North  
 10 San Francisco Bay (i.e., refineries) that contribute selenium to Suisun Bay are expected to be  
 11 reduced through a TMDL under development by the San Francisco Bay Water Board (San Francisco  
 12 Bay Water Board 2012) that is expected to result in decreasing discharges of selenium. Nonpoint  
 13 sources of selenium in the San Joaquin Valley that contribute selenium to the San Joaquin River, and  
 14 thus the Delta and Suisun Bay, will be controlled through a TMDL developed by the Central Valley  
 15 Water Board (2001) for the lower San Joaquin River, established limits for the Grassland Bypass  
 16 Project, and Basin Plan objectives (Central Valley Water Board 2010e, d; State Water Board 2010b  
 17 and 2010c) that are expected to result in decreasing discharges of selenium from the San Joaquin  
 18 River to the Delta. ~~If selenium levels are not sufficiently reduced via these efforts, it is expected that~~  
 19 ~~the State Water Board and the San Francisco Bay and Central Valley Water Boards would initiate~~  
 20 ~~additional actions to further control sources of selenium (State Water Resources Control Board~~  
 21 ~~2010b and 2010c).~~

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

42 Wetland restoration areas will not be designed such that water flows in and does not flow out.  
 43 Exchange of water between the restoration areas and existing Delta channels is an important design  
 44 factor, since one goal of the restoration areas is to export food produced in these areas to the rest of  
 45 the Delta (see BDCP Chapter 3, *Conservation Strategy*, Section 3.3, Biological Goals and Objectives).  
 46 Thus, these areas can be thought of as “flow-through” systems. Consequently, although water

1 residence times associated with BDCP restoration could increase, they are not expected to increase  
 2 without bound, and selenium concentrations in the water column would not continue to build up  
 3 and be recycled in sediments and organisms as may be the case within a closed system.

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

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

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

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

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

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

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

9 **Upstream of the Delta**

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

21 **Delta**

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

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

39 Water residence time in the North Delta and West Delta are projected to increase in both the  
 40 summer and fall periods by 11 and 8 days, respectively, compared to the No Action Alternative.  
 41 During the summer period, residence time for the Cache Slough, East Delta, and South Delta sub-  
 42 regions are projected to increase by 25 ~~[this number differs from the BDCP writeup]~~, 14, and 6 days,  
 43 respectively, compared to the No Action Alternative. During the fall period, residence time in these

1 sub-regions is projected to decrease slightly. Water residence time in Suisun Marsh is projected to  
2 decrease 21 days in the summer and increase 20 days in the fall, relative to No Action Alternative.

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

15 The relationship between Delta water temperatures, climate change, and changes in water  
16 deliveries from upstream reservoirs are discussed in Appendix 29C. In short, ambient  
17 meteorological conditions are the primary driver of Delta water temperatures, meaning that climate  
18 warming and not water operations will determine future water temperatures in the Delta. Climate  
19 projections for the Central Valley, California discussed in Appendix 5A-D indicate substantial  
20 warming of ambient air temperatures with a median increase in annual temperature of about 1.1°C  
21 (2.0°F) by 2025 and 2.2°C (4.0°F) by 2060. The projected water temperature change ranges from  
22 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  
23 temperatures could lead to earlier attainment of the water temperature threshold of 19°C required  
24 to initiate *Microcystis* bloom formation, and thus earlier occurrences of *Microcystis* blooms in the  
25 Delta, relative to Existing Conditions. Warmer water temperatures could also increase bloom  
26 duration and magnitude, relative to Existing Conditions. Elevated ambient water temperatures in  
27 the Delta, and thus an increase in *Microcystis* bloom duration and magnitude, are expected under  
28 Alternative 1A, relative to Existing Conditions, but these impacts are due entirely to climate change  
29 and not the project alternative. Because climate change is assumed under the No Action Alternative,  
30 potential water temperature-driven increases in *Microcystis* blooms in the Delta, relative to Existing  
31 Conditions, also would occur under the No Action Alternative. Therefore, no water temperature-  
32 driven increases in *Microcystis* blooms would occur in the Delta under Alternative 1A, relative to the  
33 No Action Alternative.

#### 34 **SWP/CVP Export Service Areas**

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

39 Under Alternative 1A, exports from Banks and Jones pumping plants will consist of a mixture of  
40 Sacramento River water diverted around the Delta, with water quality characteristic of both  
41 upstream Sacramento River water, and Sacramento and San Joaquin River water that has flowed  
42 through various portions of the North, South, and West Delta. Water diverted from the Sacramento  
43 River in the North Delta is expected to be unaffected by *Microcystis* and microcystins. However, the  
44 fraction of water flowing through the Delta that reaches the existing south Delta intakes is expected

1 to be influenced by an increase in the frequency, magnitude, and geographic extent of *Microcystis*  
2 blooms discussed in the “Delta” section above. Therefore, relative to Existing Conditions and the No  
3 Action Alternative, the addition of Sacramento River water from the North Delta under Alternative  
4 1A serves to dilute *Microcystis* and microcystins in water diverted from the South Delta with water  
5 that is not expected to contain them. Because the degree to which *Microcystis* blooms, and thus  
6 microcystins concentrations, will increase in source water from the South Delta is unknown, it  
7 cannot be determined whether Alternative 1A will result in increased or decreased levels of  
8 microcystins in the mixture of source waters exported from Banks and Jones pumping plants,  
9 relative to Existing Conditions and the No Action Alternative.

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

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

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

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

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

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

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

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

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

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

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

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

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

1 would not be expected to reduce or mitigate increases in *Microcystis*. In this case, achieving  
 2 *Microcystis* reduction pursuant to this mitigation measure would not be feasible.

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

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

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

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

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



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

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

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

- 9 ● Boron
- 10 ● Dissolved Oxygen
- 11 ● Pathogens
- 12 ● Pesticides
- 13 ● Trace Metals
- 14 ● Turbidity and TSS

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

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

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

34 While effects of Alternative 1A on the nutrients ammonia, nitrate, and phosphorus were determined  
 35 to be less than significant/not adverse, these constituents are addressed further below because the  
 36 response of the seaward bays to changed nutrient concentrations/loading may differ from the  
 37 response of the Delta. Selenium and mercury are discussed further, because they are  
 38 bioaccumulative constituents where changes in load due to both changes in Delta concentrations  
 39 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 80, 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 80, 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 80, 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

1 estimates, the estimated changes in mercury and methylmercury loads in Delta exports to San  
2 Francisco Bay due to Alternative 1A are not expected to result in adverse effects to beneficial uses or  
3 substantially degrade the water quality with regard to mercury, or make the existing CWA Section  
4 303(d) impairment measurably worse.

#### 5 **Selenium**

6 Changes in source water fraction and net Delta outflow under Alternative 1A, relative to Existing  
7 Conditions, are projected to cause the total selenium load to the North Bay to increase by 4%  
8 relative to Existing Conditions; relative to the No Action Alternative there would essentially be no  
9 change in load (Appendix 80, Table O-3). Changes in long-term average selenium concentrations of  
10 the North Bay are assumed to be proportional to changes in North Bay selenium loads. Under  
11 Alternative 1A, the long-term average total selenium concentration of the North Bay is estimated to  
12 be 0.13 µg/L and the dissolved selenium concentration is estimated to be 0.11 µg/L, which would be  
13 the same as Existing Conditions and the No Action Alternative (Appendix 80, Table O-3). The  
14 dissolved selenium concentration would be below the target of 0.202 µg/L developed by Presser or  
15 Luoma (2013) to coincide with a white sturgeon whole-body fish tissue selenium concentration not  
16 greater than 8 mg/kg in the North Bay. The incremental increase in dissolved selenium  
17 concentrations in the North Bay, relative to Existing Conditions, would be negligible (0.00 µg/L)  
18 under this alternative. Thus, the estimated changes in selenium loads in Delta exports to San  
19 Francisco Bay due to Alternative 1A are not expected to result in adverse effects to beneficial uses or  
20 substantially degrade the water quality with regard to selenium, or make the existing CWA Section  
21 303(d) impairment measurably worse.

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

30 **CEQA Conclusion:** Based on the above, Alternative 1A would not be expected to cause long-term  
31 degradation of water quality in San Francisco Bay resulting in sufficient use of available assimilative  
32 capacity such that occasionally exceeding water quality objectives/criteria would be likely and  
33 would result in substantially increased risk for adverse effects to one or more beneficial uses.  
34 Further, based on the above, this alternative would not be expected to cause additional exceedance  
35 of applicable water quality objectives/criteria in the San Francisco Bay by frequency, magnitude,  
36 and geographic extent that would cause significant impacts on any beneficial uses of waters in the  
37 affected environment. Any changes in boron, bromide, chloride, and DOC in the San Francisco Bay  
38 would not adversely affect beneficial uses, because the uses most affected by changes in these  
39 parameters, MUN and AGR, are not beneficial uses of the Bay. Further, no substantial changes in  
40 dissolved oxygen, pathogens, pesticides, trace metals or turbidity or TSS are anticipated in the Delta,  
41 relative to Existing Conditions, therefore, no substantial changes these constituents levels in the Bay  
42 are anticipated. Changes in Delta salinity would not contribute to measurable changes in Bay  
43 salinity, as the change in Delta outflow would two to three orders of magnitude lower than (and thus  
44 minimal compared to) the Bay's tidal flow. Adverse changes in Microcystis levels that could occur in  
45 the Delta would not cause adverse Microcystis blooms in the Bay, because Microcystis are intolerant

1 of the Bay's high salinity and, thus not have not been detected downstream of Suisun Bay. The 31%  
 2 decrease in total nitrogen load and 2% decrease in phosphorus load, relative to Existing Conditions,  
 3 are expected to have minimal effect on water quality degradation, primary productivity, or  
 4 phytoplankton community composition. The estimated no change in mercury load (0 kg/yr; 0%)  
 5 and decrease in methylmercury load (0.04 kg/yr; 1%), relative to Existing Conditions, is within the  
 6 level of uncertainty in the mass load estimate and not expected to contribute to water quality  
 7 degradation, make the CWA section 303(d) mercury impairment measurably worse or cause  
 8 mercury/methylmercury to bioaccumulate to greater levels in aquatic organisms that would, in  
 9 turn, pose substantial health risks to fish, wildlife, or humans. The estimated increase in selenium  
 10 load would be 4%, but estimated total and dissolved selenium concentrations under this alternative  
 11 would be the same as Existing Conditions, and less than the target associated with white sturgeon  
 12 whole-body fish tissue levels for the North Bay. Thus, the small increase in selenium load is not  
 13 expected to contribute to water quality degradation, or make the CWA section 303(d) selenium  
 14 impairment measurably worse or cause selenium to bioaccumulate to greater levels in aquatic  
 15 organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact  
 16 is considered to be less than significant.

## 17 **Impact WQ-5: Effects on Bromide Concentrations Resulting from Facilities Operations and** 18 **Maintenance (CM1)**

### 19 *Delta*

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

27 Under Alternative 2A, the geographic extent of effects pertaining to long-term average bromide  
 28 concentrations in the Delta would be similar to that previously described for Alternative 1A,  
 29 although the magnitude of predicted long-term change and relative frequency of concentration  
 30 threshold exceedances would be different. Using the mass-balance modeling approach for bromide  
 31 (see Section 8.3.1.3), relative to Existing Conditions, modeled long-term average bromide  
 32 concentrations would increase at Staten Island, Emmaton (during the drought period only), and  
 33 Barker Slough, while modeled long-term average bromide concentrations would decrease at all  
 34 other assessment locations(Appendix 8E, Bromide Table 6). Overall effects would be greatest at  
 35 Barker Slough, where predicted long-term average bromide concentrations would increase from 51  
 36 µg/L to 63 µg/L (22% relative increase) for the modeled 16-year hydrologic period and would  
 37 increase from 54 µg/L to 94 µg/L (75% relative increase) for the modeled drought period. At Barker  
 38 Slough, the predicted 50 µg/L exceedance frequency would decrease from 49% under Existing  
 39 Conditions to 38% under Alternative 2A, but would increase from 55% to 63% during the drought  
 40 period. At Barker Slough, the predicted 100 µg/L exceedance frequency would increase from 0%  
 41 under Existing Conditions to 17% under Alternative 2A, and would increase from 0% to 38% during  
 42 the drought period. Relative increases in long-term average bromide concentrations at Staten Island  
 43 would be of similar magnitude to that described for Barker Slough, although modeled 100 µg/L  
 44 exceedance frequency increases would be much less considerable. At Staten Island, the predicted  
 45 100 µg/L exceedance frequency would increase from 1% under Existing Conditions to 4% under

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

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

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

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

39 The increase in long-term average bromide concentrations predicted at Barker Slough, principally  
40 the relative increase in 100 µg/L exceedance frequency, would result in a substantial change in  
41 source water quality for existing drinking water treatment plants drawing water from the North Bay  
42 Aqueduct. As discussed for Alternative 1A, drinking water treatment plants obtaining water via the  
43 North Bay Aqueduct utilize a variety of conventional and enhanced treatment technologies in order  
44 to achieve DBP drinking water criteria. While the implications of such a modeled change in bromide  
45 at Barker Slough are difficult to predict, the substantial modeled increases could lead to adverse

1 changes in the formation of disinfection byproducts such that considerable treatment plant  
 2 upgrades may be necessary in order to achieve equivalent levels of health protection. Because many  
 3 of the other modeled locations already frequently exceed the 100 µg/L threshold under Existing  
 4 Conditions and the No Action Alternative, these locations likely already require treatment plant  
 5 technologies to achieve equivalent levels of health protection, and thus no additional treatment  
 6 technologies would be triggered by the small increases in the frequency of exceeding the 100 µg/L  
 7 threshold. Hence, no further impact on the drinking water beneficial use would be expected at these  
 8 locations.

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

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

### 39 **Impact WQ-7: Effects on Chloride Concentrations Resulting from Facilities Operations and** 40 **Maintenance (CM1)**

#### 41 ***Delta***

42 Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2  
 43 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter  
 44 hydrodynamics within the Delta region, which affects mixing of source waters, these effects are

1 included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of  
 2 ~~CM2-22CM2 through CM22CM2-CM21~~ not attributable to hydrodynamics, for example, additional  
 3 loading of a constituent to the Delta, are discussed within the impact header for ~~CM2-22CM2~~  
 4 ~~through CM22CM2-CM21~~. See section 8.3.1.3 for more information.

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

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

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

#### 28 *Municipal Beneficial Uses—Relative to Existing Conditions*

29 Estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output  
 30 (see Section 8.3.1.3) were used to evaluate the 150 mg/L Bay-Delta WQCP objective for municipal  
 31 and industrial beneficial uses on a basis of the percent of years the chloride objective is exceeded for  
 32 the modeled 16-year period. The objective is exceeded if chloride concentrations exceed 150 mg/L  
 33 for a specified number of days in a given water year at both the Antioch and Contra Costa Pumping  
 34 Plant #1 locations. For Alternative 2A, the modeled frequency of objective exceedance would  
 35 approximately ~~triple-double~~ from 67% of years under Existing Conditions, to ~~1913~~% of years under  
 36 Alternative 2A (Appendix 8G, Table Cl-64). The increase was due to a single year, 1990, which was  
 37 only one day short of the required number of days <150 mg/L. Given the uncertainty in the chloride  
 38 modeling approach, it is likely that real time operations of the SWP and CVP could achieve  
 39 compliance with this objective (see Section 8.3.1.1 for a discussion of chloride compliance modeling  
 40 uncertainties and a description of real time operations of the SWP and CVP).

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

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

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

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

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

### 31 *303(d) Listed Water Bodies—Relative to Existing Conditions*

32 With respect to the 303(d) listing for chloride in Tom Paine Slough, the monthly average chloride  
 33 concentrations for the 16-year period modeled at Old River at Tracy Road would generally be  
 34 similar compared to Existing Conditions, and thus, would not be further degraded on a long-term  
 35 basis (Appendix 8G, Figure Cl-2). With respect to Suisun Marsh, the monthly average chloride  
 36 concentrations for the 16-year period modeled would generally increase compared to Existing  
 37 Conditions in some months during October through May at the Sacramento River at Collinsville  
 38 (Appendix 8G, Figure Cl-3) and Mallard Island (Appendix 8G, Figure Cl-1), and would increase  
 39 substantially at Montezuma Slough at Beldon's Landing (i.e., over a doubling of concentration in  
 40 December through February) (Appendix 8G, Figure Cl-4). However, modeling of Alternative 2A  
 41 assumed no operation of the Montezuma Slough Salinity Control Gates, but the project description  
 42 assumes continued operation of the Salinity Control Gates, consistent with assumptions included in  
 43 the No Action Alternative. A sensitivity analysis modeling run conducted for Alternative 4 with the  
 44 gates operational consistent with the No Action Alternative resulted in substantially lower EC levels



1 than indicated in the original Alternative 4 modeling results for Suisun Marsh, but EC levels were  
 2 still somewhat higher than EC levels under Existing Conditions for several locations and months.  
 3 Although chloride was not specifically modeled in these sensitivity analyses, it is expected that  
 4 chloride concentrations would be nearly proportional to EC levels in Suisun Marsh. Another  
 5 modeling run with the gates operational and restoration areas removed resulted in EC levels nearly  
 6 equivalent to Existing Conditions, indicating that design and siting of restoration areas has notable  
 7 bearing on EC levels at different locations within Suisun Marsh (see Appendix 8H Attachment 1 for  
 8 more information on these sensitivity analyses). These analyses also indicate that increases in  
 9 salinity are related primarily to the hydrodynamic effects of CM4, not operational components of  
 10 CM1. Based on the sensitivity analyses, optimizing the design and siting of restoration areas may  
 11 limit the magnitude of long-term chloride increases in the Marsh. However, the chloride  
 12 concentration increases at certain locations could be substantial, depending on siting and design of  
 13 restoration areas. Thus, these increased chloride levels in Suisun Marsh are considered to  
 14 contribute to additional, measureable long-term degradation that potentially would adversely affect  
 15 the necessary actions to reduce chloride loading for any TMDL that is developed.

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

#### 18 *Municipal Beneficial Uses—Relative to No Action Alternative*

19 Similar to the assessment conducted for Existing Conditions, estimates of chloride concentrations  
 20 generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3) were used to  
 21 evaluate the 150 mg/L Bay-Delta WQCP objective for municipal and industrial beneficial uses. For  
 22 Alternative 2A, the modeled frequency of objective exceedance would increase from 60% under the  
 23 No Action Alternative to 1913% of years under Alternative 2A (Appendix 8G, Table CI-64). The  
 24 increase was due to two years, 1977 and 1990, which were only eight and one day(s) short of the  
 25 required number of days <150 mg/L, respectively. Given the uncertainty in the chloride modeling  
 26 approach, it is likely that real time operations of the SWP and CVP could achieve compliance with  
 27 this objective (see Section 8.3.1.1 for a discussion of chloride compliance modeling uncertainties and  
 28 a description of real time operations of the SWP and CVP).

29 Similarly, estimates of chloride concentrations generated using EC-chloride relationships and DSM2  
 30 EC output (see Section 8.3.1.3) were also used to evaluate the 250 mg/L Bay-Delta WQCP objective  
 31 for chloride at Contra Costa Pumping Plant #1 where daily average objectives apply. For Alternative  
 32 2A, the modeled frequency of objective exceedance would decrease from 5% of modeled days under  
 33 the No Action Alternative to 3% of modeled days under Alternative 2A (Appendix 8G, Table CI-63).

34 Similar to Existing Conditions, a comparative assessment of modeling approaches was utilized to  
 35 evaluate the 250 mg/L Bay-Delta WQCP objectives in terms of both frequency of exceedance and use  
 36 of assimilative capacity on a monthly average basis. When utilizing the mass balance approach to  
 37 model monthly average chloride concentrations for the 16-year period, the exceedance frequency  
 38 would be predicted to decrease slightly at the San Joaquin River at Antioch (i.e., from 73% for the No  
 39 Action Alternative to 70%), decrease slightly at the Contra Costa Canal at Pumping Plant #1 (i.e.,  
 40 from 14% to 12%), and increase slightly at the Sacramento River at Mallard Island (i.e., from 86% to  
 41 88%) (Appendix 8G, Table CI-15). The available assimilative capacity would be reduced at the  
 42 Antioch location compared to the No Action Alternative (i.e., reduction of 25% in April, and 100% in  
 43 April [i.e., eliminated] during the drought period modeled) (Appendix 8G, Table CI-17). Available  
 44 assimilative capacity also would be reduced at the Contra Costa Canal at Pumping Plant #1 by up to

1 17% and 12% in September and October of the 16-year modeled period, respectively, and up to  
 2 100% in the drought period) (Appendix 8G, Table CI-17), reflecting substantial degradation at these  
 3 locations during months when average concentrations would be near, or exceed, the objective.

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

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

#### 17 *303(d) Listed Water Bodies—Relative to No Action Alternative*

18 With respect to the 303(d) listing for chloride, Alternative ~~1A2A~~ would generally result in similar  
 19 changes to those discussed for the comparison to Existing Conditions. Monthly average chloride  
 20 concentrations at Tom Paine Slough would not be further degraded on a long-term basis (Appendix  
 21 8G, Figure CI-2). Monthly average chloride concentrations at source water channel locations for the  
 22 Suisun Marsh (Appendix 8G, Figures CI-1, CI-3 and CI-4) would increase substantially in some  
 23 months during October through May compared to the No Action Alternative conditions. Sensitivity  
 24 analyses suggested that operation of the Salinity Control Gates and restoration area siting and  
 25 design considerations could reduce these increases. However, the chloride concentration increases  
 26 at certain locations could be substantial, depending on siting and design of restoration areas. Thus,  
 27 these increased chloride levels in Suisun Marsh are considered to contribute to additional,  
 28 measureable long-term degradation in Suisun Marsh that potentially would adversely affect the  
 29 necessary actions to reduce chloride loading for any TMDL that is developed.

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

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

1 conditions indicate that in addition to the effects of climate change/sea level rise, implementation of  
 2 CM1 and CM4 under Alternative 2A would contribute substantially to the adverse water quality  
 3 effects.

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

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

11 **NEPA Effects:** Effects of CM1 on DO under Alternative 2A are the same as those discussed for  
 12 Alternative 1A and are considered to not be adverse.

13 **CEQA Conclusion:** Effects of CM1 on DO under Alternative 2A would be similar to those discussed for  
 14 Alternative 1A, and are summarized here, then compared to the CEQA thresholds of significance  
 15 (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this  
 16 constituent. For additional details on the effects assessment findings that support this CEQA impact  
 17 determination, see the effects assessment discussion under Alternative 1A.

18 ~~River flow rate and r~~Reservoir storage reductions that would occur under Alternative 2A, relative to  
 19 Existing Conditions, would not be expected to result in a substantial adverse change in DO levels in  
 20 the reservoirs, because oxygen sources (surface water aeration, aerated inflows, vertical mixing)  
 21 would remain. Similarly, river flow rate reductions that would occur would not be expected to  
 22 result in a substantial adverse change in DO levels in the ~~and~~ rivers upstream of the Delta, given that  
 23 mean monthly flows would remain within the ranges historically seen under Existing Conditions  
 24 and the affected river are large and turbulent. Any reduced DO saturation level that may be caused  
 25 by increased water temperature would not be expected to cause DO levels to be outside of the range  
 26 seen historically. Finally, amounts of oxygen demanding substances and salinity would not be  
 27 expected to change sufficiently to affect DO levels.

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

35 There is not expected to be substantial, if even measurable, changes in DO levels in the SWP/CVP  
 36 Export Service Areas waters under Alternative 2A, relative to Existing Conditions, because the  
 37 biochemical oxygen demand of the exported water would not be expected to substantially differ  
 38 from that under Existing Conditions (due to ever increasing water quality regulations), canal  
 39 turbulence and exposure of the water to the atmosphere and the algal communities that exist within  
 40 the canals would establish an equilibrium for DO levels within the canals. The same would occur in  
 41 downstream reservoirs.

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

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

11 ***Upstream of the Delta***

12 For the same reasons stated for the No Action Alternative, EC levels (highs, lows, typical conditions)  
 13 in the Sacramento River and its tributaries, the eastside tributaries, their associated reservoirs, and  
 14 the San Joaquin River upstream of the Delta under Alternative 2A are not expected to be outside the  
 15 ranges occurring under Existing Conditions or would occur under the No Action Alternative. Any  
 16 minor changes in EC levels that could occur under Alternative 2A in water bodies upstream of the  
 17 Delta would not be of sufficient magnitude, frequency and geographic extent that would cause  
 18 adverse effects on beneficial uses or substantially degrade water quality with regard to EC.

19 ***Delta***

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

27 Relative to Existing Conditions, ~~modeling indicates that~~ Alternative 2A would result in an increase in  
 28 the number of days the Bay-Delta WQCP EC objectives would be exceeded in the Sacramento River  
 29 at Emmaton, San Joaquin River at San Andreas Landing, ~~Jersey Point (fish and wildlife objective),~~  
 30 and Prisoners Point, and Old River near Middle River and at Tracy Bridge (Appendix 8H, *Electrical*  
 31 *Conductivity*, Table EC-2).

32 The percent of days the Emmaton EC objective would be exceeded for the entire period modeled  
 33 (1976–1991) would increase from 6% under Existing Conditions to ~~236~~% under Alternative 2A, and  
 34 the percent of days out of compliance would increase from 11% under Existing Conditions to ~~3540~~%  
 35 under Alternative 2A.

36 The percent of days the San Andreas Landing EC objective would be exceeded would increase from  
 37 1% under Existing Conditions to ~~45~~% under Alternative 2A, and the percent of days out of  
 38 compliance with the EC objective would increase from 1% under Existing Conditions to ~~68~~% under  
 39 Alternative 2A. ~~Sensitivity analyses were performed for Alternative 4 scenario H3, and indicated~~  
 40 ~~that many similar exceedances were modeling artifacts, and the small number of remaining~~  
 41 ~~exceedances were small in magnitude, lasted only a few days, and could be addressed with real time~~  
 42 ~~operations of the SWP and CVP (see Section 8.3.1.1 for a description of real time operations of the~~

1 SWP and CVP). Due to similarities in the nature of the exceedances between alternatives, the  
 2 findings from these analyses can be extended to this alternative as well.

3 The percent of days the Prisoners Point EC objective would be exceeded for the entire period  
 4 modeled would increase from 6% under Existing Conditions to 25% under Alternative 2A, and the  
 5 percent of days out of compliance with the EC objective would increase from 10% under Existing  
 6 Conditions to 279% under Alternative 2A. At Jersey Point, relative to the fish and wildlife objective,  
 7 the percent of days the EC objective would be exceeded for the entire period modeled would  
 8 increase from 0% under Existing Conditions to 1% under Alternative 2A, and the percent of days out  
 9 of compliance with the EC objective would increase from 0% under Existing Conditions to 2% under  
 10 Alternative 2A. Sensitivity analyses conducted for Alternative 4 scenario H3 indicated that removing  
 11 all tidal restoration areas would reduce the number of exceedances, but there would still be  
 12 substantially more exceedances than under Existing Conditions or the No Action Alternative.  
 13 Results of the sensitivity analyses indicate that the exceedances are partially a function of the  
 14 operations of the alternative itself, perhaps due to Head of Old River Barrier assumptions and south  
 15 Delta export differences (see Appendix 8H Attachment 1 for more discussion of these sensitivity  
 16 analyses). Due to similarities in the nature of the exceedances between alternatives, the findings  
 17 from these analyses can be extended to this alternative as well. Appendix X8H Attachment 2  
 18 contains a more detailed assessment of the likelihood of these exceedances impacting aquatic life  
 19 beneficial uses. Specifically, Appendix 8H Attachment 2 discusses whether these exceedances might  
 20 have indirect effects on striped bass spawning in the Delta, and concludes that the high level of  
 21 uncertainty precludes making a definitive determination.

22 The increase in percent of days exceeding the EC objectives and days out of compliance at the Old  
 23 River locations would be 2% at Tracy Bridge and less than 1% at Middle River. Sensitivity analyses  
 24 performed for Alternative 4 scenario H3 indicated that many of these exceedances are modeling  
 25 artifacts, and modeling barrier installation assumptions consistent with historical dry year practices  
 26 of installing barriers earlier in the year could resolve these additional exceedances (see Appendix  
 27 8H Attachment 1 for a discussion of these sensitivity analyses). Due to similarities in the nature of  
 28 the exceedances between alternatives, the findings from these analyses can be extended to this  
 29 alternative as well. Furthermore, as noted in Section 8.1.3.7, SWP and CVP operations have  
 30 relatively little influence on salinity levels at these locations, and the elevated salinity in south Delta  
 31 channels is affected substantially by local salt contributions discharged into the San Joaquin River  
 32 downstream of Vernalis. Thus, the modeling has limited ability to estimate salinity accurately in this  
 33 region.

34 Average EC levels at the western and southern Delta compliance locations would decrease from 0–  
 35 37% for the entire period modeled. During the drought period modeled (1987–1991), average EC  
 36 would decrease by 0–32%, at western and southern Delta locations, except Emmaton would have an  
 37 increase in average EC of 9% (Appendix 8H, Table EC-13). At the two interior Delta locations, there  
 38 would be increases in average EC: the S. Fork Mokelumne River at Terminous average EC would  
 39 increase 5% for the entire period modeled and 4% during the drought period modeled; and San  
 40 Joaquin River at San Andreas Landing average EC would increase 1% for the entire period modeled  
 41 and 10% during the drought period modeled. On average, EC would increase at San Andreas  
 42 Landing from February through September. Average EC in the S. Fork Mokelumne River at  
 43 Terminous would increase during all months. Average EC at Jersey Point during the months of  
 44 April–May, when the fish and wildlife objective applies in all but critical water year types, would  
 45 increase from 15–16% for the entire period modeled (Appendix 8H, Table EC-13). The comparison  
 46 to Existing Conditions reflects changes in EC due to both Alternative 2A operations (including north

1 Delta intake capacity of 15,000 cfs, Fall X2, and numerous other operational components of Scenario  
2 B) and climate change/sea level rise.

3 Relative to the No Action Alternative, the percent of days exceeding EC objectives and percent of  
4 days out of compliance would increase at: Sacramento River at Emmaton, San Joaquin River at  
5 Jersey Point, San Andreas Landing, and Prisoners Point; and Old River near Middle River and at  
6 Tracy Bridge (Appendix 8H, [Electrical Conductivity](#), Table EC-2). The increase in percent of days  
7 exceeding the EC objective would be 24% at Prisoners Point and 121% or less at the remaining  
8 locations. The increase in percent of days out of compliance would be 286% at Prisoners Point and  
9 135% or less at the remaining locations. For the entire period modeled, average EC levels would  
10 increase at all Delta compliance locations relative to the No Action Alternative, except in ~~Three Mile  
11 Slough near the Sacramento River~~, the Sacramento River at Emmaton, and the San Joaquin River at  
12 Jersey Point. The average EC increase would be 6% or less (Appendix 8H, Table EC-13). Similarly,  
13 during the drought period modeled, average EC would increase at all locations, except ~~Three Mile  
14 Slough~~, Emmaton, and Jersey Point. The greatest average EC increase during the drought period  
15 modeled would occur in the San Joaquin River at San Andreas Landing (10%); the increase at the  
16 other locations would be 1–7% (Appendix 8H, Table EC-13). The comparison to the No Action  
17 Alternative reflects changes in EC due only to Alternative 2A operations (including north Delta  
18 intake capacity of 15,000 cfs, Fall X2, and numerous other operational components of Scenario B).

19 For Suisun Marsh, October–May is the period when Bay-Delta WQCP EC objectives for protection of  
20 fish and wildlife apply. Average EC would increase for the entire period modeled under Alternative  
21 2A, relative to Existing Conditions, during the months of March through May by 0.3–0.6 mS/cm in  
22 the Sacramento River at Collinsville (Appendix 8H, Table EC-21). Long-term average EC would  
23 decrease relative to Existing Conditions in Montezuma Slough at National Steel during October–May  
24 (Appendix 8H, Table EC-22). The most substantial increase would occur near Beldon Landing, with  
25 long-term average EC levels increasing by 1.6–4.6 mS/cm, depending on the month, at least doubling  
26 during some months the long-term average EC relative to Existing Conditions (Appendix 8H, Table  
27 EC-23). Sunrise Duck Club and Volanti Slough also would have long-term average EC increases  
28 during all months of 0.5–2.4 mS/cm (Appendix 8H, Tables EC-24 and EC-25). [Modeling of this  
29 alternative assumed no operation of the Montezuma Slough Salinity Control Gates, but the project  
30 description assumes continued operation of the Salinity Control Gates, consistent with assumptions  
31 included in the No Action Alternative. A sensitivity analysis modeling run conducted for Alternative  
32 4 scenario H3 with the gates operational consistent with the No Action Alternative resulted in  
33 substantially lower EC levels than indicated in the original Alternative 4 modeling results, but EC  
34 levels were still somewhat higher than EC levels under Existing Conditions and the No Action  
35 Alternative for several locations and months. Another modeling run with the gates operational and  
36 restoration areas removed resulted in EC levels nearly equivalent to Existing Conditions and the No  
37 Action Alternative, indicating that design and siting of restoration areas has notable bearing on EC  
38 levels at different locations within Suisun Marsh \(see Appendix 8H Attachment 1 for more  
39 information on these sensitivity analyses\). These analyses also indicate that increases are related  
40 primarily to the hydrodynamic effects of CM4, not operational components of CM1. Based on the  
41 sensitivity analyses, optimizing the design and siting of restoration areas may limit the magnitude of  
42 long-term EC increases to be on the order of 1 mS/cm or less. Due to similarities in the nature of the  
43 EC increases between alternatives, the findings from these analyses can be extended to this  
44 alternative as well.](#)

45 The degree to which the long-term average EC increases [in Suisun Marsh](#) would cause exceedance of  
46 Bay-Delta WQCP objectives is unknown, because [these](#) objectives are expressed as a monthly

1 average of daily high tide EC, which does not have to be met if it can be demonstrated “equivalent or  
 2 better protection will be provided at the location” (State Water Resources Control Board 2006:14).  
 3 The ~~described~~ long-term average EC increase may, or may not, contribute to adverse effects on  
 4 beneficial uses, depending on how and when wetlands are flooded, soil leaching cycles, and how  
 5 agricultural use of water is managed, and future actions taken with respect to the marsh. However,  
 6 the EC increases at certain locations ~~would-could~~ be substantial, depending on siting and design of  
 7 restoration areas, and it is uncertain the degree to which current management plans for the Suisun  
 8 Marsh would be able to address these substantially higher EC levels and protect beneficial uses.  
 9 Thus, these increased EC levels in Suisun Marsh are considered to have a potentially adverse effect  
 10 on marsh beneficial uses. Long-term average EC increases in Suisun Marsh under Alternative 2A  
 11 relative to the No Action Alternative would be similar to the increases relative to Existing  
 12 Conditions.

13 Given that the western and southern Delta are Clean Water Act section 303(d) listed as impaired  
 14 due to elevated EC, the increase in the incidence of exceedance of EC objectives under Alternative  
 15 2A, relative to Existing Conditions and the No Action Alternative, has the potential to contribute to  
 16 additional impairment and potentially adversely affect beneficial uses. Suisun Marsh is CWA section  
 17 303(d) listed as impaired due to elevated EC, and the potential increases in long-term average EC  
 18 concentrations could contribute to additional impairment, ~~because the increases would be double~~  
 19 ~~that relative to Existing Conditions and the No Action Alternative.~~

#### 20 ***SWP/CVP Export Service Areas***

21 At the Banks and Jones pumping plants, Alternative 2A would result in no exceedances of the Bay-  
 22 Delta WQCP’s 1,000  $\mu\text{mhos/cm}$  EC objective for the entire period modeled (Appendix 8H, Table EC-  
 23 10). Thus, there would be no adverse effect on the beneficial uses in the SWP/CVP Export Service  
 24 Areas using water pumped at this location under the Alternative 2A.

25 At the Banks pumping plant, relative to Existing Conditions, average EC levels under Alternative 2A  
 26 would decrease 28% for the entire period modeled and 22% during the drought period modeled.  
 27 Relative to the No Action Alternative, average EC levels would decrease by 22% for the entire period  
 28 modeled and 17% during the drought period modeled. (Appendix 8H, Table EC-13)

29 At the Jones pumping plant, relative to Existing Conditions, average EC levels under Alternative 2A  
 30 would decrease 28% for the entire period modeled and 23% during the drought period modeled.  
 31 Relative to the No Action Alternative, average EC levels would decrease by 24% for the entire period  
 32 modeled and 20% during the drought period modeled. (Appendix 8H, Table EC-13)

33 Based on the decreases in long-term average EC levels that would occur at the Banks and Jones  
 34 pumping plants, Alternative 2A would not cause degradation of water quality with respect to EC in  
 35 the SWP/CVP Export Service Areas; rather, Alternative 2A would improve long-term average EC  
 36 conditions in the SWP/CVP Export Service Areas.

37 Commensurate with the EC decrease in exported waters, an improvement in lower San Joaquin  
 38 River average EC levels would be expected since EC in the lower San Joaquin River is, in part, related  
 39 to irrigation water deliveries from the Delta. While the magnitude of this expected lower San  
 40 Joaquin River improvement in EC is difficult to predict, the relative decrease in overall loading of EC-  
 41 elevating constituents to the Export Service Areas would likely alleviate or lessen any expected  
 42 increase in EC at Vernalis related to decreased annual average San Joaquin River flows (see EC  
 43 impact discussion under the No Action Alternative).

1 The export area of the Delta is listed on the state's CWA Section 303(d) list as impaired due to  
 2 elevated EC. Alternative 2A would result in lower average EC levels relative to Existing Conditions  
 3 and the No Action Alternative and, thus, would not contribute to additional beneficial use  
 4 impairment related to elevated EC in the SWP/CVP Export Service Areas waters.

5 **NEPA Effects:** In summary, the increased frequency of exceedance of EC objectives and increased  
 6 long-term and drought period average EC levels that would occur at western, ~~interior, and southern~~  
 7 Delta compliance locations under Alternative 2A, relative to the No Action Alternative, would  
 8 contribute to adverse effects on the agricultural beneficial uses. The increased long-term period  
 9 average EC levels between Jersey Point and Prisoners Point could contribute to adverse effects on  
 10 fish and wildlife beneficial uses (specifically, indirect adverse effects on striped bass spawning),  
 11 though there is a high degree of uncertainty associated with this impact. The western and southern  
 12 Delta are CWA section 303(d) listed as impaired due to elevated EC, and the increase in incidence of  
 13 exceedance of EC objectives and increases in long-term average and drought period average EC in  
 14 the western portion of the Delta have the potential to contribute to additional beneficial use  
 15 impairment. In addition, the increased frequency of exceedance of the San Joaquin River at Prisoners  
 16 Point EC objective and long-term and drought period average EC could contribute to adverse effects  
 17 on fish and wildlife beneficial uses. Given that the western and southern Delta are Clean Water Act  
 18 section 303(d) listed as impaired due to elevated EC, the increase in the incidence of exceedance of  
 19 EC objectives and long-term average and drought period average EC in this portion of the Delta has  
 20 the potential to contribute to additional beneficial use impairment. The increases in long-term  
 21 average EC levels that ~~would~~ could occur in Suisun Marsh would further degrade existing EC levels  
 22 and could contribute ~~additional~~ to adverse effects on the fish and wildlife beneficial uses. Suisun  
 23 Marsh is section 303(d) listed as impaired due to elevated EC, and the potential increases in long-  
 24 term average EC levels could contribute to additional beneficial use impairment. The effects on EC in  
 25 the western Delta, San Joaquin River at Prisoners Point, and in Suisun Marsh ~~These increases in EC~~  
 26 constitute an adverse effect on water quality. Mitigation Measure WQ-11 would be available to  
 27 reduce these effects (implementation of this measure along with a separate, non-environmental  
 28 commitment as set forth in EIR/EIS Appendix 3B, *Environmental Commitments*, relating to the  
 29 potential EC-related changes would reduce these effects).

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

35 River flow rate and reservoir storage reductions that would occur under Alternative 2A, relative to  
 36 Existing Conditions, would not be expected to result in a substantial adverse change in EC levels in  
 37 the reservoirs and rivers upstream of the Delta, given that: changes in the quality of watershed  
 38 runoff and reservoir inflows would not be expected to occur in the future; the state's aggressive  
 39 regulation of point-source discharge effects on Delta salinity-elevating parameters and the expected  
 40 further regulation as salt management plans are developed; the salt-related TMDLs adopted and  
 41 being developed for the San Joaquin River; and the expected improvement in lower San Joaquin  
 42 River average EC levels commensurate with the lower EC of the irrigation water deliveries from the  
 43 Delta.

44 Relative to Existing Conditions, Alternative 2A would not result in any substantial increases in long-  
 45 term average EC levels in the SWP/CVP Export Service Areas. There would be no exceedance of the



1 EC objective at the Jones and Banks pumping plants. Average EC levels for the entire period modeled  
 2 would decrease at both plants and, thus, this alternative would not contribute to additional  
 3 beneficial use impairment related to elevated EC in the SWP/CVP Export Service Areas waters.  
 4 Rather, this alternative would improve long-term EC levels in the SWP/CVP Export Service Areas,  
 5 relative to Existing Conditions.

6 In the Plan Area, Alternative 2A would result in an increase in the frequency with which Bay-Delta  
 7 WQCP EC objectives are exceeded for the entire period modeled (1976–1991): in the Sacramento  
 8 River at Emmaton (agricultural objective; ~~1720%~~ increase), in the San Joaquin River at ~~San Andreas~~  
 9 ~~Landing (agricultural objective; 34% increase), and~~ Prisoners Point (fish and wildlife objective; 19%  
 10 increase), ~~both in the interior Delta; and in Old River near Middle River and at Tracy Bridge~~  
 11 ~~(agricultural objectives; up to 2% increase), both in the southern Delta.~~ Average EC levels at San  
 12 Andreas Landing would increase by 1% during for the entire period modeled and 10% during the  
 13 drought period modeled. The increases in long-term and drought period average EC levels and  
 14 increased frequency of exceedance of EC objectives that would occur ~~in the San Joaquin River at San~~  
 15 ~~Andreas Landing, and the increased exceedance of EC objectives~~ in the Sacramento River at  
 16 Emmaton would potentially contribute to adverse effects on the agricultural beneficial uses in the  
 17 ~~interior and~~ western Delta. ~~The increased long-term period average EC levels between Jersey Point~~  
 18 ~~and Prisoners Point could contribute to adverse effects on fish and wildlife beneficial uses~~  
 19 ~~(specifically, indirect adverse effects on striped bass spawning), though there is a high degree of~~  
 20 ~~uncertainty associated with this impact. Further, the increased frequency of exceedance of the fish~~  
 21 ~~and wildlife objective at Prisoners Point could contribute to adverse effects on aquatic life.~~ Because  
 22 EC is not bioaccumulative, the increases in long-term average EC levels would not directly cause  
 23 bioaccumulative problems in aquatic life or humans. The western and southern Delta are Clean  
 24 Water Act section 303(d) listed for elevated EC and the increased frequency of exceedance of EC  
 25 objectives that would occur in ~~these portions of the~~ in the western Delta could make beneficial use  
 26 impairment measurably worse. This impact is considered to be significant.

27 Further, relative to Existing Conditions, Alternative 2A ~~would~~ could result in substantial increases in  
 28 long-term average EC during the months of October through May in Suisun Marsh, ~~such that EC~~  
 29 ~~levels would be double that relative to Existing Conditions.~~ The increases in long-term average EC  
 30 levels that would occur in Suisun Marsh could further degrade existing EC levels and thus contribute  
 31 additionally to adverse effects on the fish and wildlife beneficial uses. Because EC is not  
 32 bioaccumulative, the increases in long-term average EC levels would not directly cause  
 33 bioaccumulative problems in fish and wildlife. Suisun Marsh is Clean Water Act section 303(d) listed  
 34 for elevated EC and the increases in long-term average EC that would occur in the marsh could make  
 35 beneficial use impairment measurably worse. This impact is considered to be significant.

36 Implementation of Mitigation Measure WQ-11 along with a separate, non-environmental  
 37 commitment relating to the potential increased costs associated with EC-related changes would  
 38 reduce these effects. While mitigation measures to reduce these water quality effects in affected  
 39 water bodies to less than significant levels are not available, implementation of Mitigation Measure  
 40 WQ-11 is recommended to attempt to reduce the effect that increased EC concentrations may have  
 41 on Delta beneficial uses. However, because the effectiveness of this mitigation measure to result in  
 42 feasible measures for reducing water quality effects is uncertain, this impact is considered to remain  
 43 significant and unavoidable. Please see Mitigation Measure WQ-11 under Impact WQ-11 in the  
 44 discussion of Alternative 1A.

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

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

### 14 *Upstream of the Delta*

15 Under Alternative 2A, the magnitude and timing of reservoir releases and river flows upstream of  
 16 the Delta in the Sacramento River watershed and east-side tributaries would be altered, relative to  
 17 Existing Conditions and the No Action Alternative.

18 The Sacramento River at Freeport and San Joaquin River at Vernalis (as summarized for water  
 19 quality average concentrations in Tables 8-48 and 8-49) were examined for flow/concentration  
 20 relationships for mercury and methylmercury. No significant, predictive regression relationships  
 21 were discovered for mercury or methylmercury, except for total mercury with flow at Freeport  
 22 (monthly or annual) ([Appendix 8I.Mercury](#), Figures I-10 through I-13, ~~Appendix 8I~~). Such a positive  
 23 relationship between total mercury and flow is to be expected based on the association of mercury  
 24 with suspended sediment and the mobilization of sediments during storm flows. However, the  
 25 changes in flow in the Sacramento River under Alternative 2A relative to Existing Conditions and the  
 26 No Action Alternative are not of the magnitude of storm flows, in which substantial sediment-  
 27 associated mercury is mobilized. Therefore mercury loading should not be substantially different  
 28 due to changes in flow. In addition, even though it may be flow-affected, total mercury  
 29 concentrations remain well below criteria at upstream locations. Any negligible changes in mercury  
 30 concentrations that may occur in the water bodies of the affected environment located upstream of  
 31 the Delta would not be of frequency, magnitude, and geographic extent that would adversely affect  
 32 any beneficial uses or substantially degrade the quality of these water bodies as related to mercury.  
 33 Both waterborne methylmercury concentrations and largemouth bass fillet mercury concentrations  
 34 are expected to remain above guidance levels at upstream of Delta locations, but will not change  
 35 substantially relative to Existing Conditions or the No Action Alternative due to changes in flows  
 36 under Alternative 2A.

37 The upstream of Delta areas in the north will benefit from the implementation of the Cache Creek,  
 38 Sulfur Creek, Harley Gulch, and Clear Lake Mercury TMDLs and the American River methylmercury  
 39 TMDL. These projects will target specific sources of mercury and methylation upstream of the Delta  
 40 and could result in net improvement to Delta mercury loading in the future. The implementation of  
 41 these projects could help to ensure that upstream of Delta environments will not be substantially  
 42 degraded for water quality with respect to mercury or methylmercury.

## 1 **Delta**

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

9 The water quality impacts of waterborne concentrations of mercury and methylmercury and fish  
10 tissue mercury concentrations were evaluated for 9 Delta locations. The analysis of percentage  
11 change in assimilative capacity of waterborne total mercury of Alternative 2A relative to the 25 ng/L  
12 ecological risk benchmark showed the greatest decrease to be 2.2% for Old River at Rock Slough as  
13 compared to Existing Conditions, and 2.1% for Old River at Rock Slough as compared to the No  
14 Action Alternative (Figures 8-53 and 8-54). These changes are not expected to result in adverse  
15 effects to beneficial uses. Similarly, changes in methylmercury concentration are expected to be very  
16 small. The greatest annual average methylmercury concentration for drought conditions was 0.163  
17 ng/L for the San Joaquin River at Buckley Cove, which was slightly higher than Existing Conditions  
18 (0.161 ng/L) and slightly lower than the No Action Alternative (0.167 ng/L) (Appendix 8I, Table I-  
19 6). All modeled input concentrations exceeded the methylmercury TMDL guidance objective of 0.06  
20 ng/L, therefore percentage change in assimilative capacity was not evaluated for methylmercury.

21 Fish tissue estimates show only small or no increases in exceedance quotients based on long-term  
22 annual average concentrations for mercury at the Delta locations. The greatest increase in  
23 exceedance quotients was 13% at Old River at Rock Slough relative to Existing Conditions, and 11 -  
24 12% at the Mokelumne River (South Fork) at Staten Island, Franks Tract, and Old River at Rock  
25 Slough relative to the No Action Alternative (Figure [8-558-55a,b](#); Appendix 8I, Table I-9b). [Because](#)  
26 [these increases are relatively small, and it is not evident that substantive increases are expected at](#)  
27 [numerous locations throughout the Delta, these changes are expected to be within the uncertainty](#)  
28 [inherent in the modeling approach, and would likely not be measurable in the environment. See](#)  
29 [Appendix 8I for a discussion of the uncertainty associated with the fish tissue estimates.](#)

## 30 **SWP/CVP Export Service Areas**

31 The analysis of mercury and methylmercury in the SWP/CVP Export Service Areas was based on  
32 concentrations estimated at the Banks and Jones pumping plants. Both waterborne total and  
33 methylmercury concentrations for Alternative 2A are projected to be lower than Existing Conditions  
34 and the No Action Alternative at the Jones and Banks pumping plants (Appendix 8I, Figures I-2 and  
35 I-3). Therefore, mercury shows increased assimilative capacity at these locations (Figures 8-53 and  
36 8-54).

37 The largest improvements in bass tissue mercury concentrations and exceedance quotients for  
38 Alternative 2A, relative to Existing Conditions and the No Action Alternative at any location within  
39 the Delta are expected for the export pump locations (specifically, at Jones Pumping plant, 14%  
40 improvement relative to Existing Conditions, 17% relative to the No Action Alternative) (Figure [8-](#)  
41 [558-55a,b](#), Appendix 8I, Table I-9b).

1 **NEPA Effects:** Based on the above discussion, the effects of mercury and methylmercury in  
 2 comparison of Alternative 2A to the No Action Alternative (as waterborne and bioaccumulated  
 3 forms) are not considered to be adverse.

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

9 Under Alternative 2A, greater water demands and climate change would alter the magnitude and  
 10 timing of reservoir releases and river flows upstream of the Delta in the Sacramento River  
 11 watershed and east-side tributaries, relative to Existing Conditions. Concentrations of mercury and  
 12 methylmercury upstream of the Delta will not be substantially different relative to Existing  
 13 Conditions due to the lack of important relationships between mercury/methylmercury  
 14 concentrations and flow for the major rivers.

15 Methylmercury concentrations exceed criteria at all locations in the Delta and no assimilative  
 16 capacity exists. However, monthly average waterborne concentrations of total and methylmercury,  
 17 over the period of record, are very similar to Existing Conditions. Similarly, estimates of fish tissue  
 18 mercury concentrations show almost no differences would occur among sites for Alternative 2A as  
 19 compared to Existing Conditions for Delta sites.

20 Assessment of effects of mercury in the SWP and CVP Export Service Areas were based on effects on  
 21 mercury concentrations and fish tissue mercury concentrations at the Banks and Jones pumping  
 22 plants. The Banks and Jones pumping plants are expected to show increased assimilative capacity  
 23 for waterborne mercury and decreased fish tissue concentrations of mercury for Alternative 2A as  
 24 compared to Existing Conditions.

25 As such, this alternative is not expected to cause additional exceedance of applicable water quality  
 26 objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects  
 27 on any beneficial uses of waters in the affected environment. Because mercury concentrations are  
 28 not expected to increase substantially, no long-term water quality degradation is expected to occur  
 29 and, thus, no adverse effects to beneficial uses would occur. Because any increases in mercury or  
 30 methylmercury concentrations are not likely to be measurable, changes in mercury concentrations  
 31 or fish tissue mercury concentrations would not make any existing mercury-related impairment  
 32 measurably worse. In comparison to Existing Conditions, Alternative 2A would not increase levels of  
 33 mercury by frequency, magnitude, and geographic extent such that the affected environment would  
 34 be expected to have measurably higher body burdens of mercury in aquatic organisms, thereby  
 35 substantially increasing the health risks to wildlife (including fish) or humans consuming those  
 36 organisms. This impact is considered to be less than significant. No mitigation is required.

### 37 **Impact WQ-25: Effects on Selenium Concentrations Resulting from Facilities Operations and** 38 **Maintenance (CM1)**

#### 39 **Delta**

40 Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2  
 41 and CM4) would affect Delta hydrodynamics. To the extent that restoration actions alter  
 42 hydrodynamics within the Delta region, which affects mixing of source waters, these effects are

1 included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of  
 2 ~~CM2-22CM2 through CM22CM2-CM21~~ not attributable to hydrodynamics, for example, additional  
 3 loading of a constituent to the Delta, are discussed within the impact header for ~~CM2-22CM2~~  
 4 ~~through CM22CM2-CM21~~. See section 8.3.1.3 for more information.

5 Selenium concentrations and threshold comparisons for each of the 11 modeled Delta assessment  
 6 locations under Alternative 2A, relative to Existing Conditions and the No Action Alternative, are  
 7 presented in Appendix 8M, *Selenium*, Table M-9a for water, Tables M-12 and M-22 for most biota  
 8 (whole-body fish [excluding sturgeon], bird eggs [invertebrate diet], bird eggs [fish diet], and fish  
 9 fillets) throughout the Delta, and Tables M-30 through M-32 for sturgeon at the two western Delta  
 10 locations. Figures 8-59a and 8-60a present graphical distributions of predicted selenium  
 11 concentration changes (shown as changes in available assimilative capacity based on 1.3 µg/L) in  
 12 water at each modeled assessment location for all years. Appendix 8M, Figure M-21 provides more  
 13 detail in the form of monthly patterns of selenium concentrations in water during the modeling  
 14 period. Appendix 8M.

15 Alternative 2A would result in small changes in average selenium concentrations in water at all  
 16 modeled Delta assessment locations relative to Existing Conditions and the No Action Alternative  
 17 (Appendix 8M, *Selenium*, Table M-10A9a). Long-term average concentrations at some interior and  
 18 western Delta locations would increase by 0.01–0.04 µg/L for the entire period modeled (1976–  
 19 1991). These small changes-increases in selenium concentrations in water are reflected in would  
 20 result in small percent changes-reductions (104% or less) in available assimilative capacity for  
 21 selenium, relative to the 21.3 µg/L ecological-risk benchmark USEPA draft water quality criterion  
 22 (Figures 8-59a and 8-60a) for all years. Relative to Existing Conditions, Alternative 2A would result  
 23 in the largest modeled increase in available assimilative capacity at Buckley Cove (1%) and the  
 24 largest decrease at Contra Costa PP (4%) (Figure 8-59). Relative to the No Action Alternative, the  
 25 largest modeled increase would be at Staten Island (1%) and the largest decrease would be at  
 26 Buckley Cove (4%) (Figure 8-60). Although some small negative changes (less than 5%) in selenium  
 27 concentrations in water are expected, the effect of Alternative 2A would generally be minimal for  
 28 the Delta locations. Furthermore, the long-term average selenium concentrations in water  
 29 (Appendix 8M, Table M-10A) for Alternative 2A (range 0.2209–0.7440 µg/L) would be very similar  
 30 to those for Existing Conditions (range 0.2109–0.4761 µg/L) and the No Action Alternative (range  
 31 0.2109–0.6938 µg/L), and all would be below the ecological-risk benchmark USEPA draft water  
 32 quality criterion of (21.3 µg/L) (Appendix 8M, Table M-9a).

33 Relative to Existing Conditions and the No Action Alternative, Alternative 2A would result in very  
 34 small changes (less than 1%) in estimated selenium concentrations in most biota (whole-body fish,  
 35 bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets) throughout the Delta, with little  
 36 difference among locations (Figures 8-61a through 8-64b; Appendix 8M, *Selenium*, Table M-  
 37 22Appendix 8M, Table M-13 and Addendum M.A, *Selenium in Sturgeon*, to Appendix 8M, Table  
 38 M.A8M-2 in the sturgeon addendum to Appendix 8M). Level of Concern Exceedance Quotients (i.e.,  
 39 modeled tissue divided by Level of Concern benchmarks) for selenium concentrations in those biota  
 40 for all years and for drought years are less than 1.0 (indicating low probability of adverse effects).  
 41 Similarly, Advisory Tissue Level Exceedance Quotients for selenium concentrations in fish fillets for  
 42 all years and drought years also are less than 1.0. Estimated selenium concentrations in sturgeon for  
 43 the San Joaquin River at Antioch are predicted to increase by about 19 percent relative to Existing  
 44 Conditions and to the No Action Alternative in all years (from about 4.7 to 5.6 mg/kg dw), and those  
 45 for sturgeon in the Sacramento River at Mallard Island are predicted to increase by about 11 percent  
 46 in all years (from about 4.4 to 4.9 mg/kg dw) (Appendix 8M, Figure 8-65; Tables M-30 and M-31).

1 Selenium concentrations in sturgeon during drought years are expected to increase by only 4 to 8  
2 percent at those locations. Detection of small changes in whole-body sturgeon such as those  
3 estimated for the western Delta would require very large sample sizes because of the inherent  
4 variability in fish tissue selenium concentrations. Low Toxicity Threshold Exceedance Quotients for  
5 selenium concentrations in sturgeon in the western Delta would be 1.5 (indicating a higher  
6 probability for adverse effects) for drought years at both locations (similar to Existing Conditions  
7 and the No Action Alternative; Figure 8-65) and would increase slightly, from 0.94 to 1.1, for all  
8 years in the San Joaquin River at Antioch (Appendix 8M, Table M-32). Relative to Existing  
9 Conditions, the largest increase of selenium concentrations in biota would be at Contra Costa PP for  
10 all years and for the sturgeon at the San Joaquin River at Antioch in all years, and the largest  
11 decrease would be at Buckley Cove for drought years. Relative to the No Action Alternative, the  
12 largest increase would be at Buckley Cove for drought years (except for bird eggs [assuming a fish  
13 diet] at Old River at Rock Slough [hereafter Rock Slough] for all years) and for the sturgeon at the  
14 San Joaquin River at Antioch in all years; the largest decrease would be at Staten Island for drought  
15 years. Except for sturgeon in the western Delta, concentrations of selenium in whole-body fish and  
16 bird eggs (invertebrate and fish diets) would exceed only the lower benchmarks (4 and 6 mg/kg dry  
17 weight, respectively, indicating a low potential for effects), under drought conditions, at Buckley  
18 Cove for Existing Conditions, the No Action Alternative, and Alternative 2A (Figures 8-61 through 8-  
19 63). However, Exceedance Quotients ~~exceedance quotients~~ for these exceedances of the lower  
20 benchmarks are between 1.0 and 1.5, indicating a low risk to biota in the Delta and no substantial  
21 difference from Existing Conditions and the No Action Alternative. Selenium concentrations in fish  
22 fillets would not exceed the screening value for protection of human health (Figure 8-64). For  
23 sturgeon in the western Delta, whole-body selenium concentrations would increase from 12.3  
24 mg/kg under Existing Conditions and the No Action Alternative to 13.5 mg/kg under Alternative 2A,  
25 a 10% increase (Table 8M-2 in the sturgeon addendum to Appendix 8M Table M.A-2). Although all of  
26 these values exceed both the low and high toxicity benchmarks, it is unlikely that the modeled  
27 increases in whole-body selenium for sturgeon would be measurable in the environment (see also  
28 the discussion of results provided in Addendum the sturgeon addendum M.A, Selenium in  
29 Sturgeon, to Appendix 8M).

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

1 Increased water residence times could increase the bioaccumulation of selenium in biota, thereby  
2 potentially increasing fish tissue and bird egg concentrations of selenium (see residence time  
3 discussion in Appendix 8M, *Selenium*, and Presser and Luoma [2010b]). Thus, residence time was  
4 assessed for its relevance to selenium bioaccumulation. Table 60a (presented originally in Section  
5 8.3.1.7 in the *Microcystis* subsection) shows the time for neutrally buoyant particles to move through  
6 the Delta (surrogate for flow and residence time). Although an increase in residence time  
7 throughout the Delta is expected under the No Action Alternative, relative to Existing Conditions  
8 (because of climate change and sea level rise), the change is fairly small in most areas of the Delta.  
9 Thus, the changes in residence times between Alternative 2A and the No Action Alternative are very  
10 similar to the changes in residence times between Alternative 2A and the Existing Conditions.

11 Relative to Existing Conditions and the No Action Alternative, increases in residence times for  
12 Alternative 2A would be greater in the East Delta and South Delta than in other sub-regions. Relative  
13 to Existing Conditions, annual average residence times for Alternative 2A in the East Delta are  
14 expected to increase by more than 16 days (Table 60a). Relative to the No Action Alternative, annual  
15 average residence times for Alternative 2A in the East Delta are expected to increase by less than 10  
16 days. Increases in residence times for other sub-regions would be smaller, especially as compared to  
17 Existing Conditions and the No Action Alternative (which are longer than those modeled for the  
18 South Delta). As mentioned above, these results incorporate hydrodynamic effects of both CM1 and  
19 CM2 and CM4, and the effects of CM1 cannot be distinguished from the effects of CM2 and CM4.  
20 However, it is expected that CM2 and CM4 are substantial drivers of the increased residence time.

21 Presser and Luoma (2010b) summarized and discussed selenium uptake in the Bay-Delta (including  
22 hydrologic conditions [e.g., Delta outflow and residence time for water],  $K_d$ s [the ratio of selenium  
23 concentrations in particulates, as the lowest level of the food chain, relative to the water-borne  
24 concentration], and associated tissue concentrations [especially in clams and their consumers, such  
25 as sturgeon]). When the Delta Outflow Index (daily average flow per month) decreased by five-fold  
26 (73,732 cubic feet per second [cfs] in June 1998 to 12, 251 cfs in October 1998), residence time  
27 doubled (from 11 to 22 days) and the calculated mean  $K_d$  also doubled (from 3,198 to 6,501).  
28 However, when daily average Delta outflow in November 1999 was only 6,951 cfs (i.e., about one-  
29 half that in October 1998) and residence time was 70 days, the calculated mean  $K_d$  (7,614) did not  
30 increase proportionally.

31 Models are not available to quantitatively estimate the level of changes in selenium bioaccumulation  
32 as related to residence time, but the effects of residence time are incorporated in the  
33 bioaccumulation modeling for selenium that was based on higher  $K_d$  values for drought years in  
34 comparison to wet, normal, or all years; see Appendix 8M, *Selenium*. If increases in fish tissue or  
35 bird egg selenium were to occur, the increases would likely be of concern only where fish tissues or  
36 bird eggs are already elevated in selenium to near or above thresholds of concern. That is, where  
37 biota concentrations are currently low and not approaching thresholds of concern (which, as  
38 discussed above, is the case throughout the Delta, except for sturgeon in the western Delta), changes  
39 in residence time alone would not be expected to cause them to then approach or exceed thresholds  
40 of concern. In consideration of this factor, although the Delta as a whole is a CWA Section 303(d)-  
41 listed water body for selenium, and although monitoring data of fish tissue or bird eggs in the Delta  
42 are sparse, the most likely area in which biota tissues would be at levels high enough that additional  
43 bioaccumulation due to increased residence time from restoration areas would be a concern is the  
44 western Delta and Suisun Bay for sturgeon, as discussed above. As shown in Table 60a, the overall  
45 increase in residence time estimated in the western Delta is 5 days relative to Existing Conditions,  
46 and 3 days relative to the No Action Alternative. Given the available information, these increases are

1 small enough that they are not expected to substantially affect selenium bioaccumulation in the  
 2 western Delta. Because CM2 and CM4 are expected to be substantial drivers of the increased  
 3 residence times, further discussion is included in Impact WQ-26 below.

4 In summary, Rrelative to Existing Conditions and the No Action Alternative, Alternative 2A would  
 5 result in essentially no change in selenium concentrations throughout the Delta for most biota  
 6 (less approximately than 1% or less), although increases in selenium concentrations are predicted  
 7 for sturgeon in the western Delta. The Low Toxicity Threshold Exceedance Quotient for selenium  
 8 concentrations in sturgeon for all years in the San Joaquin River at Antioch would increase from 0.94  
 9 for Existing Conditions and the No Action Alternative to 1.1 for Alternative 2A. Concentrations of  
 10 selenium in sturgeon would exceed only the lower benchmark, indicating a low potential for effects.  
 11 The modeling of bioaccumulation for sturgeon is less calibrated to site-specific conditions than that  
 12 for other biota, which was calibrated on a robust dataset for modeling of bioaccumulation in  
 13 largemouth bass as a representative species for the Delta. Overall, Alternative 2A would not be  
 14 expected to substantially increase the frequency with which applicable benchmarks would be  
 15 exceeded in the Delta (there being only a small increase for sturgeon relative to the low benchmark  
 16 and no exceedance of the high benchmark) or substantially degrade the quality of water in the Delta,  
 17 with regard to selenium.

#### 18 ***SWP/CVP Export Service Areas***

19 Alternative 2A would result in small (0.06–0.09 µg/L) changes-decreases in long-term average  
 20 selenium concentrations in water at both modeled Export Service Area assessment locations the  
 21 Banks and Jones pumping plants relative to Existing Conditions and the No Action Alternative, for  
 22 the entire period modeled (Appendix 8M, Selenium, Table M-10A9a). These small changes-decreases  
 23 in long-term average selenium concentrations in water are reflected-would result in small percent  
 24 changes-increases (10% or less) in available assimilative capacity for selenium at these pumping  
 25 plants of 6–9%, relative to the 1.3 µg/L ecological risk benchmark USEPA draft water quality  
 26 criterion (Figures 8-59a and 8-60a) (based on 2 µg/L ecological risk benchmark) for all years.  
 27 Relative to Existing Conditions and the No Action Alternative, Alternative 2A would result in  
 28 modeled increases in assimilative capacity at Jones PP (9% and 10%, respectively) and at Banks PP  
 29 (5%) (Figures 8-59 and 8-60), and generally would have a small positive effect on the Export Service  
 30 Area locations. Furthermore, the ranges of modeled long-term average selenium concentrations in  
 31 water (Appendix 8M, Table M-10A) for Alternative 2A (range 0.3715–0.4519 µg/L) are-would  
 32 similar to those for Existing Conditions (range 0.37–0.58 µg/L) and the No Action Alternative (range  
 33 0.37–0.59 µg/L), and would be well below the ecological risk benchmark USEPA draft water quality  
 34 criterion of (21.3 µg/L) (Appendix 8M, Table M-9a).

35 Relative to Existing Conditions and the No Action Alternative, Alternative 2A would result in very  
 36 small minimal changes (less than 1%) in estimated selenium concentrations in biota (whole-body  
 37 fish, bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets) (Figures 8-61a through 8-64b;  
 38 Appendix 8M, Selenium, Table M-1322) at export service areas Banks and Jones pumping plants. The  
 39 largest increase of selenium concentrations in biota would be at Banks PP for drought years, and the  
 40 largest decrease would be at Jones PP for all years (except for bird eggs [assuming a fish diet] at  
 41 Jones PP for drought years). Concentrations of selenium in biota would not exceed any selenium  
 42 benchmarks for Alternative 2A (Figures 8-61a through 8-64b).

43 Thus, relative to Existing Conditions and the No Action Alternative, Alternative 2A would result in  
 44 minimal changes in selenium concentrations at the Export Service Area locations. Selenium



1 ~~concentrations in water and biota would generally decrease for Alternative 2A and would not~~  
 2 ~~exceed ecological benchmarks at either location. Compared to Existing Conditions and the No Action~~  
 3 ~~Alternative at Jones PP under drought conditions, there would be a small positive change in~~  
 4 ~~selenium concentrations under Alternative 2A in that it would be expected to slightly decrease the~~  
 5 ~~frequency with which applicable benchmarks would be exceeded or slightly improve the quality of~~  
 6 ~~water at the Export Service Area locations, with regard to selenium.~~

7 **NEPA Effects:** Based on the discussion above, the effects on selenium (both as waterborne and as  
 8 bioaccumulated in biota) from Alternative 2A are not considered to be adverse.

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

14 There are no substantial point sources of selenium in watersheds upstream of the Delta, and no  
 15 substantial nonpoint sources of selenium in the watersheds of the Sacramento River and the eastern  
 16 tributaries. Nonpoint sources in the San Joaquin Valley that contribute selenium to the Delta will be  
 17 controlled through a TMDL developed by the Central Valley Water Board (2001) for the lower San  
 18 Joaquin River, established limits for the Grassland Bypass Project, and Basin Plan objectives (Central  
 19 Valley Water Board [2010ed]) and State Water Board [(2010eb, 2010ec)] that are expected to result  
 20 in decreasing discharges of selenium from the San Joaquin River to the Delta. Consequently, any  
 21 modified reservoir operations and subsequent changes in river flows under Alternative 2A, relative  
 22 to Existing Conditions, are expected to cause negligible changes in selenium concentrations in water.  
 23 Any negligible changes in selenium concentrations that may occur in the water bodies of the affected  
 24 environment located upstream of the Delta would not be of frequency, magnitude, and geographic  
 25 extent that would adversely affect any beneficial uses or substantially degrade the quality of these  
 26 water bodies as related to selenium.

27 Relative to Existing Conditions, modeling estimates indicate that Alternative 2A would result in  
 28 essentially no change in selenium concentrations in water or most biota throughout the Delta,

29 with no exceedances of benchmarks for biological effects. The Low Toxicity Threshold Exceedance  
 30 Quotient for selenium concentrations in sturgeon for all years in the San Joaquin River at Antioch  
 31 would increase slightly, from 0.94 for Existing Conditions and the No Action Alternative to 1.1 for  
 32 Alternative 2A. Concentrations of selenium in sturgeon would exceed only the lower benchmark,  
 33 indicating a low potential for effects. Overall, Alternative 2A would not be expected to substantially  
 34 increase the frequency with which applicable benchmarks would be exceeded in the Delta (there  
 35 being only a modest small exceedance relative to the low benchmark for sturgeon and no exceedance  
 36 of the high benchmark) or substantially degrade the quality of water in the Delta, with regard to  
 37 selenium.

38 ~~Assessment This a~~Assessment of effects of selenium in the SWP /-and- CVP Export Service Areas is  
 39 based on effects on selenium concentrations at the Banks and Jones pumping plants. Relative to  
 40 Existing Conditions, Alternative 2A would ~~slightly decrease cause no increase in~~ the frequency with  
 41 which applicable benchmarks would be exceeded, ~~or and would~~ slightly improve the quality of water  
 42 in selenium concentrations at the Banks and Jones pumping plants ~~locations~~.

1 Based on the above, selenium concentrations that would occur in water under Alternative 2A would  
 2 not cause additional exceedances of applicable state or federal numeric or narrative water quality  
 3 objectives/criteria, or other relevant water quality effects thresholds identified for this assessment  
 4 (Table ~~M-10A8-54~~), by frequency, magnitude, and geographic extent that would result in adverse  
 5 effects to one or more beneficial uses within affected water bodies. In comparison to Existing  
 6 Conditions, water quality conditions under this alternative would not increase levels of selenium by  
 7 frequency, magnitude, and geographic extent such that the affected environment would be expected  
 8 to have measurably higher body burdens of selenium in aquatic organisms, thereby substantially  
 9 increasing the health risks to wildlife (including fish) or humans consuming those organisms. Water  
 10 quality conditions under this alternative with respect to selenium would not cause long-term  
 11 degradation of water quality in the affected environment, and therefore would not result in use of  
 12 available assimilative capacity such that exceedances of water quality objectives/criteria would be  
 13 likely and would result in substantially increased risk for adverse effects to one or more beneficial  
 14 uses. This alternative would not further degrade water quality by measurable levels, on a long-term  
 15 basis, for selenium and, thus, cause the CWA Section 303(d)-listed impairment of beneficial use to be  
 16 made discernibly worse. This alternative is considered to be less than significant. No mitigation is  
 17 required.

18 **Impact WQ-26: Effects on Selenium Concentrations Resulting from Implementation of CM2-  
 19 CM22-CM21**

20 NEPA Effects: Effects of CM2-CM21 on selenium under Alternative 2A are the same as those  
 21 discussed for Alternative 1A and are considered not to be adverse.

22 CEQA Conclusion: CM2-CM21 proposed under Alternative 2A would be similar to those proposed  
 23 under Alternative 1A. As such, effects on selenium resulting from the implementation of CM2-CM21  
 24 would be similar to that previously discussed for Alternative 1A. This impact is considered to be less  
 25 than significant. No mitigation is required.

26 NEPA Effects: In general, with the possible exception of changes in Delta hydrodynamics resulting  
 27 from habitat restoration, CM2-CM11 would not substantially increase selenium concentrations in  
 28 the water bodies of the affected environment. Modeling scenarios included assumptions regarding  
 29 how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, and  
 30 thus such effects of these restoration measures were included in the assessment of CM1 facilities  
 31 operations and maintenance (see Impact WQ 25).

32 However, implementation of these conservation measures may increase water residence time  
 33 within the restoration areas. Increased restoration area water residence times could potentially  
 34 increase the bioaccumulation of selenium in biota, thereby potentially increasing fish tissue and bird  
 35 egg concentrations of selenium, but models are not available to quantitatively estimate the level of  
 36 changes in residence time and the associated selenium bioavailability, but the effects of residence  
 37 time are incorporated in the bioaccumulation modeling for selenium that was based on higher  $K_d$   
 38 values (the ratio of selenium concentrations in particulates [as the lowest level of the food chain]  
 39 relative to the water-borne concentration) for drought years in comparison to wet, normal, or all  
 40 years; see Appendix 8M, *Selenium*. If increases in fish tissue or bird egg selenium were to occur, the  
 41 increases would likely be of concern only where fish tissues or bird eggs are already elevated in  
 42 selenium to near or above thresholds of concern. That is, where biota concentrations are currently  
 43 low and not approaching thresholds of concern, changes in residence time alone would not be  
 44 expected to cause them to then approach or exceed thresholds of concern. In consideration of this

1 factor, although the Delta as a whole is a 303(d)-listed water body for selenium, and although  
2 monitoring data of fish tissue or bird eggs in the Delta are sparse, the most likely areas in which  
3 biota tissues would be at levels high enough that additional bioaccumulation due to increased  
4 residence time from restoration areas would be a concern are the western Delta and Suisun Bay, and  
5 the South Delta in areas that receive San Joaquin River water.

6 The western Delta and Suisun Bay receive elevated selenium loads from North San Francisco Bay  
7 (including San Pablo Bay, Carquinez Strait, and Suisun Bay) and from the San Joaquin River. Point  
8 sources of selenium in North San Francisco Bay (i.e., refineries) that contribute selenium to Suisun  
9 Bay are expected to be reduced through a TMDL under development by the San Francisco Bay Water  
10 Board (San Francisco Bay Water Board 2012) that is expected to result in decreasing discharges of  
11 selenium. Nonpoint sources of selenium in the San Joaquin Valley that contribute selenium to the  
12 San Joaquin River, and thus the Delta and Suisun Bay, will be controlled through a TMDL developed  
13 by the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the  
14 Grassland Bypass Project, and Basin Plan objectives (Central Valley Water Board 2010c, d) that are  
15 expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta. If  
16 selenium levels are not sufficiently reduced via these efforts, it is expected that the State Water  
17 Board and the San Francisco Bay and Central Valley Water Boards would initiate additional actions  
18 to further control sources of selenium.

19 The South Delta receives elevated selenium loads from the San Joaquin River. In contrast to Suisun  
20 Bay and possibly the western Delta in the future, the South Delta lacks the overbite clam (*Corbula*  
21 [*Potamocorbula*] *amurensis*), which is considered a key driver of selenium bioaccumulation in  
22 Suisun Bay, due to its high bioaccumulation of selenium and its role in the benthic food web that  
23 includes long-lived sturgeon. The South Delta does have *Corbicula fluminea*, another bivalve that  
24 bioaccumulates selenium, but it is not as invasive as the overbite clam and thus likely makes up a  
25 smaller fraction of sturgeon diet. Also, as mentioned above, nonpoint sources of selenium in the San  
26 Joaquin Valley that contribute selenium to the Delta will be controlled through a TMDL developed by  
27 the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the  
28 Grassland Bypass Project, and Basin Plan objectives (Central Valley Water Board 2010c, d) that are  
29 expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta.  
30 Further, if selenium levels in the San Joaquin River are not sufficiently reduced via these efforts, it is  
31 expected that the State Water Board and Central Valley Water Board would initiate additional  
32 TMDLs to further control nonpoint sources of selenium.

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

41 However, because increases in bioavailable selenium in the habitat restoration areas are uncertain,  
42 proposed avoidance and minimization measures would require evaluating risks of selenium  
43 exposure at a project level for each restoration area, minimizing to the extent practicable potential  
44 risk of additional bioaccumulation, and monitoring selenium levels in fish and/or wildlife to  
45 establish whether, or to what extent, additional bioaccumulation is occurring. See Appendix 3B,

1 ~~*Environmental Commitments* for a description of the environmental commitment BDCP proponents~~  
 2 ~~are making with respect to Selenium Management; and Appendix 3.C. of the BDCP for~~  
 3 ~~additional detail on this avoidance and minimization measure (AMM27). Data generated as part of~~  
 4 ~~the avoidance and minimization measures will assist the State and Regional Water Boards in~~  
 5 ~~determining whether beneficial uses are being impacted by selenium, and thus will provide the data~~  
 6 ~~necessary to support regulatory actions (including additional TMDL development), should such~~  
 7 ~~actions be warranted.~~

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

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

20 ~~**CEQA Conclusion:** There would be no substantial, long-term increase in selenium concentrations in~~  
 21 ~~water in the rivers and reservoirs upstream of the Delta, water in the Delta, or the waters exported~~  
 22 ~~to the CVP and SWP service areas due to implementation of CM2-CM22CM21 relative to Existing~~  
 23 ~~Conditions. Waterborne selenium concentrations under this alternative would not exceed applicable~~  
 24 ~~water quality objectives/criteria.~~

25 ~~Given the factors discussed in the assessment above, any increases in bioaccumulation rates from~~  
 26 ~~water-borne selenium that could occur in some areas as a result of increased water residence times~~  
 27 ~~would not be of sufficient magnitude and geographic extent that any portion of the Delta would be~~  
 28 ~~expected to have measurably higher body burdens of selenium in aquatic organisms, and therefore~~  
 29 ~~would not substantially increase risk for adverse effects to beneficial uses. CM2-22CM2 through~~  
 30 ~~CM22CM2-CM21 would not cause long-term degradation of water quality resulting in sufficient use~~  
 31 ~~of available assimilative capacity such that occasionally exceeding water quality objectives/criteria~~  
 32 ~~would be likely. Also, CM2-22CM2 through CM22CM2-CM21 would not result in substantially~~  
 33 ~~increased risk for adverse effects to any beneficial uses. Furthermore, although the Delta is a 303(d)-~~  
 34 ~~listed water body for selenium, given the discussion in the assessment above, it is unlikely that~~  
 35 ~~restoration areas would result in measurable increases in selenium in fish tissues or bird eggs such~~  
 36 ~~that the beneficial use impairment would be made discernibly worse.~~

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

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

3 Effects of facilities and operations (CM1) on *Microcystis* abundance, and thus microcystins  
4 concentrations, in water bodies of the affected environment under Alternative 2A would be very  
5 similar (i.e., nearly the same) to those discussed for Alternative 1A. This is because factors that  
6 affect *Microcystis* abundance in waters upstream of the Delta, in the Delta, and in the SWP/CVP  
7 Export Services Areas under Alternative 1A would similarly change under Alternative 2A, relative to  
8 Existing Conditions and the No Action Alternative. For the Delta in particular, there are differences  
9 in the direction and magnitude of water residence time changes during the *Microcystis* bloom  
10 period among the six Delta sub-regions under Alternative 2A compared to Alternative 1A, relative to  
11 Existing Conditions and No Action Alternative. However, under Alternative 2A, relative to Existing  
12 Conditions and No Action Alternative, water residence times during the *Microcystis* bloom period in  
13 various Delta sub-regions are expected to increase to a degree that could, similar to Alternative 1A,  
14 lead to an increase in the frequency, magnitude, and geographic extent of *Microcystis* blooms  
15 throughout the Delta.

16 Similar to Alternative 1A, elevated ambient water temperatures relative to Existing Conditions  
17 would occur in the Delta under Alternative 2A, which could lead to earlier occurrences of  
18 *Microcystis* blooms in the Delta, and increase the overall duration and magnitude of blooms.  
19 However, the degradation of water quality from *Microcystis* blooms due to the expected increases in  
20 Delta water temperatures is driven entirely by climate change, not effects of CM1. While *Microcystis*  
21 blooms have not occurred in the Export Service Areas, conditions in the Export Service Areas under  
22 Alternative 2A may become more conducive to *Microcystis* bloom formation, relative to Existing  
23 Conditions, because water temperatures will increase in the Export Service Areas due to the  
24 expected increase in ambient air temperatures resulting from climate change.

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

30 Under Alternative 2A, additional impacts from *Microcystis* in the reservoirs and watersheds  
31 upstream of the Delta are not expected, relative to Existing Conditions. Operations and maintenance  
32 occurring under Alternative 2A is not expected to change nutrient levels in upstream reservoirs or  
33 hydrodynamic conditions in upstream rivers and streams such that conditions would be more  
34 conductive to *Microcystis* production.

35 Relative to Existing Conditions, water temperatures and hydraulic residence times in the Delta are  
36 expected to increase under Alternative 2A, resulting in an increase in the frequency, magnitude and  
37 geographic extent of *Microcystis* blooms in the Delta. However, the degradation of water quality  
38 from *Microcystis* blooms due to the expected increases in Delta water temperatures is driven  
39 entirely by climate change, not effects of CM1. Increases in Delta residence times are expected  
40 throughout the Delta during the summer and fall bloom period, due in small part to climate change  
41 and sea level rise, but due more proportionately to CM1 and the hydrodynamic impacts of  
42 restoration included in CM2 and CM4. The precise change in local residence times and *Microcystis*  
43 production expected within any Delta sub-region is unknown because conditions will vary across  
44 the complex networks of intertwining channels, shallow back water areas, and submerged islands

1 that compose the Delta. Nonetheless, Delta residence times are, in general, expected to increase due  
2 to Alternative 2A. Consequently, it is possible that increases in the frequency, magnitude, and  
3 geographic extent of *Microcystis* blooms in the Delta will occur due to the operations and  
4 maintenance of Alternative 2A and the hydrodynamic impacts of restoration (CM2 and CM4).

5 The assessment of effects of *Microcystis* on SWP/CVP Export Service Areas is based on the  
6 assessment of changes in *Microcystis* levels in export source waters, as well as the effects of  
7 temperature and residence time changes within the Export Service Areas on *Microcystis* production.  
8 Under Alternative 2A, relative to Existing Conditions, the potential for *Microcystis* to occur in the  
9 Export Service Area is expected to increase due to increasing water temperature, but this impact is  
10 driven entirely by climate change and not Alternative 2A. Water exported from the Delta to the  
11 Export Service Area is expected to be a mixture of *Microcystis*-affected source water from the south  
12 Delta intakes and unaffected source water from the Sacramento River. Because of this, it cannot be  
13 determined whether operations and maintenance under Alternative 2A, relative to existing  
14 conditions, will result in increased or decreased levels of *Microcystis* and microcystins in the mixture  
15 of source waters exported from Banks and Jones pumping plants.

16 Based on the above, this alternative would not be expected to cause additional exceedance of  
17 applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that  
18 would cause significant impacts on any beneficial uses of waters in the affected environment.  
19 *Microcystis* and microcystins are not 303(d) listed within the affected environment and thus any  
20 increases that could occur in some areas would not make any existing *Microcystis* impairment  
21 measurably worse because no such impairments currently exist. Because *Microcystis* and  
22 microcystins are not bioaccumulative, increases that could occur in some areas would not  
23 bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health  
24 risks to fish, wildlife, or humans. However, because it is possible that increases in the frequency,  
25 magnitude, and geographic extent of *Microcystis* blooms in the Delta will occur due to the operations  
26 and maintenance of Alternative 2A and the hydrodynamic impacts of restoration (CM2 and CM4),  
27 long-term water quality degradation may occur and, thus, significant impacts on beneficial uses  
28 could occur. Although there is considerable uncertainty regarding this impact, the effects on  
29 *Microcystis* from implementing CM1 is determined to be significant.

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

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

36 Please see Mitigation Measure WQ-32a under Impact WQ-32 in the discussion of Alternative 1A.

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

39 Please see Mitigation Measure WQ-32b under Impact WQ-32 in the discussion of Alternative 1A.

1 **Impact WQ-33. Effects on *Microcystis* Bloom Formation Resulting from Other Conservation**  
 2 **Measures (CM2–CM21)**

3 The effects of CM2–CM21 on *Microcystis* under Alternative 92A are the same as those discussed for  
 4 Alternative 1A. In summary, potential environmental effects related to CM2 and CM4 could result in  
 5 an increase in the frequency, magnitude, and geographic extent of *Microcystis* blooms in the Delta,  
 6 relative to Existing Conditions and the No Action Alternative, as a result of increased residence times  
 7 for Delta waters from implementing CM2 and CM4 restoration areas. -Because the hydrodynamic  
 8 effects associated with implementing CM2 and CM4 were incorporated into the modeling used to  
 9 assess CM1, a detailed assessment of the effects of implementing CM2 and CM4 on *Microcystis*  
 10 blooms in the Delta via their effects on Delta water residence time is provided under CM1 (above).  
 11 The effects of CM 2CM2 and CM 4CM4 on *Microcystis* may be reduced by implementation of  
 12 Mitigation Measures WQ-32A and WQ-32b. The effectiveness of these mitigation measures to result  
 13 in feasible measures for reducing water quality effects is uncertain. Conservation Measures 3 (CM3)  
 14 and CM5-CM21 would not result in an increase in the frequency, magnitude, and geographic extent  
 15 of *Microcystis* blooms in the Delta.

16 **NEPA Effects:** Effects of CM2–CM21 on *Microcystis* under Alternative 2A are the same as those  
 17 discussed for Alternative 1A and are considered to be adverse.

18 **CEQA Conclusion:** Based on the above, this alternative would not be expected to cause additional  
 19 exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic  
 20 extent that would cause significant impacts on any beneficial uses of waters in the affected  
 21 environment. *Microcystis* and microcystins are not 303(d) listed within the affected environment  
 22 and thus any increases that could occur in some areas would not make any existing *Microcystis*  
 23 impairment measurably worse because no such impairments currently exist. Because *Microcystis*  
 24 and microcystins are not bioaccumulative, increases that could occur in some areas would not  
 25 bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health  
 26 risks to fish, wildlife, or humans. Because restoration actions implemented under CM2 and CM4 will  
 27 increase residence time throughout the Delta and create local areas of warmer water during the  
 28 bloom season, it is possible that increases in the frequency, magnitude, and geographic extent of  
 29 *Microcystis* blooms, and thus long-term water quality degradation and significant impacts on  
 30 beneficial uses, could occur. Although there is considerable uncertainty regarding this impact, the  
 31 effects on *Microcystis* from implementing CM2–CM21 are determined to be significant.

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

34 The effects analysis presented in the preceding impacts (Impact WQ-1 through WQ-33) concluded  
 35 that Alternative 2A would have a less than significant impact/no adverse effect on the following  
 36 constituents in the Delta:

- 37 ● Boron
- 38 ● Dissolved Oxygen
- 39 ● Pathogens
- 40 ● Pesticides
- 41 ● Trace Metals
- 42 ● 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 80, 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 80, 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



1 zooplankton in the estuary (Senn and Novick 2014; Kimmerer and Thompson 2014). Therefore, the  
2 projected change in total nitrogen and phosphorus loading that would occur in Delta outflow to San  
3 Francisco Bay is not expected to result in degradation of water quality with regard to nutrients that  
4 would result in adverse effects to beneficial uses.

### 5 Mercury

6 The estimated long-term average mercury and methylmercury loads in Delta exports are shown in  
7 Appendix 80, Table O-2. Loads of mercury and methylmercury from the Delta to San Francisco Bay  
8 are estimated to change relatively little due to changes in source water fractions and net Delta  
9 outflow that would occur under Alternative 2A. Mercury load to the Bay, relative to Existing  
10 Conditions, is estimated to be the same relative to Existing Conditions, and to decrease by 2 kg/yr  
11 (1%) relative to the No Action Alternative. Methylmercury load is estimated to increase by 0.07  
12 kg/yr (2%), relative to Existing Conditions, and decrease by 0.02 kg/yr (1%) relative to the No  
13 Action Alternative. The estimated total mercury load to the Bay is 261 kg/yr, which would be less  
14 than the San Francisco Bay mercury TMDL WLA for the Delta of 330 kg/yr. The estimated changes in  
15 mercury and methylmercury loads would be within the overall uncertainty associated with the  
16 estimates of long-term average net Delta outflow and the long-term average mercury and  
17 methylmercury concentrations in Delta source waters. The estimated changes in mercury load  
18 under the alternative would also be substantially less than the considerable differences among  
19 estimates in the current mercury load to San Francisco Bay (SFBRWQCB 2006; David et al. 2009).  
20 Similar uncertainty is expected in the existing methylmercury load in net Delta exports, for which  
21 the best available current load estimate is based on approximately one year of monitoring data (Foe  
22 et al. 2008).

23 Given that the estimated incremental decreases/increases of mercury and methylmercury loading to  
24 San Francisco Bay would fall within the uncertainty of current mercury and methylmercury load  
25 estimates, the estimated changes in mercury and methylmercury loads in Delta exports to San  
26 Francisco Bay due to Alternative 2A are not expected to result in adverse effects to beneficial uses or  
27 substantially degrade the water quality with regard to mercury, or make the existing CWA Section  
28 303(d) impairment measurably worse.

### 29 Selenium

30 Changes in source water fraction and net Delta outflow under Alternative 2A, relative to Existing  
31 Conditions, are projected to cause the total selenium load to the North Bay to increase by 8%,  
32 relative to Existing Conditions, and 5%, relative to the No Action Alternative (Appendix 80, Table O-  
33 3). Changes in long-term average selenium concentrations of the North Bay are assumed to be  
34 proportional to changes in North Bay selenium loads. Under Alternative 2A, the long-term average  
35 total selenium concentration of the North Bay is estimated to be 0.14 µg/L and the dissolved  
36 selenium concentration is estimated to be 0.12 µg/L, which would be a 0.01 µg/L increase relative to  
37 Existing Conditions and the No Action Alternative (Appendix 80, Table O-3). The dissolved selenium  
38 concentration would be below the target of 0.202 µg/L developed by Presser or Luoma (2013) to  
39 coincide with a white sturgeon whole-body fish tissue selenium concentration not greater than 8  
40 mg/kg in the North Bay. The incremental increase in dissolved selenium concentrations in the  
41 North Bay, relative to Existing Conditions, would be negligible (0.01 µg/L) under this alternative.  
42 Thus, the estimated changes in selenium loads in Delta exports to San Francisco Bay due to  
43 Alternative 2A are not expected to result in adverse effects to beneficial uses or substantially

1 degrade the water quality with regard to selenium, or make the existing CWA Section 303(d)  
2 impairment measurably worse.

3 **NEPA Effects:** Based on the discussion above, Alternative 2A, relative to the No Action Alternative,  
4 would not cause further degradation to water quality with respect to boron, bromide, chloride,  
5 dissolved oxygen, DOC, EC, mercury, pathogens, pesticides, selenium, nutrients (ammonia, nitrate,  
6 phosphorus), trace metals, or turbidity and TSS in the San Francisco Bay. Further, changes in these  
7 constituent concentrations in Delta outflow would not be expected to cause changes in Bay  
8 concentrations of frequency, magnitude, and geographic extent that would adversely affect any  
9 beneficial uses. In summary, based on the discussion above, effects on the San Francisco Bay from  
10 implementation of CM1–CM21 are considered to be not adverse.

11 **CEQA Conclusion:** Based on the above, Alternative 2A would not be expected to cause long-term  
12 degradation of water quality in San Francisco Bay resulting in sufficient use of available assimilative  
13 capacity such that occasionally exceeding water quality objectives/criteria would be likely and  
14 would result in substantially increased risk for adverse effects to one or more beneficial uses.  
15 Further, based on the above, this alternative would not be expected to cause additional exceedance  
16 of applicable water quality objectives/criteria in the San Francisco Bay by frequency, magnitude,  
17 and geographic extent that would cause significant impacts on any beneficial uses of waters in the  
18 affected environment. Any changes in boron, bromide, chloride, and DOC in the San Francisco Bay  
19 would not adversely affect beneficial uses, because the uses most affected by changes in these  
20 parameters, MUN and AGR, are not beneficial uses of the Bay. Further, no substantial changes in  
21 dissolved oxygen, pathogens, pesticides, trace metals or turbidity or TSS are anticipated in the Delta,  
22 relative to Existing Conditions, therefore, no substantial changes these constituents levels in the Bay  
23 are anticipated. Changes in Delta salinity would not contribute to measurable changes in Bay  
24 salinity, as the change in Delta outflow would two to three orders of magnitude lower than (and thus  
25 minimal compared to) the Bay's tidal flow. Adverse changes in Microcystis levels that could occur in  
26 the Delta would not cause adverse Microcystis blooms in the Bay, because Microcystis are intolerant  
27 of the Bay's high salinity and, thus not have not been detected downstream of Suisun Bay. The 26%  
28 decrease in total nitrogen load and 1% increase in phosphorus load, relative to Existing Conditions,  
29 are expected to have minimal effect on water quality degradation, primary productivity, or  
30 phytoplankton community composition. The estimated no change in mercury load (0 kg/yr; 0%)  
31 and increase in methylmercury load (0.07 kg/yr; 2%), relative to Existing Conditions, is within the  
32 level of uncertainty in the mass load estimate and not expected to contribute to water quality  
33 degradation, make the CWA section 303(d) mercury impairment measurably worse or cause  
34 mercury/methylmercury to bioaccumulate to greater levels in aquatic organisms that would, in  
35 turn, pose substantial health risks to fish, wildlife, or humans. The estimated increase in selenium  
36 load would be 8%, but estimated total and dissolved selenium concentrations under this alternative  
37 would be nearly the same as Existing Conditions, and less than the target associated with white  
38 sturgeon whole-body fish tissue levels for the North Bay. Thus, the small increase in selenium load is  
39 not expected to contribute to water quality degradation, or make the CWA section 303(d) selenium  
40 impairment measurably worse or cause selenium to bioaccumulate to greater levels in aquatic  
41 organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact  
42 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 ~~CM2-22CM2 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 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-

1 term average bromide concentrations would be less than 29% at the remaining assessment  
2 locations. Due to the relatively small differences between modeled Existing Conditions and No  
3 Action baselines, changes in the frequency with which concentration thresholds of 50 µg/L and 100  
4 µg/L are exceeded are of similar magnitude to the previously described existing condition  
5 comparison. Unlike the comparison to Existing Conditions, this comparison to the No Action  
6 Alternative reflects changes in bromide due only to Alternative 3 operations.

7 At Barker Slough, modeled long-term average bromide concentrations for the two baseline  
8 conditions are very similar (Appendix 8E, *Bromide*, Table 8). Such similarity demonstrates that the  
9 modeled Alternative 3 change in bromide is almost entirely due to Alternative 3 operations, and not  
10 climate change/sea level rise. Therefore, operations are the primary driver of effects on bromide at  
11 Barker Slough, regardless whether Alternative 3 is compared to Existing Conditions, or compared to  
12 the No Action Alternative.

13 Results of the modeling approach which used relationships between EC and chloride and between  
14 chloride and bromide (see Section 8.3.1.3) differed somewhat from what is presented above for the  
15 mass-balance approach (see Appendix 8E, Table 9). For most locations, the frequency of exceedance  
16 of the 50 µg/L and 100 µg/L were similar. The greatest difference between the methods was  
17 predicted for Barker Slough. The increases in frequency of exceedance of the 100 µg/L threshold,  
18 relative to Existing Conditions and the No Action Alternative, were not as great using this alternative  
19 EC to chloride and chloride to bromide relationship modeling approach as compared to that  
20 presented above from the mass-balance modeling approach. However, there were still substantial  
21 increases, resulting in 9% exceedance over the modeled period under Alternative 3, as compared to  
22 1% under Existing Conditions and 2% under the No Action Alternative. For the drought period,  
23 exceedance frequency increased from 0% under Existing Conditions and the No Action Alternative,  
24 to 18% under Alternative 3. Because the mass-balance approach predicts a greater level of impact at  
25 Barker Slough, determination of impacts was based on the mass-balance results.

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

41 The seasonal intakes at Mallard Slough and City of Antioch are infrequently used due to water  
42 quality constraints related to sea water intrusion. On a long-term average basis, bromide at these  
43 locations is in excess of 3,000 µg/L, but during seasonal periods of high Delta outflow can be <300  
44 µg/L. Based on modeling using the mass-balance approach, use of the seasonal intakes at Mallard  
45 Slough and City of Antioch under Alternative 3 would experience a period average increase in

1 bromide during the months when these intakes would most likely be utilized. For those wet and  
 2 above normal water year types where mass balance modeling would predict water quality typically  
 3 suitable for diversion, predicted long-term average bromide would increase from 103 µg/L to 149  
 4 µg/L (45% increase) at City of Antioch and would increase from 150 µg/L to 201 µg/L (34%  
 5 increase) at Mallard Slough relative to Existing Conditions (Appendix 8E, *Bromide*, Table 23).  
 6 Increases would be similar for the No Action Alternative comparison. Modeling results using the EC  
 7 to chloride and chloride to bromide relationships show increases during these months, but the  
 8 relative magnitude of the increases is much lower (Appendix 8E, *Bromide*, Table 24). Regardless of  
 9 the differences in the data between the two modeling approaches, the decisions surrounding the use  
 10 of these seasonal intakes is largely driven by acceptable water quality, and thus have historically  
 11 been opportunistic. Opportunity to use these intakes would remain, and the predicted increases in  
 12 bromide concentrations at the City of Antioch and Mallard Slough intake would not be expected to  
 13 adversely affect MUN beneficial uses, or any other beneficial use, at these locations.

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

## 26 **Impact WQ-7: Effects on Chloride Concentrations Resulting from Facilities Operations and** 27 **Maintenance (CM1)**

### 28 ***Delta***

#### 29 *303(d) Listed Water Bodies—Relative to Existing Conditions*

30 With respect to the 303(d) listing for chloride in Tom Paine Slough, the monthly average chloride  
 31 concentrations for the 16-year period modeled at Old River at Tracy Road would generally be  
 32 similar compared to Existing Conditions, and thus, would not be further degraded on a long-term  
 33 basis (Appendix 8G, Figure Cl-2). With respect to Suisun Marsh, the monthly average chloride  
 34 concentrations for the 16-year period modeled would increase compared to Existing Conditions in  
 35 some months during October through May at the Sacramento River at Collinsville (Appendix 8G,  
 36 Figure Cl-3), Mallard Island (Appendix 8G, Figure Cl-1), and increase substantially at Montezuma  
 37 Slough at Beldon's Landing (i.e., up to a tripling of concentration in December through February)  
 38 (Appendix 8G, Figure Cl-4). However, modeling of Alternative 3 assumed no operation of the  
 39 Montezuma Slough Salinity Control Gates, but the project description assumes continued operation  
 40 of the Salinity Control Gates, consistent with assumptions included in the No Action Alternative. A  
 41 sensitivity analysis modeling run conducted for Alternative 4 with the gates operational consistent  
 42 with the No Action Alternative resulted in substantially lower EC levels than indicated in the original  
 43 Alternative 4 modeling results for Suisun Marsh, but EC levels were still somewhat higher than EC  
 44 levels under Existing Conditions for several locations and months. Although chloride was not

1 specifically modeled in these sensitivity analyses, it is expected that chloride concentrations would  
 2 be nearly proportional to EC levels in Suisun Marsh. Another modeling run with the gates  
 3 operational and restoration areas removed resulted in EC levels nearly equivalent to Existing  
 4 Conditions, indicating that design and siting of restoration areas has notable bearing on EC levels at  
 5 different locations within Suisun Marsh (see Appendix 8H Attachment 1 for more information on  
 6 these sensitivity analyses). These analyses also indicate that increases in salinity are related  
 7 primarily to the hydrodynamic effects of CM4, not operational components of CM1. Based on the  
 8 sensitivity analyses, optimizing the design and siting of restoration areas may limit the magnitude of  
 9 long-term chloride increases in the Marsh. However, the chloride concentration increases at certain  
 10 locations could be substantial, depending on siting and design of restoration areas. Thus, these  
 11 increased chloride levels in Suisun Marsh are considered to contribute to additional, measureable  
 12 long-term degradation that potentially would adversely affect the necessary actions to reduce  
 13 chloride loading for any TMDL that is developed.

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

#### 16 *Municipal Beneficial Uses—Relative to No Action Alternative*

#### 17 *303(d) Listed Water Bodies—Relative to No Action Alternative*

18 With respect to the 303(d) listing for chloride, Alternative 3 would generally result in similar  
 19 changes to those discussed for the comparison to Existing Conditions. Monthly average chloride  
 20 concentrations at Tom Paine Slough would not be further degraded on a long-term basis (Appendix  
 21 8G, Figure Cl-2). Monthly average chloride concentrations at source water channel locations for the  
 22 Suisun Marsh (Appendix 8G, Figures Cl-1, Cl-3 and Cl-4) would increase substantially in some  
 23 months during October through May compared to the No Action Alternative conditions but  
 24 sensitivity analyses suggest that operation of the Salinity Control Gates and restoration area siting  
 25 and design considerations could reduce these increases. However, the chloride concentration  
 26 increases at certain locations could be substantial, depending on siting and design of restoration  
 27 areas. Thus, these increased chloride levels in Suisun Marsh are considered to contribute to-  
 28 ~~Therefore~~, additional, measureable long-term degradation would occur in Suisun Marsh that  
 29 potentially would adversely affect the necessary actions to reduce chloride loading for any TMDL  
 30 that is developed.

#### 31 **Impact WQ-9: Effects on Dissolved Oxygen Resulting from Facilities Operations and** 32 **Maintenance (CM1)**

33 **NEPA Effects:** Effects of CM1 on DO under Alternative 3 are the same as those discussed for  
 34 Alternative 1A and are considered to not be adverse.

35 **CEQA Conclusion:** Effects of CM1 on DO under Alternative 3 would be similar to those discussed for  
 36 Alternative 1A, and are summarized here, then compared to the CEQA thresholds of significance  
 37 (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this  
 38 constituent. For additional details on the effects assessment findings that support this CEQA impact  
 39 determination, see the effects assessment discussion under Alternative 1A.

40 ~~River flow rate and r~~Reservoir storage reductions that would occur under Alternative 3, relative to  
 41 Existing Conditions, would not be expected to result in a substantial adverse change in DO levels in  
 42 the reservoirs, because oxygen sources (surface water aeration, aerated inflows, vertical mixing)

1 ~~would remain. Similarly, river flow rate reductions that would occur would not be expected to~~  
 2 ~~result in a substantial adverse change in DO levels in the~~ ~~and~~ rivers upstream of the Delta, given that  
 3 mean monthly flows would remain within the ranges historically seen under Existing Conditions  
 4 and the affected river are large and turbulent. Any reduced DO saturation level that may be caused  
 5 by increased water temperature would not be expected to cause DO levels to be outside of the range  
 6 seen historically. Finally, amounts of oxygen demanding substances and salinity would not be  
 7 expected to change sufficiently to affect DO levels.

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

15 There is not expected to be substantial, if even measurable, changes in DO levels in the SWP/CVP  
 16 Export Service Areas waters under Alternative 3, relative to Existing Conditions, because the  
 17 biochemical oxygen demand of the exported water would not be expected to substantially differ  
 18 from that under Existing Conditions (due to ever increasing water quality regulations), canal  
 19 turbulence and exposure of the water to the atmosphere and the algal communities that exist within  
 20 the canals would establish an equilibrium for DO levels within the canals. The same would occur in  
 21 downstream reservoirs.

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

### 30 **Impact WQ-11: Effects on Electrical Conductivity Concentrations Resulting from Facilities** 31 **Operations and Maintenance (CM1)**

#### 32 ***Delta***

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

40 Relative to Existing Conditions, ~~modeling indicates that~~ Alternative 3 would result in ~~an increase in~~  
 41 ~~the fewer~~ number of days when Bay-Delta WQCP compliance locations ~~in the western, interior, and~~  
 42 ~~southern Delta~~ would exceed EC objectives or be out of compliance with the EC objectives ~~at, with~~  
 43 ~~the exception of~~ the Sacramento River at Emmaton ~~and San Joaquin River at Jersey Point (fish and~~

1 wildlife objective) in the western Delta and San Joaquin River at San Andreas Landing in the interior  
2 Delta (Appendix 8H, Table EC-3).

3 The percent of days the Emmaton EC objective would be exceeded for the entire period modeled  
4 (1976–1991) would increase from 6% under Existing Conditions to 2730% under Alternative 3, and  
5 the days out of compliance with the EC objective would increase from 11% under Existing  
6 Conditions to 3944% under Alternative 3.

7 The percent of days the San Andreas Landing EC objective would be exceeded would increase from  
8 1% under Existing Conditions to 24% under Alternative 3. Further, the percent of days out of  
9 compliance with the EC objective would increase from 1% under Existing Conditions to 46% under  
10 Alternative 3. Sensitivity analyses were performed for Alternative 4 scenario H3, and indicated that  
11 many similar exceedances were modeling artifacts, and the small number of remaining exceedances  
12 were small in magnitude, lasted only a few days, and could be addressed with real time operations  
13 of the SWP and CVP (see Section 8.3.1.1 for a description of real time operations of the SWP and  
14 CVP). Due to similarities in the nature of the exceedances between alternatives, the findings from  
15 these analyses can be extended to this alternative as well.

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

20 Average EC levels at the western and southern Delta compliance locations, except at Emmaton in the  
21 western Delta, would decrease from 1–28% for the entire period modeled and 2–30% during the  
22 drought period modeled (1987–1991) (Appendix 8H, Table EC-14). At Emmaton, average EC would  
23 increase by 14% for the entire period modeled and 12% for the drought period modeled. At the two  
24 interior Delta locations, there would be increases in average EC: the S. Fork Mokelumne River at  
25 Terminous average EC would increase 4% for the entire period modeled and 3% during the drought  
26 period modeled; and San Joaquin River at San Andreas Landing average EC would increase 12% for  
27 the entire period modeled and 13% during the drought period modeled. On average, EC would  
28 increase at Emmaton during December and March through September. Average EC would increase  
29 at San Andreas Landing during all months except November. Average EC in the S. Fork Mokelumne  
30 River at Terminous would increase during all months. Average EC at Jersey Point during the months  
31 of April–May, when the fish and wildlife objective applies in all but critical water year types, would  
32 increase from 14–17% for the entire period modeled (Appendix 8H, Table EC-14; further discussion  
33 of EC increases relative to this objective can be found in Appendix 8H Attachment 2). Of the Clean  
34 Water Act section 303(d) listed sections of the Delta–western, northwestern, and southern–the  
35 western portion of the Delta at Emmaton would have an increased frequency of exceedance of EC  
36 objectives (Appendix 8H, Table EC-13) and increased average EC. Thus, Alternative 3 could  
37 contribute to additional impairment and adversely affect beneficial uses for section 303(d) listed  
38 Delta waterways, relative to Existing Conditions. These EC changes are similar to that described for  
39 Alternative 1A. The comparison to Existing Conditions reflects changes in EC due to both Alternative  
40 3 operations (including north Delta intake capacity of 6,000 cfs and numerous other operational  
41 components of Scenario A) and climate change/sea level rise.

42 Relative to the No Action Alternative, the percent of days exceeding EC objectives and percent of  
43 days out of compliance would increase at: Sacramento River at Emmaton, San Joaquin River at  
44 Jersey Point, San Andreas Landing, and Prisoners Point; and Old River near Middle River; and Old



1 River at Tracy Bridge (Appendix 8H, Table EC-3). The increase in percent of days exceeding the EC  
 2 objective would be ~~43~~3% or less and the increase in percent of days out of compliance would be ~~35~~5%  
 3 or less, with the exception of Emmaton, which would have a ~~156~~56% increase in days exceeding the EC  
 4 objective and a ~~179~~79% increase in days out of compliance. Regarding exceedances at Old River at  
 5 Middle River and at Tracy Bridge, as noted in Section 8.1.3.7, SWP and CVP operations have  
 6 relatively little influence on salinity levels at these locations, and the elevated salinity in south Delta  
 7 channels is affected substantially by local salt contributions discharged into the San Joaquin River  
 8 downstream of Vernalis. Thus, the modeling has limited ability to estimate salinity accurately in this  
 9 region. Average EC would increase at some compliance locations for the entire period modeled:  
 10 Sacramento River at Emmaton (13%), San Joaquin River at Jersey Point (2%), S. Fork Mokelumne  
 11 River at Terminous (4%), San Joaquin River at San Andreas Landing (18%), and San Joaquin River at  
 12 Prisoners Point (9%) (Appendix 8H, Table EC-14). For the drought period modeled, the locations  
 13 with an average EC increase, relative to the No Action Alternative, would be: Sacramento River at  
 14 Emmaton (1%), S. Fork Mokelumne River at Terminous (4%), San Joaquin River at San Andreas  
 15 Landing (13%), San Joaquin River at Brandt Bridge (1%), Old River at Tracy Bridge (1%), and San  
 16 Joaquin River at Prisoners Point (5%) (Appendix 8H, Table EC-14). The western and southern Delta  
 17 are CWA section 303(d) listed for elevated EC and the increased incidence of exceedance of EC  
 18 objectives and EC degradation that could occur in the western Delta could make beneficial use  
 19 impairment measurably worse. Since there would be very little change in EC levels in the southern  
 20 Delta and there is not expected to be an increase in frequency of exceedances of objectives, this  
 21 alternative is not expected to make beneficial use impairment measurably worse in the southern  
 22 Delta. Given that the western and southern Delta are Clean Water Act section 303(d) listed as  
 23 impaired due to elevated EC, the increase in the incidence of exceedance of EC objectives and  
 24 increases in long-term and drought period average EC at the western and southern Delta locations  
 25 under Alternative 3, relative to the No Action Alternative, has the potential to contribute to  
 26 additional impairment and potentially adversely affect beneficial uses. These EC changes are similar  
 27 to that described for Alternative 1A. The comparison to the No Action Alternative reflects changes in  
 28 EC due only to Alternative 3 operations (including north Delta intake capacity of 6,000 cfs and  
 29 numerous other operational components of Scenario A).

30 For Suisun Marsh, October–May is the period when Bay-Delta WQCP EC objectives for protection of  
 31 fish and wildlife apply. Long-term average EC would increase under Alternative 3, relative to  
 32 Existing Conditions, during the months of March through May by 0.3–0.9 mS/cm in the Sacramento  
 33 River at Collinsville (Appendix 8H, Table EC-21). Long-term average EC would decrease relative to  
 34 Existing Conditions in Montezuma Slough at National Steel during October–May (Appendix 8H,  
 35 Table EC-22). The most substantial increase would occur near Beldon Landing, with long-term  
 36 average EC levels increasing by 1.8–6.1 mS/cm, depending on the month, which would be a doubling  
 37 or tripling of long-term average EC relative to Existing Conditions (Appendix 8H, Table EC-23).  
 38 Sunrise Duck Club and Volanti Slough also would have long-term average EC increases during all  
 39 months of 1.7–4.0 mS/cm (Appendix 8H, Tables EC-24 and EC-25). Modeling of this alternative  
 40 assumed no operation of the Montezuma Slough Salinity Control Gates, but the project description  
 41 assumes continued operation of the Salinity Control Gates, consistent with assumptions included in  
 42 the No Action Alternative. A sensitivity analysis modeling run conducted for Alternative 4 scenario  
 43 H3 with the gates operational consistent with the No Action Alternative resulted in substantially  
 44 lower EC levels than indicated in the original Alternative 4 modeling results, but EC levels were still  
 45 somewhat higher than EC levels under Existing Conditions and the No Action Alternative for several  
 46 locations and months. Another modeling run with the gates operational and restoration areas  
 47 removed resulted in EC levels nearly equivalent to Existing Conditions and the No Action

1 Alternative, indicating that design and siting of restoration areas has notable bearing on EC levels at  
 2 different locations within Suisun Marsh (see Appendix 8H Attachment 1 for more information on  
 3 these sensitivity analyses). These analyses also indicate that increases are related primarily to the  
 4 hydrodynamic effects of CM4, not operational components of CM1. Based on the sensitivity analyses,  
 5 optimizing the design and siting of restoration areas may limit the magnitude of long-term EC  
 6 increases to be on the order of 1 mS/cm or less. Due to similarities in the nature of the EC increases  
 7 between alternatives, the findings from these analyses can be extended to this alternative as well.

8 The degree to which the long-term average EC increases in Suisun Marsh would cause exceedance of  
 9 Bay-Delta WQCP objectives is unknown, because these objectives are expressed as a monthly  
 10 average of daily high tide EC, which does not have to be met if it can be demonstrated “equivalent or  
 11 better protection will be provided at the location” (State Water Resources Control Board 2006:14).  
 12 The ~~described~~ long-term average EC increase may, or may not, contribute to adverse effects on  
 13 beneficial uses, depending on how and when wetlands are flooded, soil leaching cycles, and how  
 14 agricultural use of water is managed, and future actions taken with respect to the marsh. However,  
 15 the EC increases at certain locations ~~would could~~ be substantial, depending on siting and design of  
 16 restoration areas, and it is uncertain the degree to which current management plans for the Suisun  
 17 Marsh would be able to address these substantially higher EC levels and protect beneficial uses.  
 18 Thus, these increased EC levels in Suisun Marsh are considered to have a potentially adverse effect  
 19 on marsh beneficial uses. Long-term average EC increases in Suisun Marsh under Alternative 3  
 20 relative to the No Action Alternative would be similar to the increases relative to Existing  
 21 Conditions. Suisun Marsh is section 303(d) listed as impaired due to elevated EC, and the potential  
 22 increases in long-term average EC concentrations could contribute to additional impairment,  
 23 ~~because the increases would be double or triple that relative to Existing Conditions and the No~~  
 24 ~~Action Alternative~~. These EC changes are similar to that described for Alternative 1A.

25 **NEPA Effects:** In summary, the increased frequency of exceedance of EC objectives and increased  
 26 long-term and drought period average EC levels that would occur at western ~~and southern~~ Delta  
 27 compliance locations under Alternative 3, relative to the No Action Alternative, would contribute to  
 28 adverse effects on the agricultural beneficial uses. The increased long-term period average EC levels  
 29 between Jersey Point and Prisoners Point could contribute to adverse effects on fish and wildlife  
 30 beneficial uses (specifically, indirect adverse effects on striped bass spawning), though there is a  
 31 high degree of uncertainty associated with this impact. The western and southern Delta are CWA  
 32 section 303(d) listed as impaired due to elevated EC, and the increase in incidence of exceedance of  
 33 EC objectives and increases in long-term average and drought period average EC in the western  
 34 portion of the Delta have the potential to contribute to additional beneficial use impairment. The  
 35 increased frequency of exceedance of the EC objective for the San Joaquin River at Prisoners Point,  
 36 and increased long-term period average EC levels that would occur in April–May at this location  
 37 under Alternative 3, relative to the No Action Alternative, could contribute to adverse effects on fish  
 38 and wildlife beneficial uses. Given that the western and southern Delta are Clean Water Act section  
 39 303(d) listed as impaired due to elevated EC, the increase in the incidence of exceedance of EC  
 40 objectives and increases in long-term and drought period average EC in the southern Delta under  
 41 Alternative 3 has the potential to contribute to additional beneficial use impairment. The increases  
 42 in long-term average EC levels that ~~would could~~ occur in Suisun Marsh would further degrade  
 43 existing EC levels and could contribute ~~additionally~~ to adverse effects on the fish and wildlife  
 44 beneficial uses. Suisun Marsh is section 303(d) listed as impaired due to elevated EC, and the  
 45 potential increases in long-term average EC levels could contribute to additional beneficial use  
 46 impairment. The effects on EC in the western Delta, San Joaquin River at Prisoners Point, and in

1 ~~Suisun Marsh~~ ~~These increases in EC~~ constitute an adverse effect on water quality. Mitigation  
 2 Measure WQ-11 would be available to reduce these effects (implementation of this measure along  
 3 with a separate, non-environmental commitment as set forth in EIR/EIS Appendix 3B,  
 4 *Environmental Commitments*, relating to the potential EC-related changes would reduce these  
 5 effects).

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

11 River flow rate and reservoir storage reductions that would occur under Alternative 3, relative to  
 12 Existing Conditions, would not be expected to result in a substantial adverse change in EC levels in  
 13 the reservoirs and rivers upstream of the Delta, given that: changes in the quality of watershed  
 14 runoff and reservoir inflows would not be expected to occur in the future; the state's aggressive  
 15 regulation of point-source discharge effects on Delta salinity-elevating parameters and the expected  
 16 further regulation as salt management plans are developed; the salt-related TMDLs adopted and  
 17 being developed for the San Joaquin River; and the expected improvement in lower San Joaquin  
 18 River average EC levels commensurate with the lower EC of the irrigation water deliveries from the  
 19 Delta.

20 Relative to Existing Conditions, Alternative 3 would not result in any substantial increases in long-  
 21 term average EC levels in the SWP/CVP Export Service Areas. There would be no exceedance of the  
 22 EC objective at the Jones and Banks pumping plants. Average EC levels for the entire period modeled  
 23 would decrease at both plants and, thus, this alternative would not contribute to additional  
 24 beneficial use impairment related to elevated EC in the SWP/CVP Export Service Areas waters.  
 25 Rather, this alternative would improve long-term EC levels in the SWP/CVP Export Service Areas,  
 26 relative to Existing Conditions.

27 In the Plan Area, Alternative 3 would result in an increase in the frequency with which Bay-Delta  
 28 WQCP EC objectives for agricultural beneficial use protection are exceeded in the Sacramento River  
 29 at Emmaton (214%; western Delta) ~~and San Joaquin River at San Andreas Landing (31%; interior~~  
 30 ~~Delta)~~ for the entire period modeled (1976–1991). Further, average EC levels at Emmaton would  
 31 increase by 14% for the entire period modeled and 12% during the drought period modeled.  
 32 Average EC levels at San Andreas Landing would increase by 12% for the entire period modeled and  
 33 13% during the drought period modeled. In addition, there would be an increase in the frequency  
 34 with which the EC objective for fish and wildlife beneficial uses protection is exceeded in the San  
 35 Joaquin River at Jersey Point (3%; western Delta), and an increase in the average EC of 14–17% at  
 36 Jersey Point (for the entire period modeled) during the months of April–May, when the fish and  
 37 wildlife objective applies. Because EC is not bioaccumulative, the increases in long-term average EC  
 38 levels would not directly cause bioaccumulative problems in aquatic life or humans. The interior  
 39 Delta is not Clean Water Act section 303(d) listed for elevated EC; however, the western Delta is. The  
 40 increases in long-term and drought period average EC levels and increased frequency of exceedance  
 41 of EC objectives that would occur in the Sacramento River at Emmaton ~~and San Joaquin River at San~~  
 42 ~~Andreas Landing~~ would potentially contribute to adverse effects on the agricultural beneficial uses  
 43 in the ~~interior-western~~ Delta. The increased long-term period average EC levels between Jersey  
 44 Point and Prisoners Point could contribute to adverse effects on fish and wildlife beneficial uses  
 45 (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.

1 The water quality impacts of waterborne concentrations of mercury and methylmercury and fish  
 2 tissue mercury concentrations were evaluated for 9 Delta locations. The analysis of percentage  
 3 change in assimilative capacity of waterborne total mercury of Alternative 3 relative to the 25 ng/L  
 4 ecological risk benchmark as compared to Existing Conditions showed the greatest decrease to be  
 5 0.7% for Franks Tract, Old River at Rock Slough, and Contra Costa Pumping Plant, and 0.8% for the  
 6 Mokelumne River (South Fork) at Staten Island and Franks Tract relative to the No Action  
 7 Alternative (Figures 8-53 and 8-54). These changes are not expected to result in adverse effects to  
 8 beneficial uses. Similarly, changes in methylmercury concentration are expected to be very small.  
 9 The greatest annual average methylmercury concentration for drought conditions was 0.167 ng/L  
 10 for the San Joaquin River at Buckley Cove which was slightly higher than Existing Conditions (0.161  
 11 ng/L), and the same as the No Action Alternative (Appendix 8I, Table I-6) (Appendix 8I, Figure I-  
 12 3). All modeled input concentrations exceeded the methylmercury TMDL guidance objective of 0.06  
 13 ng/L, therefore percentage change in assimilative capacity was not evaluated for methylmercury.

14 Fish tissue showed small increases in exceedance quotients based on long-term annual average  
 15 concentrations for mercury at the Delta locations. There was a 6% increase at the Mokelumne River  
 16 (South Fork) at Staten Island, the San Joaquin River at Buckley Cove, Franks Tract, and Old River at  
 17 Rock Slough relative to Existing Conditions, and a 8% increase at the Mokelumne River (South Fork)  
 18 at Staten Island relative to the No Action Alternative (Figure 8-55a,b, Appendix 8I, Table I-10b). All  
 19 water export locations except Contra Costa Pumping Plant #1 showed improved bass tissue mercury  
 20 estimates (Figure 8-55a,b, Appendix 8I, Table I-10a,b). Because these increases are relatively small,  
 21 and it is not evident that substantive increases are expected at numerous locations throughout the  
 22 Delta, these changes are expected to be within the uncertainty inherent in the modeling approach,  
 23 and would likely not be measurable in the environment. See Appendix 8I for a discussion of the  
 24 uncertainty associated with the fish tissue estimates.

## 25 **Impact WQ-25: Effects on Selenium Concentrations Resulting from Facilities Operations and** 26 **Maintenance (CM1)**

### 27 ***Delta***

28 Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2  
 29 and CM4) would affect Delta hydrodynamics. To the extent that restoration actions alter  
 30 hydrodynamics within the Delta region, which affects mixing of source waters, these effects are  
 31 included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of  
 32 ~~CM2-22CM2 through CM22CM2-CM21~~ not attributable to hydrodynamics, ~~for example, such as~~  
 33 ~~additional loading of a constituent to the Delta, are discussed within the impact header for~~ ~~CM2-~~  
 34 ~~22CM2 through CM22CM2-CM21~~. See ~~section~~ Section 8.3.1.3 for more information.

35 Selenium concentrations and threshold comparisons for each of the 11 modeled Delta assessment  
 36 locations under Alternative 3, relative to Existing Conditions and the No Action Alternative, are  
 37 presented in Appendix 8M, Selenium, Table M-9a for water, Tables M-13 and M-23 for most biota  
 38 (whole-body fish [excluding sturgeon], bird eggs [invertebrate diet], bird eggs [fish diet], and fish  
 39 fillets) throughout the Delta, and Tables M-30 through M-32 for sturgeon at the two western Delta  
 40 locations. Figures 8-59a and 8-60a present graphical distributions of predicted selenium  
 41 concentration changes (shown as changes in available assimilative capacity based on 1.3 µg/L) in  
 42 water at each modeled assessment location for all years. Appendix 8M, Figure M-21 provides more  
 43 detail in the form of monthly patterns of selenium concentrations in water during the modeling  
 44 period. Appendix 8M.

1 Alternative 3 would result in small changes in average selenium concentrations in water at all  
 2 modeled Delta assessment locations relative to Existing Conditions and the No Action Alternative  
 3 (Appendix 8M, Selenium, Table M-9a). Long-term average concentrations at some interior and  
 4 western Delta locations would increase by 0.01 µg/L for the entire period modeled (1976–1991).  
 5 These small increases in selenium concentrations in water would result in small reductions (1% or  
 6 less) in available assimilative capacity for selenium, relative to the 1.3 µg/L ecological risk  
 7 benchmark USEPA draft water quality criterion (Figures 8-59a and 8-60a). The long-term average  
 8 selenium concentrations in water (Appendix 8M, Table M-9a) for Alternative 3 (range 0.09–0.38  
 9 µg/L) would be similar to those for Existing Conditions (range 0.09–0.41 µg/L) and the No Action  
 10 Alternative (range 0.09–0.38 µg/L), and all would be below the ecological risk benchmark USEPA  
 11 draft water quality criterion (of 1.32 µg/L (Appendix 8M, Table M-9a)).

12 Relative to Existing Conditions and the No Action Alternative, Alternative 3 would result in minimal  
 13 very small changes (less than 1%) in estimated selenium concentrations in most biota (whole-body  
 14 fish, bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets) throughout the Delta, with  
 15 little difference among locations (Figures 8-61a through 8-64b; Appendix 8M, Selenium, Table M-14  
 16 23 and Table 8M-2 in the sturgeon addendum to Appendix 8M, Addendum M.A, Selenium in Sturgeon,  
 17 to Appendix 8M, Table M.A-2). Level of Concern Exceedance Quotients (i.e., modeled tissue divided  
 18 by Level of Concern benchmarks) for selenium concentrations in those biota for all years and for  
 19 drought years are less than 1.0 (indicating low probability of adverse effects). Similarly, Advisory  
 20 Tissue Level Exceedance Quotients for selenium concentrations in fish fillets for all years and  
 21 drought years also are less than 1.0. Estimated selenium concentrations in sturgeon for the San  
 22 Joaquin River at Antioch are predicted to increase by about 7 percent relative Relative to Existing  
 23 Conditions and to the No Action Alternative in all years (from about 4.7 to 5.0 mg/kg dry weight  
 24 [dw]), and those for sturgeon in the Sacramento River at Mallard Island are predicted to increase by  
 25 about 4 percent in all years (from about 4.4 to 4.6 mg/kg dw) (Figure 8-65; Appendix 8M, Tables M-  
 26 30 and M-31). Selenium concentrations in sturgeon during drought years are expected to increase  
 27 by only 2 or 3 percent at those locations (Appendix 8M, Tables M-30 and M-31). Detection of small  
 28 changes in whole-body sturgeon such as those estimated for the western Delta would require very  
 29 large sample sizes because of the inherent variability in fish tissue selenium concentrations. Low  
 30 Toxicity Threshold Exceedance Quotients for selenium concentrations in sturgeon in the western  
 31 Delta would exceed 1.0 (indicating a higher probability for adverse effects) for drought years at both  
 32 locations (as they do for Existing Conditions and the No Action Alternative; Figure 8-65); however,  
 33 for the entire period modeled, the quotient would not be exceeded at either location (Appendix 8M,  
 34 Table M-32).

35 The disparity between larger estimated changes for sturgeon and smaller changes for other biota  
 36 are is attributable largely to differences in modeling approaches, as described in Appendix 8M,  
 37 Selenium. The model for most biota was calibrated to encompass the varying concentration-  
 38 dependent uptake from waterborne selenium concentrations (expressed as the  $K_d$ , which is the ratio  
 39 of selenium concentrations in particulates [as the lowest level of the food chain] relative to the  
 40 waterborne concentration) that was exhibited in data for largemouth bass in 2000, 2005, and 2007  
 41 at various locations across the Delta. In contrast, the modeling for sturgeon could not be similarly  
 42 calibrated at the two western Delta locations and used literature-derived uptake factors and trophic  
 43 transfer factors for the estuary from Presser and Luoma (2013). As noted in the appendix, there was  
 44 a significant negative log-log relationship of  $K_d$  to waterborne selenium concentration that reflected  
 45 the greater bioaccumulation rates for bass at low waterborne selenium than at higher  
 46 concentrations. (There was no difference in bass selenium concentrations in the Sacramento River

1 at Rio Vista in comparison to the San Joaquin River at Vernalis in 2000, 2005, and 2007 [Foe 2010],  
2 despite a nearly 10-fold difference in waterborne selenium.) Thus, there is more confidence in the  
3 site-specific modeling based on the Delta-wide model that was calibrated for bass data than in the  
4 estimates for sturgeon based on “fixed”  $K_d$ s for all years and for drought years without regard to  
5 waterborne selenium concentration at the two locations in different time periods.

6 Increased water residence times could increase the bioaccumulation of selenium in biota, thereby  
7 potentially increasing fish tissue and bird egg concentrations of selenium (see residence time  
8 discussion in Appendix 8M, *Selenium*, and Presser and Luoma [2010b]). Thus, residence time was  
9 assessed for its relevance to selenium bioaccumulation. Table 60a (presented originally in Section  
10 8.3.1.7 in the *Microcystis* subsection) shows the time for neutrally buoyant particles to move through  
11 the Delta (surrogate for flow and residence time). Although an increase in residence time  
12 throughout the Delta is expected under the No Action Alternative, relative to Existing Conditions  
13 (because of climate change and sea level rise), the change is fairly small in most areas of the Delta.  
14 Thus, the changes in residence times between Alternative 3 and the No Action Alternative are very  
15 similar to the changes in residence times between Alternative 3 and the Existing Conditions.

16 Relative to Existing Conditions and the No Action Alternative, increases in residence times for  
17 Alternative 3 would be greater in the East Delta than in other sub-regions. Relative to Existing  
18 Conditions, annual average residence times for Alternative 3 in the East Delta are expected to  
19 increase by more than 15 days (Table 60a). Relative to the No Action Alternative, annual average  
20 residence times for Alternative 3 in the East Delta are expected to increase by less than 9 days.  
21 Increases in residence times for other sub-regions would be smaller, especially as compared to  
22 Existing Conditions and the No Action Alternative (which are longer than those modeled for the  
23 South Delta). As mentioned above, these results incorporate hydrodynamic effects of both CM1 and  
24 CM2 and CM4, and the effects of CM1 cannot be distinguished from the effects of CM2 and CM4.  
25 However, it is expected that CM2 and CM4 are substantial drivers of the increased residence time.

26 Presser and Luoma (2010b) summarized and discussed selenium uptake in the Bay-Delta (including  
27 hydrologic conditions [e.g., Delta outflow and residence time for water],  $K_d$ s [the ratio of selenium  
28 concentrations in particulates, as the lowest level of the food chain, relative to the water-borne  
29 concentration], and associated tissue concentrations [especially in clams and their consumers, such  
30 as sturgeon]). When the Delta Outflow Index (daily average flow per month) decreased by five-fold  
31 (73,732 cubic feet per second [cfs] in June 1998 to 12, 251 cfs in October 1998), residence time  
32 doubled (from 11 to 22 days) and the calculated mean  $K_d$  also doubled (from 3,198 to 6,501).  
33 However, when daily average Delta outflow in November 1999 was only 6,951 cfs (i.e., about one-  
34 half that in October 1998) and residence time was 70 days, the calculated mean  $K_d$  (7,614) did not  
35 increase proportionally.

36 Models are not available to quantitatively estimate the level of changes in selenium bioaccumulation  
37 as related to residence time, but the effects of residence time are incorporated in the  
38 bioaccumulation modeling for selenium that was based on higher  $K_d$  values for drought years in  
39 comparison to wet, normal, or all years; see Appendix 8M, *Selenium*. If increases in fish tissue or bird  
40 egg selenium were to occur, the increases would likely be of concern only where fish tissues or bird  
41 eggs are already elevated in selenium to near or above thresholds of concern. That is, where biota  
42 concentrations are currently low and not approaching thresholds of concern (which, as discussed  
43 above, is the case throughout the Delta, except for sturgeon in the western Delta), changes in  
44 residence time alone would not be expected to cause them to then approach or exceed thresholds of  
45 concern. In consideration of this factor, although the Delta as a whole is a CWA Section 303(d)-listed

1 water body for selenium, and although monitoring data of fish tissue or bird eggs in the Delta are  
 2 sparse, the most likely area in which biota tissues would be at levels high enough that additional  
 3 bioaccumulation due to increased residence time from restoration areas would be a concern is the  
 4 western Delta and Suisun Bay for sturgeon, as discussed above. As shown in Table 60a, the overall  
 5 increase in residence time estimated in the western Delta is 6 days relative to Existing Conditions,  
 6 and 4 days relative to the No Action Alternative. Given the available information, these increases are  
 7 small enough that they are not expected to substantially affect selenium bioaccumulation in the  
 8 western Delta. Because CM2 and CM4 are expected to be substantial drivers of the increased  
 9 residence times, further discussion is included in Impact WQ-26 below,

10 ,the largest increase of selenium concentrations in biota would be at Barker Slough PP for drought  
 11 years (except for bird eggs [assuming a fish diet] at Barker Slough for all years) and for sturgeon at  
 12 the San Joaquin River at Antioch in all years, and the largest decrease would be at Buckley Cove for  
 13 drought years. Relative to the No Action Alternative, the largest increase also would be at Barker  
 14 Slough PP for drought years (except for bird eggs [assuming a fish diet] at Barker Slough for all  
 15 years) and the largest decrease would be at Staten Island for drought years (except for bird eggs  
 16 [assuming a fish diet] at Buckley Cove for drought years). Except for sturgeon in the western Delta,  
 17 concentrations of selenium in whole-body fish and bird eggs (invertebrate and fish diets) would  
 18 exceed only the lower benchmarks (4 and 6 mg/kg dry weight, respectively, indicating a low  
 19 potential for effects), under drought conditions, at Buckley Cove for Alternative 3 (as it would for  
 20 Existing Conditions and the No Action Alternative) (Figures 8-61 through 8-63). Exceedance  
 21 QuotientsExceedance quotients for all these exceedances of the lower benchmarks are between 1.0  
 22 and 1.5, indicating a low risk to biota in the Delta and no substantial difference from Existing  
 23 Conditions and the No Action Alternative. Selenium concentrations in fish fillets would not exceed  
 24 the screening value for protection of human health (Figure 8-64). For sturgeon in the western Delta,  
 25 whole-body selenium concentrations would increase from 12.3 mg/kg under Existing Conditions  
 26 and the No Action Alternative to 12.7 mg/kg under Alternative 3, a 3% increase (Table 8M-2 in the  
 27 sturgeon addendum to Appendix 8M, Table M.A-2). Although all of these values exceed both the low  
 28 and high toxicity benchmarks, it is unlikely that the modeled increases in whole-body selenium for  
 29 sturgeon would be measurable in the environment (see also the discussion of results provided in the  
 30 sturgeon addendum M.A, Selenium in Sturgeon, to Appendix 8M).

31 In summary, relative to Existing Conditions and the No Action Alternative, Alternative 3 would  
 32 result in essentially no change in selenium concentrations throughout the Delta for most biota (less  
 33 than 1%), although increases in selenium concentrations are predicted for sturgeon in the western  
 34 Delta. Concentrations of selenium in sturgeon would exceed only the lower benchmark, indicating a  
 35 low potential for effects. The modeling of bioaccumulation for sturgeon is less calibrated to site-  
 36 specific conditions than that for other biota, which was calibrated on a robust dataset for modeling  
 37 of bioaccumulation in largemouth bass as a representative species for the Delta. Overall, Alternative  
 38 3 would not be expected to substantially increase the frequency with which applicable benchmarks  
 39 would be exceeded in the Delta (there being only a small increase for sturgeon relative to the low  
 40 benchmark and no exceedance of the high benchmark) or substantially degrade the quality of water  
 41 in the Delta, with regard to selenium.

#### 42 **SWP/CVP Export Service Areas**

43 Alternative 3 would result in small (0.04 µg/L) decreases in long-term average selenium  
 44 concentrations in water at the Banks and Jones pumping plants, relative to Existing Conditions and  
 45 the No Action Alternative, for the entire period modeled (Appendix 8M, Selenium, Table M-9a). These



1 decreases in long-term average selenium concentrations in water would result in increases in  
 2 available assimilative capacity for selenium at these pumping plants of 4%, relative to the 1.3 µg/L  
 3 ~~ecological risk benchmark~~ USEPA draft water quality criterion (Figures 8-59a and 8-60a).  
 4 Furthermore, the modeled selenium concentrations in water for Alternative 3 (range 0.17–0.24  
 5 µg/L) would be below the ~~ecological risk benchmark~~ USEPA draft water quality criterion of 1.3 µg/L  
 6 (Appendix 8M, Table M-9a).

7 Relative to Existing Conditions and the No Action Alternative, Alternative 3 would result in very  
 8 small changes (less than 1%) in estimated selenium concentrations in biota (whole-body fish, bird  
 9 eggs [invertebrate diet], and fish fillets) (Figures 8-61a through 8-64b; Appendix 8M, Selenium,  
 10 Table M-1423) at Banks and Jones pumping plants. ~~Relative to Existing Conditions the largest~~  
 11 ~~increase of selenium concentrations in biota would be at Banks PP for drought years (except for bird~~  
 12 ~~eggs (assuming a fish diet) at Banks PP for all years), and the largest decrease would be at Jones PP~~  
 13 ~~for all years (except for bird eggs [assuming a fish diet] at Jones PP for drought years). Relative to~~  
 14 ~~the No Action Alternative, the largest increase of selenium in biota would be at Banks PP for drought~~  
 15 ~~years (except for bird eggs (assuming a fish diet) at Banks PP for all years), and the largest decrease~~  
 16 ~~would be at Jones PP for drought years. Furthermore, c~~Concentrations in biota would not exceed any  
 17 selenium benchmarks for Alternative 3 (Figures 8-61a through 8-64b).

18 ~~Thus, relative to Existing Conditions and the No Action Alternative, Alternative 3 would result in~~  
 19 ~~minimal changes in selenium concentrations throughout at Export Service Area locations. Selenium~~  
 20 ~~concentrations in water and biota generally would decrease for Alternative 3 and would not exceed~~  
 21 ~~ecological benchmarks at any location, whereas the lower benchmark for bird eggs (fish diet) would~~  
 22 ~~be exceeded under Existing Conditions and the No Action Alternative at Jones PP under drought~~  
 23 ~~conditions. This small positive change in selenium concentrations under Alternative 3 would be~~  
 24 ~~expected to slightly decrease the frequency with which applicable benchmarks would be exceeded~~  
 25 ~~or slightly improve the quality of water in at Export Service Area locations, with regard to selenium.~~

26 **NEPA Effects:** Based on the discussion above, the effects on selenium (both as waterborne and as  
 27 bioaccumulated in biota) from Alternative 3 are not considered to be adverse.

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

33 There are no substantial point sources of selenium in watersheds upstream of the Delta, and no  
 34 substantial nonpoint sources of selenium in the watersheds of the Sacramento River and the eastern  
 35 tributaries. Nonpoint sources in the San Joaquin Valley that contribute selenium to the Delta will be  
 36 controlled through a TMDL developed by the Central Valley Water Board (2001) for the lower San  
 37 Joaquin River, established limits for the Grassland Bypass Project, and Basin Plan objectives (Central  
 38 Valley Water Board [2010ed]) and State Water Board ([2010db, 2010ec]) that are expected to result  
 39 in decreasing discharges of selenium from the San Joaquin River to the Delta. Consequently, any  
 40 modified reservoir operations and subsequent changes in river flows under Alternative 3, relative to  
 41 Existing Conditions, are expected to cause negligible changes in selenium concentrations in water.  
 42 Any negligible changes in selenium concentrations that may occur in the water bodies of the affected  
 43 environment located upstream of the Delta would not be of frequency, magnitude, and geographic

1 extent that would adversely affect any beneficial uses or substantially degrade the quality of these  
2 water bodies as related to selenium.

3 Relative to Existing Conditions, modeling estimates indicate that Alternative 3 would result in  
4 essentially no change in selenium concentrations in water or most biota throughout the Delta, with  
5 no exceedances of benchmarks for biological effects. The Low Toxicity Threshold Exceedance  
6 Quotient for selenium concentrations in sturgeon for all years in the San Joaquin River at Antioch  
7 would increase slightly, from 0.94 for Existing Conditions and the No Action Alternative to 1.0 for  
8 Alternative 3. Concentrations of selenium in sturgeon would exceed only the lower benchmark  
9 during the drought period modeled, indicating a low potential for effects. Overall, Alternative 3  
10 would not be expected to substantially increase the frequency with which applicable benchmarks  
11 would be exceeded in the Delta (there being only a small exceedance for sturgeon relative to the low  
12 benchmark for sturgeon during the drought period and no exceedance of the high benchmark) or  
13 substantially degrade the quality of water in the Delta, with regard to selenium.

14 Assessment of effects of selenium in the SWP/CVP Export Service Areas is based on effects on  
15 selenium concentrations at the Banks and Jones pumping plants. Relative to Existing Conditions,  
16 Alternative 3 would ~~slightly decrease~~ cause no increase in ~~slightly decrease~~ the frequency with  
17 which applicable benchmarks would be exceeded and would slightly improve the quality of water in  
18 selenium concentrations at the Banks and Jones pumping plants.

19 Based on the above, selenium concentrations that would occur in water under Alternative 3 would  
20 not cause additional exceedances of applicable state or federal numeric or narrative water quality  
21 objectives/criteria, or other relevant water quality effects thresholds identified for this assessment  
22 (Table 8-54), by frequency, magnitude, and geographic extent that would result in adverse effects to  
23 one or more beneficial uses within affected water bodies. In comparison to Existing Conditions,  
24 water quality conditions under this alternative would not increase levels of selenium by frequency,  
25 magnitude, and geographic extent such that the affected environment would be expected to have  
26 measurably higher body burdens of selenium in aquatic organisms, thereby substantially increasing  
27 the health risks to wildlife (including fish) or humans consuming those organisms. Water quality  
28 conditions under this alternative with respect to selenium would not cause long-term degradation of  
29 water quality in the affected environment, and therefore would not result in use of available  
30 assimilative capacity such that exceedances of water quality objectives/criteria would be likely and  
31 would result in substantially increased risk for adverse effects to one or more beneficial uses. This  
32 alternative would not further degrade water quality by measurable levels, on a long-term basis, for  
33 selenium and, thus, cause the CWA Section 303(d)-listed impairment of beneficial use to be made  
34 discernibly worse. This impact is considered to be less than significant. No mitigation is required.

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

37 NEPA Effects: Effects of CM2–CM21 on selenium under Alternative 3 are the same as those  
38 discussed for Alternative 1A and are considered not to be adverse.

39 CEQA Conclusion: CM2–CM21 proposed under Alternative 3 would be similar to those proposed  
40 under Alternative 1A. As such, effects on selenium resulting from the implementation of CM2–CM21  
41 would be similar to that previously discussed for Alternative 1A. This impact is considered to be less  
42 than significant. No mitigation is required.

1 ~~**NEPA Effects:** In general, with the possible exception of changes in Delta hydrodynamics resulting~~  
2 ~~from habitat restoration, CM2–CM11 would not substantially increase selenium concentrations in~~  
3 ~~the water bodies of the affected environment. Modeling scenarios included assumptions regarding~~  
4 ~~how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, and~~  
5 ~~thus such effects of these restoration measures were included in the assessment of CM1 facilities~~  
6 ~~operations and maintenance (see Impact WQ-25).~~

7 ~~However, implementation of these conservation measures may increase water residence time~~  
8 ~~within the restoration areas. Increased restoration area water residence times could potentially~~  
9 ~~increase the bioaccumulation of selenium in biota, thereby potentially increasing fish tissue and bird~~  
10 ~~egg concentrations of selenium, but models are not available to quantitatively estimate the level~~  
11 ~~of changes in residence time and the associated selenium bioavailability, but the effects of residence~~  
12 ~~time are incorporated in the bioaccumulation modeling for selenium that was based on higher  $K_d$~~   
13 ~~values (the ratio of selenium concentrations in particulates [as the lowest level of the food chain]~~  
14 ~~relative to the water-borne concentration) for drought years in comparison to wet, normal, or all~~  
15 ~~years; see Appendix 8M, *Selenium*. If increases in fish tissue or bird egg selenium were to occur, the~~  
16 ~~increases would likely be of concern only where fish tissues or bird eggs are already elevated in~~  
17 ~~selenium to near or above thresholds of concern. That is, where biota concentrations are currently~~  
18 ~~low and not approaching thresholds of concern, changes in residence time alone would not be~~  
19 ~~expected to cause them to then approach or exceed thresholds of concern. In consideration of this~~  
20 ~~factor, although the Delta as a whole is a 303(d)-listed water body for selenium, and although~~  
21 ~~monitoring data of fish tissue or bird eggs in the Delta are sparse, the most likely areas in which~~  
22 ~~biota tissues would be at levels high enough that additional bioaccumulation due to increased~~  
23 ~~residence time from restoration areas would be a concern are the western Delta and Suisun Bay, and~~  
24 ~~the South Delta in areas that receive San Joaquin River water.~~

25 ~~The western Delta and Suisun Bay receive elevated selenium loads from North San Francisco Bay~~  
26 ~~(including San Pablo Bay, Carquinez Strait, and Suisun Bay) and from the San Joaquin River. Point~~  
27 ~~sources of selenium in North San Francisco Bay (i.e., refineries) that contribute selenium to Suisun~~  
28 ~~Bay are expected to be reduced through a TMDL under development by the San Francisco Bay Water~~  
29 ~~Board (San Francisco Bay Water Board 2012) that is expected to result in decreasing discharges of~~  
30 ~~selenium. Nonpoint sources of selenium in the San Joaquin Valley that contribute selenium to the~~  
31 ~~San Joaquin River, and thus the Delta and Suisun Bay, will be controlled through a TMDL developed~~  
32 ~~by the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the~~  
33 ~~Grassland Bypass Project, and Basin Plan objectives (Central Valley Water Board 2010c, d) that are~~  
34 ~~expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta. If~~  
35 ~~selenium levels are not sufficiently reduced via these efforts, it is expected that the State Water~~  
36 ~~Board and the San Francisco Bay and Central Valley Water Boards would initiate additional actions~~  
37 ~~to further control sources of selenium.~~

38 ~~The South Delta receives elevated selenium loads from the San Joaquin River. In contrast to Suisun~~  
39 ~~Bay and possibly the western Delta in the future, the South Delta lacks the overbite clam (*Corbula*~~  
40 ~~[*Potamocorbula*] *amurensis*), which is considered a key driver of selenium bioaccumulation in~~  
41 ~~Suisun Bay, due to its high bioaccumulation of selenium and its role in the benthic food web that~~  
42 ~~includes long-lived sturgeon. The South Delta does have *Corbicula fluminea*, another bivalve that~~  
43 ~~bioaccumulates selenium, but it is not as invasive as the overbite clam and thus likely makes up a~~  
44 ~~smaller fraction of sturgeon diet. Also, as mentioned above, nonpoint sources of selenium in the San~~  
45 ~~Joaquin Valley that contribute selenium to the Delta will be controlled through a TMDL developed by~~  
46 ~~the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the~~

1 Grassland Bypass Project, and Basin Plan objectives (Central Valley Water Board 2010c, d) that are  
2 expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta.  
3 Further, if selenium levels in the San Joaquin River are not sufficiently reduced via these efforts, it is  
4 expected that the State Water Board and Central Valley Water Board would initiate additional  
5 TMDLs to further control nonpoint sources of selenium.

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

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

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

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

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

43 Given the factors discussed in the assessment above, any increases in bioaccumulation rates from  
44 water-borne selenium that could occur in some areas as a result of increased water residence times

1 would not be of sufficient magnitude and geographic extent that any portion of the Delta would be  
 2 expected to have measurably higher body burdens of selenium in aquatic organisms, and therefore  
 3 would not substantially increase risk for adverse effects to beneficial uses. ~~CM2-22CM2 through~~  
 4 ~~CM22CM2-CM21~~ would not cause long-term degradation of water quality resulting in sufficient use  
 5 of available assimilative capacity such that occasionally exceeding water quality objectives/criteria  
 6 would be likely. Also, ~~CM2-22CM2 through CM22CM2-CM21~~ would not result in substantially  
 7 increased risk for adverse effects to any beneficial uses. Furthermore, although the Delta is a 303(d)-  
 8 listed water body for selenium, given the discussion in the assessment above, it is unlikely that  
 9 restoration areas would result in measurable increases in selenium in fish tissues or bird eggs such  
 10 that the beneficial use impairment would be made discernibly worse.

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

### 17 **Impact WQ-32. Effects on *Microcystis* Bloom Formation Resulting from Facilities Operations** 18 **and Maintenance (CM1)**

19 Effects of facilities and operations (CM1) on *Microcystis* abundance, and thus microcystins  
 20 concentrations, in water bodies of the affected environment under Alternative 3 would be very  
 21 similar (i.e., nearly the same) to those discussed for Alternative 1A. This is because factors that  
 22 affect *Microcystis* abundance in waters upstream of the Delta, in the Delta, and in the SWP/CVP  
 23 Export Services Areas under Alternative 1A would similarly change under Alternative 3, relative to  
 24 Existing Conditions and the No Action Alternative. For the Delta in particular, there are differences  
 25 in the direction and magnitude of water residence time changes during the *Microcystis* bloom period  
 26 among the six Delta sub-regions under Alternative 3 compared to Alternative 1A, relative to Existing  
 27 Conditions and No Action Alternative. However, under Alternative 3, relative to Existing Conditions  
 28 and No Action Alternative, water residence times during the *Microcystis* bloom period in various  
 29 Delta sub-regions are expected to increase to a degree that could, similar to Alternative 1A, lead to  
 30 an increase in the frequency, magnitude, and geographic extent of *Microcystis* blooms throughout  
 31 the Delta.

32 Similar to Alternative 1A, elevated ambient water temperatures relative to Existing Conditions  
 33 would occur in the Delta under Alternative 3, which could lead to earlier occurrences of *Microcystis*  
 34 blooms in the Delta, and increase the overall duration and magnitude of blooms. However, the  
 35 degradation of water quality from *Microcystis* blooms due to the expected increases in Delta water  
 36 temperatures is driven entirely by climate change, not effects of CM1. While *Microcystis* blooms  
 37 have not occurred in the Export Service Areas, conditions in the Export Service Areas under  
 38 Alternative 3 may become more conducive to *Microcystis* bloom formation, relative to Existing  
 39 Conditions, because water temperatures will increase in the Export Service Areas due to the  
 40 expected increase in ambient air temperatures resulting from climate change.

41 **NEPA Effects:** Effects of water facilities and operations (CM1) on *Microcystis* in water bodies of the  
 42 affected environment under Alternative 3 would be very similar to (i.e., nearly the same) to those  
 43 discussed for Alternative 1A. In summary, Alternative 3 operations and maintenance, relative to the  
 44 No Action Alternative, would result in long-term increases in hydraulic residence time of various

1 Delta sub-regions during the summer and fall *Microcystis* bloom period. During this period, the  
2 increased residence time could result in a concurrent increase in the frequency, magnitude, and  
3 geographic extent of *Microcystis* blooms, and thus microcystin levels, in affected areas of the Delta.  
4 As a result, Alternative 3 operation and maintenance activities would cause further degradation to  
5 water quality with respect to *Microcystis* in the Delta. Under Alternative 3, relative to No Action  
6 Alternative, water exported to the SWP/CVP Export Service Area will be a mixture of *Microcystis*-  
7 affected source water from the south Delta intakes and unaffected source water from the  
8 Sacramento River, diverted at the north Delta intakes. It cannot be determined whether operations  
9 and maintenance under Alternative 3 will result in increased or decreased levels of *Microcystis* and  
10 microcystins in the mixture of source waters exported from Banks and Jones pumping plants.  
11 Mitigation Measure WQ-32a and WQ-32b are available to reduce the effects of degraded water  
12 quality in the Delta. Although there is considerable uncertainty regarding this impact, the effects on  
13 *Microcystis* from implementing CM1 is determined to be adverse.

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

19 Under Alternative 3, additional impacts from *Microcystis* in the reservoirs and watersheds upstream  
20 of the Delta are not expected, relative to Existing Conditions. Operations and maintenance occurring  
21 under Alternative 3 is not expected to change nutrient levels in upstream reservoirs or  
22 hydrodynamic conditions in upstream rivers and streams such that conditions would be more  
23 conductive to *Microcystis* production.

24 Relative to Existing Conditions, water temperatures and hydraulic residence times in the Delta are  
25 expected to increase under Alternative 3, resulting in an increase in the frequency, magnitude and  
26 geographic extent of *Microcystis* blooms in the Delta. However, the degradation of water quality  
27 from *Microcystis* blooms due to the expected increases in Delta water temperatures is driven  
28 entirely by climate change, not effects of CM1. Increases in Delta residence times are expected  
29 throughout the Delta during the summer and fall bloom period, due in small part to climate change  
30 and sea level rise, but due more proportionately to CM1 and the hydrodynamic impacts of  
31 restoration included in CM2 and CM4. The precise change in local residence times and *Microcystis*  
32 production expected within any Delta sub-region is unknown because conditions will vary across  
33 the complex networks of intertwining channels, shallow back water areas, and submerged islands  
34 that compose the Delta. Nonetheless, Delta residence times are, in general, expected to increase due  
35 to Alternative 3. Consequently, it is possible that increases in the frequency, magnitude, and  
36 geographic extent of *Microcystis* blooms in the Delta will occur due to the operations and  
37 maintenance of Alternative 3 and the hydrodynamic impacts of restoration (CM2 and CM4).

38 The assessment of effects of *Microcystis* on SWP/CVP Export Service Areas is based on the  
39 assessment of changes in *Microcystis* levels in export source waters, as well as the effects of  
40 temperature and residence time changes within the Export Service Areas on *Microcystis* production.  
41 Under Alternative 3, relative to Existing Conditions, the potential for *Microcystis* to occur in the  
42 Export Service Area is expected to increase due to increasing water temperature, but this impact is  
43 driven entirely by climate change and not Alternative 3. Water exported from the Delta to the  
44 Export Service Area is expected to be a mixture of *Microcystis*-affected source water from the south  
45 Delta intakes and unaffected source water from the Sacramento River. Because of this, it cannot be

1 determined whether operations and maintenance under Alternative 3, relative to existing  
 2 conditions, will result in increased or decreased levels of *Microcystis* and microcystins in the mixture  
 3 of source waters exported from Banks and Jones pumping plants.

4 Based on the above, this alternative would not be expected to cause additional exceedance of  
 5 applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that  
 6 would cause significant impacts on any beneficial uses of waters in the affected environment.  
 7 *Microcystis* and microcystins are not 303(d) listed within the affected environment and thus any  
 8 increases that could occur in some areas would not make any existing *Microcystis* impairment  
 9 measurably worse because no such impairments currently exist. Because *Microcystis* and  
 10 microcystins are not bioaccumulative, increases that could occur in some areas would not  
 11 bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health  
 12 risks to fish, wildlife, or humans. However, because it is possible that increases in the frequency,  
 13 magnitude, and geographic extent of *Microcystis* blooms in the Delta will occur due to the operations  
 14 and maintenance of Alternative 3 and the hydrodynamic impacts of restoration (CM2 and CM4),  
 15 long-term water quality degradation may occur and, thus, significant impacts on beneficial uses  
 16 could occur. Although there is considerable uncertainty regarding this impact, the effects on  
 17 *Microcystis* from implementing CM1 is determined to be significant.

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

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

24 Please see Mitigation Measure WQ-32a under Impact WQ-32 in the discussion of Alternative 1A.

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

27 Please see Mitigation Measure WQ-32b under Impact WQ-32 in the discussion of Alternative 1A.

28 **Impact WQ-33. Effects on *Microcystis* Bloom Formation Resulting from Other Conservation**  
 29 **Measures (CM2--CM21).**

30 The effects of CM2--CM21 on *Microcystis* under Alternative 93 are the same as those discussed for  
 31 Alternative 1A. In summary, potential environmental effects related to CM2 and CM4 could result in  
 32 an increase in the frequency, magnitude, and geographic extent of *Microcystis* blooms in the Delta,  
 33 relative to Existing Conditions and the No Action Alternative, as a result of increased residence times  
 34 for Delta waters from implementing CM2 and CM4 restoration areas. -Because the hydrodynamic  
 35 effects associated with implementing CM2 and CM4 were incorporated into the modeling used to  
 36 assess CM1, a detailed assessment of the effects of implementing CM2 and CM4 on *Microcystis*  
 37 blooms in the Delta via their effects on Delta water residence time is provided under CM1 (above).  
 38 The effects of CM2 and CM4 on *Microcystis* may be reduced by implementation of  
 39 Mitigation Measures WQ-32A and WQ-32b. The effectiveness of these mitigation measures to result  
 40 in feasible measures for reducing water quality effects is uncertain. Conservation Measures 3 (CM3)  
 41 and CM5-CM21 would not result in an increase in the frequency, magnitude, and geographic extent  
 42 of *Microcystis* blooms in the Delta.

1 NEPA Effects: Effects of CM2–CM21 on Microcystis under Alternative 3 are the same as those  
 2 discussed for Alternative 1A and are considered to be adverse.

3 CEQA Conclusion: Based on the above, this alternative would not be expected to cause additional  
 4 exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic  
 5 extent that would cause significant impacts on any beneficial uses of waters in the affected  
 6 environment. Microcystis and microcystins are not 303(d) listed within the affected environment  
 7 and thus any increases that could occur in some areas would not make any existing Microcystis  
 8 impairment measurably worse because no such impairments currently exist. Because Microcystis  
 9 and microcystins are not bioaccumulative, increases that could occur in some areas would not  
 10 bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health  
 11 risks to fish, wildlife, or humans. Because restoration actions implemented under CM2 and CM4 will  
 12 increase residence time throughout the Delta and create local areas of warmer water during the  
 13 bloom season, it is possible that increases in the frequency, magnitude, and geographic extent of  
 14 Microcystis blooms, and thus long-term water quality degradation and significant impacts on  
 15 beneficial uses, could occur. Although there is considerable uncertainty regarding this impact, the  
 16 effects on Microcystis from implementing CM2–CM21 are determined to be significant.

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

19 The effects analysis presented in the preceding impacts (Impact WQ-1 through WQ-33) concluded  
 20 that Alternative 3 would have a less than significant impact/no adverse effect on the following  
 21 constituents in the Delta:

- 22 ● Boron
- 23 ● Dissolved Oxygen
- 24 ● Pathogens
- 25 ● Pesticides
- 26 ● Trace Metals
- 27 ● Turbidity and TSS

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

36 The effects of Alternative 3 on bromide, chloride, and DOC, in the Delta were determined to be  
 37 significant/adverse. Increases in bromide, chloride, and DOC concentrations are of concern in  
 38 drinking water supplies; however, as described previously, the San Francisco Bay does not have a  
 39 designated MUN use. Thus, changes in bromide, chloride, and DOC in Delta outflow would not  
 40 adversely effect any beneficial uses of San Francisco Bay.



1 Elevated EC, as assessed for this alternative, is of concern for its effects on the agricultural beneficial  
2 use (AGR) and fish and wildlife beneficial uses. As discussed above, San Francisco Bay does not have  
3 an AGR beneficial use designation. Further, as discussed for the No Action Alternative, changes in  
4 Delta salinity would not contribute to measurable changes in Bay salinity, as the change in Delta  
5 outflow, which would be the primary driver of salinity changes, would two to three orders of  
6 magnitude lower than (and thus minimal compared to) the Bay's tidal flow.

7 Also, as discussed for the No Action Alternative, adverse changes in Microcystis levels that could  
8 occur in the Delta would not cause adverse Microcystis blooms in San Francisco Bay, because  
9 Microcystis are intolerant of the Bay's high salinity and, thus not have not been detected  
10 downstream of Suisun Bay.

11 While effects of Alternative 3 on the nutrients ammonia, nitrate, and phosphorus were determined  
12 to be less than significant/not adverse, these constituents are addressed further below because the  
13 response of the seaward bays to changed nutrient concentrations/loading may differ from the  
14 response of the Delta. Selenium and mercury are discussed further, because they are  
15 bioaccumulative constituents where changes in load due to both changes in Delta concentrations  
16 and exports are of concern.

#### 17 **Nutrients: Ammonia, Nitrate, and Phosphorus**

18 Total nitrogen loads in Delta outflow to Suisun and San Pablo Bays under Alternative 3 would be  
19 dominated almost entirely by nitrate, because planned upgrades to the SRWTP will result in >95%  
20 removal of ammonia in its effluent. Total nitrogen loads to Suisun and San Pablo Bays would  
21 decrease by 33%, relative to Existing Conditions, and decrease by 9%, relative to the No Action  
22 Alternative (Appendix 80, Table O-1). The change in nitrogen loading to Suisun and San Pablo Bays  
23 under Alternative 3 would not adversely impact primary productivity in these embayments because  
24 light limitation and grazing current limit algal production in these embayments. To the extent that  
25 algal growth increases in relation to a change in ammonia concentration, this would have net  
26 positive benefits, because current algal levels in these embayments are low. Nutrient levels and  
27 ratios are not considered a direct driver of *Microcystis* and cyanobacteria levels in the North Bay.

28 The phosphorus load exported from the Delta to Suisun and San Pablo Bays for Alternative 3 is  
29 estimated to decrease by 1%, relative to Existing Conditions and by 6% relative to the No Action  
30 Alternative (Appendix 80, Table O-1). The only postulated effect of changes in phosphorus loads to  
31 Suisun and San Pablo Bays is related to the influence of nutrient stoichiometry on primary  
32 productivity. However, there is uncertainty regarding the impact of nutrient ratios on  
33 phytoplankton community composition and abundance. Any effect on phytoplankton community  
34 composition would likely be small compared to the effects of grazing from introduced clams and  
35 zooplankton in the estuary (Senn and Novick 2014; Kimmerer and Thompson 2014). Therefore, the  
36 projected change in total nitrogen and phosphorus loading that would occur in Delta outflow to San  
37 Francisco Bay is not expected to result in degradation of water quality with regard to nutrients that  
38 would result in adverse effects to beneficial uses.

#### 39 **Mercury**

40 The estimated long-term average mercury and methylmercury loads in Delta exports are shown in  
41 Appendix 80, Table O-2. Loads of mercury and methylmercury from the Delta to San Francisco Bay  
42 are estimated to change relatively little due to changes in source water fractions and net Delta  
43 outflow that would occur under Alternative 3. Mercury load to the Bay, relative to Existing

1 Conditions, is estimated to decrease by 2 kg/yr (1%), relative to Existing Conditions, and to decrease  
2 by 5 kg/yr (2%), relative to the No Action Alternative. Methylmercury load is estimated to decrease  
3 by 0.04 kg/yr (1%), relative to Existing Conditions, and by 0.13 kg/yr (4%) relative to the No Action  
4 Alternative. The estimated total mercury load to the Bay is 258 kg/yr, which would be less than the  
5 San Francisco Bay mercury TMDL WLA for the Delta of 330 kg/yr. The estimated changes in  
6 mercury and methylmercury loads would be within the overall uncertainty associated with the  
7 estimates of long-term average net Delta outflow and the long-term average mercury and  
8 methylmercury concentrations in Delta source waters. The estimated changes in mercury load  
9 under the alternative would also be substantially less than the considerable differences among  
10 estimates in the current mercury load to San Francisco Bay (SFBRWQCB 2006; David et al. 2009).  
11 Similar uncertainty is expected in the existing methylmercury load in net Delta exports, for which  
12 the best available current load estimate is based on approximately one year of monitoring data (Foe  
13 et al. 2008).

14 Given that the estimated incremental decreases/increases of mercury and methylmercury loading to  
15 San Francisco Bay would fall within the uncertainty of current mercury and methylmercury load  
16 estimates, the estimated changes in mercury and methylmercury loads in Delta exports to San  
17 Francisco Bay due to Alternative 3 are not expected to result in adverse effects to beneficial uses or  
18 substantially degrade the water quality with regard to mercury, or make the existing CWA Section  
19 303(d) impairment measurably worse.

#### 20 Selenium

21 Changes in source water fraction and net Delta outflow under Alternative 3, relative to Existing  
22 Conditions, are projected to cause the total selenium load to the North Bay to increase by 1%,  
23 relative to Existing Conditions, and decrease by 2%, relative to the No Action Alternative (Appendix  
24 80, Table O-3). Changes in long-term average selenium concentrations of the North Bay are assumed  
25 to be proportional to changes in North Bay selenium loads. Under Alternative 3, the long-term  
26 average total selenium concentration of the North Bay is estimated to be 0.13 µg/L and the dissolved  
27 selenium concentration is estimated to be 0.11 µg/L, which would be the same as Existing  
28 Conditions and the No Action Alternative (Appendix 80, Table O-3). The dissolved selenium  
29 concentration would be below the target of 0.202 µg/L developed by Presser or Luoma (2013) to  
30 coincide with a white sturgeon whole-body fish tissue selenium concentration not greater than 8  
31 mg/kg in the North Bay. The incremental increase in dissolved selenium concentrations in the  
32 North Bay, relative to Existing Conditions, would be negligible (0.00 µg/L) under this alternative.  
33 Thus, the estimated changes in selenium loads in Delta exports to San Francisco Bay due to  
34 Alternative 3 are not expected to result in adverse effects to beneficial uses or substantially degrade  
35 the water quality with regard to selenium, or make the existing CWA Section 303(d) impairment  
36 measurably worse.

37 **NEPA Effects:** Based on the discussion above, Alternative 3, relative to the No Action Alternative,  
38 would not cause further degradation to water quality with respect to boron, bromide, chloride,  
39 dissolved oxygen, DOC, EC, mercury, pathogens, pesticides, selenium, nutrients (ammonia, nitrate,  
40 phosphorus), trace metals, or turbidity and TSS in the San Francisco Bay. Further, changes in these  
41 constituent concentrations in Delta outflow would not be expected to cause changes in Bay  
42 concentrations of frequency, magnitude, and geographic extent that would adversely affect any  
43 beneficial uses. In summary, based on the discussion above, effects on the San Francisco Bay from  
44 implementation of CM1–CM21 are considered to be not adverse.

1 **CEQA Conclusion:** Based on the above, Alternative 3 would not be expected to cause long-term  
2 degradation of water quality in San Francisco Bay resulting in sufficient use of available assimilative  
3 capacity such that occasionally exceeding water quality objectives/criteria would be likely and  
4 would result in substantially increased risk for adverse effects to one or more beneficial uses.  
5 Further, based on the above, this alternative would not be expected to cause additional exceedance  
6 of applicable water quality objectives/criteria in the San Francisco Bay by frequency, magnitude,  
7 and geographic extent that would cause significant impacts on any beneficial uses of waters in the  
8 affected environment. Any changes in boron, bromide, chloride, and DOC in the San Francisco Bay  
9 would not adversely affect beneficial uses, because the uses most affected by changes in these  
10 parameters, MUN and AGR, are not beneficial uses of the Bay. Further, no substantial changes in  
11 dissolved oxygen, pathogens, pesticides, trace metals or turbidity or TSS are anticipated in the Delta,  
12 relative to Existing Conditions, therefore, no substantial changes these constituents levels in the Bay  
13 are anticipated. Changes in Delta salinity would not contribute to measurable changes in Bay  
14 salinity, as the change in Delta outflow would two to three orders of magnitude lower than (and thus  
15 minimal compared to) the Bay's tidal flow. Adverse changes in Microcystis levels that could occur in  
16 the Delta would not cause adverse Microcystis blooms in the Bay, because Microcystis are intolerant  
17 of the Bay's high salinity and, thus not have not been detected downstream of Suisun Bay. The 33%  
18 decrease in total nitrogen load and 1% decrease in phosphorus load, relative to Existing Conditions,  
19 are expected to have minimal effect on water quality degradation, primary productivity, or  
20 phytoplankton community composition. The estimated reduction in mercury load (2 kg/yr; 1%) and  
21 methylmercury load (0.04 kg/yr; 1%), relative to Existing Conditions, is within the level of  
22 uncertainty in the mass load estimate and not expected to contribute to water quality degradation,  
23 make the CWA section 303(d) mercury impairment measurably worse or cause  
24 mercury/methylmercury to bioaccumulate to greater levels in aquatic organisms that would, in  
25 turn, pose substantial health risks to fish, wildlife, or humans. The estimated increase in selenium  
26 load would be 1%, but estimated total and dissolved selenium concentrations under this alternative  
27 would be the same as Existing Conditions, and less than the target associated with white sturgeon  
28 whole-body fish tissue levels for the North Bay. Thus, the small increase in selenium load is not  
29 expected to contribute to water quality degradation, or make the CWA section 303(d) selenium  
30 impairment measurably worse or cause selenium to bioaccumulate to greater levels in aquatic  
31 organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact  
32 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 2–22CM2–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.

1 Under Alternative 4, long-term average annual Delta outflow is anticipated to range from a decrease  
 2 of 114 TAF under scenario H1 to an increase 744 TAF under scenario H4 relative to Existing  
 3 Conditions, due to both changes in operations (including north Delta intake capacity of 9,000 cfs,  
 4 Fall X2, and numerous other operational components of scenarios H1 through H4) and climate  
 5 change/sea level rise (see Chapter 5, Water Supply, for more information). Long-term average  
 6 annual Delta outflow is anticipated to decrease under Alternative 4 by between 864 (scenario H1)  
 7 and 5 TAF (scenario H4) relative to the No Action Alternative, due only to changes in operations. The  
 8 result of this is increased sea water intrusion in the west Delta. The increase in sea water intrusion  
 9 (represented by an increase in San Francisco Bay (BAY) percentage) can be seen, for example, in  
 10 Appendix 8D, ALT 4, H3–Sacramento River at Mallard Island for ALL years (1976–1991).

## 11 **Impact WQ-1: Effects on Ammonia Concentrations Resulting from Facilities Operations and** 12 **Maintenance (CM1)**

### 13 *Upstream of the Delta*

14 Substantial point sources of ammonia-N do not exist upstream of the SRWTP in the Sacramento  
 15 River watershed, in the watersheds of the eastern tributaries (Cosumnes, Mokelumne, and Calaveras  
 16 Rivers), or upstream of the Delta in the San Joaquin River watershed. Nonpoint sources of ammonia-  
 17 N within the watersheds are also relatively low, thus resulting in generally low ammonia-N  
 18 concentrations in the reservoirs and rivers of the watersheds. Consequently, any modified reservoir  
 19 operations and subsequent changes in river flows under Alternative 4 (including the different  
 20 operational components of Scenarios H1–H4) would have negligible, if any, effect on ammonia  
 21 concentrations in the rivers and reservoirs upstream of the Delta relative to Existing Conditions and  
 22 the No Action Alternative. Any negligible increases in ammonia-N concentrations that could occur in  
 23 the water bodies of the affected environment located upstream of the Delta would not be of  
 24 frequency, magnitude and geographic extent that would adversely affect any beneficial uses or  
 25 substantially degrade the quality of these water bodies, with regard to ammonia.

### 26 *Delta*

27 As summarized in Table 8-40, it is assumed that SRWTP effluent ammonia concentrations would be  
 28 substantially lower under Alternative 4 than under Existing Conditions, and would be the same as  
 29 would occur under the No Action Alternative. Relative to Existing Conditions, ammonia-N  
 30 concentrations downstream of the SRWTP would be substantially lower under Alternative 4  
 31 (including the different operational components of Scenarios H1–H4) because it is assumed that  
 32 SRWTP upgrades would be in place, and thus that the average monthly effluent ammonia-N  
 33 concentration would not exceed 1.5 mg/L-N in April through October or 2.4 mg/L-N in November  
 34 through March. Consequently, a substantial decrease in Sacramento River ammonia-N  
 35 concentrations is expected to decrease ammonia concentrations for all areas of the Delta that are  
 36 influenced by Sacramento River water. Concentrations of ammonia-N at locations not influenced  
 37 notably by Sacramento River water will change little relative to Existing Conditions, due to the  
 38 similarity in SJR and BAY concentrations and the lack of expected changes in either of these  
 39 concentrations. Thus, Alternative 4 would not result in substantial increases in ammonia  
 40 concentrations in the Plan Area, relative to Existing Conditions.

41 Because the SRWTP discharge ammonia concentrations are assumed to be the same under  
 42 Alternative 4 as would occur under the No Action Alternative, the primary mechanism that could  
 43 potentially increase ammonia concentrations in the Delta under Alternative 4, relative to the No

1 Action Alternative, is decreased flows in the Sacramento River, which would lower dilution available  
2 to the SRWTP discharge. This change would be attributable only to operations of Alternative 4, since  
3 the same assumptions regarding water demands, climate change, and sea level rise are included in  
4 both Alternative 1A and the No Action Alternative.

5 To address this possibility, a simple mixing calculation was performed to assess concentrations of  
6 ammonia downstream of the SRWTP discharge (i.e., downstream of Freeport) under Alternative 4  
7 and the No Action Alternative. Monthly average CALSIM II flows at Freeport and the upstream  
8 ammonia concentration (0.04 mg/L-N; Central Valley Water Board 2010a:5) were used, together  
9 with the SRWTP permitted average dry weather flow (181 mgd) and seasonal ammonia  
10 concentration (1.5 mg/L-N in Apr-Oct, 2.4 mg/L-N in Nov-Mar), to estimate the average change in  
11 ammonia concentrations downstream of the SRWTP. Table 8-67 shows monthly average and long  
12 term annual average predicted concentrations under the two scenarios.

13 As Table 8-67 shows, average monthly ammonia-N concentrations in the Sacramento River  
14 downstream of Freeport (upon full mixing of the SRWTP discharge with river water) under the four  
15 different operational scenarios of Alternative 4 and under the No Action Alternative are expected to  
16 be similar (Table 8-67). In comparison to the No Action Alternative, minor increases in monthly  
17 average ammonia-N concentrations would occur during February, July through September, and  
18 during November for all operational scenarios (H1 through H4). Under operational scenario H2 and  
19 H4, minor increases in ammonia-N concentrations also would occur in the months of January and  
20 March. In the month of December, average ammonia-N concentrations would increase slightly for  
21 scenario H4. Minor decreases in ammonia-N concentrations are expected for all scenarios (H1  
22 through H4) in May and June, while minor decreases would also occur in October under scenario H1.

23 A minor increase in the annual average concentration would occur under the different operational  
24 components of scenarios H1 through H4 of Alternative 4, compared to the No Action Alternative.  
25 Moreover, the estimated concentrations downstream of Freeport under Alternative 4 would be  
26 similar to existing source water concentrations for the San Francisco Bay and San Joaquin River.  
27 Consequently, changes in source water fraction anticipated under Alternative 4, relative to the No  
28 Action Alternative, are not expected to substantially increase ammonia concentrations at any Delta  
29 locations.

30 Any negligible increases in ammonia-N concentrations that could occur at certain locations in the  
31 Delta would not be of frequency, magnitude and geographic extent that would adversely affect any  
32 beneficial uses or substantially degrade the water quality at these locations, with regards to  
33 ammonia.

1 **Table 8-67. Estimated Ammonia-N (mg-L as N) Concentrations in the Sacramento River Downstream of**  
 2 **the Sacramento Regional Wastewater Treatment Plant for the No Action Alternative and Alternative 4**  
 3 **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

4

#### 5 ***SWP/CVP Export Service Areas***

6 The assessment of effects on ammonia in the SWP and CVP Export Service Area is based on  
 7 assessment of ammonia-N concentrations at Banks and Jones pumping plants. The dominant source  
 8 waters influencing the Banks and Jones pumping plants are the Sacramento and San Joaquin Rivers  
 9 (see Appendix 8D). As discussed above for the Plan Area, for areas of the Delta that are influenced by  
 10 Sacramento River water, including Banks and Jones pumping plants, ammonia-N concentrations are  
 11 expected to decrease under Alternative 4, relative to Existing Conditions (in association with less  
 12 diversion of water influenced by the SRWTP). This decrease in ammonia-N concentrations for water  
 13 exported via the south Delta pumps is not expected to result in an adverse effect on beneficial uses  
 14 or substantially degrade water quality of exported water, with regards to ammonia.

15 Furthermore, as discussed above for the Plan Area, for all areas of the Delta, including Banks and  
 16 Jones pumping plants, ammonia-N concentrations are not expected to be substantially different  
 17 under the four different operational scenarios of Alternative 4, relative to No Action Alternative. Any  
 18 negligible increases in ammonia-N concentrations that could occur at Banks and Jones pumping  
 19 plants would not be of frequency, magnitude and geographic extent that would adversely affect any  
 20 beneficial uses or substantially degrade the water quality at these locations, with regards to  
 21 ammonia.

22 ***NEPA Effects:*** In summary, based on the discussion above, effects on ammonia from implementation  
 23 of CM1 are considered to be not adverse.

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

29 Ammonia-N concentrations are generally low in the reservoirs and rivers of the watersheds, owing  
 30 to the lack of substantial point and nonpoint sources of ammonia-N upstream of the SRWTP in the  
 31 Sacramento River watershed, in the watersheds of the eastern tributaries (Cosumnes, Mokelumne,  
 32 and Calaveras Rivers), or upstream of the Delta in the San Joaquin River watershed. Consequently,  
 33 any modified reservoir operations and subsequent changes in river flows under Alternative 4,  
 34 relative to Existing Conditions, are expected to have negligible, if any, effects on reservoir and river

1 ammonia-N concentrations upstream of Freeport in the Sacramento River watershed and upstream  
2 of the Delta in the San Joaquin River watershed.

3 Ammonia-N concentrations in the Sacramento River downstream of the SRWTP would be  
4 substantially lower under Alternative 4 (regardless of operational scenario), relative to Existing  
5 Conditions, due to upgrades to the SRWTP that are assumed to be in place, and thus, ammonia  
6 concentrations for all areas of the Delta that are influenced by Sacramento River water are expected  
7 to decrease. At locations which are not influenced notably by Sacramento River water,  
8 concentrations are expected to remain relatively unchanged compared to Existing Conditions, due to  
9 the similarity in SJR and BAY concentrations and the lack of expected changes in either of these  
10 concentrations.

11 The assessment of effects on ammonia in the SWP/CVP Export Service Areas is based on assessment  
12 of ammonia-N concentrations at Banks and Jones pumping plants. As discussed above for the Plan  
13 Area, for areas of the Delta that are influenced by Sacramento River water, including Banks and  
14 Jones pumping plants, ammonia-N concentrations are expected to decrease under Alternative 4,  
15 relative to Existing Conditions.

16 Based on the above, there would be no substantial, long-term increase in ammonia-N concentrations  
17 in the rivers and reservoirs upstream of the Delta, in the Plan Area, or the waters exported to the  
18 CVP and SWP service areas under Alternative 4 relative to Existing Conditions. As such, this  
19 alternative is not expected to cause additional exceedance of applicable water quality  
20 objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects  
21 on any beneficial uses of waters in the affected environment. Because ammonia concentrations are  
22 not expected to increase substantially, no long-term water quality degradation is expected to occur  
23 and, thus, no adverse effects on beneficial uses would occur. Ammonia is not 303(d) listed within the  
24 affected environment and thus any minor increases that could occur in some areas would not make  
25 any existing ammonia-related impairment measurably worse because no such impairments  
26 currently exist. Because ammonia-N is not bioaccumulative, minor increases that could occur in  
27 some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose  
28 substantial health risks to fish, wildlife, or humans. This impact is considered to be less than  
29 significant. No mitigation is required.

30 **Impact WQ-2: Effects on Ammonia Concentrations Resulting from Implementation of CM2-**  
31 **CM22CM21**

32 **NEPA Effects:** Some habitat restoration activities would occur on lands in the Delta formerly used  
33 for irrigated agriculture. Although this may decrease ammonia loading to the Delta from agriculture,  
34 increased biota in those areas as a result of restored habitat may increase ammonia loading  
35 originating from flora and fauna. Ammonia loaded from organisms is expected to be converted  
36 rapidly to nitrate by established microbial communities. Thus, these land use changes would not be  
37 expected to substantially increase ammonia concentrations in the Delta. In general, with the  
38 exception of changes in Delta hydrodynamics resulting from habitat restoration, CM2-CM11 would  
39 not substantially increase ammonia concentrations in the water bodies of the affected environment.  
40 Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2  
41 and CM4) would affect Delta hydrodynamics, and thus such effects of these restoration measures  
42 were included in the assessment of CM1 facilities operations and maintenance (see Impact WQ-1).  
43 Additionally, implementation of CM12-CM22CM21 would not be expected to substantially alter  
44 ammonia concentrations in the affected environment.



1 The effects of ammonia from implementation of ~~CM2-22CM2 through CM22CM2-CM21~~ are  
2 considered to be not adverse.

3 **CEQA Conclusion:** There would be no substantial, long-term increase in ammonia-N concentrations  
4 in the rivers and reservoirs upstream of the Delta, in the Plan Area, or the waters exported to the  
5 CVP and SWP service areas due to implementation of CM2-~~CM22CM21~~ relative to Existing  
6 Conditions. As such, implementation of these conservation measures would not be expected to  
7 cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude,  
8 and geographic extent that would cause significant impacts on any beneficial uses of waters in the  
9 affected environment. Because ammonia concentrations would not be expected to increase  
10 substantially from implementation of these conservation measures, no long-term water quality  
11 degradation would be expected to occur and, thus, no significant impact on beneficial uses would  
12 occur. Ammonia is not 303(d) listed within the affected environment and thus any minor increases  
13 that could occur in some areas would not make any existing ammonia-related impairment  
14 measurably worse because no such impairments currently exist. Because ammonia-N is not  
15 bioaccumulative, minor increases that could occur in some areas would not bioaccumulate to  
16 greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife,  
17 or humans. This impact is considered less than significant. No mitigation is required.

### 18 **Impact WQ-3: Effects on Boron Concentrations Resulting from Facilities Operations and** 19 **Maintenance (CM1)**

#### 20 ***Upstream of the Delta***

21 Under Alternative 4 Scenarios H1-H4, there would be no expected change to the sources of boron in  
22 the Sacramento and east-side tributary watersheds, and resultant changes in flows from altered  
23 system-wide operations would have negligible, if any, effects on the concentration of boron in the  
24 rivers and reservoirs of these watersheds. The modeled long-term annual average lower San Joaquin  
25 River flow at Vernalis would decrease by an estimated 6%, relative to Existing Conditions (in  
26 association with the different operational components of Scenarios H1-H4 for Alternative 4, climate  
27 change, and increased water demands) and would remain virtually the same relative to the No  
28 Action Alternative considering only changes due only to the different operational components of  
29 Scenarios H1-H4 under Alternative 4. The reduced flow would result in possible increases in long-  
30 term average boron concentrations of up to about 3% relative to the Existing Conditions, which  
31 would be nearly identical under each of the H1-H4 scenarios (Appendix 8F, Table Bo-24). The  
32 increased boron concentrations would not increase the frequency of exceedances of any applicable  
33 objectives or criteria and would not be expected to cause further degradation at measurable levels  
34 in the lower San Joaquin River, and thus would not cause the existing impairment there to be  
35 discernibly worse. Consequently, Alternative 4 would not be expected to cause exceedance of boron  
36 objectives/criteria or substantially degrade water quality with respect to boron, and thus would not  
37 adversely affect any beneficial uses of the Sacramento River, the east-side tributaries, associated  
38 reservoirs upstream of the Delta, or the San Joaquin River.

#### 39 ***Delta***

40 Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2  
41 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter  
42 hydrodynamics within the Delta region, which affects mixing of source waters, these effects are  
43 included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of

1 ~~CM2-22CM2 through CM22CM2-CM21~~ not attributable to hydrodynamics, for example, additional  
 2 loading of a constituent to the Delta, are discussed within the impact header for ~~CM2-22CM2~~  
 3 ~~through CM22CM2-CM21~~. See section 8.3.1.3 for more information.

4 The effects relative to Existing Conditions and the No Action Alternative are discussed together  
 5 because the direction and magnitude of predicted change are so similar. Relative to Existing  
 6 Conditions, the following changes reflect the range of effects that would result from the four  
 7 potential outcomes under the Alternative 4 H1–H4 Scenarios. There would be generally similar  
 8 increased long-term average boron concentrations for the 16-year period modeled at interior Delta  
 9 locations (by as much as 8% at the SF Mokelumne River at Staten Island for all H1–H4 Scenarios,  
 10 from 12% for H1 to 15% for H4 at Franks Tract, and from 11% for H1 to 18% for H4 at Old River at  
 11 Rock Slough) (Appendix 8F, Tables Bo-12A/~~andthrough~~ Bo-12D). The comparisons to Existing  
 12 Conditions reflects changes due to the different operational components of Scenarios H1–H4 for  
 13 Alternative 4 and climate change/sea level rise. Comparison to the No Action Alternative reflects  
 14 changes due only to the different operational components of Scenarios H1–H4 for Alternative 4.

15 Implementation of tidal habitat restoration under CM4 also may contribute to increased boron  
 16 concentrations at western Delta assessment locations (more discussion of this phenomenon is  
 17 included in Section 8.3.1.3), and thus would not be anticipated to substantially affect agricultural  
 18 diversions which occur primarily at interior Delta locations. The long-term annual average and  
 19 monthly average boron concentrations, for either the 16-year period or drought period modeled,  
 20 would never exceed the 2,000 µg/L human health advisory objective (i.e., for children) or 500 µg/L  
 21 agricultural objective at any of the eleven Delta assessment locations, which represents no change  
 22 from the Existing Conditions and No Action Alternative (Appendix 8F, Table Bo-3B). Additionally,  
 23 relative to the Existing Conditions, reductions in long-term average assimilative capacity would be  
 24 small with respect to the 500 µg/L agricultural objective at interior Delta locations and reductions  
 25 would be similar for all of the Alternative 4 H1–H4 Scenarios (i.e., range of maximum monthly  
 26 reductions of 12% (H1) to 13% (H4) at Franks Tract and up to 13% (H1) to 18% (H4) at Old River at  
 27 Rock Slough (Appendix 8F, Tables Bo-13A/~~through~~ 13D), and the reductions in assimilative  
 28 capacity relative to the No Action Alternative also would be comparable. However, because the  
 29 absolute boron concentrations would still be well below the lowest 500 µg/L objective for the  
 30 protection of the agricultural beneficial use under Alternative 4, the levels of boron degradation  
 31 would not be of sufficient magnitude to substantially increase the risk of exceeding objectives or  
 32 cause adverse effects to municipal and agricultural water supply beneficial uses, or any other  
 33 beneficial uses, in the Delta (Appendix 8F, Figure Bo-3).

#### 34 ***SWP/CVP Export Service Areas***

35 Under all of the Alternative 4 H1–H4 Scenarios, long-term average boron concentrations would  
 36 decrease at the Banks Pumping Plant (ranging from as much as 21% [H1]) to a9% [H2]) and at Jones  
 37 Pumping Plant (ranging from 23% [H4] to 19% [H1]) relative to Existing Conditions, and the  
 38 reductions would be similar compared to No Action Alternative (Appendix 8F, Tables Bo-12A/  
 39 ~~through~~ 12D) as a result of export of a greater proportion of low-boron Sacramento River water.  
 40 Commensurate with the decrease in exported boron concentrations, boron concentrations in the  
 41 lower San Joaquin River may be reduced and would likely alleviate or lessen any expected increase  
 42 in boron concentrations at Vernalis associated with flow reductions (see discussion of Upstream of  
 43 the Delta), as well as locations in the Delta receiving a large fraction of San Joaquin River water.  
 44 Reduced export boron concentrations also may contribute to reducing the existing 303(d)  
 45 impairment in the lower San Joaquin River and associated TMDL actions for reducing boron loading.

1 Maintenance of SWP and CVP facilities under Alternative 4 would not be expected to create new  
2 sources of boron or contribute towards a substantial change in existing sources of boron in the  
3 affected environment. Maintenance activities would not be expected to cause any substantial  
4 increases in boron concentrations or degradation with respect to boron such that objectives would  
5 be exceeded more frequently, or any beneficial uses would be adversely affected anywhere in the  
6 affected environment.

7 **NEPA Effects:** In summary, relative to the No Action Alternative conditions, Alternative 4 would  
8 result in relatively small increases in long-term average boron concentrations in the Delta and not  
9 appreciably change boron levels in the lower San Joaquin River. However, the predicted changes  
10 would not be expected to cause exceedances of applicable objectives or further measurable water  
11 quality degradation, and thus would not constitute an adverse effect on water quality.

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

17 Boron is not a constituent of concern in the Sacramento River watershed upstream of the Delta, thus  
18 river flow rate and reservoir storage reductions that would occur under the Alternative 4, relative to  
19 Existing Conditions, would not be expected to result in a substantial adverse change in boron levels.  
20 Additionally, relative to Existing Conditions, Alternative 4 would not result in reductions in river  
21 flow rates (i.e., less dilution) or increased boron loading such that there would be any substantial  
22 increases in boron concentration upstream of the Delta in the San Joaquin River watershed.

23 Small increased boron levels predicted for interior and western Delta locations in response (i.e., up  
24 to 15% increase) to a shift in the Delta source water percentages and tidal habitat restoration under  
25 this alternative would not be expected to cause exceedances of objectives, or substantial  
26 degradation of these water bodies. Alternative 4 maintenance also would not result in any  
27 substantial increases in boron concentrations in the affected environment. Boron concentrations  
28 would be reduced in water exported from the Delta to the CVP/SWP Export Service Areas, thus  
29 reflecting a potential improvement to boron loading in the lower San Joaquin River.

30 Boron is not a bioaccumulative constituent, thus any increased concentrations under Alternative  
31 4 would not result in adverse boron bioaccumulation effects to aquatic life or humans. Relative to  
32 Existing Conditions, Alternative 4 would not result in substantially increased boron concentrations  
33 such that frequency of exceedances of municipal and agricultural water supply objectives would  
34 increase. The levels of boron degradation that may occur under Alternative 4 would not be of  
35 sufficient magnitude to cause substantially increased risk for adverse effects to municipal or  
36 agricultural beneficial uses within the affected environment. Long-term average boron  
37 concentrations would decrease in Delta water exports to the SWP and CVP service area, which may  
38 contribute to reducing the existing 303(d) impairment of agricultural beneficial uses in the lower  
39 San Joaquin River. Based on these findings, this impact is determined to be less than significant. No  
40 mitigation is required.

1 **Impact WQ-4: Effects on Boron Concentrations Resulting from Implementation of CM2-**  
 2 **CM22-CM21**

3 **NEPA Effects:** The implementation of the other conservation measures (i.e., CM2-~~CM22-CM21~~), of  
 4 which most do not involve land disturbance, present no new direct sources of boron to the affected  
 5 environment, including areas Upstream of the Delta, within the Plan Area, and the SWP/CVP Export  
 6 Service Area, nor would they affect channel flows or Delta hydrodynamic conditions. As noted  
 7 above, the potential effects of implementation of tidal habitat restoration (i.e., CM4) on Delta  
 8 hydrodynamic conditions is addressed above in the discussion of Impact WQ-3. The potential  
 9 channel flow effects of CM2 for actions in the Yolo Bypass also were accounted for in the CALSIM II  
 10 and DSM2 modeling, and thus were addressed in the discussion for Impact WQ-3. Habitat  
 11 restoration activities in the Delta (i.e., CM4-~~CM10-10~~), including restored tidal wetlands, floodplain,  
 12 and related channel margin and off-channel habitats, while involving increased land and water  
 13 interaction within these habitats, would not be anticipated to contribute boron which is primarily  
 14 associated with source water inflows to the Delta (i.e., San Joaquin River, agricultural drainage, and  
 15 Bay source water). Moreover, some habitat restoration conservation measures (CM4-~~CM10~~) would  
 16 occur on lands within the Delta currently used for irrigated agriculture, thus replacing agricultural  
 17 land uses with restored habitats. The potential reduction in irrigated lands within the Delta may  
 18 result in reduced discharges of agricultural field drainage with elevated boron concentrations,  
 19 which would be considered an improvement compared to the No Action Alternative. CM3 and CM11  
 20 provide the mechanism, guidance, and planning for the land acquisition and thus would not,  
 21 themselves, affect boron levels in the Delta. CM12-~~CM22-CM21~~ involve actions that target reduction  
 22 in other stressors at the species level involving actions such as methylmercury reduction  
 23 management (CM12), improving DO in the Stockton Deep Water Ship Channel (CM14), and urban  
 24 stormwater treatment (CM19). None of the CM12-~~CM22-CM21~~ actions would contribute to  
 25 substantially increasing boron levels in the Delta. Consequently, as they pertain to boron,  
 26 implementation of CM2-~~CM22-CM21~~ would not be expected to adversely affect any of the beneficial  
 27 uses of the affected environment.

28 The impact on boron of implementing CM2-~~CM22-CM21~~ is determined to be not adverse.

29 **CEQA Conclusion:** Implementation of the CM2-~~CM22-CM21~~ for Alternative 4 would not present new  
 30 or substantially changed sources of boron to the affected environment upstream of the Delta, within  
 31 Delta, or in the SWP and CVP service area. As such, the their implementation would not be expected  
 32 to substantially increase the frequency with which applicable Basin Plan objectives or other criteria  
 33 would be exceeded in water bodies of the affected environment located upstream of the Delta,  
 34 within the Delta, or in the SWP and CVP Service Area or substantially degrade the quality of these  
 35 water bodies, with regard to boron. Based on these findings, this impact is considered to be less than  
 36 significant. No mitigation is required.

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

39 ***Upstream of the Delta***

40 Under Alternative 4, regardless of operational scenario (i.e., Scenarios H1-H4), there would be no  
 41 expected change to the sources of bromide in the Sacramento and eastside tributary watersheds.  
 42 Bromide loading in these watersheds would remain unchanged and resultant changes in flows from  
 43 altered system-wide operations under Alternative 4 would have negligible, if any, effects on the

1 concentration of bromide in the rivers and reservoirs of these watersheds. Consequently, no  
 2 individual operational scenario of Alternative 4 would be expected to adversely affect the MUN  
 3 beneficial use, or any other beneficial uses, of the Sacramento River, the eastside tributaries, or their  
 4 associated reservoirs upstream of the Delta.

5 Under the four operational scenarios of Alternative 4, modeling indicates that long-term annual  
 6 average flows on the San Joaquin River would decrease by 6% relative to Existing Conditions and  
 7 would remain virtually the same relative to the No Action Alternative (Appendix 5A). These similar  
 8 decreases in flow, regardless of operational scenario, would result in possible increases in long-term  
 9 average bromide concentrations of about 3%, relative to Existing Conditions and less than <1%  
 10 relative to the No Action Alternative (Appendix 8E, *Bromide*, Table 22). The small predicted  
 11 increases in lower San Joaquin River bromide levels that could occur under Scenarios H1–H4 of  
 12 Alternative 4, relative to existing and No Action Alternative conditions, would not be expected to  
 13 adversely affect the MUN beneficial use, or any other beneficial uses, of the lower San Joaquin River.

#### 14 **Delta**

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

22 Under operational scenarios H1–H4 of Alternative 4, the geographic extent of effects pertaining to  
 23 long-term average bromide concentrations in the Delta would be similar to that previously  
 24 described for Alternative 1A, although the magnitude of predicted long-term change and relative  
 25 frequency of concentration threshold exceedances would be different. Using the mass-balance  
 26 modeling approach for bromide (see Section 8.3.1.3), relative to Existing Conditions, Scenario H1–  
 27 H4 modeled long-term average bromide concentrations would increase at Staten Island, Emmaton,  
 28 and Barker Slough, while Scenario H1–H4 modeled long-term average bromide concentrations  
 29 would decrease at the other assessment locations (Appendix 8E, *Bromide*, Table 10). Overall effects  
 30 would be greatest at Barker Slough, with the smallest model predicted increases occurring under  
 31 Scenario H3, and the largest model predicted increases occurring under Scenario H2. Under Scenario  
 32 H3, predicted long-term average bromide concentrations would increase from 51 µg/L to 62 µg/L  
 33 (21% relative increase) for the modeled 16-year hydrologic period and would increase from 54  
 34 µg/L to 92 µg/L (72% relative increase) for the modeled drought period. Under Scenario H2,  
 35 predicted long-term average bromide concentrations would increase from 51 µg/L to 72 µg/L (40%  
 36 relative increase) for the modeled 16-year hydrologic period and would increase from 54 µg/L to  
 37 106 µg/L (98% relative increase) for the modeled drought period. At Barker Slough, changes in  
 38 exceedance frequency would follow a similar pattern, with the greatest increase in exceedance  
 39 frequency occurring under Scenario H2. Under Scenario H2, the predicted 50 µg/L exceedance  
 40 frequency would increase from 49% under Existing Conditions to 56% under Alternative 4, and  
 41 would increase from 55% to 83% during the drought period. Similarly at Barker Slough, the  
 42 predicted 100 µg/L exceedance frequency would increase from 0% under Existing Conditions to  
 43 20% under Scenario H2, and would increase from 0% to 47% during the drought period. In contrast,  
 44 increases in bromide at Staten Island would result in a 50 µg/L bromide threshold exceedance  
 45 increase from 47% under Existing Conditions to 76% under Scenario H2 (52% to 83% during the

1 modeled drought period). However, unlike Barker Slough, modeling shows that long-term average  
2 bromide concentration at Staten Island would exceed the 100 µg/L assessment threshold  
3 concentration 1% under Existing Conditions and 3% under all operational scenarios(0% to 2%  
4 during the modeled drought period for all operational scenarios). The highest long-term average  
5 bromide concentrations would occur under Scenario H2, and would be 76 µg/L (83 µg/L for the  
6 modeled drought period) at Staten Island. Changes in exceedance frequency of the 50 µg/L and 100  
7 µg/L concentration thresholds, as well as relative change in long-term average concentration, at  
8 other assessment locations would be less substantial for all operational scenarios. This comparison  
9 to Existing Conditions reflects changes in bromide due to both Alternative 4 operations (including  
10 north Delta intake capacity of 9,000 cfs and the different operational components of Scenarios H1–  
11 H4) and climate change/sea level rise.

12 Due to the relatively small differences between modeled Existing Conditions and No Action baseline,  
13 changes in long-term average bromide concentrations and changes in exceedance frequencies  
14 relative to the No Action Alternative are generally of similar magnitude to those previously  
15 described for the existing condition comparison (Appendix 8E, *Bromide*, Table 10). Relative to the  
16 No Action Alternative, modeled long-term average bromide concentration increases would similarly  
17 be greatest at Barker Slough under Scenario H2, where long-term average concentrations are  
18 predicted to increase by 44% (97% for the modeled drought period). However, unlike the Existing  
19 Conditions comparison, under the No Action Alternative long-term average bromide concentrations  
20 at Buckley Cove would increase for all operational scenarios, although the increases would be  
21 relatively small (≤4%). Unlike the comparison to Existing Conditions, this comparison to the No  
22 Action Alternative reflects changes in bromide due only to the different operational components of  
23 Scenarios H1–H4 of Alternative 4.

24 At Barker Slough, modeled long-term average bromide concentrations for the two baseline  
25 conditions are very similar (Appendix 8E, *Bromide*, Tables 10- and 11). Such similarity demonstrates  
26 that the modeled Alternative 4 change in bromide is almost entirely due to Alternative 4 operations,  
27 and not climate change/sea level rise, regardless of the specific different operational components of  
28 Scenarios H1–H4. Therefore, operations are the primary driver of effects on bromide at Barker  
29 Slough, regardless of whether and particular operational scenario of Alternative 4 is compared to  
30 Existing Conditions, or compared to the No Action Alternative.

31 Results of the modeling approach which used relationships between EC and chloride and between  
32 chloride and bromide (see Section 8.3.1.3) differed somewhat from what is presented above for the  
33 mass-balance approach (see Appendix 8E, Table 11).For most locations, the frequency of  
34 exceedance of the 50 µg/L and 100 µg/L were similar. The greatest difference between the methods  
35 was predicted for Barker Slough. Under all of the operational scenarios, the increases in frequency  
36 of exceedance of the 100 µg/L threshold, relative to Existing Conditions and the No Action  
37 Alternative, were not as great using this alternative EC to chloride and chloride to bromide  
38 relationship modeling approach as compared to that presented above from the mass-balance  
39 modeling approach. Model predicted increases under Scenario H2 were still the greatest, and  
40 increases under the other operational scenarios were still substantial. At Barker Slough, the  
41 predicted 100 µg/L exceedance frequency for the 16-year hydrologic period would increase from  
42 1% under Existing Conditions and 2% under the No Action Alternative to as much as 11% under the  
43 Scenario H2.For the modeled drought period, the predicted 100 µg/L exceedance frequency would  
44 increase from 0% under Existing Conditions and the No Action Alternative to as much as 25% under  
45 Scenario H2.Because the mass-balance approach predicts a greater level of impact at Barker Slough,  
46 determination of impacts was based on the mass-balance results.

1 Although Scenario H2 would result in the greatest relative increase in long-term average bromide  
2 concentrations and greatest relative increase in exceedance frequency at Barker Slough, the  
3 difference between operational scenarios is very small. Regardless of particular Alternative 4  
4 operational scenario, the increase in long-term average bromide concentrations predicted at Barker  
5 Slough, principally the relative increase in 100 µg/L exceedance frequency, would result in a  
6 substantial change in source water quality for existing drinking water treatment plants drawing  
7 water from the North Bay Aqueduct. As discussed for Alternative 1A, drinking water treatment  
8 plants obtaining water via the North Bay Aqueduct utilize a variety of conventional and enhanced  
9 treatment technologies in order to achieve DBP drinking water criteria. While the implications of  
10 such a modeled change in bromide at Barker Slough are difficult to predict, the substantial modeled  
11 increases could lead to adverse changes in the formation of disinfection byproducts such that  
12 considerable treatment plant upgrades may be necessary in order to achieve equivalent levels of  
13 health protection. Because many of the other modeled locations already frequently exceed the 100  
14 µg/L threshold under Existing Conditions and the No Action Alternative, these locations likely  
15 already require treatment plant technologies to achieve equivalent levels of health protection, and  
16 thus no additional treatment technologies would be triggered by the small increases in the  
17 frequency of exceeding the 100 µg/L threshold. Hence, no further impact on the drinking water  
18 beneficial use would be expected at these locations.

19 The seasonal intakes at Mallard Slough and City of Antioch are infrequently used due to water  
20 quality constraints related to sea water intrusion. On a long-term average basis, bromide at these  
21 locations is in excess of 3,000 µg/L, but during seasonal periods of high Delta outflow can be <300  
22 µg/L. Based on modeling using the mass-balance approach, use of the seasonal intakes at Mallard  
23 Slough and City of Antioch under Scenarios H1–H4 of Alternative 4 would experience a period  
24 average increase in bromide during the months when these intakes would most likely be utilized.  
25 For those wet and above normal water year types where mass balance modeling would predict  
26 water quality typically suitable for diversion, change would be greatest for Scenario H1 and H3,  
27 where predicted long-term average bromide concentrations would increase from 103 µg/L to 155  
28 µg/L (51% increase) at City of Antioch and would increase from 150 µg/L to 201 µg/L (41%  
29 increase) at Mallard Slough relative to Existing Conditions (Appendix 8E, *Bromide*, Table 23). Under  
30 Scenarios H2 and H4, predicted increases would also occur, but would be somewhat less, with  
31 approximate 40% increases at the City of Antioch and approximate 34% increases at Mallard  
32 Slough. Increases would be similar for the No Action Alternative comparison, with slightly lower  
33 relative increases at City of Antioch (i.e., 33–44% depending on operational scenario), and slightly  
34 higher relative increases at Mallard Slough (i.e., 36–47% depending on operational scenario).  
35 Modeling results using the EC to chloride and chloride to bromide relationships show increases  
36 during these months, but the relative magnitude of the increases is much lower (Appendix 8E,  
37 *Bromide*, Table 24). Regardless of the differences in the data between the two modeling approaches,  
38 the decisions surrounding the use of these seasonal intakes is largely driven by acceptable water  
39 quality, and thus have historically been opportunistic. Opportunity to use these intakes would  
40 remain, and the predicted increases in bromide concentrations at the City of Antioch and Mallard  
41 Slough intake would not be expected to adversely affect MUN beneficial uses, or any other beneficial  
42 use, at these locations.

43 Important to the results presented above is the assumed habitat restoration footprint on both the  
44 temporal and spatial scales incorporated into the modeling. Modeling sensitivity analyses have  
45 indicated that habitat restoration (which is reflected in the modeling—see Section 8.3.1.3), not  
46 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 ( $\leq 36\%$ ), 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 ( $\leq 28\%$ ) (Appendix 8E, *Bromide*, Table 10). As a result, and regardless of operational scenario, less frequent bromide concentration exceedances of the 50  $\mu\text{g/L}$  and 100  $\mu\text{g/L}$  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.



1 **NEPA Effects:** In summary, the operations and maintenance activities under Scenarios H1–H4 of  
2 Alternative 4, relative to the No Action Alternative, would result in small increases (i.e., <1%) in  
3 long-term average bromide concentrations at Vernalis related to relatively small declines in long-  
4 term average flow on the San Joaquin River. However, the operations and maintenance activities  
5 under Scenarios H1–H4 of Alternative 4 would cause substantial degradation to water quality with  
6 respect to bromide at Barker Slough, source of the North Bay Aqueduct. This substantial  
7 degradation would be predicted to occur regardless of operational scenario, but would be greatest  
8 under Scenario H2. Resultant substantial change in long-term average bromide at Barker Slough  
9 could necessitate changes in water treatment plant operations or require treatment plant upgrades  
10 in order to maintain DBP compliance, and thus would constitute an adverse effect on water quality.  
11 Mitigation Measure WQ-5 is available to reduce these effects (implementation of this measure along  
12 with a separate, non-environmental commitment as set forth in EIR/EIS Appendix 3B,  
13 *Environmental Commitments*, relating to the potential increased treatment costs associated with  
14 bromide-related changes would reduce these effects).

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

20 Under operational Scenarios H1–H4 of Alternative 4 there would be no expected change to the  
21 sources of bromide in the Sacramento and eastside tributary watersheds. Bromide loading in these  
22 watersheds would remain unchanged and resultant changes in flows from altered system-wide  
23 operations under any operational scenario of Alternative 4 would have negligible, if any, effects on  
24 the concentration of bromide in the rivers and reservoirs of these watersheds. However, south of the  
25 Delta, the San Joaquin River is a substantial source of bromide, primarily due to the use of irrigation  
26 water imported from the southern Delta. Concentrations of bromide at Vernalis are inversely  
27 correlated to net river flow. Under all operational scenarios of Alternative 4, long-term average  
28 flows at Vernalis would decrease only slightly, resulting in less than substantial predicted increases  
29 in long-term average bromide of about 3% relative to Existing Conditions.

30 Relative to Existing Conditions, all operational scenarios of Alternative 4 would result in small  
31 decreases in long-term average bromide concentration at most Delta assessment locations, with  
32 principal exceptions being the North Bay Aqueduct at Barker Slough, Staten Island, and Emmaton on  
33 the Sacramento River. Overall effects would be greatest at Barker Slough, where substantial  
34 increases in long-term average bromide concentrations under all operational scenarios would be  
35 predicted, but would be greatest for Scenario H2. While the predicted increase in long-term average  
36 bromide concentrations at Barker Slough would be greatest for Scenario H2, the relative increases  
37 regardless of particular operational scenario would result in a substantial change in source water  
38 quality to existing drinking water treatment plants drawing water from the North Bay Aqueduct.  
39 These modeled increases in bromide at Barker Slough could lead to adverse changes in the  
40 formation of disinfection byproducts at drinking water treatment plants such that considerable  
41 water treatment plant upgrades could be necessary in order to achieve equivalent levels of drinking  
42 water health protection.

43 The assessment of effects on bromide in the SWP/CVP Export Service Areas is based on assessment  
44 of changes in bromide concentrations at Banks and Jones pumping plants. Under all of the  
45 operational scenarios of Alternative 4, substantial improvement would occur at the Banks and Jones

1 pumping plants, where long-term average bromide concentrations are predicted to decrease by as  
2 much as 44% relative to Existing Conditions. As a result, an overall improvement in bromide-related  
3 water quality would be predicted in the SWP/CVP Export Service Areas.

4 Based on the above, the operations and maintenance activities under Scenarios H1–H4 of  
5 Alternative 4 would not result in any substantial change in long-term average bromide concentration  
6 upstream of the Delta. Furthermore, under all of the operational scenarios of Alternative 4, water  
7 exported from the Delta to the SWP/CVP service area would be substantially improved relative to  
8 bromide. Bromide is not bioaccumulative, therefore change in long-term average bromide  
9 concentrations would not directly cause bioaccumulative problems in aquatic life or humans.  
10 Additionally, bromide is not a constituent related to any 303(d) listings. The operations and  
11 maintenance activities under Scenarios H1–H4 of Alternative 4 would not cause substantial long-  
12 term degradation to water quality respective to bromide with the exception of water quality at  
13 Barker Slough, source of the North Bay Aqueduct. At Barker Slough, modeled long-term annual  
14 average concentrations of bromide would increase by as much as 40%, and 98% during the modeled  
15 drought period. For the modeled 16-year hydrologic period the frequency of predicted bromide  
16 concentrations exceeding 100 µg/L would increase from 0% under Existing Conditions to as much  
17 as 20% under Alternative 4, while for the modeled drought period, the frequency would increase  
18 from 0% to as much as 47%. The substantial changes in long-term average bromide predicted for  
19 Barker Slough under all operational scenarios of Alternative 4 could necessitate changes in  
20 treatment plant operation or require treatment plant upgrades in order to maintain DBP  
21 compliance. The model predicted change at Barker Slough is substantial and, therefore, would  
22 represent a substantially increased risk for adverse effects on existing MUN beneficial uses should  
23 treatment upgrades not be undertaken. The impact is considered significant.

24 Implementation of Mitigation Measure WQ-5 along with a separate, non-environmental  
25 commitment relating to the potential increased treatment costs associated with bromide-related  
26 changes would reduce these effects. While mitigation measures to reduce these water quality effects  
27 in affected water bodies to less than significant levels are not available, implementation of  
28 Mitigation Measure WQ-5 is recommended to attempt to reduce the effect that increased bromide  
29 concentrations may have on Delta beneficial uses. However, because the effectiveness of this  
30 mitigation measure to result in feasible measures for reducing water quality effects is uncertain, this  
31 impact is considered to remain significant and unavoidable.

32 In addition to and to supplement Mitigation Measure WQ-5, the BDCP proponents have incorporated  
33 into the BDCP, as set forth in EIR/EIS Appendix 3B, *Environmental Commitments*, a separate, non-  
34 environmental commitment to address the potential increased water treatment costs that could  
35 result from bromide-related concentration effects on municipal water purveyor operations.  
36 Potential options for making use of this financial commitment include funding or providing other  
37 assistance towards implementation of the North Bay Aqueduct AIP, acquiring alternative water  
38 supplies, or other actions to indirectly reduce the effects of elevated bromide and DOC in existing  
39 water supply diversion facilities. Please refer to Appendix 3B, *Environmental Commitments*, for the  
40 full list of potential actions that could be taken pursuant to this commitment in order to reduce the  
41 water quality treatment costs associated with water quality effects relating to chloride, electrical  
42 conductivity, and bromide.

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

4 It remains to be determined whether, or to what degree, the available and existing salinity  
 5 response and countermeasure actions of SWP and CVP facilities or municipal water purveyors  
 6 would be capable of offsetting the actual level of changes in bromide that may occur from  
 7 implementation of Alternative 4. Therefore, in order to determine the feasibility of reducing the  
 8 effects of increased bromide levels, and potential adverse effects on beneficial uses associated  
 9 with CM1 operations (and hydrodynamic effects of tidal restoration under CM4), the proposed  
 10 mitigation requires a series of phased actions to identify and evaluate existing and possible  
 11 feasible actions, followed by development and implementation of the actions, if determined to  
 12 be necessary. The development and implementation of any mitigation actions shall be focused  
 13 on those incremental effects attributable to implementation of Alternative 4 operations only.  
 14 Development of mitigation actions for the incremental bromide effects attributable to climate  
 15 change/sea level rise are not required because these changed conditions would occur with or  
 16 without implementation of Alternative 4. The goal of specific actions would be to reduce/avoid  
 17 additional degradation of Barker Slough water quality conditions with respect to the CALFED  
 18 bromide goal.

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

25 Additionally, following commencement of initial operations of CM1, the BDCP proponents will  
 26 conduct additional evaluations described herein, and develop additional modeling (as  
 27 necessary), to define the extent to which modified operations could reduce or eliminate the  
 28 increased bromide concentrations currently modeled to occur under Alternative 4. The  
 29 additional evaluations should also consider specifically the changes in Delta hydrodynamic  
 30 conditions associated with tidal habitat restoration under CM4 (in particular the potential for  
 31 increased bromide concentrations that could result from increased tidal exchange) once the  
 32 specific restoration locations are identified and designed. The evaluations will also consider up-  
 33 to-date estimates of climate change and sea level rise, if and when such information is available.  
 34 If sufficient operational flexibility to offset bromide increases is not practicable/feasible under  
 35 Alternative 4 operations, and/or siting and design of restoration areas cannot feasibly reduce  
 36 bromide increases to a less than significant level without compromising the benefits of the  
 37 proposed areas, achieving bromide reduction pursuant to this mitigation measure would not be  
 38 feasible under this alternative.

39 **Impact WQ-6: Effects on Bromide Concentrations Resulting from Implementation of CM2-**  
 40 **CM22CM21**

41 **NEPA Effects:** CM12-CM22CM21 would present no new sources of bromide to the affected  
 42 environment, including areas Upstream of the Delta, within the Plan Area, and the SWP/CVP Export  
 43 Service Areas. As they pertain to bromide, implementation of these conservation measures would

1 not be expected to adversely affect MUN beneficial use, or any other beneficial uses, of the affected  
2 environment.

3 With exception to habitat restoration areas that would effectively alter Delta hydrodynamics, habitat  
4 restoration and the various land-disturbing conservation measures proposed for Alternative 4  
5 would not present new or substantially changed sources of bromide to the study area. Modeling  
6 scenarios included assumptions regarding how certain habitat restoration activities would affect  
7 Delta hydrodynamics (CM2 and CM4), and thus such hydrodynamic effects of these restoration  
8 measures were included in the assessment of CM1 facilities operations and maintenance (see Impact  
9 WQ-1).

10 Some habitat restoration activities would occur on lands in the Delta formerly used for irrigated  
11 agriculture. Such replacement or substitution of land use activity would not be expected to result in  
12 new or increased sources of bromide to the Delta. Implementation of CM2–CM11 would not be  
13 expected to adversely affect MUN beneficial use, or any other beneficial uses, within the affected  
14 environment.

15 In summary, implementation of CM2–~~CM22CM21~~ under Alternative 4, relative to the No Action  
16 Alternative, would have negligible, if any, effects on bromide concentrations. The effects on bromide  
17 from implementing CM2–~~CM22CM21~~ are determined to not be adverse.

18 **CEQA Conclusion:** Implementation of CM2–~~CM22CM21~~ under Alternative 4 would not present new  
19 or substantially changed sources of bromide to the study area. Some conservation measures may  
20 replace or substitute for existing irrigated agriculture in the Delta. This replacement or substitution  
21 would not be expected to substantially increase or present new sources of bromide. Implementation  
22 of CM2–~~CM22CM21~~ would have negligible, if any, effects on bromide concentrations throughout the  
23 affected environment, would not cause exceedance of applicable state or federal numeric or  
24 narrative water quality objectives/criteria because none exist for bromide, and would not cause  
25 changes in bromide concentrations that would result in significant impacts on any beneficial uses  
26 within affected water bodies. Implementation of CM2–~~CM22CM21~~ would not cause significant long-  
27 term water quality degradation such that there would be greater risk of significant impacts on  
28 beneficial uses, would not cause greater bioaccumulation of bromide, and would not further impair  
29 any beneficial uses due to bromide concentrations because no uses are currently impaired due to  
30 bromide levels. This impact is therefore considered less than significant. No mitigation is required.

### 31 **Impact WQ-7: Effects on Chloride Concentrations Resulting from Facilities Operations and** 32 **Maintenance (CM1)**

#### 33 ***Upstream of the Delta***

34 Under Alternative 4, Scenarios H1–H4, there would be no expected change to the sources of chloride  
35 in the Sacramento and eastside tributary watersheds. Chloride loading in these watersheds would  
36 remain unchanged and resultant changes in flows from altered system-wide operations would have  
37 negligible, if any, effects on the concentration of chloride in the rivers and reservoirs of these  
38 watersheds. The modeled long-term annual average flows on the lower San Joaquin River at Vernalis  
39 would decrease slightly compared to Existing Conditions (in association with the different  
40 operational components of Scenarios H1–H4 for Alternative 4, climate change, and increased water  
41 demands) and be similar compared to the No Action Alternative (considering only changes due only  
42 to the different operational components of Scenarios H1–H4 under Alternative 4). The reduced flow  
43 would result in possible increases in long-term average chloride concentrations of about 2%,

1 relative to the Existing Conditions, which would be nearly identical under each of the H1–H4  
 2 scenarios, and no change relative to No Action Alternative (Appendix 8G, Table Cl-62).  
 3 Consequently, the Alternative 4 H1–H4 Scenarios would not be expected to cause exceedances of  
 4 chloride objectives/criteria or substantially degrade water quality with respect to chloride, and thus  
 5 would not adversely affect any beneficial uses of the Sacramento River, the eastside tributaries,  
 6 associated reservoirs upstream of the Delta, or the San Joaquin River.

### 7 **Delta**

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

15 Relative to Existing Conditions, modeling predicts that the Alternative 4H1–H4 Scenarios would  
 16 result in similar or reduced long-term average chloride concentrations for the 16-year period  
 17 modeled at most of the assessment locations. The mass-balance modeling results indicate similar,  
 18 but slightly larger increases in chloride concentrations compared to estimates generated using EC-  
 19 chloride relationships and DSM2 EC output(see Section 8.3.1.3).Increased long-term average  
 20 chloride concentrations would occur at the North Bay Aqueduct at Barker Slough (i.e., range from up  
 21 to 33% [H2] to 16% [H3]) and ~~San Joaquin-SF Mokelumne~~ River at Staten Island (i.e., similar  
 22 increase of 22–23% for all H1–H4 Scenarios) (Appendix 8G, *Chloride*, Tables Cl-25A/~~through~~ 25D  
 23 [mass balance model results] and Tables Cl-26A/~~through~~ 26D[EC-chloride relationship  
 24 results]).Changes in long-term average concentrations in the western Sacramento River at Emmaton  
 25 would range from an increase for Scenarios H1 and H2 (14 to 16%) to no measureable change for  
 26 Scenarios H3 and H4 (i.e., -1%).Long-term average chloride concentration would decrease at other  
 27 assessment locations, with the largest reductions occurring under Scenarios H3 and H4 (i.e., up to -  
 28 24% at Franks Tract) and less reduction under Scenarios H1 and H2 (i.e., up to -12% at Franks  
 29 Tract).Additionally, implementation of tidal habitat restoration under CM4 would increase the tidal  
 30 exchange volume in the Delta, and thus may contribute to increased chloride concentrations in the  
 31 Bay source water as a result of increased salinity intrusion. More discussion of this phenomenon is  
 32 included in Section 8.3.1.3. Consequently, while uncertain, the magnitude of chloride increases may  
 33 be greater than indicated herein and would affect the western Delta assessment locations the most  
 34 which are influenced to the greatest extent by the Bay source water. This comparison to Existing  
 35 Conditions reflects changes in chloride due to both the different operational components of  
 36 Scenarios H1–H4 for Alternative 4 and climate change/sea level rise.

37 Relative to the No Action Alternative conditions, the mass balance analysis of modeling results  
 38 indicated that the Alternative 4 Scenarios H1–H4 would result in similar increases in long-term  
 39 average chloride concentrations for the 16-year period as described above compared to Existing  
 40 Conditions: SF Mokelumne River at Staten Island (i.e., up to 25 to 27% for all H1–H4 Scenarios),  
 41 North Bay Aqueduct at Barker Slough (i.e., range of 20% [H3] up to 37% [H2]), and for the  
 42 Sacramento River at Emmaton (i.e., ranging from an increase for Scenarios H1-H2 of up to 17% to  
 43 reduction under Scenarios H3-H4 [-1%]) (Appendix 8G, Table Cl-25A/~~through~~ 25D [mass balance  
 44 model results] and Tables Cl-26A/~~through~~ 26D [EC-chloride relationship results]). Relative to the  
 45 No Action Alternative, the long-term average chloride concentrations based on EC to chloride

1 relationships indicate that most of the other interior and western Delta assessment locations under  
 2 Scenarios H1 and H2 would exhibit similar increases ranging from up to 3% at San Joaquin River at  
 3 Buckley Cove to 9% at the Sacramento River at Mallard Island. The comparison to the No Action  
 4 Alternative reflects chloride changes due only to the different operational components of Scenarios  
 5 H1–H4 for Alternative 4.

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

#### 8 *Municipal Beneficial Uses—Relative to Existing Conditions*

9 Estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output  
 10 (see Section 8.3.1.3) were used to evaluate the 150 mg/L Bay-Delta WQCP objective for municipal  
 11 and industrial beneficial uses on a basis of the percent of years the chloride objective is exceeded for  
 12 the modeled 16-year period. The objective is exceeded if chloride concentrations exceed 150 mg/L  
 13 for a specified number of days in a given water year at both the Antioch and Contra Costa Pumping  
 14 Plant #1 locations. For the Alternative 4 Scenarios H1–H4, the modeled frequency of objective  
 15 exceedance would ~~approximately double~~ be unchanged relative to Existing Conditions at the Contra  
 16 Costa Pumping Plant #1 ~~at from 76% of years under Existing Conditions, to 13% of years under all of~~  
 17 ~~the Alternative 4 scenarios~~ (Appendix 8G, Table CI-64).

18 Similarly, estimates of chloride concentrations generated using EC-chloride relationships and DSM2  
 19 EC output (see Section 8.3.1.3) were also used to evaluate the 250 mg/L Bay-Delta WQCP objective  
 20 for chloride at Contra Costa Pumping Plant #1 where daily average objectives apply. The basis for  
 21 the evaluation was the predicted number of days the objective was exceeded for the modeled 16-  
 22 year period. For Alternative 4, the modeled frequency of objective exceedance would decrease  
 23 similarly for the H1–H4 Scenarios by approximately one half, from 6% of modeled days under  
 24 Existing Conditions, to 3–4% of modeled days under the Alternative 4 operational scenarios  
 25 (Appendix 8G, Table CI-63).

26 Given the limitations inherent to estimating future chloride concentrations (see Section 8.3.1.3),  
 27 estimation of chloride concentrations through both a mass balance approach and an EC-chloride  
 28 relationship approach was used to evaluate the 250 mg/L Bay-Delta WQCP objectives in terms of  
 29 both frequency of exceedance and use of assimilative capacity. When utilizing the mass balance  
 30 approach to model monthly average chloride concentrations for the 16-year period, the predicted  
 31 frequency of exceeding the 250 mg/L objective would decrease at the Contra Costa Canal at  
 32 Pumping Plant #1 from an exceedance frequency of 24% under Existing Conditions to a range of  
 33 18% (for H1) to 12–13% (for H3 and H4) (Appendix 8G, Table CI-27 and Figure CI-5). However, the  
 34 frequency of exceedances would increase slightly for the 16-year period modeled at the San Joaquin  
 35 River at Antioch (i.e., from 66% under Existing Conditions to 68% to 70% for the H1–H4 Scenarios)  
 36 and Sacramento River at Mallard Island (i.e., from 85% under Existing Conditions to 86% to 88% for  
 37 the H1–H4 Scenarios) (Appendix 8G, Table CI-27). Although these changes are within the  
 38 uncertainty of the modeling approach. ~~¶~~ The mass balance results also indicate that the increased  
 39 concentrations would reduce assimilative capacity with respect to the 250 mg/L objective, thus  
 40 causing further degradation at Antioch in March and April, with similar maximum reductions under  
 41 H1 and H3 of up to 54% to maximum reductions of up to 42% for H3 and H4 for the 16-year period  
 42 modeled, and 100% reduction, or elimination of assimilative capacity, for all of the H1–H4 Scenarios  
 43 during the drought period modeled) (Appendix 8G, Tables CI-29 A/2A through 29D and Figure CI-  
 44 5). Assimilative capacity at the Contra Costa Canal at Pumping Plant #1 also would be similarly

1 reduced in September and October under the H1 and H2 scenarios (i.e., up to 100%, or elimination)  
 2 when chloride concentrations would be near, or exceed, the objectives, thus increasing the risk of  
 3 exceeding objectives (Appendix 8G, Figure Cl-5), but would not be substantially reduced under the  
 4 H3 or H4 scenarios.

5 In comparison, when utilizing the chloride-EC relationship to model monthly average chloride  
 6 concentrations for the 16-year period, trends in frequency of exceedance and use of assimilative  
 7 capacity would be similar to that discussed when utilizing the mass balance modeling approach  
 8 (Appendix 8G, *Chloride*, Table Cl-28 and Tables Cl-30A/3A through 30D). However, as with  
 9 Alternative 1A the modeling approach utilizing the chloride-EC relationships predicted changes of  
 10 lesser magnitude, where predictions of change utilizing the mass balance approach were generally  
 11 of greater magnitude, and thus more conservative. As discussed in Section 8.3.1.3, in cases of such  
 12 disagreement, the approach that yielded the more conservative predictions was used as the basis for  
 13 determining adverse impacts.

14 Based on the ~~additional predicted annual and seasonal exceedances of one or both Bay Delta WQCP~~  
 15 ~~objectives for chloride, and the associated~~ long-term average water quality degradation in the  
 16 western Delta, the potential exists for substantial adverse effects under all of the Alternative 4H1–  
 17 H4 Scenarios on the municipal and industrial beneficial uses through reduced opportunity for  
 18 diversion of water with acceptable chloride levels.

#### 19 *303(d) Listed Water Bodies—Relative to Existing Conditions*

20 With respect to the 303(d) listing for chloride in Tom Paine Slough, the monthly average chloride  
 21 concentrations for the 16-year period modeled at Old River at Tracy Road would generally be  
 22 similar under all of the Alternative 4H1–H4 Scenarios compared to Existing Conditions, and thus,  
 23 would not be further degraded on a long-term basis (Appendix 8G, Figure Cl-6). With respect to  
 24 Suisun Marsh, the monthly average chloride concentrations for the 16-year period modeled would  
 25 generally increase under all of the Alternative 4 H1–H4 Scenarios compared to Existing Conditions  
 26 in the months of March through May at the Sacramento River at Collinsville (Appendix 8G, Figure Cl-  
 27 7), Mallard Island (Appendix 8G, Figure Cl-5), and increase substantially at Montezuma Slough at  
 28 Beldon’s Landing (i.e., over a doubling of concentration in December through February) (Appendix  
 29 8G, Figure Cl-8). ~~However, modeling data for of Alternative 4 assumed no operation of the~~  
 30 ~~Montezuma Slough Salinity Control Gates, but the project description assumes continued operation~~  
 31 ~~of the Salinity Control Gates, consistent with assumptions included in the No Action Alternative. A~~  
 32 ~~sensitivity analysis modeling run conducted for Alternative 4 with the gates operational consistent~~  
 33 ~~with the No Action Alternative resulted in substantially lower EC levels than indicated in the original~~  
 34 ~~Alternative 4 modeling results for Suisun Marsh, but EC levels was-were still somewhat higher than~~  
 35 ~~EC levels under Existing Conditions and-for several locations and months. Although chloride was~~  
 36 ~~not specifically modeled using-in these sensitivity analyses, it is expected that chloride~~  
 37 ~~concentrations would be nearly proportional to EC levels in Suisun mMarsh. Another modeling run~~  
 38 ~~with the gates operational and removing-restoration areas removed resulted in EC levels nearly~~  
 39 ~~equivalent to Existing Conditions, indicating that design and siting of restoration areas has notable~~  
 40 ~~bearing on EC levels at different locations within Suisun Marsh (see Appendix 8H Attachment 1 for~~  
 41 ~~more information on these sensitivity analyses). These analyses also indicate that increases in~~  
 42 ~~salinity are related primarily to the hydrodynamic effects of CM4, not operational components of~~  
 43 ~~CM1. Based on the sensitivity analyses, optimizing the Although chloride was not specifically~~  
 44 ~~modeled using these sensitivity analyses, it is expected that chloride would be nearly proportional~~  
 45 ~~to EC in Suisun marsh. It is believed that ddesign and siting of restoration areas can may be~~

1 ~~optimized to the degree that limit the magnitude of long-term chloride increases in the Marsh, if any,~~  
 2 ~~would be relatively small.~~ However, the chloride concentration increases at certain locations could  
 3 be substantial, depending on siting and design of restoration areas. Thus, these increased chloride  
 4 levels in Suisun Marsh are considered to ~~potentially thereby contributing contribute~~ to additional,  
 5 measureable long-term degradation that potentially would adversely affect the necessary actions to  
 6 reduce chloride loading for any TMDL that is developed.

#### 7 *Municipal Beneficial Uses—Relative to No Action Alternative*

8 Similar to the assessment conducted for Existing Conditions, estimates of chloride concentrations  
 9 generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3) were used to  
 10 evaluate the 150 mg/L Bay-Delta WQCP objective for municipal and industrial beneficial uses. For  
 11 Alternative 4, the modeled frequency of objective exceedance would increase at the Contra Costa  
 12 Pumping Plant #1 from 60% under the No Action Alternative to 137% of years under all of the  
 13 Alternative 4 H1–H4 Scenarios (Appendix 8G, Table Cl-64). The increase was due to a single year,  
 14 1977, which fell just short of the required number of days (i.e., was within 10 days minimum  
 15 number of required days < 150 mg/L). Given the uncertainty in the chloride modeling approach, it  
 16 is likely that real time operations of the SWP and CVP could achieve compliance with this objective  
 17 (see Section 8.3.1.1 for a discussion of chloride compliance modeling uncertainties and a description  
 18 of real time operations of the SWP and CVP).

19 Similarly, estimates of chloride concentrations generated using EC-chloride relationships and DSM2  
 20 EC output (see Section 8.3.1.3) were also used to evaluate the 250 mg/L Bay-Delta WQCP objective  
 21 for chloride at Contra Costa Pumping Plant #1 where daily average objectives apply. For Alternative  
 22 4, the modeled frequency of objective exceedance would decrease minimally under all the H1–H4  
 23 Scenarios, from 5% of modeled days under the No Action Alternative to 4–3% of modeled days  
 24 under the Alternative 4 scenarios (Appendix 8G, Table Cl-64).

25 Similar to Existing Conditions, a comparative assessment of modeling approaches was utilized to  
 26 evaluate the 250 mg/L Bay-Delta WQCP objectives in terms of both frequency of exceedance and use  
 27 of assimilative capacity on a monthly average basis. When utilizing the mass balance approach to  
 28 model monthly average chloride concentrations for the 16-year period, a small increase in  
 29 exceedance frequency would be predicted at the Sacramento River at Mallard Island (i.e., from 86%  
 30 for the No Action Alternative to a slight 2% increase [up to 88%] for H1 and H3), with no change in  
 31 exceedances under H2 or H4 (Appendix 8G, Table Cl-27). The frequency of exceedances would  
 32 decrease slightly at the San Joaquin River at Antioch (i.e., from 73% for the No Action Alternative to  
 33 a range of 68% [H2 and H4] to 70% [H1]), and the frequency of exceedances at the Contra Costa  
 34 Canal at Pumping Plant #1 would depend on the scenario from 14% under the No Action Alternative  
 35 increasing by 2–4% for H1 and H2 (i.e., up to 18%) and decreasing at H3 and H4 [to 12%])  
 36 (Appendix 8G, Table Cl-27). Although these changes are within the uncertainty of the modeling  
 37 approach, substantial reductions in available assimilative capacity compared to the No Action  
 38 Alternative condition would occur at Antioch under H1 and H3 (i.e., 24% in April) and no substantial  
 39 reduction under H2/H4 for the 16-year period modeled, and up to 100% in April [i.e., eliminated]  
 40 for the drought period for all H1–H4 scenarios). Assimilative capacity also would be reduced  
 41 substantially at the Contra Costa Canal at Pumping Plant #1 at similar levels for H1 and H2 in August  
 42 through November (i.e., up to 100% elimination in October) to only in August and September under  
 43 H3 and H4 (i.e., up to 29%) for the 16-year period modeled, with 100% elimination in at least one  
 44 month under all of the H1–H4 scenarios for the drought period) (Appendix 8G, Tables Cl-29A/2A



1 ~~through 29D~~), reflecting substantial degradation during months when average concentrations  
2 would be near, or exceed, the objective.

3 In comparison, when utilizing the chloride-EC relationship to model monthly average chloride  
4 concentrations for the 16-year period, trends in frequency of exceedance and use of assimilative  
5 capacity would be similar to that discussed when utilizing the mass balance modeling approach  
6 (Appendix 8G, Tables Cl-30A/~~3A through 30D~~). However, as with Alternative 1A, the modeling  
7 approach utilizing the chloride-EC relationships predicted changes of lesser magnitude, where  
8 predictions of change utilizing the mass balance approach were generally of greater magnitude, and  
9 thus more conservative. As discussed in Section 8.3.1.3, in cases of such disagreement, the approach  
10 that yielded the more conservative predictions was used as the basis for determining adverse  
11 impacts.

12 Based on the ~~additional predicted annual and seasonal exceedances of one or both Bay Delta WQCP~~  
13 ~~objectives for chloride, and the associated~~ long-term average water quality degradation in the  
14 western Delta, the potential exists for substantial adverse effects under all of the Alternative 4H1-  
15 H4 Scenarios on the municipal and industrial beneficial uses through reduced opportunity for  
16 diversion of water with acceptable chloride levels.

#### 17 *303(d) Listed Water Bodies—Relative to No Action Alternative*

18 With respect to the 303(d) listing for chloride, Alternative 4 would generally result in similar  
19 changes for all of the Alternative 4 H1–H4 Scenarios to those discussed for the comparison to  
20 Existing Conditions. Monthly average chloride concentrations at Tom Paine Slough would not be  
21 further degraded on a long-term basis (Appendix 8G, Figure Cl-6). ~~Modeling results indicated that~~  
22 ~~4m~~ monthly average chloride concentrations at source water channel locations for the Suisun Marsh  
23 (Appendix 8G, Figures Cl-5, Cl-7 and Cl-8) would increase substantially in some months during  
24 October through May compared to the No Action Alternative conditions, ~~but sensitivity analyses~~  
25 ~~suggested that operation of the Salinity Control Gates and restoration area siting and design~~  
26 ~~considerations could reduce these increases. However, the chloride concentration increases at~~  
27 ~~certain locations could be substantial, depending on siting and design of restoration areas. Thus,~~  
28 ~~these increased chloride levels in Suisun Marsh are considered to~~ ~~Therefore, contribute to~~  
29 additional, measureable long-term degradation ~~would occur~~ in Suisun Marsh that potentially would  
30 adversely affect the necessary actions to reduce chloride loading for any TMDL that is developed.

#### 31 ***SWP/CVP Export Service Areas***

32 Under the Alternative 4H1–H4 Scenarios, long-term average chloride concentrations based on the  
33 mass balance analysis of modeling results for the 16-year period modeled at the Banks and Jones  
34 pumping plants would decrease compared to Existing Conditions. Reductions at Banks would be  
35 slightly larger than at Jones, ranging from 37% (H1) to 45% (H4) (Appendix 8G, *Chloride*, Table Cl-  
36 ~~25A/2A through 25D~~). Compared to No Action Alternative, the pattern of reductions would be  
37 similar with Banks ranging from 32% (H1) to 38% (H4). The modeled frequency of exceedances of  
38 applicable water quality objectives/criteria would decrease relative to Existing Conditions and No  
39 Action Alternative, for both the 16-year period and the drought period modeled (Appendix 8G,  
40 *Chloride*, Table Cl-27). Consequently, water exported into the SWP/CVP service area would  
41 generally be of similar or better quality with regards to chloride relative to Existing Conditions and  
42 the No Action Alternative conditions.

1 Results of the modeling approach which used relationships between EC and chloride (see Section  
 2 8.3.1.3) were consistent with the discussion above, and assessment of chloride using these data  
 3 results in the same conclusions as are presented above for the mass-balance approach (Appendix  
 4 8G, Tables CI-26A/2A through 26D [for concentration changes] and Table CI-28 [for frequency of  
 5 exceedances]).

6 Commensurate with the reduced chloride concentrations in water exported to the service area,  
 7 reduced chloride loading in the lower San Joaquin River would be anticipated which would likely  
 8 alleviate or lessen any expected increase in chloride at Vernalis related to decreased annual average  
 9 San Joaquin River flows (see discussion of Upstream of the Delta).

10 Maintenance of SWP and CVP facilities would not be expected to create new sources of chloride or  
 11 contribute towards a substantial change in existing sources of chloride in the affected environment.  
 12 Maintenance activities would not be expected to cause any substantial change in chloride such that  
 13 any long-term water quality degradation would occur, thus, beneficial uses would not be adversely  
 14 affected anywhere in the affected environment.

15 **NEPA Effects:** In summary, relative to the No Action Alternative conditions, ~~the Alternative 4H1-H4~~  
 16 ~~Scenarios are not expected to result in substantial additional exceedances of the 150 mg/L or 250~~  
 17 ~~mg/L water quality objectives.~~ ~~a~~All of the Alternative 4H1–H4 Scenarios would result in increased  
 18 water quality degradation ~~and frequency of exceedance of the 150 mg/L objective at Contra Costa~~  
 19 ~~Pumping Plant #1 and Antioch, increased water quality degradation~~ with respect to the 250 mg/L  
 20 municipal and industrial objective at ~~interior and~~ western Delta locations on a monthly average  
 21 basis, and ~~could contribute~~ measureable water quality degradation relative to the 303(d)  
 22 impairment in Suisun Marsh (see Mitigation Measure WQ-7 below; implementation of this measure  
 23 along with a separate, non-environmental commitment relating to the potential increased chloride  
 24 treatment costs would reduce these effects). The predicted chloride increases constitute an adverse  
 25 effect on water quality. Additionally, the predicted changes relative to the No Action Alternative  
 26 conditions indicate that in addition to the effects of climate change/sea level rise, implementation of  
 27 CM1 and CM4 under the Alternative 4 H1–H4 Scenarios would contribute substantially to the  
 28 adverse water quality effects.

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

34 Chloride is not a constituent of concern in the Sacramento River watershed upstream of the Delta,  
 35 thus river flow rate and reservoir storage reductions that would occur under any of the Alternative  
 36 4H1–H4 Scenarios, relative to Existing Conditions, would not be expected to result in a substantial  
 37 adverse change in chloride levels. Additionally, relative to Existing Conditions, the Alternative 4 H1–  
 38 H4 Scenarios would not result in reductions in river flow rates (i.e., less dilution) or increased  
 39 chloride loading such that there would be any substantial increase in chloride concentrations  
 40 upstream of the Delta in the San Joaquin River watershed.

41 Relative to Existing Conditions, ~~all of~~ the Alternative 4H1–H4 Scenarios would ~~result in substantially~~  
 42 ~~increased chloride concentrations in the Delta such that not increase the~~ frequency of exceeding the  
 43 150 mg/L Bay-Delta WQCP objective. ~~would approximately double. Moreover, t~~Modeling results  
 44 ~~indicated that~~ the frequency of exceedance of the 250 mg/L Bay-Delta WQCP objective would

1 increase at the San Joaquin River at Antioch and at Mallard Slough (ranging by up to 2 to 4% for the  
 2 H1–H4 Scenarios), but these frequencies are expected to be within the uncertainty present in the  
 3 chloride modeling procedure. Substantial long-term degradation ~~also~~ may occur at Antioch under all  
 4 of the H1–H4 Scenarios, and at the Contra Costa Canal at Pumping Plant #1 under the H1-H2  
 5 Scenarios, that may result in adverse effects on the municipal and industrial water supply beneficial  
 6 use (see Mitigation Measure WQ-7 below; implementation of this measure along with a separate,  
 7 non-environmental commitment relating to the potential increased chloride treatment costs would  
 8 reduce these effects). Relative to the Existing Conditions, the modeled increased chloride  
 9 concentrations and degradation in the western Delta under all of the H1–H4 Scenarios could further  
 10 contribute, at measurable levels (~~i.e., over a doubling of concentration~~), to the existing 303(d) listed  
 11 impairment due to chloride in Suisun Marsh for the protection of fish and wildlife.

12 Chloride concentrations would be reduced under all of the H1–H4 Scenarios in water exported from  
 13 the Delta to the CVP/SWP Export Service Areas, thus reflecting a potential improvement to chloride  
 14 loading in the lower San Joaquin River.

15 Chloride is not a bioaccumulative constituent, thus any increased concentrations under the  
 16 Alternative 4H1–H4 Scenarios would not result in substantial chloride bioaccumulation impacts on  
 17 aquatic life or humans. Alternative 4 maintenance would not result in any substantial changes in  
 18 chloride concentration upstream of the Delta or in the SWP/CVP Export Service Areas. However,  
 19 based on these findings, this impact is determined to be significant due to increased chloride  
 20 concentrations and degradation at western Delta locations and its potential effects on municipal and  
 21 industrial water supply and fish and wildlife beneficial uses.

22 Implementation of Mitigation Measure WQ-7 along with a separate, non-environmental  
 23 commitment relating to the potential increased costs associated with chloride-related changes  
 24 would reduce these effects. Although it is not known whether implementation of WQ-7 will be able  
 25 to feasibly reduce water quality degradation in the western Delta, implementation of Mitigation  
 26 Measure WQ-7 is recommended to attempt to reduce the effect that increased chloride  
 27 concentrations may have on Delta beneficial uses. However, because the effectiveness of this  
 28 mitigation measure to result in feasible measures for reducing these water quality effects is  
 29 uncertain, this impact is considered to remain significant and unavoidable. Based on sensitivity  
 30 analyses conducted to date (see Appendix 8H Attachment 1), it is expected that implementation of  
 31 WQ-7d will be able to reduce impacts on chloride in Suisun Marsh to a less than significant level.

32 ~~While mitigation measures to reduce these water quality effects in affected water bodies to less than~~  
 33 ~~significant levels are not available, implementation of Mitigation Measure WQ-7 is recommended to~~  
 34 ~~attempt to reduce the effect that increased chloride concentrations may have on Delta beneficial~~  
 35 ~~uses. However, because the effectiveness of this mitigation measure to result in feasible measures for~~  
 36 ~~reducing water quality effects is uncertain, this impact is considered to remain significant and~~  
 37 ~~unavoidable.~~

38 In addition to and to supplement Mitigation Measure WQ-7, the BDCP proponents have incorporated  
 39 into the BDCP, as set forth in EIR/EIS Appendix 3B, *Environmental Commitments*, a separate, non-  
 40 environmental commitment to address the potential increased water treatment costs that could  
 41 result from chloride concentration effects on municipal, industrial and agricultural water purveyor  
 42 operations. Potential options for making use of this financial commitment include funding or  
 43 providing other assistance towards acquiring alternative water supplies or towards modifying  
 44 existing operations when chloride concentrations at a particular location reduce opportunities to

1 operate existing water supply diversion facilities. Please refer to Appendix 3B, *Environmental*  
 2 *Commitments*, for the full list of potential actions that could be taken pursuant to this commitment in  
 3 order to reduce the water quality treatment costs associated with water quality effects relating to  
 4 chloride, electrical conductivity, and bromide.

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

7 It is currently unknown whether the effects of increased chloride levels, and potential adverse  
 8 effects on municipal and industrial water supply and fish and wildlife beneficial uses associated  
 9 with CM1 operations (and hydrodynamic effects of tidal restoration under CM4), can be  
 10 mitigated through modifications to initial operations and/or site-specific design of tidal  
 11 restoration areas under CM4. Specifically, it remains to be determined whether, or to what  
 12 degree, the available and existing salinity response and countermeasure actions of SWP and CVP  
 13 facilities, municipal water purveyors, or Suisun Marsh salinity control facilities would be capable  
 14 of offsetting the actual level of changes in chloride that may occur from implementation of  
 15 Alternative 4. Therefore, the proposed mitigation measures require a series of actions to identify  
 16 and evaluate potentially feasible actions, to achieve reduced chloride levels in order to reduce or  
 17 avoid impacts to beneficial uses.

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

28 Nevertheless, water quality degradation could occur that may not be addressed through real-  
 29 time operations. The development and implementation of any mitigation actions shall be  
 30 focused on those incremental effects attributable to implementation of Alternative 4 operations  
 31 only. Development of mitigation actions for the incremental chloride effects attributable to  
 32 climate change/sea level rise are not required because these changed conditions would occur  
 33 with or without implementation of Alternative 4.

34 **Mitigation Measure WQ-7a: Conduct Additional Evaluation ~~and Modeling of Increased~~**  
 35 **~~Chloride Levels Following Initial Operations of CM1 of Operational Ability to Reduce or~~**  
 36 **~~Eliminate Water Quality Degradation in Western Delta Incorporating Site-Specific~~**  
 37 **~~Restoration Areas and Updated Climate Change/Sea Level Rise Projections, if Available~~**

38 ~~Following commencement of initial operations of CM1, t~~The BDCP proponents will conduct  
 39 additional evaluations ~~described herein,~~ and develop additional modeling (as necessary), to  
 40 define the extent to which modified operations of the SWP and CVP could reduce or eliminate  
 41 ~~the additional exceedances of water quality degradation relative to~~ the 250 mg/L Bay-Delta  
 42 WQCP objective for chloride currently modeled to occur under Alternative 4. The additional  
 43 evaluations ~~should will be conducted to also~~ consider specifically the changes in Delta

1 hydrodynamic conditions associated with tidal habitat restoration under CM4 ~~(in particular the~~  
 2 ~~potential for increased chloride concentrations that could result from increased tidal exchange)~~  
 3 once the specific restoration locations and timing of their construction are identified and  
 4 designed. ~~The evaluations will also consider up-to-date estimates of climate change and sea level~~  
 5 ~~rise, if and when such information is available. These evaluations will be conducted~~  
 6 ~~concurrently with Mitigation Measure WQ-7b. Together, findings from WQ-7a and WQ-7b will~~  
 7 ~~indicate if whether~~ sufficient ~~operational~~-flexibility to ~~prevent or~~ offset chloride increases is ~~not~~  
 8 feasible under Alternative 4 ~~operations, achieving chloride reduction pursuant to this~~  
 9 ~~mitigation measure would not be feasible under this alternative.~~

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

12 BDCP proponents shall consider effects of site-specific restoration areas proposed under CM4  
 13 on chloride concentrations in the western Delta. Design and siting of restoration areas shall  
 14 attempt to reduce water quality degradation with respect to the 250 mg/L chloride objective in  
 15 the western Delta to the extent possible without compromising proposed benefits of the  
 16 restoration areas. These evaluations will be conducted concurrently with Mitigation Measure  
 17 WQ-7a. Together, findings from WQ-7a and WQ-7b will indicate whether sufficient flexibility to  
 18 prevent or offset chloride increases is feasible under Alternative 4.

19 **Mitigation Measure WQ-7b7c: Consult with Delta Water Purveyors to Identify Means to**  
 20 **Avoid, Minimize, or Offset for Reduced Seasonal Availability of Water That Meets**  
 21 **Applicable Water Quality Objectives**

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

32 **Mitigation Measure WQ-7e7d: Site and Design Restoration Sites and consult with**  
 33 **CDFW/USFWS, and Suisun Marsh Stakeholders to Identify Potential Actions to Avoid or**  
 34 **Reduce Chloride Level Concentration Increases in the Marsh**

35 BDCP proponents shall consider effects of site-specific restoration areas proposed under CM4  
 36 on chloride levels concentrations in Suisun Marsh. Design and siting of restoration areas shall  
 37 attempt to reduce potential effects to the extent possible without compromising proposed  
 38 benefits of the restoration areas. BDCP proponents will also consult with CDFW/USFWS, and  
 39 Suisun Marsh stakeholders, to identify potential actions to avoid or minimize the chloride  
 40 increases in the marsh, with the goal of maintaining chloride at levels that would not further  
 41 impair fish and wildlife beneficial uses in Suisun Marsh. Potential actions may include  
 42 modifications of the existing Suisun Marsh Salinity Control Gates for effective salinity control  
 43 and evaluation of the efficacy of additional physical salinity control facilities or operations for

1 the marsh to reduce the effects of increased chloride levels. These actions are identical to the  
 2 actions discussed in Mitigation Measure WQ-11b regarding levels of electrical conductivity in  
 3 Suisun Marsh. Consult with DFW/USFWS, and Suisun Marsh Stakeholders, to Identify Potential  
 4 Actions to Avoid or Minimize Chloride Level Increases in the Marsh

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

18 **Impact WQ-8: Effects on Chloride Concentrations Resulting from Implementation of CM2-**  
 19 **CM22CM21**

20 *NEPA Effects:* The implementation of the other conservation measures (i.e., CM2-~~CM22CM21~~), of  
 21 which most do not involve land disturbance, present no new direct sources of chloride to the  
 22 affected environment, including areas Upstream of the Delta, within the Plan Area, and the SWP/CVP  
 23 Export Service Area, nor would they affect channel flows or Delta hydrodynamic conditions. As  
 24 noted above, the potential effects of implementation of tidal habitat restoration (i.e., CM4) on Delta  
 25 hydrodynamic conditions is addressed above in the discussion of Impact WQ-8. The potential  
 26 channel flow effects of CM2 for actions in the Yolo Bypass also were accounted for in the CALSIM II  
 27 and DSM2 modeling, and thus were addressed in the discussion for Impact WQ-8. CM3 and CM11  
 28 provide the mechanism, guidance, and planning for the land acquisition and thus would not,  
 29 themselves, affect chloride levels in the Delta. CM12-~~CM22CM21~~ involve actions that target  
 30 reduction in other stressors at the species level involving actions such as methylmercury reduction  
 31 management (CM12), improving DO in the Stockton Deep Water Ship Channel (CM14), and urban  
 32 stormwater treatment (CM19). None of CM12-~~CM22CM21~~ would contribute to substantially  
 33 increasing chloride levels in the Delta. Consequently, as they pertain to chloride, implementation of  
 34 CM2-~~CM22CM21~~ would not be expected to adversely affect any of the beneficial uses of the affected  
 35 environment. Moreover, some habitat restoration conservation measures (CM4-CM10) would occur  
 36 on lands within the Delta currently used for irrigated agriculture, thus replacing agricultural land  
 37 uses with restored tidal wetlands, floodplain, and related channel margin and off-channel habitats.  
 38 The potential reduction in irrigated lands within the Delta may result in reduced discharges of  
 39 agricultural field drainage with elevated chloride concentrations, which would be considered an  
 40 improvement compared to the No Action Alternative.

41 In summary, based on the discussion above, the effects on chloride from implementing CM2-  
 42 ~~CM22CM21~~ are considered to be not adverse.

43 *CEQA Conclusion:* Implementation of the CM2-~~CM22CM21~~ for Alternative 4 would not present new  
 44 or substantially changed sources of chloride to the affected environment upstream of the Delta,

1 within Delta, or in the SWP/CVP service area. Replacement of irrigated agricultural land uses in the  
 2 Delta with habitat restoration conservation measures may result in some reduction in discharge of  
 3 agricultural field drainage with elevated chloride concentrations, thus resulting in improved water  
 4 quality conditions. Based on these findings, this impact is considered to be less than significant. No  
 5 mitigation is required.

## 6 **Impact WQ-9: Effects on Dissolved Oxygen Resulting from Facilities Operations and** 7 **Maintenance (CM1)**

### 8 *Upstream of the Delta*

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

17 A reservoir can exhibit seasonal changes in the DO profile from the water surface to the sediments  
 18 that is affected by its degree of thermal stratification, where oxygenated inflows enter and mix with  
 19 the reservoir, its level of productivity that contributes DO through photosynthesis and consumes DO  
 20 through respiration and decomposition, as well as the prevailing winds that cause mixing within the  
 21 reservoir. Water temperature also is a factor in that it affects the level (between the surface and the  
 22 bottom) at which oxygenated river inflows enter the reservoir, the DO saturation level, and  
 23 photosynthesis and respiration rates. Cold inflows tend to move deep into the reservoir due to the  
 24 lower density of cold water, whereas warm water inflows tend to mix with the surface waters,  
 25 particularly when the reservoir is thermally stratified. Under Alternative 4, the primary factor that  
 26 would change relative to Existing Conditions is that end-of-September carryover storage may be  
 27 lower in some years (see Chapter 5, *Water Supply*, Section 5.3.3.9), which would affect the  
 28 temperature profile of the reservoirs at the end of summer. Nevertheless, the reservoirs would  
 29 continue to thermally stratify seasonally, as they do under Existing Conditions. Given the size of the  
 30 reservoirs—Lake Oroville, Trinity Lake, Shasta Lake, and Folsom Lake—and their significant surface  
 31 area, inflows and wind fetch that would still contribute to oxygenating these water bodies, the lower  
 32 carryover storage that could occur in some years under Alternative 4 is not expected to cause DO  
 33 depletions or substantial changes in DO that would adversely affect the beneficial uses of these  
 34 water bodies.

35 The four operational scenarios of Alternative 4 would alter the magnitude and timing of water  
 36 releases from reservoirs upstream of the Delta relative to Existing Conditions and the No Action  
 37 Alternative, which would consequently alter downstream river flows. There would be some  
 38 increases and decreases in the mean monthly river flows, depending on month and year. Mean  
 39 monthly flows would remain within the range historically seen under Existing Conditions and the  
 40 No Action Alternative. Moreover, these are large, turbulent rivers with flow velocities typically in the  
 41 range of 0.5 fps to 2.0 fps or higher. Consequently, flow changes that would occur under any  
 42 operational scenario of Alternative 4 would not be expected to have substantial effects on river DO  
 43 levels; likely, the changes would be immeasurable. This is because sufficient turbulence and  
 44 interaction of river water with the atmosphere would continue to occur under this alternative to

1 maintain water saturation levels (due to these factors) at levels similar to that of Existing Conditions  
2 and the No Action Alternative.

3 The changes in the magnitude and timing of water releases from reservoirs upstream of the Delta,  
4 relative to Existing Conditions and the No Action Alternative, could affect downstream river  
5 temperatures, depending on month and year. Water temperature affects the maximum DO  
6 saturation level; as temperature increases, the DO saturation level decreases. When holding  
7 constant for barometric pressure (e.g., 760 mm mercury), the DO saturation level ranges from 7.5  
8 mg/L at 30°C (86°F) to 11 mg/L at 10°C(50°F) (Tchobanoglous and Schroeder 1987:735). As  
9 described in the affected environment section, DO in the Sacramento River at Keswick, Feather River  
10 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  
11 13.0 mg/L, respectively. Thus, these rivers are well oxygenated and experience periods of  
12 supersaturation (i.e., when DO level exceeds the saturation concentration). Because these are large,  
13 turbulent rivers, any reduced DO saturation level that would be caused by an increase in  
14 temperature under any operational scenario of Alternative 4 would not be expected to cause DO  
15 levels to be outside of the range seen historically. This is because sufficient turbulence and  
16 interaction of river water with the atmosphere would continue to occur under this alternative to  
17 maintain saturation levels.

18 Amounts of oxygen demanding substances present (e.g., ammonia, organics) in the reservoirs and  
19 rivers upstream of the Delta, rates of photosynthesis (which is influenced by nutrient  
20 levels/loading), and respiration and decomposition of aquatic life is not expected to change  
21 sufficiently under Alternative 4 to substantially alter DO levels relative to Existing Conditions or the  
22 No Action Alternative. Any minor reductions in DO levels that may occur under this alternative  
23 would not be expected to be of sufficient frequency, magnitude and geographic extent to adversely  
24 affect beneficial uses, or substantially degrade the quality of these water bodies, with regard to DO.

25 An effect on salinity (expressed as EC) would not be expected in the rivers and reservoirs upstream  
26 of the Delta. Thus, these parameters would not be expected to measurably change DO levels under  
27 any of the operational scenarios of Alternative 4, relative to Existing Conditions or the No Action  
28 Alternative.

### 29 ***Delta***

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

35 Under all operational scenarios of Alternative 4, minor DO level changes could occur due to nutrient  
36 loading to the Delta relative to Existing Conditions and the No Action Alternative (see WQ-1, WQ-15,  
37 WQ-23). The state has begun to aggressively regulate point-source discharge effects on Delta  
38 nutrients, and is expected to further regulate nutrients upstream of and in the Delta in the future.  
39 Although population increased in the affected environment between 1983 and 2001, average  
40 monthly DO levels during this period of record show no trend in decline in the presence of  
41 presumed increases in anthropogenic sources of nutrients (see Table [8-114.4-15 in the ES/AE](#)  
42 [section](#)). Based on these considerations, excessive nutrients that would cause low DO levels would  
43 not be expected to occur under any operational scenario of Alternative 4.



1 Various areas of the Delta could experience salinity increases due to change in quantity of Delta  
2 inflows (see WQ-11) For a 5 ppt salinity increase at 68°Fahrenheit, the saturation level of oxygen  
3 dissolved in the water is reduced by only about 0.25 mg/L. Thus, increased salinity under  
4 Alternative 4 would generally have relatively minor effects on Delta DO levels where salinity is  
5 increased on the order of 5 ppt or less.

6 The relative degree of tidal exchange of flows and turbulence, which contributes to exposure of  
7 Delta waters to the atmosphere for reaeration, would not be expected to substantially change  
8 relative to Existing Conditions or the No Action Alternative, such that these factors would reduce  
9 Delta DO levels below objectives or levels that protect beneficial uses.

10 As discussed in the section on DO in section 8.3.1.7 Effects of climate change on air and Delta water  
11 temperatures are discussed in Appendix 29C. In general, waters of the Delta would be expected to  
12 warm less than 5 degrees F under Alternative 4, relative to Existing Conditions, due to climate  
13 change, which translates into a < 0.5 mg/L decrease in DO saturation. Thus, increased temperature  
14 under Alternative 4 would generally have relatively minor effects on Delta DO levels, relative to  
15 Existing Conditions.

16 Some waterways in the eastern, southern, and western Delta are listed on the state's Clean Water  
17 Act section 303(d) list as impaired due to low oxygen levels. A TMDL for the Deep Water Ship  
18 channel in the eastern Delta has been approved and identifies the factors contributing to low DO in  
19 the Deep Water Ship Channel as oxygen demanding substances from upstream sources, Deep Water  
20 Ship Channel geometry, and reduced flow through the Deep Water Ship Channel (Central Valley  
21 Water Board 2005:28). The TMDL takes a phased approach to allow more time to gather additional  
22 informational on sources and linkages to the DO impairment, while at the same time moving  
23 forward on making improvements to DO conditions. One component of the TMDL implementation  
24 activities is an aeration device demonstration project.

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

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

38 Overall, assuming continued operation of the aerators, the alternative is not expected to have a  
39 substantial impact on DO in the Deep Water Ship Channel. It is expected that under Alternative 4  
40 that DO levels in the Deep Water Ship Channel would remain similar to those under Existing  
41 Conditions and the No Action Alternative or improve as the TMDL-required studies are completed  
42 and actions are implemented to improve DO levels. DO levels in other Clean Water Act section  
43 303(d)-listed waterways would not be expected to change relative to Existing Conditions or the No

1 Action Alternative, as the circulation of flows, tidal flow exchange, and re-aeration would continue to  
2 occur.

### 3 **SWP/CVP Export Service Areas**

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

17 **NEPA Effects:** The effects on dissolved oxygen from implementing any operational scenario of  
18 Alternative 4 is determined to not be adverse.

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

24 ~~River flow rate and r~~Reservoir storage reductions that would occur under any operational scenario  
25 of Alternative 4, relative to Existing Conditions, would not be expected to result in a substantial  
26 adverse change in DO levels in the reservoirs, because oxygen sources (surface water aeration,  
27 aerated inflows, vertical mixing) would remain. Similarly, river flow rate reductions that would  
28 occur would not be expected to result in a substantial adverse change in DO levels in the -and rivers  
29 upstream of the Delta, given that mean monthly flows would remain within the ranges historically  
30 seen under Existing Conditions and the affected river are large and turbulent. Any reduced DO  
31 saturation level that may be caused by increased water temperature would not be expected to cause  
32 DO levels to be outside of the range seen historically. Finally, amounts of oxygen demanding  
33 substances and salinity would not be expected to change sufficiently to affect DO levels.

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

41 There is not expected to be substantial, if even measurable, changes in DO levels in the SWP/CVP  
42 Export Service Areas waters under any operational scenario of Alternative 4, relative to Existing  
43 Conditions, because the biochemical oxygen demand of the exported water would not be expected to

1 substantially differ from that under Existing Conditions (due to ever increasing water quality  
2 regulations), canal turbulence and exposure of the water to the atmosphere and the algal  
3 communities that exist within the canals would establish an equilibrium for DO levels within the  
4 canals. The same would occur in downstream reservoirs.

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

13 **Impact WQ-10: Effects on Dissolved Oxygen Resulting from Implementation of CM2-  
14 ~~CM22CM21~~**

15 **NEPA Effects:** CM2-~~CM22CM21~~ would not be expected to contribute to adverse DO levels in the  
16 Delta. The increased habitat provided by CM2-CM11 could contribute to an increased biochemical  
17 or sediment demand, through contribution of organic carbon and plants decaying. However, similar  
18 habitat exists currently in the Delta and is not identified as contributing to adverse DO conditions.  
19 Although additional DOC loading to the Delta may occur (see impact WQ-18), only a fraction of the  
20 DOC is available to microorganisms that would consume oxygen as part of the decay and  
21 mineralization process. Since decreases in dissolved organic carbon are not typically observed in  
22 Delta waterways due to these processes, any increase in DOC is unlikely to contribute to adverse DO  
23 levels in the Delta. CM14, an oxygen aeration facility in the Stockton Deep Water Ship Channel to  
24 meet TMDL objectives established by the Central Valley Water Board, would maintain DO levels  
25 above those that impair fish species when covered species are present. CM19, which would fund  
26 projects to contribute to reducing pollutant discharges in stormwater, would be expected to reduce  
27 biochemical oxygen demand load and, thus, would not adversely affect DO levels. The remaining  
28 conservation measures would not be expected to affect DO levels because they are actions that do  
29 not affect the presence of oxygen-demanding substances.

30 The effects on dissolved oxygen from implementing CM2-~~CM22CM21~~ is determined to not be  
31 adverse.

32 **CEQA Conclusion:** It is expected that DO levels in the Upstream of the Delta Region, in the Plan Area,  
33 or in the SWP/CVP Export Service Areas following implementation of CM2-~~CM22CM21~~ under  
34 Alternative 4 would not be substantially different from existing DO conditions. Therefore, this  
35 alternative is not expected to cause additional exceedance of applicable water quality objectives by  
36 frequency, magnitude, and geographic extent that would result in significant impacts on any  
37 beneficial uses within affected water bodies. Because no substantial changes in DO levels would be  
38 expected, long-term water quality degradation would not be expected, and, thus, beneficial uses  
39 would not be adversely affected. Various Delta waterways are 303(d)-listed for low DO, but because  
40 no substantial decreases in DO levels would be expected, greater degradation and impairment of  
41 these areas would not be expected. Implementation of CM14 would have a net beneficial effect on  
42 DO conditions in the Stockton Deep Water Ship Channel. This impact would be less than significant.  
43 No mitigation is required.

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

3 ***Upstream of the Delta***

4 Alternative 4, Scenarios H1–H4, would alter the magnitude and timing of water releases from  
 5 reservoirs upstream of the Delta relative to Existing Conditions and the No Action Alternative. With  
 6 respect to EC, an increase or decrease in river flow alone is not of concern. Measureable changes in  
 7 the quality of the watershed runoff and reservoir inflows would not be expected to occur in the  
 8 future; therefore, the EC levels in these reservoirs would not be expected to change relative to  
 9 Existing Conditions or the No Action Alternative. There could be increased discharges of EC-  
 10 elevating parameters in the future in water bodies upstream of the Delta as a result of urban growth  
 11 and increased runoff and wastewater discharges. The state has begun to aggressively regulate point-  
 12 source discharge effects on Delta salinity-elevating parameters, capping dischargers at existing  
 13 levels, and is expected to further regulate EC and related parameters upstream of and within the  
 14 Delta in the future as salt management plans are developed. Based on these considerations, EC levels  
 15 (highs, lows, typical conditions) in the Sacramento River and its tributaries, the eastside tributaries,  
 16 or their associated reservoirs upstream of the Delta would not be expected to be outside the ranges  
 17 occurring under Existing Conditions or the No Action Alternative.

18 The effects on lower San Joaquin River EC would be somewhat different. Elevated EC in the San  
 19 Joaquin River can be sourced to agricultural use of irrigation water imported from the southern  
 20 Delta and applied on soils high in salts. This accumulation of salts is a primary contributor of  
 21 elevated EC on the lower San Joaquin River. Tributary flows generally provide dilution of the high  
 22 EC agricultural drainage waters. Depending on operational scenario, long-term average flows at  
 23 Vernalis would decrease about 6% (as a result of climate change and increased water demands)  
 24 relative to Existing Conditions, and would increase about 0.1% relative to the No Action  
 25 Alternative(Appendix 5A). These decreases in flow, alone, would correspond to a possible increase  
 26 in long-term average EC levels. The level of EC increase cannot be readily quantified but, based on  
 27 estimated increase in bromide and chloride concentrations, to which EC is correlated, would be  
 28 relatively small and on the order of about 3% relative to Existing Conditions, and less than 0.1%  
 29 relative to the No Action Alternative. However, with the implementation of the adopted TMDL for  
 30 the San Joaquin River at Vernalis and the ongoing development of the TMDL for the San Joaquin  
 31 River upstream of Vernalis and its implementation, it is expected that long-term EC levels will  
 32 improve. Based on these considerations, substantial changes in EC levels in the San Joaquin River  
 33 relative to Existing Conditions or the No Action Alternative would not be expected of sufficient  
 34 magnitude and geographic extent that would result in adverse effects on any beneficial uses, or  
 35 substantially degrade the quality of these water bodies, with regard to EC.

36 ***Delta***

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

1 Relative to Existing Conditions, modeling indicates that Alternative 4, Scenarios H1–H4, would result  
 2 in an increase in the number of days the Bay-Delta WQCP EC objectives would be exceeded in the  
 3 Sacramento River at Emmaton, San Joaquin River at San Andreas Landing, Jersey Point, and  
 4 Prisoners Point, and Old River near Middle River and at Tracy Bridge (Appendix 8H, Table EC-4).

5 The percent of days the Emmaton EC objective would be exceeded for the entire period modeled  
 6 (1976–1991) would increase from 6% under Existing Conditions to ~~237~~259%, depending on the  
 7 operations scenario, and the percent of days out of compliance would increase from 11% under  
 8 Existing Conditions to ~~3540~~3843%, depending on the operations scenario. Although these results  
 9 are for modeling that was originally performed for Alternative 4 assuming the Emmaton compliance  
 10 point shifted to Threemile Slough, Alternative 4 now does not include a change in compliance point  
 11 from Emmaton to Threemile Slough. Sensitivity analyses were performed that modeled Alternative  
 12 4 scenario H3 with ~~compliance at Emmaton~~ as the compliance point. Assuming the compliance  
 13 location at Emmaton instead of Threemile Slough in the CALSIM II modeling decreased exceedances  
 14 at Emmaton from 28% to 15% under Alternative 4, operations scenario H3 (see Appendix XX8H  
 15 Attachment 1 for more discussion of these sensitivity analyses), which ~~is~~ would still be greater than  
 16 Existing Conditions. Table 2 of Appendix 8H Attachment 1 indicates that most of these exceedances  
 17 are a result of modeling artifacts, but some exceedances are due to dead pool conditions that  
 18 occurred in 1977, 1981, and 1990 ~~occurred~~ under Alternative 4 and not under Existing Conditions.  
 19 As discussed in Chapter 5, Water Supply, Section 5.3.1, Methods for Analysis, under extreme  
 20 hydrologic and operational conditions where there is not enough water supply to meet all  
 21 requirements, CALSIM II uses a series of operating rules to reach a solution that ~~are~~ is a simplified  
 22 version of the very complex decision processes that SWP and CVP operators would use in actual  
 23 extreme conditions. Thus, it is unlikely that the Emmaton objective would actually be violated due  
 24 to dead pool conditions. However, these results indicate that water supply and water quality  
 25 conditions could be either under greater stress or under stress earlier in the year, and salinity EC  
 26 levels at Emmaton and in the western Delta may increase as a result, leading to EC ~~water quality~~  
 27 degradation and increased possibility of ~~impacts~~ adverse effects to agricultural beneficial uses.

28 The percent of days the San Andreas Landing EC objective would be exceeded would increase from  
 29 1% to ~~3~~46%, depending on the operations scenario. The percent of days out of compliance with the  
 30 EC objective for San Andreas Landing would increase from 1% to ~~5~~79%, depending on the  
 31 operations scenario. Sensitivity analyses performed indicated that ~~removing monthly-daily~~  
 32 patterning reduced the many number of these exceedances under all scenarios are modeling  
 33 artifacts, and the small number of remaining exceedances were small in magnitude, lasted only a few  
 34 days, and could be addressed with real time operations of the SWP and CVP (see Section 8.3.1.1 for a  
 35 description of real time operations of the SWP and CVP).

36 The percent of days the Prisoners Point EC objective would be exceeded for the entire period  
 37 modeled would increase from 6% to ~~20~~31% and the percent of days out of compliance with the  
 38 EC objective would increase from 10% to ~~225~~313%, depending on the operations scenario. At  
 39 Jersey Point, the percent of days the EC fish and wildlife objective would be exceeded for the entire  
 40 period modeled would increase from 0% to 0–2%, and the percent of days out of compliance with  
 41 the EC objective would increase from 0% to 0–2%, depending on operations scenario. Sensitivity  
 42 analyses conducted indicate that removing all tidal restoration areas would reduce the number of  
 43 exceedances, but there would still be substantially more exceedances than under Existing  
 44 Conditions or the No Action Alternative. Results of the sensitivity analyses indicate that the  
 45 exceedances are partially a function of the operations of the ~~A~~ alternative itself, perhaps due to Head  
 46 of Old River Barrier assumptions and ~~S~~ South Delta ~~E~~ export differences (see Appendix XX8H

1 [Attachment 1 for more discussion of these sensitivity analyses](#)). [Appendix X8H Attachment 2](#)  
 2 [contains a more detailed assessment of the likelihood of these exceedances impacting aquatic life](#)  
 3 [beneficial uses. Specifically, Appendix X8H Attachment 2 discusses whether these exceedances](#)  
 4 [might have indirect effects on striped bass spawning in the Delta, and concludes that the high level](#)  
 5 [of uncertainty precludes making a definitive determination.](#)

6 The increase in percent of days exceeding the EC objectives and days out of compliance at the Old  
 7 River locations would be 1–2% at Tracy Bridge and less than 1% at Middle River for all operations  
 8 scenarios. [Sensitivity analyses performed indicated that removing monthly daily patterning many of](#)  
 9 [these exceedances are modeling artifacts, and modeling barrier installation assumptions consistent](#)  
 10 [with historical dry year practices of installing barriers earlier in the year could resolve these](#)  
 11 [additional exceedances \(see Appendix XX8H Attachment 1 for a discussion of these sensitivity](#)  
 12 [analyses\). Furthermore, as noted in Section 8.1.3.7, SWP and CVP operations have relatively little](#)  
 13 [influence on salinity levels at these locations, and the elevated salinity in south Delta channels is](#)  
 14 [affected substantially by local salt contributions discharged into the San Joaquin River downstream](#)  
 15 [of Vernalis. Thus, the modeling has limited ability to estimate salinity accurately in this region.](#)

16 Average EC levels at the western and southern Delta compliance locations would decrease, except at  
 17 Emmaton, from 1–36% for the entire period modeled and 2–33% during the drought period  
 18 modeled (1987–1991) (Appendix 8H, Tables EC-15A through EC-15D). At Emmaton, there would be  
 19 an increase in average EC under all operational scenarios, though the increase would be less for  
 20 scenarios H3 and H4 (0% for entire period; 8% for drought period) than for scenarios H1 and H2  
 21 (13–14% for entire period; 12–13% for drought period). There would be increases in average EC at  
 22 two interior Delta locations under all operational scenarios: the S. Fork Mokelumne River at  
 23 Terminous average EC would increase 5% for the entire period modeled and 4% during the drought  
 24 period modeled; and San Joaquin River at San Andreas Landing average EC would increase 0–9% for  
 25 the entire period modeled and 7–13% during the drought period modeled. In addition, under  
 26 Scenarios H1 and H2, there would be slight increase (<1–2%) in drought period average EC in the  
 27 San Joaquin River at Prisoners Point. On average, EC would increase at San Andreas Landing from  
 28 March through September under all operations scenarios; Scenarios H1, H2, and H4 also would  
 29 increase EC at this location in February and Scenarios H1 and H2 would increase EC in October.  
 30 Average EC in the S. Fork Mokelumne River at Terminous would increase during all months. [Average](#)  
 31 [EC at Jersey Point during the months of April–May, when the fish and wildlife objective applies in all](#)  
 32 [but critical water year types, would increase from 14–15% for the entire period modeled](#) (Appendix  
 33 8H, Tables EC-15A through EC-15D). The comparison to Existing Conditions reflects changes in EC  
 34 due to both Alternative 4 operations (including north Delta intake capacity of 9,000 cfs and  
 35 numerous other operational components of Scenarios H1–H4) and climate change/sea level rise.

36 Relative to the No Action Alternative, the percent of days exceeding EC objectives and percent of  
 37 days out of compliance would increase at: Sacramento River at Emmaton, San Joaquin River at  
 38 Jersey Point, San Andreas Landing, and Prisoners Point; and Old River near Middle River and at  
 39 Tracy Bridge (Appendix 8H, Table EC-4). The increase in percent of days exceeding the EC objective  
 40 would be ~~19~~20–30% at Prisoners Point, depending on the operations scenario, and ~~15~~3% or less at  
 41 the remaining locations. The increase in percent of days out of compliance would be ~~21~~4–~~30~~2% at  
 42 Prisoners Point, depending on the operations scenario, and ~~16~~7% or less at the remaining locations.  
 43 [In general, the changes in frequency of exceedances of EC objectives were similar relative to the No](#)  
 44 [Action Alternative would be similar to those as discussed above relative to Existing Conditions, and](#)  
 45 [thus the conclusions of the sensitivity analyses discussed above extend to the comparison to the No](#)  
 46 [Action Alternative. The exception to this is for Emmaton. As discussed above, assuming the](#)

1 compliance location at Emmaton instead of Threemile Slough in the CALSIM II modeling decreased  
 2 the frequency of objective exceedances at Emmaton from 28% to 15% under Alternative 4,  
 3 operations scenario H3 (see Appendix 8H Attachment 1 for more discussion of these sensitivity  
 4 analyses). This frequency of objective exceedance ~~which was still greater than under Existing~~  
 5 Conditions, but is very similar to the 13% frequency of exceedances under the No Action Alternative,  
 6 which would be 13%. Nevertheless, Table 2 of Appendix 8H Attachment 1 indicates that  
 7 exceedances due to deadpool conditions in 1981 and 1990 occurred under Alternative 4 and not  
 8 under the No Action Alternative. As discussed above, it is unlikely that the Emmaton objective  
 9 would actually be ~~violated~~exceeded due to dead pool conditions. However, these results indicate  
 10 that water supply and water quality conditions could be either under greater stress or under stress  
 11 earlier in the year, and salinity-EC levels at Emmaton and in the western Delta may increase as a  
 12 result, leading to water quality-EC degradation and increased possibility of ~~impacts~~adverse effects  
 13 to agricultural beneficial uses. The frequency and magnitude of increased ~~impacts~~EC levels relative  
 14 to the No Action Alternative at Emmaton is lower than relative to ~~the Existing Conditions, since~~  
 15 climate change and sea level rise present in both the No Action Alternative and Alternative 4  
 16 contribute to the extreme hydrologic conditions in several years.

17 For the entire period modeled, average EC levels would increase at western (scenarios H1 and H2  
 18 only), interior, and southern Delta locations; the average EC increase would be 12–13% at Emmaton  
 19 (western Delta; for scenarios H1 and H2 only), 5–15% at interior Delta locations and 2% or less at  
 20 southern Delta locations, depending on the operations scenario (Appendix 8H, Tables EC-15A  
 21 through EC-15D). During the drought period modeled, average EC would increase at western  
 22 (scenarios H1 and H2 only), interior, and southern Delta locations. The greatest average EC increase  
 23 during the drought period modeled would occur in the interior Delta in the San Joaquin River at San  
 24 Andreas Landing (7–13% depending on the operations scenario); the increase at the other locations  
 25 would be <1–9% (Appendix 8H, Tables EC-15A through EC-15D). The comparison to the No Action  
 26 Alternative reflects changes in EC due only to the different operational components of Scenarios H1–  
 27 H4 of Alternative 4.

28 For Suisun Marsh, October–May is the period when Bay-Delta WQCP EC objectives for protection of  
 29 fish and wildlife apply. Modeling data indicate that Average EC for the entire period modeled would  
 30 increase in the Sacramento River at Collinsville during the months of March through May under all  
 31 operations scenarios of Alternative 4, relative to Existing Conditions, by 0.3–0.9 mS/cm (Appendix  
 32 8H, Table EC-21). Long-term average EC would decrease under all operations scenarios, relative to  
 33 Existing Conditions, in Montezuma Slough at National Steel during October–May (Appendix 8H,  
 34 Table EC-22). The most substantial EC increase would occur near Beldon Landing, with long-term  
 35 average EC levels increasing by 1.3–6.0 mS/cm, depending on the month and operations scenario, at  
 36 least doubling during some months the long-term average EC relative to Existing Conditions  
 37 (Appendix 8H, Table EC-23). Sunrise Duck Club and Volanti Slough also would have long-term  
 38 average EC increases during all months ranging 0.5–3.9 mS/cm (Appendix 8H, Tables EC-24 and EC-  
 39 25). Modeling data for of Alternative 4 assumed no operation of the Montezuma Slough Salinity  
 40 Control Gates, but the project description assumes continued operation of the Salinity Control Gates,  
 41 consistent with assumptions included in the No Action Alternative. A sensitivity analysis modeling  
 42 run conducted for Alternative 4 scenario H3 with the gates operational consistent with the No  
 43 Action Alternative resulted in substantially lower EC levels than indicated in the original Alternative  
 44 4 modeling results discussed above, but EC ~~was~~levels were still somewhat higher than EC levels  
 45 under Existing Conditions and the No Action Alternative for several locations and months. Another  
 46 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 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 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  $\mu$ mhos/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-~~1315A~~ 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



1 Joaquin River improvement in EC is difficult to predict, the relative decrease in overall loading of EC-  
 2 elevating constituents to the Export Service Areas would likely alleviate or lessen any expected  
 3 increase in EC at Vernalis related to decreased annual average San Joaquin River flows.

4 The export area of the Delta is listed on the state's CWA Section 303(d) list as impaired due to  
 5 elevated EC. Alternative 4, Scenarios H1-H4, would result in lower average EC levels relative to  
 6 Existing Conditions and the No Action Alternative and, thus, would not contribute to additional  
 7 beneficial use impairment related to elevated EC in the SWP/CVP Export Service Areas waters.

8 **NEPA Effects:** In summary, based on the results of the modeling and sensitivity analyses conducted,  
 9 it is unlikely that there would be the increased frequency of exceedance of agricultural EC objectives  
 10 in the western, interior, or southern Delta. ~~or that~~ and However, modeling results indicates that  
 11 there could be increased long-term and drought period average EC levels that would occur at in the  
 12 western, interior, and southern Delta compliance locations under Alternative 4, Scenarios H1-H4,  
 13 relative to the No Action Alternative, that would contribute to adverse effects on the agricultural  
 14 beneficial uses. In addition, ~~t~~The increased frequency of exceedance of the San Joaquin River at  
 15 Prisoners Point EC objective and long-term and drought period average EC could contribute to  
 16 adverse effects on fish and wildlife beneficial uses (specifically, indirect adverse effects on striped  
 17 bass spawning), though there is a high degree of uncertainty associated with this impact. Given  
 18 that Although ~~t~~The western and southern Delta are CWA section 303(d) listed as impaired due to  
 19 elevated EC, and increases in long-term average and drought period average EC in ~~this~~the western  
 20 portion of the Delta generally did not result in substantial increases in the frequency of objective  
 21 exceedances, indicating the increase in the incidence of exceedance of EC objectives and long-term  
 22 average and drought period average EC in this portion of the Delta has the potential ~~a low~~have the  
 23 potential to contribute to additional beneficial use impairment. The increases in long-term average  
 24 EC levels that would ~~could~~ occur in Suisun Marsh would further degrade existing EC levels and could  
 25 contribute additional to adverse effects on the fish and wildlife beneficial uses. Suisun Marsh is CWA  
 26 section 303(d) listed as impaired due to elevated EC, and the potential increases in long-term  
 27 average EC levels could contribute to additional beneficial use impairment. The effects on EC in the  
 28 western Delta, San Joaquin River at Prisoners Point, and in Suisun Marsh ~~These increases in EC~~  
 29 constitute an adverse effect on water quality. Mitigation Measure WQ-11 would be available to  
 30 reduce these effects (implementation of this measure along with a separate, non-environmental  
 31 commitment as set forth in EIR/EIS Appendix 3B, *Environmental Commitments*, relating to the  
 32 potential EC-related changes would reduce these effects). Specifically, Mitigation Measure WQ-11 ~~d~~  
 33 would be expected to reduce effects in Suisun Marsh to a level that would not be adverse.

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

39 River flow rate and reservoir storage reductions that would occur under Alternative 4, Scenarios  
 40 H1-H4, relative to Existing Conditions, would not be expected to result in a substantial adverse  
 41 change in EC levels in the reservoirs and rivers upstream of the Delta, given that: changes in the  
 42 quality of watershed runoff and reservoir inflows would not be expected to occur in the future; the  
 43 state's aggressive regulation of point-source discharge effects on Delta salinity-elevating parameters  
 44 and the expected further regulation as salt management plans are developed; the salt-related  
 45 TMDLs adopted and being developed for the San Joaquin River; and the expected improvement in

1 lower San Joaquin River average EC levels commensurate with the lower EC of the irrigation water  
2 deliveries from the Delta.

3 Relative to Existing Conditions, Alternative 4, Scenarios H1–H4, would not result in any substantial  
4 increases in long-term average EC levels in the SWP/CVP Export Service Areas. There would be no  
5 exceedance of the EC objective at the Jones and Banks pumping plants. Average EC levels for the  
6 entire period modeled would decrease at both plants and, thus, this alternative would not contribute  
7 to additional beneficial use impairment related to elevated EC in the SWP/CVP Export Service Areas  
8 waters. Rather, this alternative would improve long-term EC levels in the SWP/CVP Export Service  
9 Areas, relative to Existing Conditions.

10 In the Plan Area, Alternative 4, Scenarios H1–H4, would result in an increase in the frequency with  
11 which Bay-Delta WQCP EC objectives are exceeded for the entire period modeled (1976–1991) ~~in;~~  
12 ~~in the Sacramento River at Emmaton, (agricultural objective; 1721–1923% increase) the and San~~  
13 ~~Joquin River at Jersey Point (fish and wildlife objective; 0–2% increase), in the western Delta, and~~  
14 ~~in the San Joaquin River at San Andreas Landing (agricultural objective; 2–35% increase) and the~~  
15 ~~San Joaquin River at Prisoners Point (fish and wildlife objective; 145–25% increase), both in the~~  
16 ~~interior Delta; and in Old River near Middle River and at Tracy Bridge (agricultural objectives; up to~~  
17 ~~2% increase), both in the southern Delta. Though objective exceedance would likely not occur in~~  
18 ~~the Sacramento River at Emmaton, A~~ average EC levels at Emmaton would increase by <1–14% for  
19 the entire period modeled and 8–13% during the drought period modeled. ~~Together with the~~  
20 ~~increase in frequency of exceedances of the objectives that would occur in the Sacramento River at~~  
21 ~~Emmaton, Average EC levels at San Andreas Landing would increase by 0–9% during for the entire~~  
22 ~~period modeled and 7–13% during the drought period modeled. Tt~~ These increases in long-term and  
23 drought period average EC levels ~~and increased frequency of exceedance of EC objectives that would~~  
24 ~~occur in the Sacramento River at Emmaton and San Joaquin River at San Andreas Landing~~ would  
25 potentially contribute to adverse effects on the agricultural beneficial uses in the western ~~and~~  
26 ~~interior~~ Delta. ~~The comparison to Existing Conditions reflects changes in EC due to both Alternative~~  
27 ~~4 operations and climate change/sea level rise. The adverse effects expected to occur at Emmaton~~  
28 ~~are~~ would be due in part to the effects of climate change/sea level rise, ~~not~~ and in part due to  
29 ~~Alternative 4 operations. This is evidenced by the significant effects expected in the No Action~~  
30 ~~Alternative at Emmaton relative to Existing Conditions (see Section 8.3.3.1, Impact WQ-11), as well~~  
31 ~~as the fact that a lesser level of adverse effects are is expected at Emmaton under Alternative 4~~  
32 ~~relative to the No Action Alternative (see “NEPA Effects” section above). Based on the results of the~~  
33 ~~modeling and sensitivity analyses conducted, it is unlikely that there would be increased frequency~~  
34 ~~of exceedance of agricultural EC objectives in the interior or southern Delta, or that increased long-~~  
35 ~~term and drought period average EC levels that would occur in these areas, relative to Existing~~  
36 ~~Conditions, would contribute to adverse effects on the agricultural beneficial uses. Further, t~~The  
37 increased frequency of exceedance of the fish and wildlife objective at ~~Jersey Point and~~ Prisoners  
38 Point could contribute to adverse effects on aquatic life ~~(specifically, indirect adverse effects on~~  
39 ~~striped bass spawning), though there is a high degree of uncertainty associated with this impact.~~  
40 Because EC is not bioaccumulative, the increases in long-term average EC levels would not directly  
41 cause bioaccumulative problems in aquatic life or humans. The western and southern Delta are CWA  
42 section 303(d) listed for elevated EC and the increased ~~frequency of exceedance of EC objectives~~  
43 ~~that would~~ EC and water quality degradation that could occur in ~~the western Delta these portions of~~  
44 ~~the Delta~~ could make beneficial use impairment measurably worse. ~~Since there is~~ would be very  
45 ~~little change in EC levels in the southern Delta and there is not expected to be an increase in~~

1 frequency of exceedances of objectives, this Alternative is not expected to make beneficial use  
2 impairment measurably worse in the southern Delta. This impact is considered to be significant.

3 Further, relative to Existing Conditions, Alternative 4, Scenarios H1–H4, ~~would could~~ result in  
4 substantial increases in long-term average EC during the months of October through May in Suisun  
5 Marsh, ~~such that EC levels would be double that relative to Existing Conditions.~~ The increases in  
6 long-term average EC levels that would occur in Suisun Marsh could further degrade existing EC  
7 levels and thus contribute additionally to adverse effects on the fish and wildlife beneficial uses.  
8 Because EC is not bioaccumulative, the increases in long-term average EC levels would not directly  
9 cause bioaccumulative problems in fish and wildlife. Suisun Marsh is CWA section 303(d) listed for  
10 elevated EC and the increases in long-term average EC that would occur in the marsh could make  
11 beneficial use impairment measurably worse. This impact is considered to be significant. However,  
12 based on sensitivity analyses conducted to date (see Appendix 8H Attachment 1), it is expected that  
13 implementation of WQ-11d will be able to reduce impacts on EC in Suisun Marsh to a less than  
14 significant level.

15 Implementation of Mitigation Measure WQ-11 along with a separate, non-environmental  
16 commitment relating to the potential increased costs associated with EC-related changes would  
17 reduce these effects. Although it is not known whether implementation of WQ-11 will be able to  
18 feasibly reduce water quality degradation in the western Delta, implementation of Mitigation  
19 Measure WQ-11 is recommended to attempt to reduce the effect that increased EC may have on  
20 Delta beneficial uses. However, because the effectiveness of this mitigation measure to result in  
21 feasible measures for reducing these water quality effects is uncertain, this impact is considered to  
22 remain significant and unavoidable. As mentioned above, it is expected that implementation of WQ-  
23 11d will be able to reduce impacts on EC in Suisun Marsh to a less than significant level.

24 ~~Implementation of Mitigation Measure WQ-11 along with a separate, non-environmental~~  
25 ~~commitment relating to the potential increased costs associated with EC-related changes would~~  
26 ~~reduce these effects. While mitigation measures to reduce these water quality effects in affected~~  
27 ~~water bodies to less than significant levels are not available, implementation of Mitigation Measure~~  
28 ~~WQ-11 is recommended to attempt to reduce the effect that increased EC concentrations may have~~  
29 ~~on Delta beneficial uses. However, because the effectiveness of this mitigation measure to result in~~  
30 ~~feasible measures for reducing water quality effects is uncertain, this impact is considered to remain~~  
31 ~~significant and unavoidable.~~

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

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

3 ~~It remains to be determined whether, or to what degree, the available and existing salinity~~  
 4 ~~response and countermeasure actions of SWP and CVP facilities, municipal water purveyors, or~~  
 5 ~~Suisun Marsh salinity control facilities would be capable of offsetting the actual level of changes~~  
 6 ~~in EC that may occur from implementation of Alternative 4. Therefore, i~~n order to ~~determine~~  
 7 ~~the feasibility of reducing/reduce~~ the effects of increased EC levels, and potential adverse effects  
 8 on beneficial uses associated with CM1 operations (and hydrodynamic effects of tidal  
 9 restoration under CM4), the proposed mitigation requires a series of phased actions to identify  
 10 and evaluate ~~existing and possible~~ feasible actions, followed by development and  
 11 implementation of the actions, if determined to be necessary. ~~The phased actions for reducing~~  
 12 ~~EC levels and associated adverse effects on agricultural water supply also could mitigate adverse~~  
 13 ~~effects on fish and wildlife life.~~ The emphasis and mitigation actions would be limited to those  
 14 identified as necessary to avoid, reduce, or offset adverse EC effects at Delta compliance  
 15 locations and the Suisun Marsh. The development and implementation of any mitigation actions  
 16 shall be focused on those incremental effects attributable to implementation of Alternative 4  
 17 operations only. Development of mitigation actions for the incremental EC effects attributable to  
 18 climate change/sea level rise are not required because these changed conditions would occur  
 19 with or without implementation of Alternative 4. The goal of specific actions would be to  
 20 reduce/avoid additional exceedances of Delta EC objectives and reduce long-term average  
 21 concentration increases to levels that would not adversely affect beneficial uses within the Delta  
 22 and Suisun Marsh.

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

27 ~~The BDCP proponents will conduct additional evaluations and develop additional modeling (as~~  
 28 ~~necessary) to define the extent to which modified operations of the SWP and CVP could reduce~~  
 29 ~~or eliminate water quality degradation in the western Delta currently modeled to occur under~~  
 30 ~~Alternative 4. The additional evaluations will be conducted to consider specifically the changes~~  
 31 ~~in Delta hydrodynamic conditions associated with tidal habitat restoration under CM4 once the~~  
 32 ~~specific restoration locations and timing of their construction are identified and designed. The~~  
 33 ~~evaluations will also consider up-to-date estimates of climate change and sea level rise, if and~~  
 34 ~~when such information is available. These evaluations will be conducted concurrently with~~  
 35 ~~Mitigation Measure WQ-11b. Together, findings from WQ-11a and WQ-11b will indicate~~  
 36 ~~whether sufficient flexibility to prevent or offset EC increases is feasible under Alternative 4.~~  
 37 ~~These actions are identical to the actions discussed in Mitigation Measure WQ-7a regarding~~  
 38 ~~levels of chloride in the western Delta.~~

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

41 ~~BDCP proponents shall consider effects of site-specific restoration areas proposed under CM4~~  
 42 ~~on EC levels in the western Delta. Design and siting of restoration areas shall attempt to reduce~~  
 43 ~~water quality degradation in the western Delta to the extent possible without compromising~~  
 44 ~~proposed benefits of the restoration areas. These evaluations will be conducted concurrently~~

1 with Mitigation Measure WQ-11a. Together, findings from WQ-11a and WQ-11b will indicate  
 2 whether sufficient flexibility to prevent or offset EC increases is feasible under Alternative 4.  
 3 These actions are identical to the actions discussed in Mitigation Measure WQ-7b regarding  
 4 levels of chloride in the western Delta.

5 **Mitigation Measure WQ-11a11c: Design Restoration Sites to Reduce Effects on**  
 6 **Compliance with the Fish and Wildlife EC Objective between Prisoners Point and Jersey**  
 7 **Point, Evaluate Striped Bass Monitoring Data, and Consult with CDFW/USFWS/NMFS to**  
 8 **Determine Whether Additional Actions are Warranted**~~Conduct Additional Evaluation and~~  
 9 **Modeling of Increased EC Levels Following Initial Operations of CM1**

10 Following commencement of initial operations of CM1, the BDCP proponents will conduct  
 11 additional evaluations described herein, and develop additional modeling (as necessary), to  
 12 define the extent to which modified operations could reduce or eliminate the additional  
 13 exceedances of the Bay-Delta WQCP objectives for EC currently modeled to occur under  
 14 Alternative 4. The additional evaluations should also consider specifically the changes in Delta  
 15 hydrodynamic conditions associated with tidal habitat restoration under CM4 (in particular the  
 16 potential for increased EC concentrations that could result from increased tidal exchange) once  
 17 the specific restoration locations are identified and designed. If sufficient operational flexibility  
 18 to offset EC increases is not feasible under Alternative 4 operations, achieving EC reduction  
 19 pursuant to this mitigation measure would not be feasible under this Alternative. BDCP  
 20 proponents shall consider effects of site-specific restoration areas proposed under CM4 on  
 21 compliance with the fish and wildlife EC objective between Jersey Point and Prisoners point on  
 22 the San Joaquin River. Design of restoration areas shall attempt to reduce potential effects to  
 23 the extent possible without compromising proposed benefits of the restoration areas.  
 24 Additionally, following commencement of initial operations of CM1, the BDCP proponents will  
 25 evaluate ongoing monitoring of striped bass populations, and, specifically spawning in the San  
 26 Joaquin River between Jersey Point and Prisoners Point, and will conduct such monitoring if it is  
 27 not already being conducted by CDFW at that time. The BDCP proponents will consult with  
 28 CDFW, USFWS, and NMFS to determine whether adaptive changes to Head of Old River Barrier  
 29 operations and/or changes in North Delta vs. South Delta exports are warranted to avoid  
 30 adverse impacts of salinity on striped bass spawning in the San Joaquin River. Because these  
 31 actions may have adverse effects on other species, consultation is required, and the changes may  
 32 not be warranted depending on conditions of striped bass populations and populations of other  
 33 species at that time.

34 **Mitigation Measure WQ-11b11d: Site and Design Restoration Sites and consult with**  
 35 **CDFW/USFWS, and Suisun Marsh Stakeholders to Identify Potential Actions to Avoid or**  
 36 **Reduce EC Level Increases in the Marsh**~~Consult with CDFW/USFWS, and Suisun~~  
 37 **Marsh Stakeholders, to Identify Potential Actions to Avoid or Minimize EC Level Increases**  
 38 **in the Marsh**

39 BDCP proponents shall consider effects of site-specific restoration areas proposed under CM4  
 40 on EC levels and compliance with the fish and wildlife EC objectives for Suisun Marsh. Design  
 41 and siting of restoration areas shall attempt to reduce potential effects to the extent possible  
 42 without compromising proposed benefits of the restoration areas. In order to determine the  
 43 feasibility of reducing the effects of CM1/CM4 operations on increased EC concentrations as  
 44 shown in modeling estimates to occur in the Suisun Marsh, the BDCP proponents will also

1 consult with CDFW/USFWS, and Suisun Marsh stakeholders, to identify potential actions to  
 2 avoid or minimize the EC increases in the marsh, with the goal of maintaining EC at levels that  
 3 would not further impair fish and wildlife beneficial uses in Suisun Marsh. Potential actions may  
 4 include modifications of the existing Suisun Marsh Salinity Control Gates for effective salinity  
 5 control and evaluation of the efficacy of additional physical salinity control facilities or  
 6 operations for the marsh to reduce the effects of increased EC levels. ~~These actions are identical~~  
 7 ~~to the actions discussed in Mitigation Measure WQ-7ed regarding levels of chloride in Suisun~~  
 8 ~~Marsh. Based on the modeled conditions, the emphasis would be identification of potentially~~  
 9 ~~feasible actions to reduce adverse EC-related effects. Any such action will be developed~~  
 10 ~~following, and in conjunction with, the completion of the evaluation and development of any~~  
 11 ~~feasible actions described in Mitigation Measure WQ-11a.~~

12 **Impact WQ-12: Effects on Electrical Conductivity Resulting from Implementation of CM2-**  
 13 **~~CM22CM21~~**

14 **NEPA Effects:** The implementation of the other conservation measures (i.e., CM2-~~CM22CM21~~)  
 15 present no new direct sources of EC to the affected environment, including areas upstream of the  
 16 Delta, within the Delta region, and in the SWP/CVP Export Service Areas. As they pertain to EC,  
 17 implementation of these conservation measures would not be expected to adversely affect any of the  
 18 beneficial uses of the affected environment. Moreover, some habitat restoration conservation  
 19 measures would occur on lands within the Delta currently used for irrigated agriculture. Such  
 20 replacement or substitution of land use activity is not expected to result in new or increased sources  
 21 of EC to the Delta and, in fact, could decrease EC through elimination of high EC agricultural runoff.

22 CM4 would result in substantial tidal habitat restoration that would increase the magnitude of daily  
 23 tidal water exchange at the restoration areas, and alter other hydrodynamic conditions in adjacent  
 24 Delta channels. The DSM2 modeling included assumptions regarding possible locations of tidal  
 25 habitat restoration areas, and how restoration would affect Delta hydrodynamic conditions, and  
 26 thus the effects of this restoration measure on Delta EC were included in the assessment of CM1  
 27 facilities operations and maintenance.

28 Implementation of CM2-~~CM22CM21~~ would not be expected to adversely affect EC levels in the  
 29 affected environment and thus would not adversely affect beneficial uses or substantially degrade  
 30 water quality with regard to EC within the affected environment.

31 The effects on EC from implementing CM2-~~CM22CM21~~ is determined to not be adverse.

32 **CEQA Conclusion:** Implementation of CM2-~~CM22CM21~~ under Alternative 4 would not present new  
 33 or substantially changed sources of EC to the affected environment. Some conservation measures  
 34 may replace or substitute for existing irrigated agriculture in the Delta. This replacement or  
 35 substitution is not expected to substantially increase or present new sources of EC, and could  
 36 actually decrease EC loads to Delta waters. Thus, implementation of CM2-~~CM22CM21~~ would have  
 37 negligible, if any, adverse effects on EC levels throughout the affected environment and would not  
 38 cause exceedance of applicable state or federal numeric or narrative water quality  
 39 objectives/criteria that would result in adverse effects on any beneficial uses within affected water  
 40 bodies. Further, implementation of CM2-~~CM22CM21~~ would not cause significant long-term water  
 41 quality degradation such that there would be greater risk of adverse effects on beneficial uses. Based  
 42 on these findings, this impact is considered to be less than significant. No mitigation is required.

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

3 ***Upstream of the Delta***

4 Under the various Alternative 4 scenarios (H1–H4), greater water demands and climate change  
 5 would alter the magnitude and timing of reservoir releases and river flows upstream of the Delta in  
 6 the Sacramento River watershed and east-side tributaries, relative to Existing Conditions.

7 The Sacramento River at Freeport and San Joaquin River at Vernalis (as summarized for water  
 8 quality average concentrations in Tables 8-48 and 8-49) were examined for flow/concentration  
 9 relationships for mercury and methylmercury. No significant, predictive regression relationships  
 10 were discovered for mercury or methylmercury, except for total mercury with flow at Freeport  
 11 (monthly or annual) (Appendix 8I, Figure 8I-10 through 8I-13). Such a positive relationship between  
 12 total mercury and flow is to be expected based on the association of mercury with suspended  
 13 sediment and the mobilization of sediments during storm flows. However, the changes in flow in the  
 14 Sacramento River under the operational scenarios of Alternative 4 relative to Existing Conditions  
 15 and No Action Alternative are not of the magnitude of storm flows, in which substantial sediment-  
 16 associated mercury is mobilized. Therefore mercury loading should not be substantially different  
 17 due to changes in flow. In addition, even though it may be flow-affected, total mercury  
 18 concentrations remain well below criteria at upstream locations. Any negligible changes in mercury  
 19 concentrations that may occur in the water bodies of the affected environment located upstream of  
 20 the Delta would not be of frequency, magnitude, and geographic extent that would adversely affect  
 21 any beneficial uses or substantially degrade the quality of these water bodies as related to mercury.  
 22 Both waterborne methylmercury concentrations and largemouth bass fillet mercury concentrations  
 23 are expected to remain above guidance levels at upstream of Delta locations, but will not change  
 24 substantially relative to Existing Conditions or No Action Alternative due to changes in flows under  
 25 the operational scenarios of Alternative 4.

26 The upstream of Delta areas in the north will benefit from the implementation of the Cache Creek,  
 27 Sulfur Creek, Harley Gulch, and Clear Lake Mercury TMDLs and the American River methylmercury  
 28 TMDL. These projects will target specific sources of mercury and methylation upstream of the Delta  
 29 and could result in net improvement to Delta mercury loading in the future. The implementation of  
 30 these projects could help to ensure that upstream of Delta environments will not be substantially  
 31 degraded for water quality with respect to mercury or methylmercury.

32 ***Delta***

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

40 The water quality impacts of waterborne concentrations of mercury (Appendix 8I, Table I-5) and  
 41 methylmercury (Appendix 8I, Table I-6) and fish tissue mercury concentrations (Appendix 8I,  
 42 Tables I-11A through I-11D) were evaluated for nine Delta locations.

1 The analysis of percentage change in assimilative capacity of waterborne total mercury of  
 2 Alternative 4 scenarios as compared to Existing Conditions showed the greatest decrease to be of -  
 3 2.4% in the Old River at Rock Slough and the Contra Costa Pumping Plant for scenario. These are  
 4 bounded by Alternative 4 H1 estimates of -1.4% and -1.5% at these two locations, respectively. In  
 5 contrast the greatest increase in assimilative capacity relative to Existing Conditions was 4.4% for  
 6 H4 at the Jones Pumping Plant (Figures 8-53 through 8-54). Scenarios H2 and H3 range in changes in  
 7 assimilative capacity in relation to Existing Conditions from -2.1% (H3 at Contra Costa Pumping  
 8 Plant to 4.1 (H2 at Banks). These small changes in assimilative capacity are not expected to result in  
 9 adverse (or positive) effects to beneficial uses.

10 As compared to the No Action Alternative, Alternative 4 H4 showed the greatest range in changes in  
 11 assimilative capacity for total mercury; ranging from 5.0% at the Jones Pumping Plant to -2.3% at  
 12 the Old River site. These same sites show the smallest range of effects for Alternative 4 H1; with  
 13 4.3% and -1.4% for these same two stations, respectively. Scenarios H2 and H3 fall between these  
 14 extremes. However, these small ranges of changes are not expected to result in adverse effects to  
 15 beneficial uses.

16 All methylmercury concentrations in water were estimated to exceed TMDL guidelines and no  
 17 assimilative capacity exists. Changes in methylmercury concentration are expected to be very small.  
 18 The greatest annual average methylmercury concentration for drought conditions was 0.163 ng/L  
 19 for the San Joaquin River at Buckley Cove (all scenarios) which was slightly higher than Existing  
 20 Conditions (0.161 ng/L) and slightly lower than the No Action Alternative (0.167 ng/L) (Appendix  
 21 8I Table I-6). In general, the Alternative 4 H4 conditions were highest in concentration and  
 22 Alternative 4 H1 was lowest, as compared among scenarios for modeled methylmercury  
 23 concentrations in water. All modeled concentrations exceeded the methylmercury TMDL guidance  
 24 objective of 0.06 ng/L, therefore percentage change in assimilative capacity was not evaluated for  
 25 methylmercury.

26 Similar to waterborne methylmercury, fish tissue mercury concentration estimates all exceed TMDL  
 27 guidelines. Percentage changes were somewhat larger than for waterborne concentrations, but not  
 28 expected to result in changes to beneficial use. Fish tissue estimates show only small or no increases  
 29 in EQs based on long-term annual average concentrations for mercury at the Delta locations  
 30 (Appendix 8I, Table I-11Aa through I-11Db). The greatest increase over Existing Conditions was for  
 31 scenario H4 and was 15% at Old River at Rock Slough and 13% for Franks Tract as compared to H1  
 32 estimates for both of those locations of 9% (Table 1-11 Ab – Db). In comparison to the No Action  
 33 Alternative, the greatest increases in concentrations mirrored the Existing Condition comparisons  
 34 and were estimated to be 12% for Old River at Rock Slough, and 12% for Franks Tract. Scenario H1  
 35 provided the lowest set of percent changes in bass mercury for those locations (Figure 8-558-55a,b,  
 36 Appendix 8I, Tables I-11Aa through I-11Db). Because these increases are relatively small, and it is  
 37 not evident that substantive increases are expected at numerous locations throughout the Delta,  
 38 these changes are expected to be within the uncertainty inherent in the modeling approach, and  
 39 would likely not be measurable in the environment. See Appendix 8I for a discussion of the  
 40 uncertainty associated with the fish tissue estimates.

#### 41 **SWP/CVP Export Service Areas**

42 The analysis of mercury and methylmercury in the SWP/CVP Export Service Areas was based on  
 43 concentrations estimated at the Banks and Jones pumping plants. Both waterborne total and  
 44 methylmercury concentrations for Alternative 4, all scenarios, at the Jones and Banks pumping



1 plants, were lower than Existing Conditions and the No Action Alternative (Appendix 8I, Figures 8I-4  
2 and 8I-5). Therefore, mercury shows an increased assimilative capacity at these locations (Figures 8-  
3 53 and 8-54). The greatest increase was 5% for scenario H4 for Jones Plant (compared to No Action);  
4 the least was H2 at Banks of 2.9% (compared to Existing Conditions).

5 The largest improvements in bass tissue mercury concentrations and EQs for Alternative 4, relative  
6 to Existing Conditions and the No Action Alternative at any location within the Delta are expected  
7 for the export pump locations. The greatest improvement in bass tissue mercury concentration are  
8 expected for scenario H4 at the Banks and Jones pumping plants (-14% and -16%, respectively)  
9 (Figure 8-558-55a,b, Appendix 8I Table I-11Aa through I-11Db).

10 **NEPA Effects:** Based on the above discussion, the effects of mercury and methylmercury in  
11 comparison of Scenarios H1–H4 of Alternative 4 to the No Action Alternative (as waterborne and  
12 bioaccumulated forms) are not considered to be adverse.

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

18 Under Alternative 4, greater water demands and climate change would alter the magnitude and  
19 timing of reservoir releases and river flows upstream of the Delta in the Sacramento River  
20 watershed and east-side tributaries, relative to Existing Conditions. Concentrations of mercury and  
21 methylmercury upstream of the Delta will not be substantially different relative to Existing  
22 Conditions due to the lack of important relationships between mercury/methylmercury  
23 concentrations and flow for the major rivers.

24 Methylmercury concentrations exceed criteria at all locations in the Delta and no assimilative  
25 capacity exists. However, monthly average waterborne concentrations of total and methylmercury,  
26 over the period of record, are very similar to Existing Conditions. Similarly, estimates of fish tissue  
27 mercury concentrations show almost no differences would occur among sites for Alternative 4  
28 scenarios as compared to Existing Conditions for Delta sites. The greatest changes in assimilative  
29 capacity and tissue mercury estimates were for scenario H4; these least for scenario H1.

30 Assessment of effects of mercury in the SWP and CVP Export Service Areas were based on effects on  
31 mercury concentrations and fish tissue mercury concentrations at the Banks and Jones pumping  
32 plants. The Banks and Jones pumping plants are expected to show increased assimilative capacity  
33 for waterborne mercury and decreased fish tissue concentrations of mercury for Alternative 4, all  
34 scenarios, as compared to Existing Conditions.

35 As such, none of the H1–H4 scenarios for this alternative are expected to cause additional  
36 exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic  
37 extent that would cause adverse effects on any beneficial uses of waters in the affected environment.  
38 Because mercury concentrations are not expected to increase substantially, no long-term water  
39 quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur.  
40 Because any increases in mercury or methylmercury concentrations are not likely to be measurable,  
41 changes in mercury concentrations or fish tissue mercury concentrations would not make any  
42 existing mercury-related impairment measurably worse. In comparison to Existing Conditions,  
43 Alternative 4 would not increase levels of mercury by frequency, magnitude, and geographic extent

1 such that the affected environment would be expected to have measurably higher body burdens of  
 2 mercury in aquatic organisms, thereby substantially increasing the health risks to wildlife (including  
 3 fish) or humans consuming those organisms. This impact is considered to be less than significant. No  
 4 mitigation is required.

5 **Impact WQ-14: Effects on Mercury Concentrations Resulting from Implementation of ~~CM2-~~**  
 6 **~~22CM2 through CM22CM2-CM21~~**

7 **NEPA Effects:** Some habitat restoration activities under Alternative 4 would occur on lands in the  
 8 Delta formerly used for irrigated agriculture. Tidal and other restoration proposed under  
 9 Alternative 4 have the potential to increase water residence times and increase accumulation of  
 10 organic sediments that are known to enhance methylmercury bioaccumulation in biota in the  
 11 restored habitat. Therefore, increases in mercury methylation in the habitat restoration areas is  
 12 possible but uncertain depending on the specific restoration design implemented at a particular  
 13 Delta location. Models to estimate the potential for methylmercury formation in restored areas are  
 14 not currently available. However, DSM2 modeling for Alternative 4 operations does incorporate  
 15 assumptions for certain habitat restoration activities proposed under CM2 and CM4 (see Section  
 16 8.3.1.3) that result in changes to Delta hydrodynamics compared to the No Action Alternative. These  
 17 modeled restoration assumptions provide some insight into potential hydrodynamic changes that  
 18 could be expected related to implementing CM2 and CM4 and are considered in the evaluation of the  
 19 potential for increased mercury and methylmercury concentrations under Alternative 4.

20 BDCP Conservation Measure 12 (CM12) addresses the potential for methylmercury bioaccumulation  
 21 associated with restoration activities and acknowledges the uncertainties associated with mitigating  
 22 or minimizing this potential effect. CM12 proposes project-specific mercury management plans for  
 23 restoration actions that will incorporate relevant approaches recommended in Phase 1  
 24 Methylmercury TMDL control studies. Specific approaches recommended under CM12 that are  
 25 intended to minimize or mitigate for potential increases in methylmercury bioaccumulation at  
 26 future restoration sites include:

- 27 ● Characterizing mercury, methylmercury, organic carbon, iron, and sulfate concentrations to  
 28 better inform restoration design,
- 29 ● Sequestering methylmercury at restoration sites using low intensity chemical dosing  
 30 techniques,
- 31 ● Minimizing microbial methylation associated with anoxic conditions by reducing the amount of  
 32 organic material at a restoration site (this approach could limit the benefit of restoration areas  
 33 by limiting the amount of carbon supplied by these areas to the Delta as a whole. In some cases,  
 34 this would run directly counter to the goals and objectives of the BDCP. This approach should  
 35 not be implemented in such a way that it reduces the benefits to the Delta ecosystem provided  
 36 by restoration areas),
- 37 ● Designing restoration sites to enhance photo degeneration that converts methylmercury into a  
 38 biologically unavailable, inorganic form of mercury,
- 39 ● Remediating restoration site soils with iron to reduce methylation in sulfide rich soils, and
- 40 ● Considering capping mercury laden sediments, where feasible, to reduce methylation potential  
 41 at a site.

1 Because of the uncertainties associated with site-specific estimates of methylmercury  
 2 concentrations and the uncertainties in source modeling and tissue modeling, the effectiveness of  
 3 methylmercury management proposed under CM12 to reduce methylmercury concentrations would  
 4 need to be evaluated separately for each restoration effort, as part of design and implementation.  
 5 Because of this uncertainty and the known potential for methylmercury creation in the Delta this  
 6 potential effect of implementing CM2-~~CM22~~CM21 is considered adverse.

7 **CEQA Conclusion:** There would be no substantial, long-term increase in mercury or methylmercury  
 8 concentrations or loads in the rivers and reservoirs upstream of the Delta or the waters exported to  
 9 the CVP and SWP service areas due to implementation of CM2-~~CM22~~CM21 relative to Existing  
 10 Conditions. However, in the Delta, uptake of mercury from water and/or methylation of inorganic  
 11 mercury may increase to an unquantified degree as part of the creation of new, marshy, shallow, or  
 12 organic-rich restoration areas. Methylmercury is 303(d)-listed within the affected environment, and  
 13 therefore any potential measurable increase in methylmercury concentrations would make existing  
 14 mercury-related impairment measurably worse. Because mercury is bioaccumulative, increases in  
 15 water-borne mercury or methylmercury that could occur in some areas could bioaccumulate to  
 16 somewhat greater levels in aquatic organisms and would, in turn, pose health risks to fish, wildlife,  
 17 or humans. Design of restoration sites under Alternative 4 would be guided by CM12 which requires  
 18 development of site-specific mercury management plans as restoration actions are implemented.  
 19 The effectiveness of minimization and mitigation actions implemented according to the mercury  
 20 management plans is not known at this time, although the potential to reduce methylmercury  
 21 concentrations exists based on current research. Although the BDCP will implement CM12 with the  
 22 goal to reduce this potential effect, the uncertainties related to site specific restoration conditions  
 23 and the potential for increases in methylmercury concentrations in the Delta result in this potential  
 24 impact being considered significant. No mitigation measures would be available until specific  
 25 restoration actions are proposed. Therefore this programmatic impact is considered significant and  
 26 unavoidable.

## 27 **Impact WQ-15: Effects on Nitrate Concentrations Resulting from Facilities Operations and** 28 **Maintenance (CM1)**

### 29 ***Upstream of the Delta***

30 Although point sources of nitrate do exist upstream of the Delta in the Sacramento River watershed,  
 31 nitrate levels in the major rivers (Sacramento, Feather, American) are low, generally due to ample  
 32 dilution available in the rivers relative to the magnitude of the discharges. Furthermore, while many  
 33 dischargers have already improved facilities to remove more nitrate, many others are likely to do so  
 34 over the next few decades. Non-point sources of nitrate within the Sacramento watersheds are also  
 35 relatively low, thus resulting in generally low nitrate-N concentrations in the reservoirs and rivers  
 36 of the watershed. Furthermore, there is no correlation between historical water year average nitrate  
 37 concentrations and water year average flow in the Sacramento River at Freeport (Nitrate Appendix  
 38 8J, Figure 1). Consequently, any modified reservoir operations and subsequent changes in river  
 39 flows under various operational scenarios of Alternative 4, relative to Existing Conditions or the No  
 40 Action Alternative, are expected to have negligible, if any, effects on average reservoir and river  
 41 nitrate-N concentrations in the Sacramento River watershed upstream of the Delta.

42 In the San Joaquin River watershed, nitrate concentrations are higher than in the Sacramento  
 43 watershed, owing to use of nitrate based fertilizers throughout the lower watershed. The correlation  
 44 between historical water year average nitrate concentrations and water year average flow in the San

1 Joaquin River at Vernalis is a weak inverse relationship—that is, generally higher flows result in  
 2 lower nitrate concentrations, while low flows result in higher nitrate concentrations (linear  
 3 regression  $r^2=0.49$ , Nitrate Appendix 8J, Figure 2). Under Alternative 4, Scenarios H1–H4, modeling  
 4 indicates that long-term annual average flows on the San Joaquin River would decrease by an  
 5 estimated 6% relative to Existing Conditions, and would remain virtually the same relative to the No  
 6 Action Alternative (Appendix 5A). Given these relatively small decreases in flows and the weak  
 7 correlation between nitrate and flows in the San Joaquin River (see Nitrate Appendix 8J, Figure 2), it  
 8 is expected that nitrate concentrations in the San Joaquin River would be minimally affected, if at all,  
 9 by changes in flow rates under any operational scenario of Alternative 4.

10 Any negligible changes in nitrate-N concentrations that may occur in the water bodies of the affected  
 11 environment located upstream of the Delta would not be of frequency, magnitude and geographic  
 12 extent that would adversely affect any beneficial uses or substantially degrade the quality of these  
 13 water bodies, with regards to nitrate.

#### 14 **Delta**

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

22 Mixing calculations indicate that under Alternative 4 (including the different operational  
 23 components of Scenarios H1–H4), relative to Existing Conditions and the No Action Alternative,  
 24 nitrate concentrations throughout the Delta are anticipated to remain low (<1.4 mg/L-N) relative to  
 25 adopted objectives (~~Nitrate~~Appendix 8J, ~~Nitrate~~. Table 16, ~~17A/1A through 17D~~). Although changes  
 26 at specific Delta locations and for specific months may be substantial on a relative basis, the absolute  
 27 concentration of nitrate in Delta waters would remain low (<1.4 mg/L-N) in relation to the drinking  
 28 water MCL of 10 mg/L-N, as well as all other thresholds identified in Table 8-50. Long-term average  
 29 nitrate concentrations are anticipated to remain below 1 mg/L-N at all 11 assessment locations  
 30 except the San Joaquin River at Buckley Cove, where long-term average concentrations would be  
 31 somewhat above 1 mg/L-N. Nevertheless, at this location, long-term average nitrate concentration  
 32 would be somewhat reduced under Alternative 4 relative to Existing Conditions, and slightly  
 33 increased relative to the No Action Alternative. Regardless of operational scenario, no additional  
 34 exceedances of the MCL are anticipated at any location under Alternative 4 (~~Nitrate~~Appendix  
 35 8J, ~~Nitrate~~. Table 16).

36 Use of assimilative capacity relative to the drinking water MCL of 10 mg/L-N under the four  
 37 operational scenarios of Alternative 4 is low or negligible (i.e., <5%) in comparison to both Existing  
 38 Conditions and the No Action Alternative, for all locations and months, for all modeled years, and for  
 39 the drought period (~~Nitrate~~Appendix 8J, ~~Nitrate~~. Table 18A/1A through 18D). One exception is for  
 40 Buckley Cove on the San Joaquin River in August, where use of assimilative capacity available during  
 41 the drought period (1987–1991) relative to the No Action Alternative for the four operational  
 42 scenarios of Alternative 4 ranged from 6.3% to 6.5%.

43 Nitrate concentrations will likely be higher than the modeling results indicate in certain locations.  
 44 This includes in the Sacramento River between Freeport and Mallard Island and other areas in the

1 Delta downstream of Freeport that are influenced by Sacramento River water. These increases are  
 2 associated with ammonia and nitrate that are discharged from the SRWTP, which are not included in  
 3 the modeling.

- 4 • Under Existing Conditions, most of the ammonia discharged from the SRWTP is converted to  
 5 nitrate downstream of the facility's discharge at Freeport, and thus, nitrate concentrations  
 6 under Existing Conditions in these areas are expected to be higher than the modeling predicts,  
 7 the increase becoming greater with increasing distance downstream. However, the increase in  
 8 nitrate concentrations downstream of the SRWTP is expected to be small—the existing increase  
 9 appears to be from approximately 0.1 mg/L-N to approximately 0.4–0.5 mg/L-N over this reach,  
 10 due to approximately a 1:1 conversion of ammonia-N to nitrate-N (Central Valley Water Board  
 11 2010a:32).
- 12 • Under the four operational scenarios of Alternative 4, the planned upgrades to the SRWTP,  
 13 which include nitrification/partial denitrification, would substantially decrease ammonia  
 14 concentrations in the discharge, but would increase nitrate concentrations in the discharge up to  
 15 10 mg/L-N, which is substantially higher than under Existing Conditions.
- 16 • Overall, under the four operational scenarios of Alternative 4, the nitrogen load from the SRWTP  
 17 discharge is expected to decrease (by up to 50%), relative to Existing Conditions, due to  
 18 nitrification/partial denitrification upgrades at the SRWTP facility. Thus, while concentrations of  
 19 nitrate downstream of the facility are expected to be higher than modeling results indicate for  
 20 both Existing Conditions and the four operational scenarios of Alternative 4, the increase is  
 21 expected to be greater under Existing Conditions than for the four operational scenarios of  
 22 Alternative 4 due to the upgrades that are assumed under the four operational scenarios of  
 23 Alternative 4.

24 The other areas in which nitrate concentrations will be higher than the modeling results indicate are  
 25 immediately downstream of other wastewater treatment plants that practice nitrification, but not  
 26 denitrification (e.g., City of Rio Vista Beach WWTF, Town of Discovery Bay WWTF, City of Stockton  
 27 RWCF). For all such facilities in the Delta, the Regional Water Boards have issued NPDES permits  
 28 that allow discharge of wastewater containing nitrate into the Delta, and under these permits, the  
 29 State has determined that no beneficial uses are adversely affected by the discharge, and that the  
 30 discharger's use of available assimilative capacity of the water body is acceptable. When dilution is  
 31 necessary in order for the discharge to be in compliance with the Basin Plans (which incorporate the  
 32 10 mg/L-N MCL by reference), not all of the assimilative capacity of the receiving water is granted to  
 33 the discharger. Thus, limited decreases in flows are not anticipated to result in systemic  
 34 exceedances of the MCLs by these POTWs. Furthermore, NPDES permits are renewed on a 5-year  
 35 basis, and thus, if under changes in flows, dilution was no longer sufficient to maintain nitrate below  
 36 the MCL in the receiving water, the NPDES permit renewal process would address such cases.

37 In summary, any increases in nitrate-N concentrations that may occur at certain locations within the  
 38 Delta would not be of frequency, magnitude and geographic extent that would adversely affect any  
 39 beneficial uses or substantially degrade the water quality at these locations, with regards to nitrate.

#### 40 ***SWP/CVP Export Service Areas***

41 Assessment of effects of nitrate in the SWP and CVP Export Service Areas is based on effects on  
 42 nitrate-N at the Banks and Jones pumping plants.

1 Results of the mixing calculations indicate that the change in nitrate concentrations and use of  
 2 assimilative capacity are similar for the four operational scenarios of Alternative 4 (~~Nitrate Appendix~~  
 3 ~~8J, Nitrate, Tables 16, 17A/1A through 17D, 18A/1A through 18D~~). Relative to Existing Conditions  
 4 and the No Action Alternative, nitrate concentrations at Banks and Jones pumping plants under  
 5 Alternative 4 are anticipated to decrease on a long-term average annual basis (~~Nitrate Appendix~~  
 6 ~~8J, Appendix 8J, Nitrate, Tables 17A/1A through 17D~~). During the late summer, particularly in the  
 7 drought period assessed, concentrations are expected to increase substantially on a relative basis  
 8 (i.e., >50%), but the absolute value of these changes (i.e., in mg/L-N) is small. Additionally, given the  
 9 many factors that contribute to potential algal blooms in the SWP and CVP canals within the Export  
 10 Service Area, and the lack of studies that have shown a direct relationship between nutrient  
 11 concentrations in the canals and reservoirs and problematic algal blooms in these water bodies,  
 12 there is no basis to conclude that these small (i.e., generally <0.3 mg/L-N), seasonal increases in  
 13 nitrate concentrations would increase the potential for problem algal blooms in the SWP and CVP  
 14 Export Service Area. No additional exceedances of the MCL are anticipated (~~Nitrate Appendix~~  
 15 ~~8J, Appendix 8J, Nitrate, Table 16~~). On a monthly average basis and on a long term annual average  
 16 basis, for all modeled years and for the drought period (1987–1991) only, use of assimilative  
 17 capacity available under Existing Conditions and the No Action Alternative, relative to the 10 mg/L-  
 18 N MCL, was negligible (<5%) for both Banks and Jones pumping plants (~~Nitrate Appendix~~  
 19 ~~8J, Appendix 8J, Nitrate, Table 18A/1A through 18D~~).

20 Any increases in nitrate-N concentrations that may occur in water exported via Banks and Jones  
 21 pumping plants are not expected to result in adverse effects to beneficial uses or substantially  
 22 degrade the quality of exported water, with regards to nitrate.

23 **NEPA Effects:** In summary, based on the discussion above, the effects on nitrate from implementing  
 24 CM1 are considered to be not adverse.

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

30 Nitrate-N concentrations are generally low in the reservoirs and rivers of the watersheds, owing to  
 31 substantial dilution available for point sources and the lack of substantial nonpoint sources of  
 32 nitrate-N upstream of the SRWTP in the Sacramento River watershed, and in the watersheds of the  
 33 eastern tributaries (Cosumnes, Mokelumne, and Calaveras Rivers). Although higher in the San  
 34 Joaquin River watershed, nitrate-N concentrations are not well-correlated with flow rates.  
 35 Consequently, any modified reservoir operations and subsequent changes in river flows under  
 36 Alternative 4, relative to Existing Conditions, are expected to have negligible, if any, effects on  
 37 reservoir and river nitrate-N concentrations upstream of Freeport in the Sacramento River  
 38 watershed and upstream of the Delta in the San Joaquin River watershed.

39 In the Delta, results of the mixing calculations indicate that under the four operational scenarios of  
 40 Alternative 4 (H1 through H4), relative to Existing Conditions, nitrate concentrations throughout the  
 41 Delta are anticipated to remain low (<1.4 mg/L-N) relative to adopted objectives. No additional  
 42 exceedances of the MCL are anticipated at any location, and use of assimilative capacity available  
 43 under Existing Conditions, relative to the drinking water MCL of 10 mg/L-N, was low or negligible  
 44 (i.e., <5%) for all operational scenarios for virtually all locations and months.

1 Assessment of effects of nitrate in the SWP and CVP Export Service Areas is based on effects on  
 2 nitrate-N concentrations at the Banks and Jones pumping plants. Results of the mixing calculations  
 3 indicate that under Alternative 4 (including the different operational components of Scenarios H1–  
 4 H4), relative to Existing Conditions, long-term average nitrate concentrations at Banks and Jones  
 5 pumping plants are anticipated to change negligibly. No additional exceedances of the MCL are  
 6 anticipated, and use of assimilative capacity available under Existing Conditions, relative to the MCL  
 7 was negligible (i.e., <5%) for both Banks and Jones pumping plants for all months.

8 Based on the above, there would be no substantial, long-term increase in nitrate-N concentrations in  
 9 the rivers and reservoirs upstream of the Delta, in the Delta Region, or the waters exported to the  
 10 CVP and SWP service areas under Alternative 4 relative to Existing Conditions. As such, this  
 11 alternative is not expected to cause additional exceedance of applicable water quality  
 12 objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects  
 13 on any beneficial uses of waters in the affected environment. Because nitrate concentrations are not  
 14 expected to increase substantially, no long-term water quality degradation is expected to occur and,  
 15 thus, no adverse effects to beneficial uses would occur. Nitrate is not 303(d) listed within the  
 16 affected environment and thus any increases that may occur in some areas and months would not  
 17 make any existing nitrate-related impairment measurably worse because no such impairments  
 18 currently exist. Because nitrate is not bioaccumulative, increases that may occur in some areas and  
 19 months would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose  
 20 substantial health risks to fish, wildlife, or humans. This impact is considered to be less than  
 21 significant. No mitigation is required.

22 **Impact WQ-16: Effects on Nitrate Concentrations Resulting from Implementation of CM2–**  
 23 **CM22CM21**

24 **NEPA Effects:** Some habitat restoration activities included in CM2–CM11 would occur on lands  
 25 within the Delta formerly used for agriculture. It is expected that this will decrease nitrate  
 26 concentrations in the Delta, due to less use of nitrate-based fertilizers, relative to the No Action  
 27 Alternative. Modeling scenarios included assumptions regarding how certain habitat restoration  
 28 activities (i.e., CM2 and CM4) would affect Delta hydrodynamics, and thus such effects of these  
 29 restoration measures were included in the assessment of CM1 facilities operations and maintenance  
 30 (see Impact WQ-1). In general, aside from changes in Delta hydrodynamics resulting from habitat  
 31 restoration discussed in Impact WQ-1, CM2–CM11 proposed for Alternative 4 are not expected to  
 32 increase nitrate concentrations in water bodies of the affected environment, relative to the No  
 33 Action Alternative.

34 Because urban stormwater is a source of nitrate in the affected environment, CM19, Urban  
 35 Stormwater Treatment, is expected to slightly reduce nitrate loading to the Delta, thus slightly  
 36 decreasing nitrate-N concentrations relative to the No Action Alternative. Implementation of CM12–  
 37 CM18 and CM20–CM22CM21 is not expected to substantially alter nitrate concentrations in any of  
 38 the water bodies of the affected environment.

39 The effects on nitrate from implementing CM2–22CM2 through CM22CM2–CM21 are considered to  
 40 be not adverse.

41 **CEQA Conclusion:** There would be no substantial, long-term increase in nitrate-N concentrations in  
 42 the rivers and reservoirs upstream of the Delta, in the Delta Region, or the waters exported to the  
 43 CVP and SWP service areas due to implementation of CM2–CM22CM21 under Alternative 4,  
 44 Scenarios H1–H4, relative to Existing Conditions. Because urban stormwater is a source of nitrate in

1 the affected environment, CM19, Urban Stormwater Treatment, is expected to slightly reduce nitrate  
 2 loading to the Delta. As such, implementation of these conservation measures is not expected to  
 3 cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude,  
 4 and geographic extent that would cause adverse effects on any beneficial uses of waters in the  
 5 affected environment. Because nitrate concentrations are not expected to increase substantially due  
 6 to these conservation measures, no long-term water quality degradation is expected to occur and,  
 7 thus, no adverse effects to beneficial uses would occur. Nitrate is not 303(d) listed within the  
 8 affected environment and thus any minor increases that may occur in some areas would not make  
 9 any existing nitrate-related impairment measurably worse because no such impairments currently  
 10 exist. Because nitrate is not bioaccumulative, minor increases that may occur in some areas would  
 11 not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health  
 12 risks to fish, wildlife, or humans. This impact is considered to be less than significant. No mitigation  
 13 is required.

#### 14 **Impact WQ-17: Effects on Dissolved Organic Carbon Concentrations Resulting from Facilities** 15 **Operations and Maintenance (CM1)**

##### 16 *Upstream of the Delta*

17 Under Alternative 4, Scenarios H1–H4, there would be no substantial change to the sources of DOC  
 18 within the watersheds upstream of the Delta. Moreover, long-term average flow and DOC levels in  
 19 the Sacramento River at Hood and San Joaquin River at Vernalis are poorly correlated. Thus changes  
 20 in system operations and resulting reservoir storage levels and river flows under the various  
 21 operational scenarios of Alternative 4 would not be expected to cause a substantial long-term  
 22 change in DOC concentrations in the water bodies upstream of the Delta. Any negligible changes in  
 23 DOC levels in water bodies upstream of the Delta under Scenarios H1–H4 of Alternative 4, relative to  
 24 Existing Conditions and the No Action Alternative, would not be of sufficient frequency, magnitude  
 25 and geographic extent that would adversely affect any beneficial uses or substantially degrade the  
 26 quality of these water bodies, with regards to DOC.

##### 27 *Delta*

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

35 Under the four operational scenarios of Alternative 4, the geographic extent of effects pertaining to  
 36 long-term average DOC concentrations in the Delta would be similar to that previously described for  
 37 Alternative 1A, although the magnitude of predicted long-term change and relative frequency of  
 38 concentration threshold exceedances would be slightly greater. For all the operational scenarios  
 39 relative to Existing Conditions, the modeled effects would be greatest at Franks Tract, Rock Slough,  
 40 and Contra Costa PP No. 1. Increased long-term average DOC concentrations at these locations would  
 41 be greatest under Scenario H4 and would be least under Scenario H1, although differences would be  
 42 generally small between operational scenarios (i.e.,  $\leq 0.2$  mg/L). Under Scenario H4, long-term  
 43 average DOC concentrations for the modeled 16-year hydrologic period and the modeled drought



1 period would be predicted to increase between 0.4–0.5 mg/L at Franks Tract, Rock Slough, and  
 2 Contra Costa PP No. 1 ( $\leq 14\%$  net increase) (Appendix 8K, *Organic Carbon*, DOC Table 5). Under  
 3 Scenario H4, increases in long-term average concentrations of between 0.4–0.5 mg/L at Franks  
 4 Tract, Rock Slough, and Contra Costa PP No. 1 would correspond to more frequent concentration  
 5 threshold exceedances, with the greatest change occurring at Rock Slough and Contra Costa PP No. 1  
 6 locations. For Rock Slough, long-term average DOC concentrations exceeding 3 mg/L would increase  
 7 from 52% under Existing Conditions to 76% under Scenario H4 of Alternative 4 (an increase from  
 8 47% to 67% for the drought period), and concentrations exceeding 4 mg/L would increase from  
 9 30% to 38% (32% to 38% for the drought period). For Contra Costa PP No. 1, long-term average  
 10 DOC concentrations exceeding 3 mg/L would increase from 52% under Existing Conditions to 81%  
 11 under Scenario H4 of Alternative 4 (45% to 78% for the drought period), and concentrations  
 12 exceeding 4 mg/L would increase from 32% to 45% (35% to 47% for the drought period). Relative  
 13 change in frequency of threshold exceedance for the other operational scenarios and at other  
 14 assessment locations would be similar or less. While all of the operational scenarios of Alternative 4  
 15 would generally lead to slightly higher long-term average DOC concentrations ( $\leq 0.5$  mg/L) at some  
 16 municipal water intakes and Delta interior locations, the predicted change would not be expected to  
 17 adversely affect MUN beneficial uses, or any other beneficial use. This comparison to Existing  
 18 Conditions reflects changes in DOC due to both Alternative 4 operations (including north Delta  
 19 intake capacity of 9,000 cfs and the different operational components of Scenarios H1–H4) and  
 20 climate change/sea level rise.

21 In comparison, relative to the No Action Alternative, the operational scenarios of Alternative 4  
 22 would generally result in a similar magnitude of change to that discussed for the Alternative 4  
 23 operational scenario comparison to Existing Conditions. Scenario H4 would generally lead to the  
 24 largest model predicted long-term average DOC concentration increases, and Scenario H1 would  
 25 generally lead to the smallest model predicted increases, although the relative difference between  
 26 operational scenarios would be small (i.e.,  $\leq 0.2$  mg/L). Under Scenario H4, maximum increases of  
 27 0.3–0.4 mg/L DOC (i.e.,  $\leq 12\%$ ) would be predicted at Franks Tract, Rock Slough, and Contra Costa  
 28 PP No. 1 relative to No Action Alternative (Appendix 8K, *Organic Carbon*, DOC Table 5). For the  
 29 operational scenarios, threshold concentration exceedance frequency trends would also be similar  
 30 to that discussed for the existing condition comparison, with exception to the drought period  
 31 predicted 4 mg/L exceedance frequency at Buckley Cove. In comparison to the No Action  
 32 Alternative, and regardless of operational scenario, the frequency which long-term average DOC  
 33 concentrations exceeded 4 mg/L during the modeled drought period at Buckley Cove would  
 34 increase from 42% to 50%. While the operational scenarios of Alternative 4 would generally lead to  
 35 slightly higher long-term average DOC concentrations at some Delta assessment locations when  
 36 compared to No Action Alternative conditions, the predicted change would not be expected to  
 37 adversely affect MUN beneficial uses, or any other beneficial use, particularly when considering the  
 38 relatively small change in long-term annual average concentration. Unlike the comparison to  
 39 Existing Conditions, this comparison to the No Action Alternative reflects changes in DOC due only  
 40 to the different operational components of Scenarios H1–H4 of Alternative 4.

41 As discussed for Alternative 1A, substantial change in ambient DOC concentrations would need to  
 42 occur before significant changes in drinking water treatment plant design or operations are  
 43 triggered. The increases in long-term average DOC concentrations estimated to occur at various  
 44 Delta locations under the four alternative operational scenarios of Alternative 4 are of sufficiently  
 45 small magnitude that they would not require existing drinking water treatment plants to  
 46 substantially upgrade treatment for DOC removal above levels currently employed.

1 Relative to existing and No Action Alternative conditions, Alternative 4 would lead to predicted  
 2 improvements in long-term average DOC concentrations at Barker Slough, as well as Banks and  
 3 Jones pumping plants (discussed below). At Barker Slough, long-term average DOC concentrations  
 4 would be predicted to decrease by as much as 0.1–0.2 mg/L, depending on operational scenario,  
 5 baseline conditions comparison and modeling period.

### 6 ***SWP/CVP Export Service Areas***

7 Under all operational scenarios of Alternative 4, relative to Existing Conditions and the No Action  
 8 Alternative, modeled long-term average DOC concentrations would decrease at Banks and Jones  
 9 pumping plants. Modeled decreases would be greatest under Scenarios H2 and H4. Relative to  
 10 Existing Conditions, long-term average DOC concentrations at Banks under Scenarios H2 and H4  
 11 would be predicted to decrease by 0.4 mg/L (0.4 mg/L during drought period) (Appendix 8K,  
 12 *Organic Carbon*, DOC Table 5). At Jones, long-term average DOC concentrations would be predicted  
 13 to decrease by 0.4 mg/L (<0.1 mg/L during drought period). Under all the operational scenarios,  
 14 decreases in long-term average DOC would result in generally lower exceedance frequencies for  
 15 concentration thresholds, although the frequency of exceedance during the modeled drought period  
 16 (i.e., 1987–1991) in particular would be predicted to increase. For the Banks pumping plant during  
 17 the drought period, exceedance of the 3 mg/L threshold would increase from 57% under Existing  
 18 Conditions to as much as 83% under Scenario H3, and exceedance of the 4 mg/L concentration  
 19 threshold would increase slightly for only Scenarios H1 and H3 from 42% to as much as 45%. At the  
 20 Jones pumping plant, exceedance of the 3 mg/L concentration threshold during the drought period  
 21 would increase from 72% under Existing Conditions to as much as 93% under Scenario H1, and  
 22 exceedance of the 4 mg/L threshold would increase slightly for all operational scenarios, from 35%  
 23 to as much as 41% for Scenario H4. Comparisons to the No Action Alternative yield similar trends,  
 24 but with slightly smaller magnitude drought period changes. Overall, modeling results for the  
 25 SWP/CVP Export Service Areas predict an overall improvement in Export Service Areas water  
 26 quality, although more frequent exports of >3mg/L DOC water would likely occur for drought  
 27 periods.

28 Similar to the discussion pertaining to the No Action Alternative, maintenance of SWP and CVP  
 29 facilities under Scenarios H1–H4 of Alternative 4 would not be expected to create new sources of  
 30 DOC or contribute towards a substantial change in existing sources of DOC in the affected area.  
 31 Maintenance activities would not be expected to cause any substantial change in long-term average  
 32 DOC concentrations such that MUN beneficial uses, or any other beneficial use, would be adversely  
 33 affected.

34 ***NEPA Effects:*** In summary, the operations and maintenance activities under Scenarios H1–H4 of  
 35 Alternative 4, relative to the No Action Alternative, would not cause a substantial long-term change  
 36 in DOC concentrations in the water bodies upstream of the Delta. Depending on operational  
 37 scenario, long-term average DOC concentrations at Banks and Jones pumping plants are predicted to  
 38 decrease by as much as 0.5 mg/L, while long-term average DOC concentrations for some Delta  
 39 interior locations, including Contra Costa PP #1, are predicted to increase by as much as 0.4 mg/L.  
 40 Regardless of operational scenario, the increase in long-term average DOC concentration that could  
 41 occur within the Delta interior would not be of sufficient magnitude to adversely affect the MUN  
 42 beneficial use, or any other beneficial uses, of Delta waters. The effect of operations and  
 43 maintenance activities on DOC under Scenarios H1–H4 of Alternative 4 is determined not to be  
 44 adverse.

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

6 While greater water demands under the operational scenarios of Alternative 4 would alter the  
7 magnitude and timing of reservoir releases north, south and east of the Delta, these activities would  
8 have no substantial effect on the various watershed sources of DOC. Moreover, long-term average  
9 flow and DOC at Sacramento River at Hood and San Joaquin River at Vernalis are poorly correlated;  
10 therefore, changes in river flows would not be expected to cause a substantial long-term change in  
11 DOC concentrations upstream of the Delta.

12 Relative to Existing Conditions, the operational scenarios of Alternative 4 would result in relatively  
13 small increases (i.e.,  $\leq 14\%$ ) in long-term average DOC concentrations at some Delta interior  
14 locations, including Franks Tract, Rock Slough, and Contra Costa PP No. 1. These increases would be  
15 greatest for Scenario H4, and least for Scenarios H1, although the difference in change would be  
16 relatively small. The predicted increases under the operational scenarios modeled would not  
17 substantially increase the frequency with which long-term average DOC concentrations exceeds 2, 3,  
18 or 4 mg/L. While Scenarios H1–H4 would generally lead to slightly higher long-term average DOC  
19 concentrations ( $\leq 0.2$ – $0.5$  mg/L) within the Delta interior and some municipal water intakes, the  
20 predicted change would not be expected to adversely affect MUN beneficial uses, or any other  
21 beneficial use.

22 The assessment of Alternative 4 Scenario H1–H4 effects on DOC in the SWP/CVP Export Service  
23 Areas is based on assessment of changes in DOC concentrations at Banks and Jones pumping plants.  
24 Relative decreases in long-term average DOC concentrations would be greatest under Scenarios H2  
25 and H4, where long-predicted concentrations would decrease as much as 0.4 mg/L at Banks and  
26 Jones pumping plants. Regardless of operational scenario, however, slightly more frequent export of  
27  $>3$  mg/L DOC water is predicted during the drought period. Nevertheless, under any operational  
28 scenario, an overall improvement in DOC-related water quality would be predicted in the SWP/CVP  
29 Export Service Areas.

30 Based on the above, the operations and maintenance activities of Scenarios H1–H4 of Alternative 4  
31 would not result in any substantial change in long-term average DOC concentration upstream of the  
32 Delta or result in substantial increase in the frequency with which long-term average DOC  
33 concentrations exceeds 2, 3, or 4 mg/L levels at the 11 assessment locations analyzed for the Delta.  
34 Increases in long-term average DOC concentrations at some Delta interior locations, including  
35 Franks Tract, Rock Slough, and Contra Costa PP No. 1 would be predicted, with the greatest  
36 increases occurring under Scenario H4 and the smallest increase occurring under Scenario  
37 H1. Under Scenario H4, modeled long-term average DOC concentrations would increase by no more  
38 than 0.5 mg/L at any single Delta assessment location (i.e.,  $\leq 14\%$  relative increase) while under  
39 Scenario H1, modeled long-term DOC concentrations would increase by no more than 0.3 mg/L at  
40 any single Delta assessment location (i.e.,  $\leq 9\%$  relative increase). For all operational scenarios  
41 considered, the increases in long-term average DOC concentration that could occur within the Delta  
42 would not be of sufficient magnitude to adversely affect the MUN beneficial use, or any other  
43 beneficial uses, of Delta waters or waters of the SWP/CVP Service Area. Because DOC is not  
44 bioaccumulative, the increases in long-term average DOC concentrations would not directly cause  
45 bioaccumulative problems in aquatic life or humans. Finally, DOC is not causing beneficial use

1 impairments and thus is not 303(d) listed for any water body within the affected environment. Thus,  
 2 the increases in long-term average DOC that could occur at various locations would not make any  
 3 beneficial use impairment measurably worse. Because long-term average DOC concentrations are  
 4 not expected to increase substantially, no long-term water quality degradation with respect to DOC  
 5 is expected to occur and, thus, no adverse effects on beneficial uses would occur. This impact is  
 6 considered to be less than significant. No mitigation is required.

7 **Impact WQ-18: Effects on Dissolved Organic Carbon Concentrations Resulting from**  
 8 **Implementation of CM2-~~CM22~~CM21**

9 **NEPA Effects:** The mostly non-land disturbing CM12-~~CM22~~CM21 present no new sources of DOC to  
 10 the affected environment, including areas Upstream of the Delta, within the Plan Area, and the  
 11 SWP/CVP Export Service Area. Implementation of methylmercury control measures (CM12) and  
 12 urban stormwater treatment measures (CM19) may result in beneficial effects, to the extent that  
 13 control measures treat or reduce organic carbon loading from tidal wetlands and urban land uses.  
 14 Control of nonnative aquatic vegetation (CM13) may include killing mature aquatic vegetation in  
 15 place, leading to their decay and contribution to DOC in Delta channels. However, this measure is not  
 16 expected to be a significant source of long-term DOC loading as vegetation control would be  
 17 sporadic and on an as needed basis, with decreasing need for treatments in the long-term as  
 18 nonnative vegetation is eventually controlled and managed. Implementation of CM12-~~CM22~~CM21  
 19 would not be expected to have substantial, if even measurable, effect on DOC concentrations  
 20 upstream of the Delta, within the Delta, and in the SWP/CVP service areas. Consequently, any  
 21 negligible increases in DOC levels in these areas of the affected environment are not expected to be  
 22 of sufficient frequency, magnitude and geographic extent that they would adversely affect the MUN  
 23 beneficial use, or any other beneficial uses, of the affected environment, nor would potential  
 24 increases substantially degrade water quality with regards to DOC.

25 For CM2-~~CM11~~, effects on DOC concentrations can generally be considered in terms of: (1)  
 26 alternative-caused change in Delta hydrodynamics, and (2) alternative-caused change in Delta DOC  
 27 sources. Change in Delta hydrodynamics involves a two part process, including the conveyance  
 28 facilities and operational scenarios of CM1, as well as the change in Delta channel geometry and  
 29 open water areas that would occur as a consequence of implementing tidal wetland restoration  
 30 measures such as that described for CM4. Modeling scenarios included assumptions regarding how  
 31 these habitat restoration activities would affect Delta hydrodynamics, and thus the effects of these  
 32 restoration measures, via their effects on delta hydrodynamics, were included in the assessment of  
 33 CM1 facilities operations and maintenance (see Impact WQ-17). The potential for these same  
 34 conservation measures to change Delta DOC sources are addressed below.

35 CM2, CM3, CM8, CM9, and CM11 could include activities that would target increasing primary  
 36 production (i.e., algae growth) within the Delta. Algae currently are not estimated to be a major  
 37 source of DOC in the Delta (CALFED Bay-Delta Program 2008a: 4, 6), and comprise mostly the  
 38 particulate fraction of TOC. Conventional drinking water treatment removes much of the POC from  
 39 raw source water; therefore, conservation measure activities targeted at increased algae production  
 40 are not expected to contribute substantial amounts of new DOC, or adversely affect MUN beneficial  
 41 use, or any other beneficial uses, of the affected environment.

42 CM4-~~CM7~~ and CM10 include land disturbing restoration activities known to be sources of DOC.  
 43 Research within the Delta has focused primarily on non-tidal wetlands and flooding of Delta island  
 44 peat soils. The dynamics of DOC production and export from wetlands and seasonally flooded soils is

1 complex, as well as highly site and circumstance specific. Age and configuration of a wetland  
2 significantly affects the amount of DOC that may be generated in a wetland. In a study of a  
3 permanently flooded non-tidal constructed wetland on Twitchell Island, initial DOC loading was  
4 determined to be much greater (i.e., approximately 10 times greater) than equivalent area of  
5 agricultural land, but trends in annual loading led researchers to estimate that loading from the  
6 wetland would be equivalent to that of agriculture within about 15 years (Fleck et. al. 2007: 18). It  
7 was observed that the majority of the wetland load originated from seepage through peat soils.  
8 Trends in declining load were principally associated with flushing of mobile DOC from submerged  
9 soils, the origins of which were related to previous agricultural activity prior to restoration to  
10 wetland. Peaks in annual loading, however, would be different, where peaks in agricultural drainage  
11 occur in winter months while peaks in wetland loading occur in spring and summer months. As  
12 such, age, configuration, location, operation, and season all factor into DOC loading, and long-term  
13 average DOC concentrations in the Delta.

14 Available evidence suggests that restoration activities establishing new tidal and non-tidal wetlands,  
15 new riparian and new seasonal floodplain habitat could potentially lead to new substantial sources  
16 of localized DOC loading within the Delta. If established in areas presently used for agriculture, these  
17 restoration activities could result in a substitution and temporary increase in localized DOC loading  
18 for years. Presently, the specific design, operational criteria, and location of these activities are not  
19 well established. Depending on localized hydrodynamics, such restoration activities could  
20 contribute substantial amounts of DOC to municipal raw water if established near municipal intakes.  
21 Substantially increased DOC concentrations in municipal source water may create a need for  
22 existing drinking water treatment plants to upgrade treatment systems in order to achieve EPA  
23 Stage 1 Disinfectants and Disinfection Byproduct Rule action thresholds. While treatment  
24 technologies sufficient to achieve the necessary DOC removals exist, implementation of such  
25 technologies would likely require substantial investment in new or modified infrastructure.

26 In summary, the habitat restoration elements of CM4–CM7 and CM10 under Alternative 4 would  
27 present new localized sources of DOC to the study area, and in some circumstances would substitute  
28 for existing sources related to replaced agriculture. Depending on localized hydrodynamics and  
29 proximity to municipal drinking water intakes, such restoration activities could contribute  
30 substantial amounts of DOC to municipal raw water. Substantial increases in municipal raw water  
31 DOC could necessitate changes in water treatment plant operations or require treatment plant  
32 upgrades in order to maintain DBP compliance, and thus would constitute an adverse effect on  
33 water quality. Mitigation Measure WQ-18 is available to reduce these effects.

34 **CEQA Conclusion:** Implementation of CM2, CM3, CM8,CM9, and CM11–~~CM22~~CM21 would not  
35 present new or substantially changed sources of organic carbon to the affected environment of the  
36 Delta, and thus would not contribute substantially to changes in long-term average DOC  
37 concentrations in the Delta. Therefore, related long-term water quality degradation would not be  
38 expected to occur and, thus, no adverse effects on beneficial uses would occur through  
39 implementation of CM2, CM3, CM8,CM9, and CM11–~~CM22~~CM21. Furthermore, DOC is not  
40 bioaccumulative, therefore changes in DOC concentrations would not cause bioaccumulative  
41 problems in aquatic life or humans. Nevertheless, implementation of CM4–CM7 and 10 would  
42 present new localized sources of DOC to the study area, and in some circumstances would substitute  
43 for existing sources related to replaced agriculture. Depending on localized hydrodynamics and  
44 proximity to municipal drinking water intakes, such restoration activities could contribute  
45 substantial amounts of DOC to municipal raw water. The potential for substantial increases in long-  
46 term average DOC concentrations related to the habitat restoration elements of CM4–CM7 and 10

1 could contribute to long-term water quality degradation with respect to DOC and, thus, adversely  
 2 affect MUN beneficial uses. The impact is considered to be significant and mitigation is required. It is  
 3 uncertain whether implementation of Mitigation Measure WQ-18 would reduce identified impacts  
 4 to a less-than-significant level. Hence, this impact remains significant and unavoidable.

5 In addition to and to supplement Mitigation Measure WQ-18, the BDCP proponents have  
 6 incorporated into the BDCP, as set forth in EIR/EIS Appendix 3B, *Environmental Commitments*, a  
 7 separate, non-environmental commitment to address the potential increased water treatment costs  
 8 that could result from DOC concentration effects on municipal and industrial water purveyor  
 9 operations. Potential options for making use of this financial commitment include funding or  
 10 providing other assistance towards implementing treatment for DOC and/or DBPs or DOC source  
 11 control strategies. Please refer to Appendix 3B, *Environmental Commitments*, for the full list of  
 12 potential actions that could be taken pursuant to this commitment in order to reduce the water  
 13 quality treatment costs associated with water quality effects relating to DOC.

14 **Mitigation Measure WQ-18: Design Wetland and Riparian Habitat Features to Minimize**  
 15 **Effects on Municipal Intakes**

16 The BDCP proponents will design wetland and riparian habitat features taking into  
 17 consideration effects on Delta hydrodynamics and impacts on municipal intakes. Locate  
 18 restoration features such that impacts on municipal intakes are minimized and habitat benefits  
 19 are maximized. Incorporate design features to control the load and/or timing of DOC exports  
 20 from habitat restoration features. This could include design elements to control seepage from  
 21 non-tidal wetlands (e.g., incorporation of slurry walls into levees), and features to increase  
 22 retention time and decrease tidal exchange in tidal wetlands and riparian and channel margin  
 23 habitat designs. For restoration features directly connected to open channel waters, design  
 24 wetlands with only channel margin exchanges to decrease DOC loading. Stagger construction of  
 25 wetlands and channel margin/riparian sites both spatially and temporally so as to allow aging of  
 26 the restoration features and associated decreased creation of localized “hot spots” and net Delta  
 27 loading.

28 The BDCP proponents will also establish measures to help guide the design and creation of the  
 29 target wetland habitats. At a minimum, the measures should limit potential increases in long-  
 30 term average DOC concentrations, and thus guide efforts to site, design, and maintain wetland  
 31 and riparian habitat features, consistent with the biological goals and objectives of the BDCP.  
 32 For example, restoration activities could be designed and located with the goal of preventing,  
 33 consistent with the biological goals and objectives of the BDCP, net long-term average DOC  
 34 concentration increases of greater than 0.5 mg/L at any municipal intake location within the  
 35 Delta.

36 However, it must be noted that some of these measures could limit the benefit of restoration  
 37 areas by limiting the amount of carbon supplied by these areas to the Delta as a whole. In some  
 38 cases, these measures would run directly counter to the goals and objectives of the BDCP. This  
 39 mitigation measure should not be implemented in such a way that it reduces the benefits to the  
 40 Delta ecosystem provided by restoration areas. As mentioned above, the BDCP proponents have  
 41 incorporated into the BDCP, as set forth in EIR/EIS Appendix 3B, *Environmental Commitments*, a  
 42 separate, non-environmental commitment to address the potential increased water treatment  
 43 costs that could result from DOC concentration effects on municipal and industrial water  
 44 purveyor operations.

1 **Impact WQ-19: Effects on Pathogens Resulting from Facilities Operations and Maintenance**  
 2 **(CM1)**

3 ***Upstream of the Delta***

4 Under Alternative 4, Scenarios H1–H4, the only pathogen sources expected to change in the  
 5 watersheds upstream of the Delta relative to Existing Conditions or the No Action Alternative would  
 6 be associated with population growth, i.e., increased municipal wastewater discharges and  
 7 development contributing to increased urban runoff.

8 Increased municipal wastewater discharges resulting from future population growth would not be  
 9 expected to measurably increase pathogen concentrations in receiving waters due to state and  
 10 federal water quality regulations requiring disinfection of effluent discharges and the state’s  
 11 implementation of Title 22 filtration requirements for many wastewater dischargers in the  
 12 Sacramento River and San Joaquin River watersheds.

13 Pathogen loading from urban areas would generally occur in association with both dry and wet  
 14 weather runoff from urban landscapes. Municipal stormwater regulations and permits have become  
 15 increasingly stringent in recent years, and such further regulation of urban stormwater runoff is  
 16 expected to continue in the future. Municipalities may implement BMPs for reducing pollutant  
 17 loadings from urban runoff, particularly in response to NPDES stormwater-related regulations  
 18 requiring reduction of pollutant loading in urban runoff. The ability of these BMPs to consistently  
 19 reduce pathogen loadings and the extent of future implementation is uncertain, but would be  
 20 expected to improve as new technologies are continually tested and implemented. Also, some of the  
 21 urbanization may occur on lands used by other pathogens sources, such as grazing lands, resulting  
 22 in a change in pathogen source, but not necessarily an increase (and possibly a decrease) in  
 23 pathogen loading.

24 Pathogen concentrations in the Sacramento and San Joaquin Rivers have a minimal relationship to  
 25 flow rate in these rivers, although most of the high concentrations observed have been during the  
 26 wet months (Tetra Tech 2007). Further, urban runoff contributions during the dry season would be  
 27 expected to be a relatively small fraction of the rivers’ total flow rates. During wet weather events,  
 28 when urban runoff contributions would be higher, the flows in the rivers also would be higher.  
 29 Given the small magnitude of urban runoff contributions relative to the magnitude of river flows,  
 30 that pathogen concentrations in the rivers have a minimal relationship to river flow rate, and the  
 31 expected reduced pollutant loadings in response to NPDES stormwater-related regulations, river  
 32 flow rate and reservoir storage reductions that would occur under Alternative 4, Scenarios H1–H4,  
 33 relative to Existing Conditions and the No Action Alternative, would not be expected to result in a  
 34 substantial adverse change in pathogen concentrations in the reservoirs and rivers upstream of the  
 35 Delta. As such, none of the operational scenarios of Alternative 4 would be expected to substantially  
 36 increase the frequency with which applicable Basin Plan objectives or U.S. EPA-recommended  
 37 pathogen criteria would be exceeded in water bodies of the affected environment located upstream  
 38 of the Delta or substantially degrade the quality of these water bodies, with regard to pathogens.

39 ***Delta***

40 *The Conceptual Model for Pathogens and Pathogen Indicators in the Central Valley and Sacramento-*  
 41 *San Joaquin Delta* (Pathogens Conceptual Model; Tetra Tech 2007) provides a comprehensive  
 42 evaluation of factors affecting pathogen levels in the Delta. The Pathogens Conceptual Model  
 43 characterizes relative pathogen contributions to the Delta from the Sacramento and San Joaquin

1 Rivers and various pathogen sources, including wastewater discharges and urban runoff.  
 2 Contributions from the San Francisco Bay to the Delta are not addressed. The Pathogens Conceptual  
 3 Model is based on a database compiled by the Central Valley Drinking Water Policy Group in 2004–  
 4 2005, supplemented with data from Natomas East Main Drainage Canal Studies, North Bay Aqueduct  
 5 sampling, and the USGS. Data for multiple sites in the Sacramento River and San Joaquin River  
 6 watersheds, and in the Delta were compiled. Indicator species evaluated include fecal coliforms,  
 7 total coliforms, and *E. coli*. Because of its availability, *Cryptosporidium* and *Giardia* data for the  
 8 Sacramento River also were evaluated. Key results of the data evaluation are:

#### 9 **Total Coliform**

- 10 • In the Sacramento Valley, the highest total coliform concentrations (>10,000 MPN/100 ml)  
 11 were located near urban areas.
- 12 • Similarly high total coliform concentrations were not observed in the San Joaquin Valley,  
 13 because reported results were capped at about 2,400 MPN/100 ml, though a large number of  
 14 results were reported as being greater than this value.
- 15 • The data should not to be interpreted to conclude that Sacramento River has higher total  
 16 coliform concentrations; rather, the “appearance” of the lower total coliform concentrations in  
 17 the San Joaquin Valley is attributed to a lower upper limit of reporting (2,400 MPN/100 ml  
 18 versus 10,000 MPN/100 ml).

#### 19 ***E. coli***

- 20 • Comparably high concentrations observed in the Sacramento River and San Joaquin River  
 21 watersheds for waters affected by urban environments and intensive agriculture.
- 22 • The highest concentrations in the San Joaquin River were not at the most downstream location  
 23 monitored, but rather at an intermediate location near Hills Ferry.
- 24 • *E. coli* concentrations in the Delta were somewhat higher than in the San Joaquin River and  
 25 Sacramento River, indicating the importance of in-Delta sources and influence of distance of  
 26 pathogen source on concentrations at a particular location in the receiving waters.
- 27 • Temporal (seasonal) trends were weak, however, the highest concentrations in the Sacramento  
 28 River were observed during the wet months and the lowest concentrations were observed in  
 29 July and August.

#### 30 **Fecal Coliform**

- 31 • There was limited data from which to make comparisons/observations.

#### 32 **Cryptosporidium and Giardia**

- 33 • Data were available only for the Sacramento River, limiting the ability to make comparisons  
 34 between sources.
- 35 • Often not detected and when detected, concentrations typically less than 1 organism per liter.
- 36 • There may be natural/artificial barriers/processes that limit *Cryptosporidium* transport to  
 37 water. Significant die off of those that reach the water may contribute to the low frequency of  
 38 detection.



1 The Pathogens Conceptual Model found that coliform indicators vary by orders of magnitudes over  
 2 small distances and short time-scales. Concentrations appear to be more closely related to what  
 3 happens in the proximity of a sampling station, rather than what happens in the larger watershed  
 4 where significant travel time and concomitant pathogen die-off can occur. Sites in the Delta close to  
 5 urban discharges had elevated concentrations of coliform organisms. The highest total coliform and  
 6 *E. coli* concentrations were observed in the discharge from the Natomas East Main Drainage Canal  
 7 and several stations near sloughs, indicating the relative influence of urban and wildlife pathogen  
 8 sources on receiving water concentrations.

9 The effects of the operational scenarios of Alternative 4 relative to Existing Conditions and the No  
 10 Action Alternative would be changes in the relative percentage of water throughout the Delta being  
 11 comprised of various source waters (i.e., water from the Sacramento River, San Joaquin River, Bay  
 12 water, eastside tributaries, and agricultural return flow), due to potential changes in inflows  
 13 particularly from the Sacramento River watershed due to increased water demands (see Table 8-55)  
 14 and somewhat modified SWP and CVP operations. However, it is expected there would be no  
 15 substantial change in Delta pathogen concentrations in response to a shift in the Delta source water  
 16 percentages under this alternative or substantial degradation of these water bodies, with regard to  
 17 pathogens. This conclusion is based on the Pathogens Conceptual Model, which found that pathogen  
 18 sources in close proximity to a Delta site appear to have the greatest influence on pathogen levels at  
 19 the site, rather than the primary source(s) of water to the site. In-Delta potential pathogen sources,  
 20 including water-based recreation, tidal habitat, wildlife, and livestock-related uses, would continue  
 21 under this alternative.

#### 22 ***SWP/CVP Export Service Areas***

23 None of the operational scenarios of Alternative 4 are expected to result in substantial changes in  
 24 pathogen levels in Delta waters, relative to Existing Conditions or the No Action Alternative. As such,  
 25 there is not expected to be substantial, if even measurable, changes in pathogen concentrations in  
 26 the SWP/CVP Export Service Area waters.

27 ***NEPA Effects:*** The effects on pathogens from implementing Alternative 4, Scenarios H1–H4, is  
 28 determined to not be adverse.

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

34 River flow rate and reservoir storage reductions that would occur due to implementation of CM1  
 35 (water facilities and operations) under Alternative 4, relative to Existing Conditions, would not be  
 36 expected to result in a substantial adverse change in pathogen concentrations in the reservoirs and  
 37 rivers upstream of the Delta, given the small magnitude of urban runoff contributions relative to the  
 38 magnitude of river flows, that pathogen concentrations in the rivers have a minimal relationship to  
 39 river flow rate, and the expected reduced pollutant loadings in response to NPDES stormwater-  
 40 related regulations.

41 It is expected there would be no substantial change in Delta pathogen concentrations in response to  
 42 a shift in the Delta source water percentages under this alternative or substantial degradation of  
 43 these water bodies, with regard to pathogens. This conclusion is based on the Pathogens Conceptual

1 Model, which found that pathogen sources in close proximity to a Delta site appear to have the  
2 greatest influence on pathogen levels at the site, rather than the primary source(s) of water to the  
3 site. In-Delta potential pathogen sources, including water-based recreation, tidal habitat, wildlife,  
4 and livestock-related uses, would continue under this alternative.

5 In the SWP/CVP Export Service Areas waters, relative to Existing Conditions, an increased  
6 proportion of water coming from the Sacramento River would not adversely affect beneficial uses in  
7 the SWP/CVP Export Service Areas. The pathogen levels in the Sacramento River are similar to or  
8 lower than the water diverted at the Delta export pumps. Further, it is localized sources of  
9 pathogens that appear to have the greatest influence on concentrations. Thus, an increased  
10 proportion of Sacramento River water diverted to the SWP/CVP Export Service Areas would result  
11 in minimal changes in pathogen levels in the SWP/CVP Export Service Areas waters.

12 Therefore, this alternative is not expected to cause additional exceedance of applicable water quality  
13 objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any  
14 beneficial uses of waters in the affected environment. Because pathogen concentrations are not  
15 expected to increase substantially, no long-term water quality degradation for pathogens is  
16 expected to occur and, thus, no adverse effects on beneficial uses would occur. The San Joaquin  
17 River in the Stockton Deep Water Ship Channel is Clean Water Act section 303(d) listed for  
18 pathogens. Because no measurable increase in Deep Water Ship Channel pathogen concentrations  
19 are expected to occur on a long-term basis, further degradation and impairment of this area is not  
20 expected to occur. Finally, pathogens are not bioaccumulative constituents. This impact is  
21 considered to be less than significant. No mitigation is required.

## 22 **Impact WQ-20: Effects on Pathogens Resulting from Implementation of CM2-~~CM22~~CM21**

23 **NEPA Effects:** CM2-CM11 would involve habitat restoration actions, and ~~CM22~~CM21 involves  
24 waterfowl and shorebird areas. Tidal wetlands are known to be sources of coliforms originating  
25 from aquatic, terrestrial, and avian wildlife that inhabit these areas (Desmarais et al. 2001, Grant et  
26 al. 2001, Evanson and Ambrose 2006, Tetra Tech 2007). Specific locations of restoration areas for  
27 this alternative have not yet been established. However, most low-lying land suitable for restoration  
28 is unsuitable for livestock. Therefore, it is likely that the majority of land to be converted to wetlands  
29 would be crop-based agriculture or fallow/idle land. Because of a great deal of scientific uncertainty  
30 in the loading of coliforms from these various sources, the resulting change in coliform loading is  
31 uncertain, but it is anticipated that coliform loading to Delta waters would increase. Based on  
32 findings from the Pathogens Conceptual Model that pathogen concentrations are greatly influenced  
33 by the proximity to the source, this could result in localized increases in wildlife-related coliforms  
34 relative to the No Action Alternative. The Delta currently supports similar habitat types and, with  
35 the exception of the Clean Water Act section 303(d) listing for the Stockton Deep Water Ship  
36 Channel, is not recognized as exhibiting pathogen concentrations that rise to the level of adversely  
37 affecting beneficial uses. As such, the potential increase in wildlife-related coliform concentrations  
38 due to tidal habitat creation is not expected to adversely affect beneficial uses.

39 CM19, which would fund projects to contribute to reducing pollutant discharges in stormwater,  
40 would be expected to reduce pathogen load relative to the No Action Alternative. The remaining  
41 conservation measures would not be expected to affect pathogen levels, because they are actions  
42 that do not affect the presence of pathogen sources.

43 The effects on pathogens from implementing CM2-~~CM22~~CM21 is determined to not be adverse.

1 **CEQA Conclusion:** Based on findings from the Pathogens Conceptual Model that pathogen  
 2 concentrations are greatly influenced by the proximity to the source, implementation of CM2–CM11  
 3 and ~~CM22~~CM21 could result in localized increases in wildlife-related coliforms relative to Existing  
 4 Conditions. The Delta currently supports similar habitat types and, with the exception of the Clean  
 5 Water Act section 303(d) listing for the Stockton Deep Water Ship Channel, is not recognized as  
 6 exhibiting pathogen concentrations that rise to the level of adversely affecting beneficial uses. As  
 7 such, the potential increase in wildlife-related coliform concentrations due to tidal habitat creation  
 8 is not expected to adversely affect beneficial uses. Therefore, this alternative is not expected to cause  
 9 additional exceedance of applicable water quality objectives by frequency, magnitude, and  
 10 geographic extent that would cause adverse effects on any beneficial uses of waters in the affected  
 11 environment. Because pathogen concentrations are not expected to increase substantially, no long-  
 12 term water quality degradation for pathogens is expected to occur and, thus, no adverse effects on  
 13 beneficial uses would occur. The San Joaquin River in the Stockton Deep Water Ship Channel is Clean  
 14 Water Act section 303(d) listed for pathogens. Because no measurable increase in Deep Water Ship  
 15 Channel pathogen concentrations are expected to occur on a long-term basis, further degradation  
 16 and impairment of this area is not expected to occur. Finally, pathogens are not bioaccumulative  
 17 constituents. This impact is considered to be less than significant. No mitigation is required.

18 **Impact WQ-21: Effects on Pesticide Concentrations Resulting from Facilities Operations and**  
 19 **Maintenance (CM1)**

20 Residues of “legacy” OC pesticides enter rivers primarily through surface runoff and erosion of  
 21 terrestrial soils during storm events, and through resuspension of riverine bottom sediments, the  
 22 combination of which to this day may contribute to excursions above water quality objectives  
 23 (Central Valley Water Board 2010c). Operation of the CVP/SWP does not affect terrestrial sources,  
 24 but may result in geomorphic changes to the affected environment that ultimately could result in  
 25 changes to sediment suspension and deposition. However, as discussed in greater detail for  
 26 Turbidity/TSS, operations under any alternative would not be expected to change TSS or turbidity  
 27 levels (highs, lows, typical conditions) to any substantial degree. Changes in the magnitude,  
 28 frequency, and geographic distribution of legacy pesticides in water bodies of the affected  
 29 environment that would result in new or more severe adverse effects on aquatic life or other  
 30 beneficial uses, relative to Existing Conditions or the No Action Alternative, would not be expected  
 31 to occur. Therefore, the pesticide assessment focuses on the present use pesticides for which  
 32 substantial information is available, namely diazinon, chlorpyrifos, pyrethroids, and diuron.

33 ***Upstream of the Delta***

34 Pyrethroid and OP insecticides are applied to agricultural fields, orchards, row crops, and confined  
 35 animal facilities on an annual basis, with peaks in agricultural application during the winter  
 36 dormant season (January–February) and during field cropping in the spring and summer.  
 37 Applications of diuron occur year-round, but the majority of diuron is applied to road rights-of-way  
 38 as a pre-emergent and early post emergent weed treatment during the late fall and early winter  
 39 (Green and Young 2006). Pyrethroid insecticides and urban use herbicides are additionally applied  
 40 around urban and residential structures and landscapes on an annual basis. These applications  
 41 throughout the upstream watershed represent the source and potential pool of these pesticides that  
 42 may enter the rivers upstream of the Delta by way of surface runoff and/or drift. Principal factors  
 43 contributing to pesticide loading in the Sacramento River watershed include the amount of pesticide  
 44 used and amount of precipitation (Guo et al. 2004). Although urban dry weather runoff occurs, this  
 45 is generally believed to be less significant source of pesticides to main stem receiving waters, but for

1 pyrethroids a recent study concluded that municipal wastewater treatment plants in Sacramento  
2 and Stockton represent a continuous year-round source of pyrethroids to the lower Sacramento and  
3 San Joaquin River's (Weston and Lydy 2010).

4 Pesticide-related toxicity has historically been observed throughout the affected environment  
5 regardless of season or water year type; however, toxicity is generally observed with increased  
6 incidence during spring and summer months of April to June, coincident with the peak in irrigated  
7 agriculture in the Sacramento and San Joaquin Valleys, as well as the winter rainy season,  
8 particularly December through February, coincident with urban and agricultural storm-water runoff  
9 and the orchard dormant spraying season (Fox and Archibald 1997). Although OP insecticide  
10 incidence and related toxicity can be observed throughout the year, diazinon is most frequently  
11 observed during the winter months and chlorpyrifos is most frequently observed in the summer  
12 irrigation months (Central Valley Water Board 2007). These seasonal trends coincide with their use,  
13 where diazinon is principally used as an orchard dormant season spray, and chlorpyrifos is  
14 primarily used on crops during the summer.

15 Application of diuron peaks in the late fall and early winter. Coincidentally, diuron is found most  
16 frequently in surface waters during the winter precipitation and runoff months of January through  
17 March (Green and Young 2006), although diuron can be found much less frequently in surface  
18 waters throughout the year (Johnson et al. 2010).

19 Monitoring for pyrethroid insecticides in main-stem rivers is limited and detections are rather few.  
20 With the replacement of many traditionally OP related uses, however, it is conservatively assumed  
21 that pyrethroid incidence and associated toxicity could ultimately take a pattern of seasonality  
22 similar to that of the chlorpyrifos or diazinon.

23 In comparison to the Valley floor, relatively small amounts of pesticides are used in watersheds  
24 upstream of project reservoirs. Water released from reservoirs flow through urban and agricultural  
25 areas at which point these waters may acquire a burden of pesticide from agricultural or urban  
26 sourced discharges. These discharges with their potential burden of pesticides are effectively  
27 diluted by reservoir water. Under the operational scenarios of Alternative 4, no activity of the SWP  
28 or CVP would substantially drive a change in pesticide use, and thus pesticide sources would remain  
29 unaffected. Nevertheless, changes in the timing and magnitude of reservoir releases could have an  
30 effect on available dilution capacity along river segments such as the Sacramento, Feather,  
31 American, and San Joaquin Rivers.

32 Under the operational scenarios of Alternative 4, winter (November–March) and summer (April–  
33 October) season average flow rates on the Sacramento River at Freeport, American River at Nimbus,  
34 Feather River at Thermalito and the San Joaquin River at Vernalis would change. Relative to Existing  
35 Conditions and the No Action Alternative, seasonal average flow rates on the Sacramento for  
36 Scenarios H1–H4 would decrease no more than 7% during the summer and 4% during the winter  
37 (Appendix 8L, [Pesticides, Seasonal average flows](#) Tables 1–4). On the Feather River, average flow  
38 rates for Scenarios H1–H4 would decrease no more than 9% during the summer and 2% during the  
39 winter, while on the American River average flow rates would decrease by as much as 19% in the  
40 summer but would increase by as much as 8% in the winter. Seasonal average flow rates for  
41 Scenarios H1–H4 on the San Joaquin River would decrease by as much as 12% in the summer, but  
42 increase by as much as 1% in the winter.

43 As previously stated, historically chlorpyrifos is used in greater amounts in agriculture in the  
44 summer, and consequently observed in surface waters with greater frequency in the summer, while

1 diazinon and diuron are used and observed in surface water with greater frequency in the winter.  
 2 While flow reductions in the summer on the American River would not coincide with urban  
 3 stormwater discharges, summer flow reductions on the San Joaquin River would correspond to the  
 4 agricultural irrigation season. However, summer average flow reductions of up to 19% are not  
 5 considered of sufficient magnitude to substantially increase in-river concentrations or alter the  
 6 long-term risk of pesticide-related effects on aquatic life beneficial uses. Greater long-term average  
 7 flow reductions, and corresponding reductions in dilution/assimilative capacity, would be necessary  
 8 before long-term risk of pesticide related effects on aquatic life beneficial uses would be adversely  
 9 altered.

## 10 **Delta**

11 Sources of diuron, OP and pyrethroid insecticides to the Plan Area include direct input of surface  
 12 runoff from in-Delta agriculture and Delta urbanized areas as well as inputs from rivers upstream of  
 13 the Delta. Similar to Upstream of the Delta, CVP/SWP operations under Scenarios H1–H4 of  
 14 Alternative 4 would not affect these sources.

15 Under Scenarios H1–H4, the distribution and mixing of Delta source waters would change. Percent  
 16 change in monthly average source water fraction were evaluated for the modeled 16-year (1976–  
 17 1991) hydrologic period and a representative drought period (1987–1991), with special attention  
 18 given to changes in San Joaquin River, Sacramento River and Delta Agriculture sources water  
 19 fractions. Changes in source water fractions at the modeled Delta assessment locations would vary  
 20 depending on operational scenario, but relative differences between the operational scenarios  
 21 would be small. Relative to Existing Conditions, under Scenarios H1–H4 of Alternative 4 modeled  
 22 San Joaquin River fractions would increase greater than 10% at Buckley Cove (drought period only),  
 23 Franks Tract, Rock Slough, and Contra Costa PP No. 1, with the largest changes occurring under  
 24 Scenario H4 (Appendix 8D, Source Water Fingerprinting). At Buckley Cove under Scenario H4,  
 25 change in drought period San Joaquin River source water fractions would increase 11% in July and  
 26 16% in August. At Franks Tract under Scenario H4, change in San Joaquin River source water  
 27 fractions when modeled for the 16-year hydrologic period, would increase 11–16% during October  
 28 through November and February through June. At Rock Slough, modeled San Joaquin River source  
 29 water fractions under Scenario H4 would increase 15–22% during September through March (11–  
 30 15% during October and November of the modeled drought period). Similarly, under Scenario H4  
 31 modeled San Joaquin River fractions at Contra Costa Pumping Plant No. 1 would increase 15–23%  
 32 during October through April (12% during October and November of the modeled drought period).  
 33 While the modeled 22–23% increases of San Joaquin River Fraction at Rock Slough and Contra Costa  
 34 PP No. 1 in November are considerable, the resultant net fraction would be  $\leq 29\%$ . For all  
 35 operational scenarios, relative to Existing Conditions, there would be no modeled increases in  
 36 Sacramento River fractions greater than 14% (with exception to Banks and Jones, discussed below)  
 37 and Delta agricultural fractions greater than 8%. These modeled changes in the source water  
 38 fractions of Sacramento, San Joaquin and Delta agriculture water are not of sufficient magnitude to  
 39 substantially alter the long-term risk of pesticide-related toxicity to aquatic life, nor adversely affect  
 40 other beneficial uses of the Delta.

41 When compared to the No Action Alternative, changes in source water fractions resulting from  
 42 Scenarios H1–H4 would be similar in season, geographic extent, and magnitude to those discussed  
 43 for Existing Conditions, with exception to Buckley Cove. Relative to the No Action Alternative, on a  
 44 source water basis Buckley Cove is comprised predominantly of water of San Joaquin River origin  
 45 (i.e., typically >80% San Joaquin River) for all months of the year but July and August. In July and

1 August, the combined operational effects on Delta hydrodynamics of the Delta Cross Channel being  
 2 open, the absence of a barrier at Head of Old River, and seasonally high exports from south Delta  
 3 pumps results in substantially lower San Joaquin River source water fraction at Buckley Cove  
 4 relative to all other months of the year. Under the operational scenarios of Alternative 4, however,  
 5 modeled July and August San Joaquin River fractions at Buckley Cove would increase relative to the  
 6 No Action Alternative, with increases between 16–17% in July (31–34% for the modeled drought  
 7 period) and 24–25% in August (47–49% for the modeled drought period) (Appendix 8D, Source  
 8 Water Fingerprinting). Despite these San Joaquin River increases, the resulting net San Joaquin River  
 9 source water fraction for July and August would remain less than all other months. As a result, these  
 10 modeled changes in the source water fractions are not of sufficient magnitude to substantially alter  
 11 the long-term risk of pesticide-related toxicity to aquatic life, nor adversely affect other beneficial  
 12 uses of the Delta.

### 13 ***SWP/CVP Export Service Areas***

14 Assessment of effects in SWP/CVP Export Service Areas is based on effects seen in the Plan Area at  
 15 the Banks and Jones pumping plants. Under all operational scenarios of Alternative 4, Sacramento  
 16 River source water fractions would increase substantially at both Banks and Jones pumping plants  
 17 relative to Existing Conditions and the No Action Alternative (Appendix 8D, Source Water  
 18 Fingerprinting). Sacramento River source water fractions would increase similarly by both season  
 19 and magnitude extent under all operational scenarios at both Banks and Jones pumping plant. At  
 20 Banks pumping plant, Sacramento source water fractions would generally increase from 16–48%  
 21 for the period of January through June (12–35% for March through April of the modeled drought  
 22 period) and at Jones pumping plant Sacramento source water fractions would generally increase  
 23 from 21–56% for the period of January through June (15–48% for February through May of the  
 24 modeled drought period). These increases in Sacramento source water fraction would primarily  
 25 balance through equivalent decreases in San Joaquin River water. Based on the general observation  
 26 that San Joaquin River, in comparison to the Sacramento River, is a greater contributor of OP  
 27 insecticides in terms of greater frequency of incidence and presence at concentrations exceeding  
 28 water quality benchmarks, modeled increases in Sacramento River fraction at Banks and Jones  
 29 would generally represent an improvement in export water quality respective to pesticides.

30 ***NEPA Effects:*** In summary, the changes in long-term average flows on the Sacramento, Feather,  
 31 American, and San Joaquin Rivers, under Scenarios H1–H4 of Alternative 4 relative to the No Action  
 32 Alternative, are of insufficient magnitude to substantially increase the long-term risk of pesticide-  
 33 related water quality degradation and related toxicity to aquatic life in these water bodies upstream  
 34 of the Delta. Similarly, modeled changes in source water fractions to the Delta are of insufficient  
 35 magnitude to substantially alter the long-term risk of pesticide-related water quality degradation  
 36 and related toxicity to aquatic life in the Delta or CVP/SWP export service areas. The effects on  
 37 pesticides from operations and maintenance (CM1) are determined not to be adverse.

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

43 Sources of pesticides upstream of the Delta include direct input of pesticide containing surface  
 44 runoff from agriculture and urbanized areas. Flows in rivers receiving these discharges dilute these

1 pesticide inputs. For all operational scenarios relative to Existing Conditions, however, modeled  
 2 changes in long-term average flows on the Sacramento, Feather, American, and San Joaquin Rivers  
 3 are of insufficient magnitude to substantially increase the long-term risk of pesticide-related water  
 4 quality degradation and related toxicity to aquatic life in these water bodies upstream of the Delta.

5 In the Delta, sources of pesticides include direct input of surface runoff from Delta agriculture and  
 6 Delta urbanized areas as well as inputs from rivers upstream of the Delta. While facilities operations  
 7 and maintenance activities under Scenarios H1–H4 would not affect these sources, changes in Delta  
 8 source water fraction could change the relative risk associated with pesticide related toxicity to  
 9 aquatic life. Under Scenarios H1–H4 of Alternative 4, however, modeled changes in source water  
 10 fractions relative to Existing Conditions are of insufficient magnitude to substantially alter the long-  
 11 term risk of pesticide-related toxicity to aquatic life within the Delta, nor would such changes result  
 12 in adverse pesticide-related effects on any other beneficial uses of Delta waters.

13 The assessment of Alternative 4 effects on pesticides in the SWP/CVP Export Service Areas is based  
 14 on assessment of changes predicted at Banks and Jones pumping plants. As just discussed regarding  
 15 Scenario H1–H4 effects to pesticides in the Delta, modeled changes in source water fractions at the  
 16 Banks and Jones pumping plants are of insufficient magnitude to substantially alter the long-term  
 17 risk of pesticide-related toxicity to aquatic life beneficial uses, or any other beneficial uses, in water  
 18 bodies of the SWP and CVP export service area.

19 Based on the above, the considered operational scenarios of Alternative 4 would not result in any  
 20 substantial change in long-term average pesticide concentration or result in substantial increase in  
 21 the anticipated frequency with which long-term average pesticide concentrations would exceed  
 22 aquatic life toxicity thresholds or other beneficial use effect thresholds upstream of the Delta, at the  
 23 11 assessment locations analyzed for the Delta, or the SWP/CVP service area. Numerous pesticides  
 24 are currently used throughout the affected environment, and while some of these pesticides may be  
 25 bioaccumulative, those present-use pesticides for which there is sufficient evidence for their  
 26 presence in waters affected by SWP and CVP operations (i.e., diazinon, chlorpyrifos, diuron, and  
 27 pyrethroids) are not considered bioaccumulative, and thus changes in their concentrations would  
 28 not directly cause bioaccumulative problems in aquatic life or humans. Furthermore, while there are  
 29 numerous 303(d) listings throughout the affected environment that name pesticides as the cause for  
 30 beneficial use impairment, the modeled changes in upstream river flows and Delta source water  
 31 fractions under Scenarios H1–H4 would not be expected to make any of these beneficial use  
 32 impairments measurably worse. Because long-term average pesticide concentrations are not  
 33 expected to increase substantially, no long-term water quality degradation with respect to  
 34 pesticides is expected to occur and, thus, no adverse effects on beneficial uses would occur. This  
 35 impact is considered to be less than significant. No mitigation is required.

36 **Impact WQ-22: Effects on Pesticide Concentrations Resulting from Implementation of CM2–**  
 37 **CM22CM21**

38 **NEPA Effects:** With the exception of CM13, the mostly non-land disturbing CM12–CM22CM21  
 39 present no new sources of pesticides to the affected environment, including areas Upstream of the  
 40 Delta, within the Plan Area, and the SWP/CVP Export Service Area. Implementation of urban  
 41 stormwater treatment measures (CM19) may result in beneficial effects, to the extent that control  
 42 measures treat or reduce pesticide loading from urban land uses. However, control of nonnative  
 43 aquatic vegetation (CM13) associated with tidal habitat restoration efforts would include killing  
 44 invasive and nuisance aquatic vegetation through direct application of herbicides or through

1 alternative mechanical means. Use and selection of type of herbicides would largely be circumstance  
 2 specific, but would follow existing control methods used by the CDBW. The CDBW's use of  
 3 herbicides is regulated by permits and regulatory agreements with the Central Valley Water Board,  
 4 US Fish and Wildlife Service, and National Marine Fisheries Service and is guided by research  
 5 conducted on the efficacy of vegetation control in the Delta through herbicide use. Through a  
 6 program of adaptive management and assessment, the CDBW has employed a program of herbicide  
 7 use that reduces potential environmental impacts, nevertheless, the CDBW found that impacts on  
 8 water quality and associated aquatic beneficial uses would continue to occur and could not be  
 9 avoided, including non-target impacts on aquatic invertebrates and beneficial aquatic plants  
 10 (California Department of Boating and Waterways 2006).

11 In addition to the potential beneficial and adverse effects of CM19 and CM13, respectively, the  
 12 various restoration efforts of CM2–CM11 could involve the conversion of active or fallow  
 13 agricultural lands to natural landscapes, such as wetlands, grasslands, floodplains, and vernal pools.  
 14 In the long-term, conversion of agricultural land to natural landscapes could possibly result in a  
 15 limited reduction in pesticide use throughout the Delta. In the short-term, tidal and non-tidal  
 16 wetland restoration, as well as seasonal floodplain restoration (i.e., CM4, CM5, and CM10) over  
 17 former agricultural lands may include the contamination of water with pesticide residues contained  
 18 in the soils. Present use pesticides typically degrade fairly rapidly, and in such cases where pesticide  
 19 containing soils are flooded, dissipation of those pesticides would be expected to occur rapidly.  
 20 Moreover, seasonal floodplain restoration (CM5) and Yolo Bypass enhancements (CM2) may be  
 21 managed alongside continuing agriculture, where pesticides may be used on a seasonal basis and  
 22 where water during flood events may come in contact with residues of these pesticides. Similarly,  
 23 however, rapid dissipation would be expected, particularly in the large volumes of water involved in  
 24 flooding. During these flooding events, pesticides potentially suspended in water would not be  
 25 expected to cause toxicity to aquatic life or cause substantial adverse effects on any other beneficial  
 26 uses of these water bodies.

27 In summary, CM13 of Alternative 4 proposes the use of herbicides to control invasive aquatic  
 28 vegetation around habitat restoration sites. Herbicides directly applied to water could adversely  
 29 affect non-target aquatic life, such as aquatic invertebrates and beneficial aquatic plants. Use of  
 30 herbicides could potentially exceed aquatic life toxicity objectives with sufficient frequency and  
 31 magnitude such that beneficial uses would be adversely affected, thus constituting an adverse effect  
 32 on water quality. Mitigation Measure WQ-22 would be available to reduce this effect.

33 **CEQA Conclusion:** With the exception of CM13, implementation of CM2–~~CM22~~CM21 would not  
 34 present new or substantially increased sources of pesticides in the Plan Area. In the long-term,  
 35 implementation of conservation measures could possibly result in a limited reduction in pesticide  
 36 use throughout the Delta through the potential repurposing of active or fallow agricultural land for  
 37 natural habitat purposes. In the short-term, the repurposing of agricultural land associated with  
 38 CM4, CM5, and CM10 may expose water used for habitat restoration to pesticide residues. Moreover,  
 39 CM2 and CM5 may be managed alongside continuing agriculture, where pesticides may be used on a  
 40 seasonal basis and where water during flood events may come in contact with residues of these  
 41 pesticides. However, rapid dissipation would be expected, particularly in the large volumes of water  
 42 involved in flooding, such that aquatic life toxicity objectives would not be exceeded by frequency,  
 43 magnitude, and geographic extent whereby adverse effects on beneficial uses would be expected.  
 44 ~~Conservation Measures 2–22~~CM2–CM21 do not include the use of pesticides known to be  
 45 bioaccumulative in animals or humans, nor do the conservation measures propose the use of any  
 46 pesticide currently named in a Section 303(d) listing of the affected environment. CM13 proposes



1 the use of herbicides to control invasive aquatic vegetation around habitat restoration sites.  
 2 Herbicides directly applied to water could include adverse effects on non-target aquatic life, such as  
 3 aquatic invertebrates and beneficial aquatic plants. As such, aquatic life toxicity objectives could be  
 4 exceeded with sufficient frequency and magnitude such that beneficial uses would be impacted.  
 5 Potential environmental effects related only to CM13 are considered significant. Mitigation Measure  
 6 WQ-22 is available to partially reduce this impact of pesticides on water quality; however, because  
 7 of the uncertainty about successful implementation of this measure at specific restoration sites  
 8 programmatic impact is considered significant and unavoidable.

### 9 **Mitigation Measure WQ-22: Implement Least Toxic Integrated Pest Management** 10 **Strategies**

11 Implement the principals of IPM in the management of invasive aquatic vegetation under CM13,  
 12 including the selective use of pesticides applied in a manner that minimizes risks to human  
 13 health, nontarget organisms and the aquatic ecosystem. In doing so, the BDCP proponents will  
 14 consult with the Central Valley Water Board, USFWS, NMFS, and CDBW to obtain effective IPM  
 15 strategies such as selective application of pesticides, timing of applications in order to minimize  
 16 tidal dispersion, and timing to target the invasive plant species at the most vulnerable times  
 17 such that less herbicide can be used or the need for repeat applications can be reduced.

### 18 **Impact WQ-23: Effects on Phosphorus Concentrations Resulting from Facilities Operations** 19 **and Maintenance (CM1)**

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

#### 26 ***Upstream of the Delta***

27 A conceptual model of nutrients in the Delta stated that: “previous attempts to relate concentration  
 28 data to flow data in the Central Valley and Delta showed little correlation between the two variables  
 29 (Tetra Tech 2006b, Conceptual Model for Organic Carbon in the Central Valley). One possible reason  
 30 is that the Central Valley and Delta system is a highly managed system with flows controlled by  
 31 major reservoirs on most rivers” (Tetra Tech 2006b:4-1 to 4-2). Attempts made in the Nitrate  
 32 section of this chapter also showed weak correlation between nitrate and flows for major source  
 33 waters to the Delta. The linear regressions between average dissolved ortho-phosphate  
 34 concentrations and average flows in the San Joaquin and Sacramento Rivers were derived for this  
 35 analysis (Figure 8-58 and Figure 8-59). As expected, neither relationship is very strong, although  
 36 over the large range in flows for the Sacramento River, the relationship is stronger than for the San  
 37 Joaquin River. However, over smaller changes in flows, neither relationship can function as a  
 38 predictor of phosphorus concentrations because the variability in the data over small to medium  
 39 ranges of flows (i.e., <10,000 CFS) is large.

40 Because phosphorus loading to waters upstream of the Delta is not anticipated to change, and  
 41 because changes in flows do not necessarily result in changes in concentrations or loading of  
 42 phosphorus to these water bodies, substantial changes in phosphorus concentration are not  
 43 anticipated under the operational scenarios of Alternative 4, relative to Existing Conditions or the

1 No Action Alternative. Any negligible changes in phosphorus concentrations that may occur in the  
2 water bodies of the affected environment located upstream of the Delta would not be of frequency,  
3 magnitude and geographic extent that would adversely affect any beneficial uses or substantially  
4 degrade the quality of these water bodies, with regards to phosphorus.

#### 5 ***Delta***

6 Because phosphorus concentrations in the major source waters to the Delta are similar for much of  
7 the year, phosphorus concentrations in the Delta are not anticipated to change substantially on a  
8 long term-average basis. Phosphorus concentrations may increase during January through March at  
9 locations where the source fraction of San Joaquin River water increases, due to the higher  
10 concentration of phosphorus in the San Joaquin River during these months compared to Sacramento  
11 River water or San Francisco Bay water. Based on the DSM2 fingerprinting results (see Appendix  
12 8D), together with source water concentrations shown in Figure 8-56, the magnitude of increases  
13 during these months may range from negligible up to approximately 0.05 mg/L. However, there are  
14 no state or federal objectives/criteria for phosphorus and thus any increases would not cause  
15 exceedances of objectives/criteria. Because algal growth rates are limited by availability of light in  
16 the Delta, increases in phosphorus levels that may occur at some locations and times within the  
17 Delta under Alternative 4, Scenarios H1–H4, would be expected to have little effect on primary  
18 productivity in the Delta. Moreover, such increases in concentrations would not be anticipated to be  
19 of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or  
20 substantially degrade the water quality at these locations, with regards to phosphorus.

#### 21 ***SWP/CVP Export Service Areas***

22 The assessment of effects of phosphorus under Alternative 4, Scenarios H1–H4, in the SWP and CVP  
23 Export Service Areas is based on effects on phosphorus at the Banks and Jones pumping plants.

24 As noted in the Delta Region section above, phosphorus concentrations in the Delta (including Banks  
25 and Jones pumping plants) are not anticipated to change substantially on a long term-average basis.  
26 During January through March, phosphorus concentrations may increase as a result of more San  
27 Joaquin River water reaching Banks and Jones pumping plants and the higher concentration of  
28 phosphorus in the San Joaquin River. However, based on the DSM2 fingerprinting results (see  
29 Appendix 8D), together with source water concentrations show in Figure 8-56, the magnitude of this  
30 increase is expected to be negligible (<0.01 mg/L-P). Additionally, there are no state or federal  
31 objectives for phosphorus. Moreover, given the many factors that contribute to potential algal  
32 blooms in the SWP and CVP canals within the Export Service Area, and the lack of studies that have  
33 shown a direct relationship between nutrient concentrations in the canals and reservoirs and  
34 problematic algal blooms in these water bodies, there is no basis to conclude that any seasonal  
35 increases in phosphorus concentrations at the levels expected under this alternative, should they  
36 occur, would increase the potential for problem algal blooms in the SWP and CVP Export Service  
37 Area.

38 Any increases in phosphorus concentrations that may occur in water exported via Banks and Jones  
39 pumping plants are not expected to result in adverse effects to beneficial uses of exported water or  
40 substantially degrade the quality of exported water, with regards to phosphorus.

41 ***NEPA Effects:*** In summary, based on the discussion above, effects on phosphorus of CM1 are  
42 considered to be not adverse.

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

6 Because phosphorus loading to waters upstream of the Delta is not anticipated to change, and  
 7 because changes in flows do not necessarily result in changes in concentrations or loading of  
 8 phosphorus to these water bodies, substantial changes in phosphorus concentration upstream of the  
 9 Delta are not anticipated for any operational scenario of Alternative 4, relative to Existing  
 10 Conditions.

11 Because phosphorus concentrations in the major source waters to the Delta are similar for much of  
 12 the year, phosphorus concentrations in the Delta are not anticipated to change substantially on a  
 13 long term-average basis under the operational scenarios of Alternative 4, relative to Existing  
 14 Conditions. Algal growth rates are limited by availability of light in the Delta, and therefore any  
 15 minor increases in phosphorus levels that may occur at some locations and times within the Delta  
 16 would be expected to have little effect on primary productivity in the Delta.

17 The assessment of effects of phosphorus under the various operational scenarios of Alternative 4 in  
 18 the SWP and CVP Export Service Areas is based on effects on phosphorus at the Banks and Jones  
 19 pumping plants. As noted above, phosphorus concentrations in the Delta (including Banks and Jones  
 20 pumping plants) are not anticipated to change substantially on a long term-average basis.

21 Based on the above, there would be no substantial, long-term increase in phosphorus concentrations  
 22 in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the waters exported to the  
 23 CVP and SWP service areas under any operational scenario of Alternative 4 relative to Existing  
 24 Conditions. As such, this alternative is not expected to cause additional exceedance of applicable  
 25 water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause  
 26 adverse effects on any beneficial uses of waters in the affected environment. Because phosphorus  
 27 concentrations are not expected to increase substantially, no long-term water quality degradation is  
 28 expected to occur and, thus, no adverse effects to beneficial uses would occur. Phosphorus is not  
 29 303(d) listed within the affected environment and thus any minor increases that may occur in some  
 30 areas would not make any existing phosphorus-related impairment measurably worse because no  
 31 such impairments currently exist. Because phosphorus is not bioaccumulative, minor increases that  
 32 may occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would,  
 33 in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less  
 34 than significant. No mitigation is required.

### 35 **Impact WQ-24: Effects on Phosphorus Concentrations Resulting from Implementation** 36 **of CM2-~~CM22~~CM21**

37 **NEPA Effects:** CM2–CM11 include activities that create additional aquatic habitat within the affected  
 38 environment, and therefore may increase the total amount of algae and plant-life within the Delta.  
 39 These activities would not affect phosphorus loading to the affected environment, but may affect  
 40 phosphorus dynamics and speciation. For example, water column concentrations of total  
 41 phosphorus may increase or decrease in localized areas as a result of increased or decreased  
 42 suspended solids, while ortho-phosphate concentrations may be locally altered as a result of  
 43 changing planktonic and macroinvertebrate species contributing to the cycling of phosphorus  
 44 within the affected environment. Additionally, depending on age, configuration, location, operation,

1 and season, some of the restoration measures included under these conservation measures may  
 2 function to remove or sequester phosphorus, but since presently, the specific design, operational  
 3 criteria, and location of these activities are not well established, the degree to which this would  
 4 occur is unknown. Overall, phosphorus concentrations are not expected to change substantially in  
 5 the affected environment as a result of CM2-~~CM22CM21~~. Because increases or decreases in  
 6 phosphorus levels are, in general, expected to have little effect on productivity, any changes in  
 7 phosphorus concentrations that may occur at certain locations within the affected environment are  
 8 not anticipated to be of frequency, magnitude and geographic extent that would adversely affect any  
 9 beneficial uses or substantially degrade the water quality at these locations, with regards to  
 10 phosphorus.

11 Because urban stormwater is a source of phosphorus in the affected environment, CM19, Urban  
 12 Stormwater Treatment, is expected to slightly reduce phosphorus loading to the Delta, thus slightly  
 13 decreasing phosphorus concentrations relative to the No Action Alternative. Implementation of  
 14 CM12-CM18 and CM20-~~CM22CM21~~ is not expected to substantially alter phosphorus  
 15 concentrations in the affected environment.

16 The effects on phosphorus from implementing ~~CM2-22CM2 through CM22CM2-CM21~~ are  
 17 considered to be not adverse.

18 **CEQA Conclusion:** There would be no substantial, long-term increase in phosphorus concentrations  
 19 in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the waters exported to the  
 20 CVP and SWP service areas due to implementation of CM2-~~CM22CM21~~ under Alternative 4 relative  
 21 to Existing Conditions. Because urban stormwater is a source of phosphorus in the affected  
 22 environment, CM19, Urban Stormwater Treatment, is expected to slightly reduce phosphorus  
 23 loading to the Delta. As such, implementation of these conservation measures is not expected to  
 24 cause adverse effects on any beneficial uses of waters in the affected environment. Because  
 25 phosphorus concentrations are not expected to increase substantially due to these conservation  
 26 measures, no long-term water quality degradation is expected to occur and, thus, no adverse effects  
 27 to beneficial uses would occur. Phosphorus is not 303(d) listed within the affected environment and  
 28 thus any minor increases that may occur in some areas would not make any existing phosphorus-  
 29 related impairment measurably worse because no such impairments currently exist. Because  
 30 phosphorus is not bioaccumulative, minor increases that may occur in some areas would not  
 31 bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health  
 32 risks to fish, wildlife, or humans. This impact is considered to be less than significant. No mitigation  
 33 is required.

## 34 **Impact WQ-25: Effects on Selenium Concentrations Resulting from Facilities Operations and** 35 **Maintenance (CM1)**

### 36 ***Upstream of the Delta***

37 ~~For the same reasons stated for the No Action Alternative, Alternative 4 would have negligible, if~~  
 38 ~~any, effect on selenium concentrations in the rivers and reservoirs upstream of the Delta relative to~~  
 39 ~~Existing Conditions and the No Action Alternative. Any negligible increases in selenium~~  
 40 ~~concentrations that could occur in the water bodies of the affected environment upstream of the~~  
 41 ~~Delta would not be of frequency, magnitude, and geographic extent that would adversely affect any~~  
 42 ~~beneficial uses or substantially degrade the quality of these water bodies, with regard to selenium.~~

1 Substantial point sources of selenium do not exist upstream in the Sacramento River watershed, in  
 2 the watersheds of the eastern tributaries (Cosumnes, Mokelumne, and Calaveras Rivers), or  
 3 upstream of the Delta in the San Joaquin River watershed. Nonpoint sources of selenium within the  
 4 watersheds of the Sacramento River and the eastern tributaries also are relatively low, resulting in  
 5 generally low selenium concentrations in the reservoirs and rivers of those watersheds.

6 Consequently, any modified reservoir operations and subsequent changes in river flows under  
 7 Alternative 4, Scenarios H1–H4, relative to Existing Conditions or the No Action Alternative, are  
 8 expected to have negligible, if any, effects on reservoir and river selenium concentrations upstream  
 9 of Freeport in the Sacramento River watershed or in the eastern tributaries upstream of the Delta.

10 Non-point sources of selenium in the San Joaquin River watershed are associated with discharges of  
 11 subsurface agricultural drainage to the river and its tributaries. Selenium concentrations in the San  
 12 Joaquin River upstream of the Delta comply with NTR criteria and Basin Plan objectives at Vernalis  
 13 under Existing Conditions, and they are expected to do so under the No Action Alternative. This is  
 14 because a TMDL has been developed by the Central Valley Water Board (2001), the Grassland  
 15 Bypass Project has established limits that will result in reduced inputs of selenium to the Delta, and  
 16 the Central Valley Water Board (2010ad) and State Water Board (2010db, 2010ec) have established  
 17 Basin Plan objectives that are expected to result in decreasing discharges of selenium from the San  
 18 Joaquin River to the Delta, as previously discussed in 8.1.3.15.

19 Selenium concentrations at Vernalis are generally higher during lower San Joaquin River flows, with  
 20 considerable variability in concentrations below about 3,000 cfs, as shown in Appendix 8M,  
 21 Selenium (Table M-313 and Figures M-47 through M-1720). The only monthly average selenium  
 22 concentrations greater than 2 µg/L were in March 2002 (2.3 µg/L) and February and March 2003  
 23 (2.1 and 2.3 µg/L), when monthly average flows were 1,879 to 2,193 cfs. Under the four operational  
 24 scenarios of Alternative 4, modeling indicates that long-term annual average flows on the San  
 25 Joaquin River would decrease by 6% relative to Existing Conditions and would remain virtually the  
 26 same relative to the No Action Alternative (Appendix 5A). Given these relatively small decreases in  
 27 flows and the considerable variability in the relationship between selenium concentrations and  
 28 flows in the San Joaquin River, it is expected that selenium concentrations in the San Joaquin River  
 29 would be minimally affected, if at all, by anticipated changes in flow rates under the operational  
 30 scenarios of Alternative 4.

31 Thus, available information indicates selenium concentrations are well below the Basin Plan  
 32 objective and are likely to remain so. Any negligible changes in selenium concentrations that may  
 33 occur in the water bodies of the affected environment located upstream of the Delta would not be of  
 34 frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or  
 35 substantially degrade the quality of these water bodies as related to selenium.

### 36 **Delta**

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

1 Selenium concentrations and threshold comparisons for each of the 11 modeled Delta assessment  
 2 locations under Alternative 4, relative to Existing Conditions and the No Action Alternative, are  
 3 presented in Appendix 8M, *Selenium*, Table M-9b for water, Tables M-14a, through M-14d, and  
 4 Tables M-24a through M-24d for most biota (whole-body fish (excluding sturgeon), bird eggs  
 5 [invertebrate diet], bird eggs [fish diet], and fish fillets) throughout the Delta, and Tables M-30  
 6 through M-32 for sturgeon at the two western Delta locations. Figures 8-59b and 8-60b present  
 7 graphical distributions of predicted selenium concentration changes (shown as changes in available  
 8 assimilative capacity based on 1.3 µg/L) in water at each modeled assessment location for all years.  
 9 Appendix 8M, Figure M-22 provides more detail in the form of monthly patterns of selenium  
 10 concentrations in water during the modeling period.

11 All scenarios (H1, H2, H3, and H4) under Alternative 4 would result in small changes in average  
 12 selenium concentrations in water relative to Existing Conditions and No Action Alternative at **almost**  
 13 all modeled Delta assessment locations (Appendix 8M, *Selenium*, Table M-10B9b). Long-term  
 14 average concentrations at some interior and western Delta locations would increase by 0.01–0.05  
 15 µg/L for the entire period modeled (1976–1991), depending on operational scenario. These small  
 16 changes-increases in selenium concentrations in water are-~~reflected~~would result in small percent  
 17 changes-reductions (104% or less) in available assimilative capacity for selenium, relative to the  
 18 (based on 21.3 µg/L ecological-risk benchmark USEPA draft water quality criterion) for all years  
 19 (Figures 8-59b and 8-60b). Relative to Existing Conditions, Scenario H1 would result in the largest  
 20 modeled increase in assimilative capacity (range of +1% at Buckley Cove to –3% at Contra Costa PP),  
 21 and the largest decrease would be under Scenario H4 (range of –4% at Contra Costa PP to +1% at  
 22 Buckley Cove). Relative to the No Action Alternative, the largest modeled increase in assimilative  
 23 capacity would be under Scenario H1 (range of <+1% at Staten Island to –4% at Buckley Cove) and  
 24 the largest decrease would be under Scenario H4 (range of –4% at Buckley Cove to +1% at Staten  
 25 Island) (Figure 8-60). Although some small negative changes in selenium concentrations in water  
 26 are expected, the effect of any of the scenarios under Alternative 4 would generally be minimal for  
 27 the Delta locations. Furthermore, ~~t~~The modeled long-term average selenium concentrations in water  
 28 under (Appendix 8M, *Selenium*, Table M-10B) for Existing Conditions (range 0.21–0.76 µg/L), No  
 29 Action Alternative (range 0.21–0.69 µg/L), Alternative 4 Scenarios H1–H4 (range 0.2109–0.7440  
 30 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  
 31 would be generally similar to Existing Conditions (range 0.09–0.41 µg/L) and the No Action  
 32 Alternative (range 0.09–0.38 µg/L), and would all be below the ecological risk benchmark USEPA  
 33 draft water quality criterion (of 21.3 µg/L (Appendix 8M, *Selenium*, Table M-9b).

34 Relative to Existing Conditions and the No Action Alternative, all scenarios under Alternative 4  
 35 would result in small changes (approximately 1%) in estimated selenium concentrations in most  
 36 biota (whole-body fish, bird eggs [invertebrate diet or fish diet], and fish fillets) throughout the  
 37 Delta, with little difference among locations (Figures 8-61a through 8-64b; Appendix 8M, *Selenium*,  
 38 Tables M-15A-24Aa through M-15D-24d and Table 8M-2 in the sturgeon addendum to Appendix  
 39 8M Addendum M.A to Appendix 8M, *Selenium in Sturgeon*, Table M.A-2). Level of Concern  
 40 Exceedance Quotients (i.e., modeled tissue divided by Level of Concern benchmarks) for selenium  
 41 concentrations in those biota for all years and for drought years are less than 1.0 (indicating low  
 42 probability of adverse effects). Similarly, Advisory Tissue Level Exceedance Quotients for selenium  
 43 concentrations in fish fillets for all years and drought years also are less than 1.0. Estimated  
 44 selenium concentrations in sturgeon for the San Joaquin River at Antioch are predicted to increase  
 45 by 14 to 179 percent relative Relative to Existing Conditions and to the No Action Alternative in all  
 46 years ~~fo~~(from about 4.7 to around 5.65 mg/kg dry weight [dw]), and those for sturgeon in the

1 Sacramento River at Mallard Island are predicted to increase by 9 to 11 percent in all years (from  
2 about 4.4 to 4.89 mg/kg dw) (Figure 8-65; Appendix 8M, Tables M-30 and M-31), with the highest  
3 percent increase for Scenario H4. Selenium concentrations in sturgeon during drought years are  
4 expected to increase by about 3 to 9 percent at those locations, with the highest increase in San  
5 Joaquin River Antioch in drought years for Scenario H4 (Appendix 8M, Tables M-30 and M-31).  
6 Detection of small changes in whole-body sturgeon such as those estimated for the western Delta  
7 would require very large sample sizes because of the inherent variability in fish tissue selenium  
8 concentrations. Low Toxicity Threshold Exceedance Quotients for selenium concentrations in  
9 sturgeon in the western Delta would exceed 1.0 (indicating a higher probability for adverse effects)  
10 for drought years at both locations (as they do for Existing Conditions and the No Action Alternative;  
11 Figure 8-65) and would increase slightly, from 0.94 to 1.1, for all years in the San Joaquin River at  
12 Antioch and for all years in the San Joaquin River at Antioch (where quotients increase from 0.94 to  
13 1.1) (Appendix 8M, Table M-32). for all scenarios under Alternative 4, the largest increase of  
14 selenium concentrations in all biota would be at Contra Costa PP for all years and in sturgeon at the  
15 San Joaquin River at Antioch in all years, and the largest decrease of selenium in all biota would be at  
16 Buckley Cove for drought years. Relative to the No Action Alternative, the largest increases and  
17 decreases in estimated selenium concentrations in biota for each scenario are provided below.

18 Alternative 4, Scenario H1: The largest increase of estimated selenium concentrations in all biota  
19 would be at Buckley Cove for drought years (except for bird eggs [assuming a fish diet] at Buckley  
20 Cove for all years) and in sturgeon at the San Joaquin River at Antioch in all years; the largest  
21 decrease in all biota would be at Staten Island for all years (except for bird eggs [assuming a fish  
22 diet] at Staten Island for drought years).

23 Alternative 4, Scenario H2: The largest increase of estimated selenium concentrations in all biota  
24 would be at Buckley Cove for drought years (except for bird eggs [assuming a fish diet] at Buckley  
25 Cove for all years) and in sturgeon at the San Joaquin River at Antioch in all years; the largest  
26 decrease for all biota would be at Staten Island for drought years.

27 Alternatives 4, Scenarios H3 and H4: The largest increase of estimated selenium concentrations in  
28 all biota would be at Buckley Cove for drought years (except for bird eggs [assuming a fish diet] at  
29 Contra Costa PP for all years) and in sturgeon at the San Joaquin River at Antioch in all years; the  
30 largest decrease for all biota would be at Staten Island for drought years.

31 The disparity between larger estimated changes for sturgeon and smaller changes for other biota  
32 are is attributable largely to differences in modeling approaches, as described in Appendix 8M,  
33 Selenium. The model for most biota was calibrated to encompass the varying concentration-  
34 dependent uptake from waterborne selenium concentrations (expressed as the  $K_d$ , which is the ratio  
35 of selenium concentrations in particulates [as the lowest level of the food chain] relative to the  
36 waterborne concentration) that was exhibited in data for largemouth bass in 2000, 2005, and 2007  
37 at various locations across the Delta. In contrast, the modeling for sturgeon could not be similarly  
38 calibrated at the two western Delta locations and used literature-derived uptake factors and trophic  
39 transfer factors for the estuary from Presser and Luoma (2013). As noted in the appendix, there was  
40 a significant negative log-log relationship of  $K_d$  to waterborne selenium concentration that reflected  
41 the greater bioaccumulation rates for bass at low waterborne selenium than at higher  
42 concentrations. (There was no difference in bass selenium concentrations in the Sacramento River  
43 at Rio Vista in comparison to the San Joaquin River at Vernalis in 2000, 2005, and 2007 [Foe 2010],  
44 despite a nearly 10-fold difference in waterborne selenium.) Thus, there is more confidence in the  
45 site-specific modeling based on the Delta-wide model that was calibrated for bass data than in the

1 estimates for sturgeon based on “fixed”  $K_d$ s for all years and for drought years without regard to  
2 waterborne selenium concentration at the two locations in different time periods.

3 Increased water residence times could increase the bioaccumulation of selenium in biota, thereby  
4 potentially increasing fish tissue and bird egg concentrations of selenium (see residence time  
5 discussion in Appendix 8M, *Selenium*, and Presser and Luoma [2010b]). Thus, residence time was  
6 assessed for its relevance to selenium bioaccumulation. Table 60a (presented originally in Section  
7 8.3.1.7 in the *Microcystis* subsection) shows the time for neutrally buoyant particles to move through  
8 the Delta (surrogate for flow and residence time). Although an increase in residence time  
9 throughout the Delta is expected under the No Action Alternative, relative to Existing Conditions  
10 (because of climate change and sea level rise), the change is fairly small in most areas of the Delta.  
11 Thus, the changes in residence times between Alternative 4 and the No Action Alternative are very  
12 similar to the changes in residence times between Alternative 4 and the Existing Conditions.

13 Relative to Existing Conditions and the No Action Alternative, increases in residence times for  
14 Alternative 4 would be greater in the East Delta and South Delta than in other sub-regions. Relative  
15 to Existing Conditions, annual average residence times for Alternative 4 in the South Delta are  
16 expected to increase by more than 10 days (Table 60a). Relative to the No Action Alternative, annual  
17 average residence times for Alternative 4 in the South Delta are expected to increase by less than 10  
18 days. Increases in residence times for other sub-regions would be smaller, especially as compared to  
19 Existing Conditions and the No Action Alternative (which are longer than those modeled for the  
20 South Delta). As mentioned above, these results incorporate hydrodynamic effects of both CM1 and  
21 CM2 and CM4, and the effects of CM1 cannot be distinguished from the effects of CM2 and CM4.  
22 However, it is expected that CM2 and CM4 are substantial drivers of the increased residence time.

23 Presser and Luoma (2010b) summarized and discussed selenium uptake in the Bay-Delta (including  
24 hydrologic conditions [e.g., Delta outflow and residence time for water],  $K_d$ s [the ratio of selenium  
25 concentrations in particulates, as the lowest level of the food chain, relative to the water-borne  
26 concentration], and associated tissue concentrations [especially in clams and their consumers, such  
27 as sturgeon]). When the Delta Outflow Index (daily average flow per month) decreased by five-fold  
28 (73,732 cubic feet per second [cfs] in June 1998 to 12, 251 cfs in October 1998), residence time  
29 doubled (from 11 to 22 days) and the calculated mean  $K_d$  also doubled (from 3,198 to 6,501).  
30 However, when daily average Delta outflow in November 1999 was only 6,951 cfs (i.e., about one-  
31 half that in October 1998) and residence time was 70 days, the calculated mean  $K_d$  (7,614) did not  
32 increase proportionally.

33 Models are not available to quantitatively estimate the level of changes in selenium bioaccumulation  
34 as related to residence time, but the effects of residence time are incorporated in the  
35 bioaccumulation modeling for selenium that was based on higher  $K_d$  values for drought years in  
36 comparison to wet, normal, or all years; see Appendix 8M, *Selenium*. If increases in fish tissue or bird  
37 egg selenium were to occur, the increases would likely be of concern only where fish tissues or bird  
38 eggs are already elevated in selenium to near or above thresholds of concern. That is, where biota  
39 concentrations are currently low and not approaching thresholds of concern (which, as discussed  
40 above, is the case throughout the Delta, except for sturgeon in the western Delta), changes in  
41 residence time alone would not be expected to cause them to then approach or exceed thresholds of  
42 concern. In consideration of this factor, although the Delta as a whole is a CWA Section 303(d)-listed  
43 water body for selenium, and although monitoring data of fish tissue or bird eggs in the Delta are  
44 sparse, the most likely area in which biota tissues would be at levels high enough that additional  
45 bioaccumulation due to increased residence time from restoration areas would be a concern is the



1 western Delta and Suisun Bay for sturgeon, as discussed above. As shown in Table 60a, the overall  
 2 increase in residence time estimated in the western Delta is 4 days relative to Existing Conditions,  
 3 and 2 days relative to the No Action Alternative. Given the available information, these increases are  
 4 small enough that they are not expected to substantially affect selenium bioaccumulation in the  
 5 western Delta. Because CM2 and CM4 are expected to be substantial drivers of the increased  
 6 residence times, further discussion is included in Impact WQ-26 below.

7 In summary, relative to Existing Conditions and the No Action Alternative, all scenarios under  
 8 Alternative 4 would result in essentially no change in selenium concentrations throughout the Delta  
 9 for most biota (approximately 1% or less), although increases in selenium concentrations are  
 10 predicted for sturgeon in the western Delta. The Low Toxicity Threshold Exceedance Quotient for  
 11 selenium concentrations in sturgeon for all years in the San Joaquin River at Antioch would increase  
 12 from 0.94 for Existing Conditions and the No Action Alternative to 1.1 for Alternative 4.  
 13 Concentrations of selenium in sturgeon would exceed only the lower benchmark, indicating a low  
 14 potential for effects. The modeling of bioaccumulation for sturgeon is less calibrated to site-specific  
 15 conditions than that for other biota, which was calibrated on a robust dataset for modeling of  
 16 bioaccumulation in largemouth bass as a representative species for the Delta. Overall, all scenarios  
 17 under Alternative 4 would not be expected to substantially increase the frequency with which  
 18 applicable benchmarks would be exceeded in the Delta (there being only a small increase for  
 19 sturgeon relative to the low benchmark and no exceedance of the high benchmark) or substantially  
 20 degrade the quality of water in the Delta, with regard to selenium. Except for sturgeon in the western  
 21 Delta, concentrations of selenium in whole-body fish and bird eggs (invertebrate and fish diets)  
 22 would exceed only the lower benchmarks (4 and 6 mg/kg dry weight, respectively, indicating a low  
 23 potential for effects) at Buckley Cove, under drought conditions, for Existing Conditions, No Action  
 24 Alternative, and all scenarios for Alternative 4 (Figures 8-61, 8-62, and 8-63). However, Exceedance  
 25 Quotient exceedance quotients for these exceedances of the lower benchmarks for all Alternative 4  
 26 scenarios are between 1.0 and 1.5 (similar to Existing Conditions, and No Action Alternative),  
 27 indicating a low risk to biota in the Delta and no substantial difference from baseline conditions.  
 28 Estimated selenium concentrations in fish fillets would not exceed the screening value for protection  
 29 of human health (Figure 8-64). For sturgeon in the western Delta, whole-body selenium  
 30 concentrations would increase from 12.3 mg/kg under Existing Conditions and the No Action  
 31 Alternative to 13.1-13.5 mg/kg under Alternative 4 (depending on the operational scenario), a 7-  
 32 10% increase (Table 8M-2 in the sturgeon addendum to Appendix 8M Table M.A-2). Although all of  
 33 these values exceed both the low and high toxicity benchmarks, it is unlikely that the modeled  
 34 increases in whole-body selenium for sturgeon would be measurable in the environment (see also  
 35 the discussion of results provided in the sturgeon addendum M.A to Appendix 8M).

36 Selenium concentrations in water and biota would slightly increase progressively from Alternative  
 37 4, Scenario H1 (smallest) to Alternative 4, Scenario H4 (largest). However, relative to baseline  
 38 conditions, all scenarios under Alternative 4 would result in essentially no change in selenium  
 39 concentrations throughout the Delta. Consequently, Alternative 4 scenarios would not be expected  
 40 to substantially increase the frequency with which applicable benchmarks would be exceeded in the  
 41 Delta or substantially degrade the quality of water in the Delta, with regard to selenium.

#### 42 ***SWP/CVP Export Service Areas***

43 Alternative 4 scenarios would result in small (0.05-0.08 µg/L) changes-decreases in long-term  
 44 average selenium concentrations in water at both modeled Export Service Area assessment  
 45 locations-the Banks and Jones pumping plants, relative to baseline-Existing eConditions and the No

1 Action Alternative, for the entire period modeled (Appendix 8M, Table M-10B9b). These small  
 2 changes are reflected decreases in long-term average selenium concentrations in water would result  
 3 in small percent changes (10% or less) in increases in available assimilative capacity for selenium  
 4 for all years at these pumping plants, relative to the 1.3 µg/L ecological risk benchmark USEPA draft  
 5 water quality criterion (Figures 8-59b and 8-60b) and generally would have a small positive effect  
 6 on the Export Service Area locations. Relative to Existing Conditions, Alternative 4, Scenarios H1, H2,  
 7 H3, and H4 would result in modeled increases in assimilative capacity at Banks PP (5%, 4%, 5%, and  
 8 4%, respectively) and at Jones PP (7%, 8%, 8%, and 8%, respectively). Relative to the No Action  
 9 Alternative, Alternative 4, Scenarios H1, H2, H3, and H4 would result in modeled increases in  
 10 assimilative capacity at Banks PP (5%, 4%, 4%, and 4%, respectively) and at Jones PP (8%, 9%, 9%,  
 11 and 9%, respectively). The modeled long-term average selenium concentrations in water (Appendix  
 12 8M, Selenium, Table M-10B) for Existing Conditions (range 0.37–0.58 µg/L), No Action Alternative  
 13 (range 0.37–0.59 µg/L), for Alternative 4, Scenarios H1–H4 (range 0.3716–0.4721 µg/L), H2 (range  
 14 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  
 15 would be well below the ecological risk benchmark USEPA draft water quality criterion (of 21.3 µg/L  
 16 (Appendix 8M, Table M-9b)).

17 Relative to Existing Conditions and the No Action Alternative, all scenarios under Alternative 4  
 18 would result in small changes (approximately 1%) in estimated selenium concentrations in biota  
 19 (whole-body fish, bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets) (Figures 8-61a  
 20 through 8-64b; Appendix 8M, Selenium, Table M-24a through M-24dD) at export service areas Banks  
 21 and Jones pumping plants. Concentrations in biota would not exceed any selenium benchmarks for  
 22 Alternative 4A (Figures 8-61a through 8-64b).

23 Relative to baseline conditions for Export Service Areas, all scenarios under Alternative 4 would  
 24 result in small changes in estimated selenium concentrations in biota (Appendix 8M, Selenium, Table  
 25 M-15A through M-15D). Relative to Existing Conditions and No Action Alternative, the largest  
 26 increase of selenium concentrations in biota, under all scenarios, would be at Banks PP for drought  
 27 years (except for bird eggs [assuming a fish diet] at Banks PP for all years). Relative to Existing  
 28 Conditions, under all scenarios, the largest decrease would be at Jones PP for all years (except for  
 29 bird eggs (assuming a fish diet) at Jones PP for drought years). Relative to the No Action Alternative,  
 30 the largest decreases in estimated selenium concentrations in biota for each scenario are provided  
 31 below.

- 32 ●—Scenarios H1, H2, and H3: The largest decrease of estimated selenium concentration for biota  
 33 would be at Jones PP for all years (except for bird eggs (assuming a fish diet) at Jones PP for  
 34 drought years).
- 35 ●—Scenario H4: the largest decrease of selenium concentrations in all biota would be at Jones PP  
 36 for drought years.

37 Concentrations of selenium in biota would not exceed any benchmarks under any scenario for  
 38 Alternative 4 (Figures 8-61 through 8-64). Thus, relative to baseline conditions, all scenarios under  
 39 Alternative 4 would result in minimal changes in selenium concentrations at the Export Service Area  
 40 locations. Selenium concentrations in water and biota generally would decrease for Alternative 4  
 41 scenarios and would not exceed ecological benchmarks at either location, whereas the lower  
 42 benchmark for bird eggs (fish diet) would be exceeded under Existing Conditions and No Action  
 43 Alternative at Jones PP under drought conditions. This small positive change in selenium  
 44 concentrations under Alternative 4 scenarios would be expected to slightly decrease the frequency

1 ~~with which applicable benchmarks would be exceeded or slightly improve the quality of water at the~~  
 2 ~~Export Service Area locations, with regard to selenium.~~

3 **NEPA Effects:** Selenium concentrations in water and biota very slightly increase progressively from  
 4 Scenario H1 (smallest) to Scenario H4 (largest). However, based on the discussion above, the effects  
 5 on selenium (both as waterborne and as bioaccumulated in biota) from all scenarios under  
 6 Alternative 4 are not considered to be adverse.

7 ~~Based on the discussion above, the effects on selenium (both as waterborne and as bioaccumulated~~  
 8 ~~in biota) from Alternative 4 are not considered to be adverse.~~

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

14 There are no substantial point sources of selenium in watersheds upstream of the Delta, and no  
 15 substantial nonpoint sources of selenium in the watersheds of the Sacramento River and the eastern  
 16 tributaries. Nonpoint sources in the San Joaquin Valley that contribute selenium to the Delta will be  
 17 controlled through a TMDL developed by the Central Valley Water Board (2001) for the lower San  
 18 Joaquin River, established limits for the Grassland Bypass Project, and Basin Plan objectives (Central  
 19 Valley Water Board [2010ed]) and State Water Board ([2010db, 2010ec]) that are expected to  
 20 result in decreasing discharges of selenium from the San Joaquin River to the Delta. Consequently,  
 21 any modified reservoir operations and subsequent changes in river flows under Alternative 4  
 22 scenarios, relative to Existing Conditions, are expected to cause negligible changes in selenium  
 23 concentrations in water. Any negligible changes in selenium concentrations that may occur in the  
 24 water bodies of the affected environment located upstream of the Delta would not be of frequency,  
 25 magnitude, and geographic extent that would adversely affect any beneficial uses or substantially  
 26 degrade the quality of these water bodies as related to selenium.

27 Relative to Existing Conditions, modeling estimates indicate that all scenarios under Alternative 4  
 28 would result in essentially no change in selenium concentrations in water or most biota throughout  
 29 the Delta, with no exceedances of benchmarks for biological effects. The Low Toxicity Threshold  
 30 Exceedance Quotient for selenium concentrations in sturgeon for all years in the San Joaquin River  
 31 at Antioch would increase slightly, from 0.94 for Existing Conditions and the No Action Alternative  
 32 to 1.1 for Alternative 4. Concentrations of selenium in sturgeon would exceed only the lower  
 33 benchmark, indicating a low potential for effects. Overall, Alternative 4 would not be expected to  
 34 substantially increase the frequency with which applicable benchmarks would be exceeded in the  
 35 Delta (there being only a small increase for sturgeon exceedance relative to the low benchmark for  
 36 sturgeon and no exceedance of the high benchmark) or substantially degrade the quality of water in  
 37 the Delta, with regard to selenium.

38 ~~This Assessment a~~Assessment of effects of selenium in the SWP, ~~and~~ CVP Export Service Areas is  
 39 based on effects on selenium concentrations at the Banks and Jones pumping plants. Relative to  
 40 Existing Conditions, all scenarios under Alternative 4 would ~~slightly decrease~~cause no change  
 41 increase in the frequency with which applicable benchmarks would be exceeded, ~~{there would be~~  
 42 ~~none} or and would~~ slightly improve the quality of water in selenium concentrations at the Banks  
 43 and Jones pumping plants ~~locations.~~

1 Based on the above, selenium concentrations that would occur in water under all Alternative 4  
 2 scenarios would not cause additional exceedances of applicable state or federal numeric or narrative  
 3 water quality objectives/criteria, or other relevant water quality effects thresholds identified for  
 4 this assessment (Table 8-54), by frequency, magnitude, and geographic extent that would result in  
 5 adverse effects to one or more beneficial uses within affected water bodies. In comparison to  
 6 Existing Conditions, water quality conditions under all scenarios for Alternative 4 would not  
 7 increase levels of selenium by frequency, magnitude, and geographic extent such that the affected  
 8 environment would be expected to have measurably higher body burdens of selenium in aquatic  
 9 organisms, thereby substantially increasing the health risks to wildlife (including fish) or humans  
 10 consuming those organisms. Water quality conditions under these alternative scenarios with  
 11 respect to selenium would not cause long-term degradation of water quality in the affected  
 12 environment, and therefore would not result in use of available assimilative capacity such that  
 13 exceedances of water quality objectives/criteria would be likely and would result in substantially  
 14 increased risk for adverse effects to one or more beneficial uses. All scenarios under this alternative  
 15 would not further degrade water quality by measurable levels, on a long-term basis, for selenium  
 16 and, thus, cause the CWA Section 303(d)-listed impairment of beneficial use to be made discernibly  
 17 worse. This impact is considered to be less than significant. No mitigation is required.

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

20 NEPA Effects: In general, with the possible exception of changes in Delta hydrodynamics resulting  
 21 from habitat restoration, CM2–CM21 would not substantially increase selenium concentrations in  
 22 the water bodies of the affected environment. Modeling scenarios included assumptions regarding  
 23 how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, and  
 24 thus such effects of these restoration measures were included in the assessment of CM1 facilities  
 25 operations and maintenance (see Impact WQ-25).

26 As discussed in Impact WQ-25, implementation of these conservation measures may increase water  
 27 residence time within the restoration areas. Increased restoration area water residence times could  
 28 increase the bioaccumulation of selenium in biota, thereby potentially increasing fish tissue and bird  
 29 egg concentrations of selenium (see residence time discussion in Appendix 8M, Selenium, and  
 30 Presser and Luoma [2010b]). Models are not available to quantitatively estimate the level of changes  
 31 in selenium bioaccumulation as related to residence time, but the effects of residence time are  
 32 incorporated in the bioaccumulation modeling for selenium that was based on higher  $K_d$  values for  
 33 drought years in comparison to wet, normal, or all years; see Appendix 8M, Selenium. If increases in  
 34 fish tissue or bird egg selenium were to occur, the increases would likely be of concern only where  
 35 fish tissues or bird eggs are already elevated in selenium to near or above thresholds of concern.  
 36 That is, where biota concentrations are currently low and not approaching thresholds of concern  
 37 (which, as discussed above, is the case throughout the Delta, except for sturgeon in the western  
 38 Delta), changes in residence time alone would not be expected to cause them to then approach or  
 39 exceed thresholds of concern. In consideration of this factor, although the Delta as a whole is a CWA  
 40 Section 303(d)-listed water body for selenium, and although monitoring data of fish tissue or bird  
 41 eggs in the Delta are sparse, the most likely area in which biota tissues would be at levels high  
 42 enough that additional bioaccumulation due to increased residence time from restoration areas  
 43 would be a concern is the western Delta and Suisun Bay for sturgeon, as discussed above. As shown  
 44 in Table 60a, the overall increase in residence time estimated in the western Delta is 4 days relative  
 45 to Existing Conditions, and 2 days relative to the No Action Alternative. Given the available

1 information, these increases are small enough that they are not expected to substantially affect  
2 selenium bioaccumulation in the western Delta. Models are not available to quantitatively estimate  
3 the level of changes in residence time and the associated selenium bioavailability, but the effects of  
4 residence time are incorporated in the bioaccumulation modeling for selenium that was based on  
5 higher  $K_d$  values (the ratio of selenium concentrations in particulates [as the lowest level of the food  
6 chain] relative to the water-borne concentration) for drought years in comparison to wet, normal, or  
7 all years; see Appendix 8M, *Selenium*. If increases in fish tissue or bird egg selenium were to occur,  
8 the increases would likely be of concern only where fish tissues or bird eggs are already elevated in  
9 selenium to near or above thresholds of concern. That is, where biota concentrations are currently  
10 low and not approaching thresholds of concern, changes in residence time alone would not be  
11 expected to cause them to then approach or exceed thresholds of concern. In consideration of this  
12 factor, although the Delta as a whole is a CWA Section 303(d) listed water body for selenium, and  
13 although monitoring data of fish tissue or bird eggs in the Delta are sparse, the most likely areas in  
14 which biota tissues would be at levels high enough that additional bioaccumulation due to increased  
15 residence time from restoration areas would be a concern are the western Delta and Suisun Bay, and  
16 the South Delta in areas that receive San Joaquin River water.

17 The western Delta and Suisun Bay receive elevated selenium loads from North San Francisco Bay  
18 (including San Pablo Bay, Carquinez Strait, and Suisun Bay) and from the San Joaquin River. The San  
19 Francisco Bay Water Board is conducting a TMDL project to address selenium toxicity in the North  
20 San Francisco Bay (North Bay), defined to include a portion of the Delta, Suisun Bay, Carquinez  
21 Strait, San Pablo Bay, and the Central Bay (State Water Resources Control Board 2011). The North  
22 Bay selenium TMDL will identify and characterize selenium sources to the North Bay and the  
23 processes that control the uptake of selenium by wildlife. The TMDL will quantify selenium loads,  
24 develop and assign waste load and load allocations among sources, and include an implementation  
25 plan designed to achieve the TMDL and protect beneficial uses. Nonpoint sources of selenium in the  
26 San Joaquin Valley that contribute selenium to the San Joaquin River, and thus the Delta and Suisun  
27 Bay, will be controlled through a TMDL developed by the Central Valley Water Board (2001) for the  
28 lower San Joaquin River, established limits for the Grassland Bypass Project, and Basin Plan  
29 objectives (Central Valley Water Board 2010e-d; State Water Board 2010b and 2010c) that are  
30 expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta,

31 (State Water Resources Control Board 2010b and 2010c)

32 The South Delta receives elevated selenium loads from the San Joaquin River, and as Table 8-60a  
33 shows, residence times in this area are expected to increase on an annual average by 11 days  
34 relative to Existing Conditions, and 9 days relative to the No Action Alternative. However, as  
35 discussed in Impact WQ-25, biota concentrations in the South Delta are not approaching levels of  
36 concern. Furthermore, in contrast to Suisun Bay and possibly the western Delta in the future, the  
37 South Delta lacks the overbite clam (*Corbula [Potamocorbula] amurensis*), which is considered a key  
38 driver of selenium bioaccumulation in Suisun Bay, due to its high bioaccumulation of selenium and  
39 its role in the benthic food web that includes long-lived sturgeon. The South Delta does have  
40 *Corbicula fluminea*, another bivalve that bioaccumulates selenium, but to a lesser degree than the  
41 overbite clam (Lee et al. 2006). it is not as invasive as the overbite clam and thus likely makes up a  
42 smaller fraction of sturgeon diet. Also, as mentioned above, nonpoint sources of selenium in the San  
43 Joaquin Valley that contribute selenium to the Delta will be controlled through a TMDL developed by  
44 the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the  
45 Grassland Bypass Project, and Basin Plan objectives (Central Valley Water Board 2010e-d; State  
46 Water Board 2010b and 2010c) that are expected to result in decreasing discharges of selenium

1 from the San Joaquin River to the Delta. Further, if selenium levels in the San Joaquin River are not  
2 sufficiently reduced via these efforts, it is expected that the State Water Board and Central Valley  
3 Water Board would initiate additional TMDLs to further control nonpoint sources of selenium. Given  
4 the available information, these increases are small enough that they are not expected to cause  
5 selenium concentrations in biota in the south Delta to approach or exceed thresholds of concern.

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

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

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

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

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

43 Given the factors discussed in the assessment above, any increases in bioaccumulation rates from  
44 water-borne selenium that could occur in some areas as a result of increased water residence times

1 would not be of sufficient magnitude and geographic extent that any portion of the Delta would be  
 2 expected to have measurably higher body burdens of selenium in aquatic organisms, and therefore  
 3 would not substantially increase risk for adverse effects to beneficial uses. CM2–CM21 would not  
 4 cause long-term degradation of water quality resulting in sufficient use of available assimilative  
 5 capacity such that occasionally exceeding water quality objectives/criteria would be likely. Also,  
 6 CM2–CM21 would not result in substantially increased risk for adverse effects to any beneficial uses.  
 7 Furthermore, although the Delta is a 303(d)-listed water body for selenium, given the discussion in  
 8 the assessment above, it is unlikely that restoration areas would result in measurable increases in  
 9 selenium in fish tissues or bird eggs such that the beneficial use impairment would be made  
 10 discernibly worse.

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

17 ***NEPA Effects:*** In general, with the possible exception of changes in Delta hydrodynamics resulting  
 18 from habitat restoration, CM2–CM11 would not substantially increase selenium concentrations in  
 19 the water bodies of the affected environment. Modeling scenarios included assumptions regarding  
 20 how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, and  
 21 thus such effects of these restoration measures were included in the assessment of CM1 facilities  
 22 operations and maintenance (see Impact WQ-25).

23 However, implementation of these conservation measures may increase water residence time  
 24 within the restoration areas. Increased restoration area water residence times could potentially  
 25 increase the bioaccumulation of selenium in biota, thereby potentially increasing fish tissue and bird  
 26 egg concentrations of selenium, but models are not available to quantitatively estimate the level  
 27 of changes in residence time and the associated selenium bioavailability, but the effects of residence  
 28 time are incorporated in the bioaccumulation modeling for selenium that was based on higher  $K_d$   
 29 values (the ratio of selenium concentrations in particulates [as the lowest level of the food chain]  
 30 relative to the water borne concentration) for drought years in comparison to wet, normal, or all  
 31 years; see Appendix 8M, *Selenium*. If increases in fish tissue or bird egg selenium were to occur, the  
 32 increases would likely be of concern only where fish tissues or bird eggs are already elevated in  
 33 selenium to near or above thresholds of concern. That is, where biota concentrations are currently  
 34 low and not approaching thresholds of concern, changes in residence time alone would not be  
 35 expected to cause them to then approach or exceed thresholds of concern. In consideration of this  
 36 factor, although the Delta as a whole is a 303(d)-listed water body for selenium, and although  
 37 monitoring data of fish tissue or bird eggs in the Delta are sparse, the most likely areas in which  
 38 biota tissues would be at levels high enough that additional bioaccumulation due to increased  
 39 residence time from restoration areas would be a concern are the western Delta and Suisun Bay, and  
 40 the South Delta in areas that receive San Joaquin River water.

41 The western Delta and Suisun Bay receive elevated selenium loads from North San Francisco Bay  
 42 (including San Pablo Bay, Carquinez Strait, and Suisun Bay) and from the San Joaquin River. Point  
 43 sources of selenium in North San Francisco Bay (i.e., refineries) that contribute selenium to Suisun  
 44 Bay are expected to be reduced through a TMDL under development by the San Francisco Bay Water  
 45 Board (San Francisco Bay Water Board 2012) that is expected to result in decreasing discharges of

1 selenium. Nonpoint sources of selenium in the San Joaquin Valley that contribute selenium to the  
2 San Joaquin River, and thus the Delta and Suisun Bay, will be controlled through a TMDL developed  
3 by the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the  
4 Grassland Bypass Project, and Basin Plan objectives (Central Valley Water Board 2010c, d) that are  
5 expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta. If  
6 selenium levels are not sufficiently reduced via these efforts, it is expected that the State Water  
7 Board and the San Francisco Bay and Central Valley Water Boards would initiate additional actions  
8 to further control sources of selenium.

9 The South Delta receives elevated selenium loads from the San Joaquin River. In contrast to Suisun  
10 Bay and possibly the western Delta in the future, the South Delta lacks the overbite clam (*Corbula*  
11 [*Potamocorbula*] *amurensis*), which is considered a key driver of selenium bioaccumulation in  
12 Suisun Bay, due to its high bioaccumulation of selenium and its role in the benthic food web that  
13 includes long-lived sturgeon. The South Delta does have *Corbicula fluminea*, another bivalve that  
14 bioaccumulates selenium, but it is not as invasive as the overbite clam and thus likely makes up a  
15 smaller fraction of sturgeon diet. Also, as mentioned above, nonpoint sources of selenium in the San  
16 Joaquin Valley that contribute selenium to the Delta will be controlled through a TMDL developed by  
17 the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the  
18 Grassland Bypass Project, and Basin Plan objectives (Central Valley Water Board 2010c, d) that are  
19 expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta.  
20 Further, if selenium levels in the San Joaquin River are not sufficiently reduced via these efforts, it is  
21 expected that the State Water Board and Central Valley Water Board would initiate additional  
22 TMDLs to further control nonpoint sources of selenium.

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

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

43 Given the factors discussed in the assessment above, any increases in bioaccumulation rates from  
44 water-borne selenium that could occur in some areas as a result of increased water residence time  
45 would not be of sufficient magnitude and geographic extent that any portion of the Delta would be



1 ~~expected to have measurably higher body burdens of selenium in aquatic organisms and, therefore,~~  
 2 ~~would not substantially increase risk for adverse effects to beneficial uses. Furthermore, although~~  
 3 ~~the Delta is a 303(d)-listed water body for selenium, given the discussion in the assessment above, it~~  
 4 ~~is unlikely that restoration areas would result in measurable increases in selenium in fish tissues or~~  
 5 ~~bird eggs such that the beneficial use impairment would be made discernibly worse.~~

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

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

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

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

### 33 **Impact WQ-27: Effects on Trace Metal Concentrations Resulting from Facilities Operations** 34 **and Maintenance (CM1)**

#### 35 ***Upstream of the Delta***

36 Relative to Existing Conditions and the No Action Alternative, under Alternative 4, Scenarios H1–H4,  
 37 sources of trace metals would not be expected to change substantially with exception to sources  
 38 related to population growth, such as increased municipal wastewater discharges and development  
 39 contributing to increased urban dry and wet weather runoff. Facility operations could have an effect  
 40 on these sources if concentrations of dissolved metals were closely correlated to river flow,  
 41 suggesting that changes in river flow, and the related capacity to dilute these sources, could  
 42 ultimately have a substantial effect on long-term metals concentrations.

1 On the Sacramento River, available dissolved trace metals data and river flow at Freeport are poorly  
2 associated (Appendix 8N, *Trace Metals*, Figure 1). Similarly, dissolved copper, iron, and manganese  
3 concentrations on the San Joaquin River at Vernalis are poorly associated (Appendix 8N, Figure 2).  
4 While there is an insufficient number of data for the other trace metals to observe trends at Vernalis,  
5 it is reasonable to assume that these metals similarly show poor association to San Joaquin River  
6 flow, as shown for the corresponding dissolved metals on the Sacramento River.

7 Given the poor association of dissolved trace metal concentrations with flow, river flow rate and  
8 reservoir storage reductions that would occur under Alternative 4, Scenarios H1–H4, relative to  
9 Existing Conditions and the No Action Alternative, would not be expected to result in a substantial  
10 adverse change in trace metal concentrations in the reservoirs and rivers upstream of the Delta. As  
11 such, the Alternative 4, Scenarios H1–H4, would not be expected to substantially increase the  
12 frequency with which applicable Basin Plan objectives or CTR criteria would be exceeded in water  
13 bodies of the affected environment located upstream of the Delta or substantially degrade the  
14 quality of these water bodies, with regard to trace metals.

### 15 ***Delta***

16 For metals of primarily aquatic life concern (copper, cadmium, chromium, lead, nickel, silver, and  
17 zinc), average and 95<sup>th</sup> percentile trace metal concentrations of the primary source waters to the  
18 Delta are very similar, with difference typically not greater than a factor of 2 to 5 (Appendix 8N,  
19 Table 1–7). For example, average dissolved copper concentrations on the Sacramento River, San  
20 Joaquin River, and Bay (Martinez) are 1.7 µg/L, 2.4 µg/L, and 1.7 µg/L, respectively. The 95<sup>th</sup>  
21 percentile dissolved copper concentrations on the Sacramento River, San Joaquin River, and Bay  
22 (Martinez) are 3.4 µg/L, 4.5 µg/L, and 2.4 µg/L, respectively. Given this similarity, very large  
23 changes in source water fraction would be necessary to effect a relatively small change in trace  
24 metal concentration at a particular Delta location. Moreover, average and 95<sup>th</sup> percentile trace metal  
25 concentrations for these primary source waters are all below their respective water quality criteria,  
26 including those that are hardness-based without a WER adjustment (Tables 8-51 and 8-52). No  
27 mixing of these three source waters could result in a metal concentration greater than the highest  
28 source water concentration, and given that the average and 95<sup>th</sup> percentile source water  
29 concentrations for copper, cadmium, chromium, led, nickel, silver, and zinc do not exceed their  
30 respective criteria, more frequent exceedances of criteria in the Delta would not occur under the  
31 operational scenario for this alternative.

32 For metals of primarily human health and drinking water concern (arsenic, iron, manganese),  
33 average and 95<sup>th</sup> percentile concentrations are also very similar (Appendix 8N, *Trace Metals*, Tables  
34 8–10). The arsenic criterion was established to protect human health from the effects of long-term  
35 chronic exposure, while secondary maximum contaminant levels for iron and manganese were  
36 established as reasonable goals for drinking water quality. The primary source water average  
37 concentrations for arsenic, iron, and manganese are below these criteria. No mixing of these three  
38 source waters could result in a metal concentration greater than the highest source water  
39 concentration, and given that the average water concentrations for arsenic, iron, and manganese do  
40 not exceed water quality criteria, more frequent exceedances of drinking water criteria in the Delta  
41 would not be expected to occur under this alternative.

42 Relative to Existing Conditions and the No Action Alternative, facilities operation under Alternative  
43 4, Scenarios H1–H4, would result in negligible change in trace metal concentrations throughout the  
44 Delta. The operational scenarios of Alternative 4 would not be expected to substantially increase the

1 frequency with which applicable Basin Plan objectives or CTR criteria would be exceeded in the  
2 Delta or substantially degrade the quality of water in the Delta, with regard to trace metals.

### 3 **SWP/CVP Export Service Areas**

4 Alternative 4, Scenarios H1–H4, would not result in substantial increases in trace metal  
5 concentrations in the water exported from the Delta or diverted from the Sacramento River through  
6 the proposed conveyance facilities. As such, there is not expected to be substantial changes in trace  
7 metal concentrations in the SWP/CVP export service area waters under any operational scenario of  
8 Alternative 4, relative to Existing Conditions or the No Action Alternative. As such, Alternative 4,  
9 Scenarios H1–H4, would not be expected to substantially increase the frequency with which  
10 applicable Basin Plan objectives or CTR criteria would be exceeded in the water bodies of the  
11 affected environment in the SWP and CVP Service Area or substantially degrade the quality of these  
12 water bodies, with regard to trace metals.

13 **NEPA Effects:** In summary, relative to the No Action Alternative, Alternative 4, Scenarios H1–H4,  
14 would not cause a substantial increase in long-term average trace metals concentrations within the  
15 affected environment, nor would it cause an increased frequency of water quality objective/criteria  
16 exceedances within the affected environment. The effect on trace metals is determined not to be  
17 adverse.

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

23 While greater water demands under the operational scenarios of Alternative 4 would alter the  
24 magnitude and timing of reservoir releases north, south and east of the Delta, these activities would  
25 have no substantial effect on the various watershed sources of trace metals. Moreover, long-term  
26 average flow and trace metals at Sacramento River at Hood and San Joaquin River at Vernalis are  
27 poorly correlated; therefore, changes in river flows would not be expected to cause a substantial  
28 long-term change in trace metal concentrations upstream of the Delta.

29 Average and 95<sup>th</sup> percentile trace metal concentrations are very similar across the primary source  
30 waters to the Delta. Given this similarity, very large changes in source water fraction would be  
31 necessary to effect a relatively small change in trace metal concentration at a particular Delta  
32 location. Moreover, average and 95<sup>th</sup> percentile trace metal concentrations for these primary source  
33 waters are all below their respective water quality criteria, including those that are hardness-based  
34 without a WER adjustment. No mixing of these three source waters could result in a metal  
35 concentration greater than the highest source water concentration, and given that trace metals do  
36 not already exceed water quality criteria, more frequent exceedances of criteria in the Delta would  
37 not be expected to occur under any operational scenario of Alternative 4.

38 The assessment of Alternative 4, Scenario H1–H4, effects on trace metals in the SWP/CVP Export  
39 Service Areas is based on assessment of changes in trace metal concentrations at Banks and Jones  
40 pumping plants. As just discussed regarding similarities in Delta source water trace metal  
41 concentrations, no operational scenario of Alternative 4 is expected to result in substantial changes  
42 in trace metal concentrations in Delta waters, including Banks and Jones pumping plants, therefore

1 effects on trace metal concentrations in the SWP/CVP Export Service Area are expected to be  
2 negligible.

3 Based on the above, there would be no substantial long-term increase in trace metal concentrations  
4 in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the SWP/CVP export  
5 service area waters under any operational scenario of Alternative 4 relative to Existing Conditions.  
6 As such, this alternative is not expected to cause additional exceedance of applicable water quality  
7 objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any  
8 beneficial uses of waters in the affected environment. Because trace metal concentrations are not  
9 expected to increase substantially, no long-term water quality degradation for trace metals is  
10 expected to occur and, thus, no adverse effects to beneficial uses would occur. Furthermore, any  
11 negligible changes in long-term trace metal concentrations that may occur in water bodies of the  
12 affected environment would not be expected to make any existing beneficial use impairments  
13 measurably worse. The trace metals discussed in this assessment are not considered  
14 bioaccumulative, and thus would not directly cause bioaccumulative problems in aquatic life or  
15 humans. This impact is considered to be less than significant. No mitigation is required.

16 **Impact WQ-28: Effects on Trace Metal Concentrations Resulting from Implementation of CM2-  
17 CM22CM21**

18 **NEPA Effects:** Implementation of CM2-CM22CM21 present no new sources of trace metals to the  
19 affected environment, including areas upstream of the Delta, within the Delta, or in the SWP and CVP  
20 service areas. However, CM19, which would fund projects to contribute to reducing pollutant  
21 discharges in urban stormwater, would be expected to reduce trace metal loading to surface waters  
22 of the affected environment. The remaining conservation measures would not be expected to affect  
23 trace metal levels, because they are actions that do not affect the presence of trace metal sources. As  
24 they pertain to trace metals, implementation of these conservation measures would not be expected  
25 to adversely affect beneficial uses of the affected environment or substantially degrade water quality  
26 with respect to trace metals.

27 In summary, implementation of CM2-CM22CM21 under Alternative 4 relative to Existing Conditions  
28 and the No Action Alternative, would have negligible, if any, effect on trace metals concentrations.  
29 The effect on trace metals from implementing CM2-CM22CM21 is determined not to be adverse.

30 **CEQA Conclusion:** Implementation of CM2-CM22CM21 under Alternative 4 would not cause  
31 substantial long-term increase in trace metal concentrations in the rivers and reservoirs upstream  
32 of the Delta, in the Delta Region, or the SWP/CVP export service area. As such, this alternative is not  
33 expected to cause additional exceedance of applicable water quality objectives by frequency,  
34 magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters  
35 in the affected environment. Because trace metal concentrations are not expected to increase  
36 substantially, no long-term water quality degradation for trace metals is expected to occur and, thus,  
37 no adverse effects to beneficial uses would occur. Furthermore, any negligible changes in long-term  
38 trace metal concentrations that may occur throughout the affected environment would not be  
39 expected to make any existing beneficial use impairments measurably worse. The trace metals  
40 discussed in this assessment are not considered bioaccumulative, and thus would not directly cause  
41 bioaccumulative problems in aquatic life or humans. This impact is considered to be less than  
42 significant. No mitigation is required.

1 **Impact WQ-29: Effects on TSS and Turbidity Resulting from Facilities Operations and**  
 2 **Maintenance (CM1)**

3 ***Upstream of the Delta***

4 TSS concentrations and turbidity levels in rivers upstream of the Delta are affected primarily by: 1)  
 5 TSS concentrations and turbidity levels of the water released from the upstream reservoirs, 2)  
 6 erosion occurring within the river channel beds, which is affected by river flow velocity and bank  
 7 protection, 3) TSS concentrations and turbidity levels of tributary inflows, point-source inputs, and  
 8 nonpoint runoff as influenced by surrounding land uses; and 4) phytoplankton, zooplankton and  
 9 other biological material in the water.

10 Alternative 4, Scenarios H1–H4, would alter the magnitude and timing of water releases from  
 11 reservoirs upstream of the Delta relative to Existing Conditions and the No Action Alternative, which  
 12 in turn would alter downstream river flows. With respect to TSS and turbidity, an increase in river  
 13 flow is generally the concern, as this increases shear stress on the channel, suspending particles  
 14 resulting in higher TSS concentrations and turbidity levels. Schoellhamer et al. (2007b) noted that  
 15 suspended sediment concentration was more affected by season than flow, with the higher  
 16 concentrations for a given flow rate occurring during “first flush events” and lower concentrations  
 17 occurring during spring snowmelt events. Because of such a relationship, the changes in mean  
 18 monthly average river flows under the operational scenarios of Alternative 4 are not expected to  
 19 cause river TSS concentrations or turbidity levels (highs, lows, typical conditions) to be outside the  
 20 ranges occurring under Existing Conditions or the No Action Alternative. Consequently, this  
 21 alternative is expected to have minimal effect on TSS concentrations and turbidity levels in the  
 22 reservoirs and rivers upstream of the Delta.

23 Changes in land use that would occur relative to Existing Conditions and the No Action Alternative  
 24 could have minor effects on TSS concentrations and turbidity levels throughout this portion of the  
 25 affected environment. Site-specific and temporal exceptions may occur due to localized temporary  
 26 construction activities, dredging activities, development, or other land use changes. These localized  
 27 actions would generally require agency permits that would regulate and limit both their short-term  
 28 and long-term effects on TSS concentrations and turbidity levels to less-than-substantial levels.

29 ***Delta***

30 TSS concentrations and turbidity levels in Delta waters are affected by TSS concentrations and  
 31 turbidity levels of the Delta inflows (and associated sediment load). TSS concentrations and  
 32 turbidity levels within Delta waters also are affected by fluctuation in flows within the channels due  
 33 to the tides, with sediments depositing as flow velocities and turbulence are low at periods of slack  
 34 tide, and sediments becoming suspended when flow velocities and turbulence increase when tides  
 35 are near the maximum. TSS and turbidity variations can also be attributed to phytoplankton,  
 36 zooplankton and other biological material in the water.

37 Under Alternative 4, Scenarios H1–H4, any land use changes that may occur under this alternative  
 38 would not be expected to have permanent, substantial effects on TSS concentrations and turbidity  
 39 levels of Delta waters, relative to Existing Conditions or the No Action Alternative. Furthermore, this  
 40 alternative would not cause the TSS concentrations or turbidity levels in the rivers contributing  
 41 inflows to the Delta to be outside the ranges occurring under Existing Conditions or the No Action  
 42 Alternative. Consequently, this alternative is expected to have minimal effect on TSS concentrations  
 43 and turbidity levels in the Delta region. As such, any minor TSS and turbidity changes that may occur

1 under Alternative 4, Scenarios H1–H4, would not be of sufficient frequency, magnitude, and  
2 geographic extent that would result in adverse effects on beneficial uses in the Delta region, or  
3 substantially degrade the quality of these water bodies, with regard to TSS and turbidity.

#### 4 ***SWP/CVP Export Service Areas***

5 The operational scenarios of Alternative 4 are expected to have minimal effect on TSS  
6 concentrations and turbidity levels in Delta waters, including water exported at the south Delta  
7 pumps, relative to Existing Conditions or the No Action Alternative. As such, Alternative 4 is  
8 expected to have minimal effect on TSS concentrations and turbidity levels in the SWP/CVP Export  
9 Service Areas waters.

10 ***NEPA Effects:*** The effects on TSS and turbidity from implementing any operational scenario of  
11 Alternative 4 is determined to not be adverse.

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

17 Changes in river flow rate and reservoir storage that would occur under the operational scenarios of  
18 Alternative 4, relative to Existing Conditions, would not be expected to result in a substantial  
19 adverse change in TSS concentrations and turbidity levels in the reservoirs and rivers upstream of  
20 the Delta, given that suspended sediment concentrations are more affected by season than flow.  
21 Site-specific and temporal exceptions may occur due to localized temporary construction activities,  
22 dredging activities, development, or other land use changes would be site-specific and temporal,  
23 which would be regulated to limit both their short-term and long-term effects on TSS and turbidity  
24 levels to less than substantial levels.

25 Within the Delta, geomorphic changes associated with sediment transport and deposition are  
26 usually gradual, occurring over years, and high storm event inflows would not be substantially  
27 affected. Thus, it is expected that the TSS concentrations and turbidity levels in the affected channels  
28 would not be substantially different from the levels under Existing Conditions. Consequently, this  
29 alternative is expected to have minimal effect on TSS concentrations and turbidity levels in the Delta  
30 region, relative to Existing Conditions.

31 There is not expected to be substantial, if even measurable, changes in TSS concentrations and  
32 turbidity levels in the SWP/CVP Export Service Areas waters under any operational scenario of  
33 Alternative 4, relative to Existing Conditions, because as stated above, this alternative is not  
34 expected to result in substantial changes in TSS concentrations and turbidity levels at the south  
35 Delta export pumps, relative to Existing Conditions.

36 Therefore, this alternative is not expected to cause additional exceedance of applicable water quality  
37 objectives where such objectives are not exceeded under Existing Conditions. Because TSS  
38 concentrations and turbidity levels are not expected to be substantially different, long-term water  
39 quality degradation is not expected, and, thus, beneficial uses are not expected to be adversely  
40 affected. Finally, TSS and turbidity are neither bioaccumulative nor Clean Water Act section 303(d)  
41 listed constituents. This impact is considered to be less than significant. No mitigation is required.

1 **Impact WQ-30: Effects on TSS and Turbidity Resulting from Implementation of CM2-**  
 2 **CM22CM21**

3 **NEPA Effects:** Creation of habitat and open water through implementation of CM2–CM11 could  
 4 affect Delta hydrodynamics and, thus, erosion and deposition potential in certain Delta channels.  
 5 The magnitude of increases in TSS concentrations and turbidity levels in the affected channels due  
 6 to higher potential of erosion cannot be readily quantified. The increases in TSS concentrations and  
 7 turbidity levels in the affected channels could be substantial in localized areas, depending on how  
 8 rapidly the Delta hydrodynamics are altered and the channels equilibrate with the new tidal flux  
 9 regime, after implementation of this alternative. However, geomorphic changes associated with  
 10 sediment transport and deposition are usually gradual, occurring over years. Within the  
 11 reconfigured channels there could be localized increases in TSS concentrations and turbidity levels,  
 12 but within the greater Plan Area it is expected that the TSS concentrations and turbidity levels  
 13 would not be substantially different from the levels under the No Action Alternative.

14 CM19, which would fund projects to contribute to reducing pollutant discharges in stormwater,  
 15 would be expected to reduce TSS and turbidity in urban discharges relative to the No Action  
 16 Alternative. The remaining conservation measures would not be expected to affect TSS  
 17 concentrations and turbidity levels, because they are actions that do not affect the presence of TSS  
 18 and turbidity sources.

19 The effects on TSS and turbidity from implementing CM2–CM22CM21 is determined to not be  
 20 adverse.

21 **CEQA Conclusion:** It is expected that the TSS concentrations and turbidity levels Upstream of the  
 22 Delta, in the Plan Area, and the SWP/CVP Export Service Areas due to implementation of CM2–  
 23 CM22CM21 under Alternative 4 would not be substantially different relative to Existing Conditions,  
 24 except within localized areas of the Delta modified through creation of habitat and open water.  
 25 Therefore, this alternative is not expected to cause additional exceedance of applicable water quality  
 26 objectives where such objectives are not exceeded under Existing Conditions. Because TSS  
 27 concentrations and turbidity levels Upstream of the Delta, in the greater Plan Area, and in the  
 28 SWP/CVP Export Service Areas are not expected to be substantially different, long-term water  
 29 quality degradation is not expected relative to TSS and turbidity, and, thus, beneficial uses are not  
 30 expected to be adversely affected. Finally, TSS and turbidity are neither bioaccumulative nor Clean  
 31 Water Act section 303(d) listed constituents. This impact is considered to be less than significant. No  
 32 mitigation is required.

33 **Impact WQ-31: Water Quality Effects Resulting from Construction-Related Activities (CM1-**  
 34 **CM22CM21)**

35 This section addresses construction-related water quality effects to constituents of concern other  
 36 than effects caused by changes in the operations and maintenance of CM1–CM22CM21, which are  
 37 addressed in terms of constituent-specific impact assessments elsewhere in this chapter. The  
 38 conveyance features for CM1 under Alternative 4 would be very similar to those discussed for  
 39 Alternative 1A and most of the construction activity would occur in the Delta. The primary  
 40 difference between Alternative 4 and Alternative 1A is that under Alternative 4, there would be two  
 41 fewer intakes and two fewer pumping plant locations, which would result in a reduced level of  
 42 construction activity. However, construction techniques and locations of major features of the  
 43 conveyance system within the Delta would be similar. Alternative 4 additionally would include  
 44 construction of an operable barrier at the head of Old River. The remainder of the facilities

1 constructed under Alternative 4, including CM2-~~CM22CM21~~, would be very similar to, or the same  
2 as, those to be constructed for Alternative 1A. Few, if any, of the CM1-~~CM22CM21~~ actions involve  
3 construction work in the SWP and CVP Service Area or areas upstream of the Delta. The  
4 conservation measures, or components of measures, that are anticipated to be constructed in areas  
5 upstream of the Delta would be limited to: (1) the Yolo Bypass Fishery Enhancement (CM2) (i.e., the  
6 Fremont Weir component of the action), (2) Conservation Hatcheries (CM18) (i.e., the new hatchery  
7 facility), and (3) Urban Stormwater Treatment (CM19). Anticipated construction activities that may  
8 occur under CM11-~~CM22CM21~~, if any, would involve relatively minor disturbances, and thus would  
9 not be anticipated to result in substantial discharges of any constituents of concern.

10 Within the Delta, the construction-related activities for Alternative 4 would be most extensive for  
11 CM1 involving the new water conveyance facilities. Construction of water conveyance facilities  
12 would involve vegetation removal, material storage and handling, excavation, overexcavation for  
13 facility foundations, surface grading, trenching, road construction, levee construction, construction  
14 site dewatering, soil stockpiling, RTM dewatering basin construction and storage operations, and  
15 other general facility construction activities (i.e., concrete, steel, carpentry, and other building  
16 trades) over approximately 7,500 acres during the course of constructing the facilities. Vegetation  
17 would be removed (via grubbing and clearing) and grading and other earthwork would be  
18 conducted at the intakes, pumping plants, the intermediate forebay, the expanded Clifton Court  
19 Forebay, culvert siphon between the northern cell of the expanded Clifton Court Forebay to a new  
20 canal to the Jones Pumping Plant and a siphon under the Byron Highway into a short segment of  
21 canal leading to the Banks Pumping Plant, borrow areas, RTM and spoil storage areas, setback and  
22 transition levees, sedimentation basins, solids handling facilities, transition structures, surge shafts  
23 and towers, substations, transmission line footings, access roads, concrete batch plants, fuel stations,  
24 bridge abutments, barge unloading facilities, and laydown areas. Construction of each intake would  
25 take nearly 4 years to complete.

26 Construction activities necessary to develop the new habitat restoration areas for CM2 and CM4-  
27 CM10 including restored tidal wetlands, floodplain, and related channel margin and off-channel  
28 habitats, would likely involve a variety of extensive conventional clearing and grading activities on  
29 relatively dry sites of the Delta that are currently separated from the Delta channels by levees.  
30 Construction would involve new setback levees, excavation and soil placement for new wetland and  
31 other habitat feature development, and a variety of potential in-water construction activities such as  
32 excavation, sediment dredging, levee breaching, and hauling and placement or disposal of excavated  
33 sediment or dredge material. Construction activities for the proposed restoration sites, due to the  
34 direct connectivity with Delta channels, have the potential to result in direct discharge of eroded soil  
35 and construction-related contaminants, or indirectly through erosion and site inundation during the  
36 weeks or months following construction prior to stabilization of newly contoured and restored  
37 landforms and colonization by vegetation.

38 **NEPA Effects:** The types and magnitude of potential construction-related water quality effects  
39 associated with implementation of CM1-~~CM22CM21~~ under Alternative 4 would be very similar to  
40 the effects discussed for Alternative 1A, and the effects anticipated with implementation of CM2-  
41 ~~CM22CM21~~ would be essentially identical. Potential construction-related water quality effects may  
42 include discharges of turbidity/TSS due to the erosion of disturbed soils and associated  
43 sedimentation entering surface water bodies or other construction-related wastes (e.g., concrete,  
44 asphalt, cleaning agents, paint, and trash). Construction activities also may result in temporary or  
45 permanent changes in stormwater generation or drainage and runoff patterns (i.e., velocity, volume,  
46 and direction) that may cause or contribute to soil erosion and offsite sedimentation, such as



1 creation of additional impervious surfaces (e.g., pavement, buildings, compacted soils), blockage or  
 2 restriction of existing drainage channels, or general surface drainage changes from grading and  
 3 excavation activity. Additionally, the use of heavy earthmoving equipment may result in spills and  
 4 leakage of oils, gasoline, diesel fuel, and related petroleum contaminants used in the fueling and  
 5 operation of such construction equipment.

6 Land surface grading and excavation activities, or exposure of disturbed sites immediately following  
 7 construction and prior to stabilization, could result in rainfall- and stormwater-related soil erosion,  
 8 runoff, and offsite sedimentation in surface water bodies. The initial runoff following construction,  
 9 or return of seasonal rains to previously disturbed sites, can result in runoff with peak pollutant  
 10 levels and is referred to as “first flush” storm events. Soil erosion and runoff can also result in  
 11 increased concentrations and loading of organic matter, nutrients (nitrogen and phosphorus), and  
 12 other contaminants contained in the soil such as trace metals, pesticides, or animal-related  
 13 pathogens. Graded and exposed soils also can be compacted by heavy machinery, resulting in  
 14 reduced infiltration of rainfall and runoff, thus increasing the rate of runoff (and hence  
 15 contaminants) to downstream water bodies.

16 Construction activities also would be anticipated to involve the transport, handling, and use of a  
 17 variety of hazardous substances and non-hazardous materials that may adversely affect water  
 18 quality if discharged inadvertently to construction sites or directly to water bodies. Typical  
 19 construction-related contaminants include petroleum products for refueling and maintenance of  
 20 machinery (e.g., fuel, oils, solvents), concrete, paints and other coatings, cleaning agents, debris and  
 21 trash, and human wastes. Construction activities also would involve large material storage and  
 22 laydown areas, and occasional accidental spills of hazardous materials stored and used for  
 23 construction may occur. Contaminants released or spilled on bare soil also may result in  
 24 groundwater contamination. Dewatering operations may contain elevated levels of suspended  
 25 sediment or other constituents that may cause water quality degradation.

26 The intensity of construction activity along with the fate and transport characteristics of the  
 27 chemicals used, would largely determine the magnitude, duration, and frequency of construction-  
 28 related discharges and resulting concentrations and degradation associated with the specific  
 29 constituents of concern. The potential water quality concerns associated with the major categories  
 30 of contaminants that might be discharged as a result of construction activity include the following.

- 31 • Suspended sediment: May increase turbidity (i.e., reduce water clarity) that can affect aquatic  
 32 organisms and increase the costs and effort of removal in municipal/industrial water supplies.  
 33 Downstream sedimentation can affect aquatic habitat, or cause a nuisance if it affects functions  
 34 of agricultural or municipal intakes, or boat navigation.
- 35 • Organic matter: May contribute turbidity and oxygen demanding substances (i.e., reduce  
 36 dissolved oxygen levels) that can affect aquatic organisms. Organic carbon may increase the  
 37 potential for disinfection byproduct formation in municipal drinking water supplies.
- 38 • Nutrients: May contribute nitrogen, phosphorus, and other key nutrients that can contribute to  
 39 nuisance biostimulation of algae and vascular aquatic plants, which may affect municipal water  
 40 supplies, recreation, aquatic life, and aesthetics.
- 41 • Petroleum hydrocarbons: May contribute toxic compounds to aquatic life, and oily sheens may  
 42 reduce oxygen/gas transfer in water, foul aquatic habitats, and reduce water quality for  
 43 municipal supplies, recreation, and aesthetics.

- 1 • Trace constituents (metals, pesticides, synthetic organic compounds): Compounds in eroded soil  
2 or construction-related materials (e.g., paints, coatings, cleaning agents) may be toxic to aquatic  
3 life.
- 4 • Pathogens: Bacteria, viruses, and protozoans may affect aquatic life and increase human health  
5 risks via municipal water supplies, reduced recreational water quality, or contaminated shellfish  
6 beds.
- 7 • Other inorganic compounds: Construction-related materials can contain inorganic compounds  
8 such as acidic/basic materials which can change pH and may adversely affect aquatic life and  
9 habitats. Concrete contains lime which can increase pH levels, and drilling fluids may alter pH.

10 Some construction-related contaminants, such as PAHs that may be in some fuel and oil petroleum  
11 byproducts, may be bioaccumulative in aquatic and terrestrial organisms. Construction activities  
12 also may disturb areas where bioaccumulative constituents are present in the soil (e.g., mercury,  
13 selenium, organochlorine pesticides, PCBs, and dioxin/furan compounds), or may disturb soils that  
14 contain constituents included on the Section 303(d) lists of impaired water bodies in the affected  
15 environment. While the 303(d)-listed Delta channels impaired by mercury are widespread,  
16 impairment by selenium, pesticides, PCBs, and dioxin/furan compounds is more limited, and there  
17 are no 303(d) listings for PAH impairment. Bioaccumulation of constituents in the aquatic  
18 foodchain, and 303(d)-related impaired water bodies, arise as a result of long-term loading of a  
19 constituent or a pervasive and widespread source of constituent discharge (e.g., mercury). However,  
20 as a result of the generally localized disturbances, and intermittent and temporary nature of  
21 construction-related activities, construction would not be anticipated to result in contaminant  
22 discharges of substantial magnitude or duration to contribute to long-term bioaccumulation  
23 processes, or cause measureable long-term degradation such that existing 303(d) impairments  
24 would be made discernibly worse or TMDL actions to reduce loading would be adversely affected.

25 The environmental commitments for construction-related water quality protection would be  
26 specifically designed as a part of the final design, included in construction contracts as a required  
27 element, and would be implemented for Alternative 4 to avoid, prevent, and minimize the potential  
28 discharges of constituents of concern to water bodies and associated adverse water quality effects  
29 and comply with state water quality regulations. Additionally, temporary and permanent changes in  
30 stormwater drainage and runoff would be minimized and avoided through construction of new or  
31 modified drainage facilities, as described in the Chapter 3, *Description of Alternatives*. Alternative 4  
32 would include installation of temporary drainage bypass facilities, long-term cross drainage, and  
33 replacement of existing drainage facilities that would be disrupted due to construction of new  
34 facilities.

35 Construction-related activities under Alternative 4 would be conducted in accordance with the  
36 environmental commitment to develop and implement BMPs for all activities that may result in  
37 discharge of soil, sediment, or other construction-related contaminants to surface water bodies, and  
38 obtain authorization for the construction activities under the State Water Board's NPDES  
39 Stormwater General Permit for Stormwater Discharges Associated with Construction and Land  
40 Disturbance Activities (Order No. 2009-0009-DWQ/NPDES Permit No. CAS000002). The General  
41 Construction NPDES Permit requires the preparation and implementation of SWPPPs, which are the  
42 principal plans within the required PRDs that identify the proposed erosion control and pollution  
43 prevention BMPs that would be used to avoid and minimize construction-related erosion and  
44 contaminant discharges. The development of the SWPPPs, and applicability of other provisions of  
45 this General Construction Permit depends on the "risk" classification for the construction which is

1 determined based on the potential for erosion to occur as well as the susceptibility of the receiving  
2 water to potential adverse effects of construction. While the determination of project risk level, and  
3 planning and development of the SWPPPs and BMPs to be implemented, would be completed as a  
4 part of final design and contracting for the work, the responsibility for compliance with the  
5 provisions of the General Construction Permit necessitates that BMPs are applied to all disturbance  
6 activities. In addition to the BMPs, the SWPPPs would include BMP inspection and monitoring  
7 activities, and identify responsibilities of all parties, contingency measures, agency contacts, and  
8 training requirements and documentation for those personnel responsible for installation,  
9 inspection, maintenance, and repair of BMPs. The General Construction Permit contains NALs and  
10 for pH and turbidity, and specifies storm event water quality monitoring to determine if  
11 construction is resulting in elevated discharges of these constituents, and monitoring for any non-  
12 visible contaminants determined to have been potentially released. If an NAL is determined to have  
13 been exceeded, the General Construction Permit requires the discharger to conduct a construction  
14 site and run-on evaluation to determine whether contaminant sources associated with the site's  
15 construction activity may have caused or contributed to the exceedance and immediately implement  
16 corrective actions if they are needed.

17 The BMPs that are routinely implemented in the construction industry and have proven successful  
18 at reducing adverse water quality effects include, but are not limited to, the following broad  
19 categories of actions (letters refer to categories of specific BMPs identified in Appendix 3B,  
20 *Environmental Commitments*), for which Appendix 3B identifies specific BMPs within these  
21 categories:

- 22 • Waste Management and Spill Prevention and Response (BMP categories A.2 and A.3): Waste  
23 management BMPs are designed to minimize exposure of waste materials at all construction  
24 sites and staging areas such as waste collection and disposal practices, containment and  
25 protection of wastes from wind and rain, and equipment cleaning measures. Spill prevention  
26 and response BMPs involve planning, equipment, and training for personnel for emergency  
27 event response.
- 28 • Erosion and Sedimentation Control (BMP categories A.4 and A.5): Erosion control BMPs are  
29 designed to prevent erosion processes or events including scheduling work to avoid rain events,  
30 stabilizing exposed soils; minimize offsite sediment runoff; remove sediment from onsite runoff  
31 before it leaves the site; and slow runoff rates across construction sites. Identification of  
32 appropriate temporary and long-term seeding, mulching, and other erosion control measures as  
33 necessary. Sedimentation BMPs are designed to minimize offsite sediment runoff once erosion  
34 has occurred involving drainage controls, perimeter controls, detention/sedimentation basins,  
35 or other containment features.
- 36 • Good Housekeeping and Non-Stormwater Discharge Management (BMP category A.6 and A.7):  
37 Good housekeeping BMPs are designed to reduce exposure of construction sites and materials  
38 storage to stormwater runoff including truck tire tracking control facilities; equipment washing;  
39 litter and construction debris; and designated refueling and equipment inspection/maintenance  
40 practices Non-stormwater discharge management BMPs involve runoff measures for  
41 contaminants not directly associated with rain or wind including vehicle washing and street  
42 cleaning operations.
- 43 • Construction Site Dewatering and Pipeline Testing (BMP category A.8).Dewatering BMPs  
44 involve actions to prevent discharge of contaminants present in dewatering of groundwater

1 during construction, discharges of water from testing of pipelines or other facilities, or the  
2 indirect erosion that may be caused by dewatering discharges.

- 3 • BMP Inspection and Monitoring (BMP category A.9): Identification of clear objectives for  
4 evaluating compliance with SWPPP provisions, and specific BMP inspection and monitoring  
5 procedures, environmental awareness training, contractor and agency roles and responsibilities,  
6 reporting procedures, and communication protocols.

7 In addition to the Category “A” BMPs for surface land disturbances identified in the environmental  
8 commitments (Appendix 3B, *Environmental Commitments*), BMPs implemented for Alternative 4  
9 also would include the Category “B” BMPs for tunnel/pipeline construction that involves actions  
10 primarily to avoid and minimize sediment and contaminant discharges associated with RTM  
11 excavation, hauling, and RTM dewatering operations. Additionally, habitat restoration activities  
12 under CM2 and CM4–CM10 would be subject to implementation of the Category “C” BMPs (In-Water  
13 Construction BMPs) and Category “D” BMPs (Tidal and Wetland Restoration) designed to minimize  
14 disturbance and direct discharge of turbidity/suspended solids to the water during in-water  
15 construction activities. Category “E” BMPs identify general permanent post-construction actions that  
16 would be implemented for all terrestrial, in-water, and habitat restoration activities and would  
17 involve planning, design, and development of final site stabilization, revegetation, and drainage  
18 control features.

19 Finally, acquisition of applicable environmental permits may be required for specific conservation  
20 measures, which as described for the No Action Alternative, may include specific WDRs or CWA  
21 Section 401 water quality certifications from the appropriate Regional Water Boards, CDFW  
22 Streambed Alteration Agreements, and USACE CWA Section 404 dredge and fill permits. These other  
23 permit processes may include requirements to implement additional action-specific BMPs that may  
24 reduce potential adverse discharge effects of constituents of concern.

25 The potential construction-related contaminant discharges that could result from projects defined  
26 under Alternative 4 would not be anticipated to result in adverse water quality effects at a  
27 magnitude, frequency, or regional extent that would cause substantial adverse effects to aquatic life.  
28 Relative to Existing Conditions, this assessment indicates the following.

- 29 • Projects would be managed under state water quality regulations and project-defined actions to  
30 avoid and minimize contaminant discharges.
- 31 • Individual projects would generally be dispersed, and involve infrequent and temporary  
32 activities, thus not likely resulting in substantial exceedances of water quality standards or long-  
33 term degradation.
- 34 • Potential construction-related contaminant discharges under the Alternative 4 would not cause  
35 additional exceedance of applicable water quality objectives where such objectives are not  
36 exceeded under Existing Conditions. Long-term water quality degradation is not anticipated,  
37 and hence would not be expected to adversely affect beneficial uses.
- 38 • By the intermittent and temporary frequency of construction-related activities and potential  
39 contaminant discharges, the constituent-specific effects would not be of substantial magnitude  
40 or duration to contribute to long-term bioaccumulation processes, or cause measureable long-  
41 term degradation such that existing 303(d) impairments would be made discernibly worse or  
42 TMDL actions to reduce loading would be adversely affected.

1 Consequently, because the construction-related activities for the conservation measures would be  
2 conducted with implementation of environmental commitments, including but not limited to those  
3 identified in Appendix 3B, with respect to the Existing Conditions and No Action Alternative  
4 conditions, Alternative 4 would not be expected to cause constituent discharges of sufficient  
5 frequency and magnitude to result in a substantial increase of exceedances of water quality  
6 objectives/criteria, or substantially degrade water quality with respect to the constituents of  
7 concern, and thus would not adversely affect any beneficial uses in the Delta.

8 In summary, with implementation of environmental commitments in Appendix 3B, the potential  
9 construction-related water quality effects are considered to be not adverse.

10 **CEQA Conclusion:** Because environmental commitments would be implemented under Alternative 4  
11 for construction-related activities along with agency-issued permits that also contain construction  
12 requirements to protect water quality, the construction-related effects, relative to Existing  
13 Conditions, would not be expected to cause or contribute to substantial alteration of existing  
14 drainage patterns which would result in substantial erosion or siltation on- or off-site, substantial  
15 increased frequency of exceedances of water quality objectives/criteria, or substantially degrade  
16 water quality with respect to the constituents of concern on a long-term average basis, and thus  
17 would not adversely affect any beneficial uses in water bodies upstream of the Delta, within the  
18 Delta, or in the SWP and CVP service area. Moreover, because the construction-related activities  
19 would be temporary and intermittent in nature, the construction would involve negligible  
20 discharges, if any, of bioaccumulative or 303(d) listed constituents to water bodies of the affected  
21 environment. As such, construction activities would not contribute measurably to bioaccumulation  
22 of contaminants in organisms or humans or cause 303(d) impairments to be discernibly worse.  
23 Based on these findings, this impact is determined to be less than significant. No mitigation is  
24 required.

### 25 **Impact WQ-32. Effects on *Microcystis* Bloom Formation Resulting from Facilities Operations** 26 **and Maintenance (CM1).**

#### 27 **Upstream of the Delta**

28 Impacts from *Microcystis* upstream of the Delta have only been documented in lakes such as Clear  
29 Lake, where eutrophic levels of nutrients give cyanobacteria a competitive advantage over other  
30 phytoplankton during the bloom season. Large reservoirs upstream of the Delta are typically  
31 characterized by low nutrient concentrations, where other phytoplankton outcompete  
32 cyanobacteria, including *Microcystis*. In the rivers and streams of the Sacramento River watershed,  
33 watersheds of the eastern tributaries (Cosumnes, Mokelumne, and Calaveras Rivers), and the San  
34 Joaquin River upstream of the Delta, under Existing Conditions and the No Action Alternative, bloom  
35 development is limited by high water velocity and low residence times. These conditions are not  
36 expected to change under the four operational scenarios of Alternative 4. Consequently, any  
37 modified reservoir operations under any of the four operational scenarios of Alternative 4 are not  
38 expected to promote *Microcystis* production upstream of the Delta, relative to Existing Conditions  
39 and the No Action Alternative.

#### 40 **Delta**

41 Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2  
42 and CM4) would affect Delta hydrodynamics. To the extent that restoration actions alter  
43 hydrodynamics within the Delta region, which affects mixing of source waters, these effects are

1 included in this assessment of operations-related changes of water residence times and its effects on  
2 *Microcystis* production (i.e., CM1). Other effects of CM2 through CM21 not attributable to  
3 hydrodynamics are discussed within the impact header for CM2 through CM21.

4 **Table Ms-18-60a** shows modeled long-term average residence times in the six Delta sub-regions  
5 during the *Microcystis* summer and fall bloom periods for Existing Conditions, No Action Alternative,  
6 and operational scenario H3 of Alternative 4. Modeled average residence times for operational  
7 scenarios H1, H2, and H4 of Alternative 4 are not available. However, during the summer and fall  
8 period, the operations and maintenance of operational scenarios H3 and H4 are identical, and  
9 operations and maintenance of operational scenarios H1 and H2 during the summer and fall periods  
10 are identical to those of Alternative 3. Thus, the assessment of effects of water residence times on  
11 *Microcystis* during the summer and fall bloom periods under operational scenarios H1 and H2 of  
12 Alternative 4 are based on the assumption that the changes in modeled residence times that would  
13 occur under these two operational scenarios would be equivalent to those that would occur under  
14 Alternative 3, as shown in Table Ms-18-60a. Likewise, the assessment of effects of water residence  
15 times which would occur under operational scenario H4 assumes that the changes in modeled  
16 residence times that would occur under operational scenario H4 would be equivalent to those that  
17 would occur under operational scenario H3, as shown in Table Ms-18-60a.

18 Under the four operational scenarios of Alternative 4, modeled long-term average residence times in  
19 the six Delta sub-regions during the *Microcystis* bloom season of June through September show  
20 varying levels of change, depending on sub-region and timeframe (Table Ms-18-60a). Although an  
21 increase in residence time throughout the Delta is expected under the No Action Alternative, relative  
22 to Existing Conditions, because of climate change and sea level rise, the change is fairly small in most  
23 areas of the Delta. Thus, the changes in residence times between Alternative 4 and the No Action  
24 Alternative are very similar to the changes in residence times between Alternative 4 and the Existing  
25 Conditions. Below, residence times under Alternative 4 is compared to residence times under the  
26 No Action Alternative to remove the effect of climate change and sea level rise, thereby revealing the  
27 effect due to CM1 (i.e., operations) and the effect of the CM2 and CM4 restoration areas, which were  
28 accounted for in the modeling performed for CM1.

29 For operational scenarios H1 and H2 of Alternative 4 (as shown for Alternative 3 in Table Ms-18-  
30 60a), relative to the No Action Alternative, water residence time is expected to increase 3–10 days in  
31 the North Delta (summer and fall); increase 24 days in the summer and decrease 3 days in the fall in  
32 the Cache Slough sub-region; increase 6 days in the West Delta (both summer and fall); increase 8  
33 days in the summer and decrease 3 days in the fall in the East Delta; increase 4 days in the summer  
34 and decrease 3 days in the fall in the South Delta; and decrease 22 days in the summer and increase  
35 20 days in the fall in the Suisun Marsh sub-region.

36 For operational scenarios H3 and H4 of Alternative 4 (as shown for Alternative 4 in **Table Ms-18-**  
37 **60a**), relative to the No Action Alternative, water residence time is expected to increase 1–7 days in  
38 the North Delta (summer and fall); increase 18 days in the summer and decrease 6 days in the fall in  
39 the Cache Slough sub-region; increase 3–4 days in the West Delta (both summer and fall); increase  
40 8–13 days in the East Delta (summer and fall); increase 6 days in the summer and 32 days in the fall  
41 in the South Delta; and decrease 23 days in the summer and increase 15 days in the fall in the Suisun  
42 Marsh sub-region.

43 The summer and fall period average residence times provide a general direction in which residence  
44 time may change under the four operational scenarios of Alternative 4 compared to the No Action

1 Alternative. The changes in residence time are driven by a number of factors accounted for in the  
2 modeling, including the hydrodynamic effects of restoration actions planned under CM2 and CM4,  
3 diversion of Sacramento River water at the proposed north Delta intake facility, as well as changes  
4 in net Delta outflows. Variability in local residence times is expected within any Delta sub-region  
5 because major portions of the Delta are comprised of complex networks of intertwining channels,  
6 shallow back water areas, and submerged islands. Siting and design of restoration areas has  
7 substantial influence on the magnitude of residence time increases that would occur under  
8 Alternative 4. However, the expected residence time increases that would occur during the summer  
9 bloom period at various Delta locations under the four operational scenarios of Alternative 4,  
10 compared to the No Action Alternative, are in a direction and of magnitude that could lead to an  
11 increase in the frequency, magnitude, and geographic extent of *Microcystis* blooms throughout the  
12 Delta.

13 The relationship between Delta water temperatures, climate change, and changes in water  
14 deliveries from upstream reservoirs are discussed in Appendix 29C. In short, ambient  
15 meteorological conditions are the primary driver of Delta water temperatures, meaning that climate  
16 warming and not water operations will determine future water temperatures in the Delta. Climate  
17 projections for the Central Valley, California discussed in Appendix 5A-D indicate substantial  
18 warming of ambient air temperatures with a median increase in annual temperature of about 1.1°C  
19 (2.0°F) by 2025 and 2.2°C (4.0°F) by 2060. The projected water temperature change ranges from  
20 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  
21 temperatures could lead to earlier attainment of the water temperature threshold of 19°C required  
22 to initiate *Microcystis* bloom formation, and thus earlier occurrences of *Microcystis* blooms in the  
23 Delta, relative to Existing Conditions. Warmer water temperatures could also increase bloom  
24 duration and magnitude, relative to Existing Conditions. Elevated ambient water temperatures in  
25 the Delta, and thus an increase in *Microcystis* bloom duration and magnitude, are expected under  
26 operational scenarios H1–H4 of Alternative 4, relative to Existing Conditions, but these impacts are  
27 due entirely to climate change and not the project alternative. Because climate change is assumed  
28 under the No Action Alternative, potential water temperature-driven increases in *Microcystis*  
29 blooms in the Delta, relative to Existing Conditions, also would occur under the No Action  
30 Alternative. Therefore, no water temperature-driven increases in *Microcystis* blooms would occur in  
31 the Delta under Alternative 4, relative to the No Action Alternative.

### 32 **SWP/CVP Export Service Areas**

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

37 Under operational scenarios H1–H4 of Alternative 4, exports from Banks and Jones pumping plants  
38 will consist of a mixture of Sacramento River water diverted around the Delta, with water quality  
39 characteristic of both upstream Sacramento River water, and Sacramento and San Joaquin River  
40 water that has flowed through various portions of the North, South, and West Delta. Water diverted  
41 from the Sacramento River in the North Delta is expected to be unaffected by *Microcystis* and  
42 microcystins. However, the fraction of water flowing through the Delta that reaches the existing  
43 south Delta intakes is expected to be influenced by an increase in the frequency, magnitude, and  
44 geographic extent of *Microcystis* blooms discussed in the “Delta” section above. Therefore, relative  
45 to Existing Conditions and the No Action Alternative, the addition of Sacramento River water from

1 the North Delta under Alternative 4 serves to dilute *Microcystis* and microcystins in water diverted  
2 from the South Delta with water that is not expected to contain them. Because the degree to which  
3 *Microcystis* blooms, and thus microcystins concentrations, will increase in source water from the  
4 South Delta is unknown, it cannot be determined whether Alternative 4 will result in increased or  
5 decreased levels of microcystins in the mixture of source waters exported from Banks and Jones  
6 pumping plants, relative to Existing Conditions and the No Action Alternative.

7 *Microcystis* blooms have not occurred in the Export Service Areas even though source waters to the  
8 SWP and CVP have been affected. Conditions in the Export Service Areas under the four operational  
9 scenarios of Alternative 4 may become more conducive to *Microcystis* bloom formation, relative to  
10 Existing Conditions, because water temperatures will increase in the Export Service Areas due to the  
11 expected increase in ambient air temperatures resulting from climate change. Residence times in  
12 this area are not expected to substantially change under the four operational scenarios of  
13 Alternative 4, relative to Existing Conditions. Conditions in the Export Service Areas under the four  
14 operational scenarios of Alternative 4 are not expected to become more conducive to *Microcystis*  
15 bloom formation, relative to the No Action Alternative, because neither water residence time nor  
16 water temperatures will increase in the Export Service Areas.

17 **NEPA Effects:** In summary, operations and maintenance under the four operational scenarios of  
18 Alternative 4, relative to the No Action Alternative, would result in long-term increases in hydraulic  
19 residence time of various Delta sub-regions during the summer and fall *Microcystis* bloom period.  
20 During this period, the increased residence time could result in a concurrent increase in the  
21 frequency, magnitude, and geographic extent of *Microcystis* blooms, and thus microcystin levels, in  
22 affected areas of the Delta. As a result, Alternative 4 operation and maintenance activities would  
23 cause further degradation to water quality with respect to *Microcystis* in the Delta. Under the four  
24 operational scenarios of Alternative 4, relative to No Action Alternative, water exported to the  
25 SWP/CVP Export Service Area will be a mixture of *Microcystis*-affected source water from the south  
26 Delta intakes and unaffected source water from the Sacramento River, diverted at the north Delta  
27 intakes. It cannot be determined whether operations and maintenance under Alternative 4 will  
28 result in increased or decreased levels of *Microcystis* and microcystins in the mixture of source  
29 waters exported from Banks and Jones pumping plants. Mitigation Measure WQ-32a and WQ-32b  
30 are available to reduce the effects of degraded water quality in the Delta. Although there is  
31 considerable uncertainty regarding this impact, the effects on *Microcystis* from implementing CM1 is  
32 determined to be adverse.

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

38 Under the various operational scenarios of Alternative 4 additional impacts from *Microcystis* in the  
39 reservoirs and watersheds upstream of the Delta are not expected, relative to Existing Conditions.  
40 Operations and maintenance occurring under any of the operational scenarios of Alternative 4 is not  
41 expected to change nutrient levels in upstream reservoirs or hydrodynamic conditions in upstream  
42 rivers and streams such that conditions would be more conducive to *Microcystis* production.

43 Relative to Existing Conditions, water temperatures and hydraulic residence times in the Delta are  
44 expected to increase under all operational scenarios of Alternative 4, resulting in an increase in the



1 frequency, magnitude and geographic extent of *Microcystis* blooms in the Delta. However, the  
2 degradation of water quality from *Microcystis* blooms due to the expected increases in Delta water  
3 temperatures is driven entirely by climate change, not effects of CM1. Increases in Delta residence  
4 times are expected throughout the Delta during the summer and fall bloom period, due in small part  
5 to climate change and sea level rise, but due more proportionately to CM1 and the hydrodynamic  
6 impacts of restoration included in CM2 and CM4. The precise change in local residence times and  
7 *Microcystis* production expected within any Delta sub-region is unknown because conditions will  
8 vary across the complex networks of intertwining channels, shallow back water areas, and  
9 submerged islands that compose the Delta. Nonetheless, Delta residence times are, in general,  
10 expected to increase during the *Microcystis* bloom period at various Delta locations under all  
11 operational scenarios of Alternative 4. Consequently, it is possible that increases in the frequency,  
12 magnitude, and geographic extent of *Microcystis* blooms in the Delta will occur due to the operations  
13 and maintenance of under the four operational scenarios of Alternative 4 and the hydrodynamic  
14 impacts of restoration (CM2 and CM4).

15 The assessment of effects of *Microcystis* on SWP/CVP Export Service Areas is based on the  
16 assessment of changes in *Microcystis* levels in export source waters, as well as the effects of  
17 temperature and residence time changes within the Export Service Areas on *Microcystis* production.  
18 Under the various operational scenarios of Alternative 4A4, relative to Existing Conditions, the  
19 potential for *Microcystis* to occur in the Export Service Area is expected to increase due to increasing  
20 water temperature, but this impact is driven entirely by climate change and not Alternative 4A4.  
21 Water exported from the Delta to the Export Service Area is expected to be a mixture of *Microcystis*-  
22 affected source water from the south Delta intakes and unaffected source water from the  
23 Sacramento River. Because of this, it cannot be determined whether operations and maintenance  
24 under the four operational scenarios of Alternative 4A4, relative to existing conditions, will result in  
25 increased or decreased levels of *Microcystis* and microcystins in the mixture of source waters  
26 exported from Banks and Jones pumping plants.

27 Based on the above, this alternative would not be expected to cause additional exceedance of  
28 applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that  
29 would cause significant impacts on any beneficial uses of waters in the affected environment.  
30 *Microcystis* and microcystins are not 303(d) listed within the affected environment and thus any  
31 increases that could occur in some areas would not make any existing *Microcystis* impairment  
32 measurably worse because no such impairments currently exist. Because *Microcystis* and  
33 microcystins are not bioaccumulative, increases that could occur in some areas would not  
34 bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health  
35 risks to fish, wildlife, or humans. However, because it is possible that increases in the frequency,  
36 magnitude, and geographic extent of *Microcystis* blooms in the Delta will occur due to the operations  
37 and maintenance of the four operational scenarios of Alternative 4A4 and the hydrodynamic  
38 impacts of restoration (CM2 and CM4), long-term water quality degradation may occur and, thus,  
39 significant impacts on beneficial uses could occur. Although there is considerable uncertainty  
40 regarding this impact, the effects on *Microcystis* from implementing CM1 is determined to be  
41 significant.

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

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

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

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

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

33 Because it is not known where, when, and to what extent *Microcystis* will be more abundant  
34 under CM1 than under Existing Conditions, specific mitigation measures cannot be described.  
35 However, this mitigation measure requires the project proponents to monitor for *Microcystis*  
36 abundance in the Delta and use appropriate statistical methods to determine whether increases  
37 in abundance are significant. This mitigation measure also requires that if *Microcystis*  
38 abundance increases, relative to Existing Conditions, the project proponents will investigate and  
39 evaluate measures that could be taken to reduce residence time in the affected areas of the  
40 Delta. Operational actions could include timing of temporary or operable barrier openings and  
41 closings, reservoir releases, and location of Delta exports (i.e., North Delta vs. South Delta  
42 pumping facilities). Depending on the location and severity of the increases, one or more of  
43 these actions may be feasible for reducing residence times. If so, these actions could mitigate  
44 increases in *Microcystis* under CM1 attributable to the project alternative, relative to Existing  
45 Conditions. However, it is possible that these actions would not be feasible because they would

1 conflict with other project commitments, would cause their own environmental impacts, or  
 2 would not be expected to reduce or mitigate increases in *Microcystis*. In this case, achieving  
 3 *Microcystis* reduction pursuant to this mitigation measure would not be feasible.

4 **Impact WQ-33. Effects on *Microcystis* Bloom Formation Resulting from Other Conservation**  
 5 **Measures (CM2--CM21).**

6 Implementation of CM3 and CM6--CM21 is unlikely to eaffect to *Microcystis* abundance in the rivers  
 7 and reservoirs upstream of the Delta, in the Delta region, or the waters exported to the CVP and SWP  
 8 service areas. Implementation of CM5, Seasonally Inundated Floodplain Restoration, could result in  
 9 increased local water temperatures in areas near restored seasonally inundated floodplains.  
 10 However, floodplain inundation typically occurs during spring and winter months when *Microcystis*  
 11 growth is limited in general by low water temperatures and by insufficient surface water irradiance,  
 12 and water temperatures would not increase sufficiently due to floodplain inundation such that  
 13 effects on *Microcystis* growth would occur. Therefore, implementation of CM5 is unlikely to affect  
 14 *Microcystis* blooms in the project area. Implementation of CM13, Invasive Aquatic Vegetation  
 15 Control, may increase turbidity and flow velocity, particularly in restored aquatic habitats, which  
 16 could discourage *Microcystis* growth in these areas. To the extent that IAV removal would affect  
 17 turbidity and water velocity, it is possible that IAV removal could, to some degree, help offset the  
 18 increase in *Microcystis* production expected under Alternative 4, relative to the No Action  
 19 Alternative.

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

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

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

1 bloom season, it is possible that increases in the frequency, magnitude, and geographic extent of  
 2 *Microcystis* blooms, and thus long-term water quality degradation and significant impacts on  
 3 beneficial uses, could occur. Although there is considerable uncertainty regarding this impact, the  
 4 effects on *Microcystis* from implementing CM2–CM21 are determined to be significant.

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

7 The effects analysis presented in the preceding impacts (Impact WQ-1 through WQ-33) concluded  
 8 that Alternative 4 would have a less than significant impact/no adverse effect on the following  
 9 constituents in the Delta:

- 10 ● Boron
- 11 ● Dissolved Oxygen
- 12 ● Pathogens
- 13 ● Pesticides
- 14 ● Trace Metals
- 15 ● Turbidity and TSS

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

24 The effects of Alternative 4 on bromide, chloride, and DOC, in the Delta were determined to be  
 25 significant/adverse. Increases in bromide, chloride, and DOC concentrations are of concern in  
 26 drinking water supplies; however, as described previously, the San Francisco Bay does not have a  
 27 designated MUN use. Thus, changes in bromide, chloride, and DOC in Delta outflow would not  
 28 adversely effect any beneficial uses of San Francisco Bay.

29 The effects of Alternative 4 on EC in the Delta were determined to be significant/adverse. Elevated  
 30 EC, as assessed for this alternative, is of concern for its effects on the agricultural beneficial use  
 31 (AGR) and fish and wildlife beneficial uses. As discussed above, San Francisco Bay does not have an  
 32 AGR beneficial use designation. However, potential effects on bay salinity are discussed further  
 33 below, with consideration to effects on fish and wildlife beneficial uses.

34 While effects of Alternative 4 on the nutrients ammonia, nitrate, and phosphorus were determined  
 35 to be less than significant/not adverse, these constituents are addressed further below because the  
 36 response of the seaward bays to changed nutrient concentrations/loading may differ from the  
 37 response of the Delta. Because the potential change in *Microcystis* levels were found to be significant  
 38 in the Delta, potential effects on *Microcystis* levels and microcystin concentrations in San Francisco  
 39 Bay are discussed. Selenium and mercury are discussed further, because they are bioaccumulative  
 40 constituents where changes in load due to both changes in Delta concentrations and exports are of  
 41 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 80, 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 80, 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 80, 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 methylmercury loads in Delta exports to San

1 San Francisco Bay due to Alternative 4 are not expected to result in adverse effects to beneficial uses or  
2 substantially degrade the water quality with regard to mercury, or make the existing CWA Section  
3 303(d) impairment measurably worse.

#### 4 **Salinity**

5 Salinity throughout San Francisco Bay is largely a function of the tides, as well as to some extent the  
6 freshwater inflow from upstream. Thus, Delta outflow is the main mechanism by which the  
7 alternative could affect salinity in San Francisco Bay. According to the Delta Atlas (DWR 1995),  
8 average historical tidal flow through the Golden Gate Bridge is 2,300,000 cubic feet per second (cfs)  
9 and average historical tidal flow at Chipps Island is 170,000 cfs. The historical average tidal flows  
10 are two to three orders of magnitude larger than the largest mean monthly change in Delta outflow  
11 due to the No Action Alternative (shown in Appendix 5A, Section C.7). Thus, the changes in Delta  
12 outflow due to Alternative 4 would be minor compared to tidal flows, and thus no substantial  
13 adverse effects on salinity, or fish and wildlife beneficial uses, downstream of the Delta are expected.

#### 14 **Selenium**

15 Changes in source water fraction and net Delta outflow under Alternative 4, relative to Existing  
16 Conditions, are projected to cause the total selenium load to the North Bay to increase by 6–11%,  
17 relative to Existing Conditions, and increase by 2–8%, relative to the No Action Alternative,  
18 depending on operations scenario (Appendix 80, Table O-3). Changes in long-term average selenium  
19 concentrations of the North Bay are assumed to be proportional to changes in North Bay selenium  
20 loads. Under Alternative 4, the long-term average total selenium concentration of the North Bay is  
21 estimated to be 0.013–0.14 µg/L and the dissolved selenium concentration is estimated to be 0.12  
22 µg/L, which would be 0.01 µg/L higher than Existing Conditions and the No Action Alternative  
23 (Appendix 80, Table O-3). The dissolved selenium concentration would be below the target of 0.202  
24 µg/L developed by Presser or Luoma (2013) to coincide with a white sturgeon whole-body fish  
25 tissue selenium concentration not greater than 8 mg/kg in the North Bay. The incremental increase  
26 in dissolved selenium concentrations in the North Bay, relative to Existing Conditions, would be  
27 negligible (0.01 µg/L) under this alternative. Thus, the estimated changes in selenium loads in Delta  
28 exports to San Francisco Bay due to Alternative 4 are not expected to result in adverse effects to  
29 beneficial uses or substantially degrade the water quality with regard to selenium, or make the  
30 existing CWA Section 303(d) impairment measurably worse.

#### 31 **Microcystis**

32 Microcystis has not been detected in embayments of the San Francisco Bay downstream of Suisun  
33 Bay. Low levels of microcystins occur throughout San Francisco Bay, but their concentrations do not  
34 correspond to Microcystis abundance, nor is there evidence that they have been transported  
35 downstream from Microcystis blooms that have occurred in the Delta (Senn and Novick 2013). The  
36 low levels of microcystins present in San Francisco Bay are likely derived from cyanobacteria  
37 besides Microcystis, such as Cyanobium sp. and Synechocystis, which are currently resident in the San  
38 Francisco Bay at levels well below bloom magnitude (Senn and Novick 2013). Elevated microcystin  
39 levels could occur at various locations in the Delta during Microcystis blooms under Alternative 4,  
40 but because of the sufficient dilution available in San Francisco Bay, downstream transport of Delta-  
41 derived microcystins are not expected to result in measurable changes in the microcystin levels of  
42 San Francisco Bay.

1 The absence of *Microcystis* in San Francisco Bay is likely directly related to its intolerance of elevated  
2 salinity, as its growth ceases and breakdown of its cellular tissues starts at salinities of 10–12.6 ppt  
3 (Tonk et al. 2007; Black et al. 2011). San Pablo Bay is the only embayment of San Francisco Bay  
4 downstream of Suisun Bay that would experience salinities of this magnitude for any significant  
5 duration of the year, although these and lower salinities would only occur under conditions of high  
6 Delta outflow. However, high Delta outflows occur during wet years and during the winter and  
7 spring runoff season, under which water temperatures are expected to be low, turbidity high, and  
8 water residence times low, making the environment of San Pablo Bay unsuitable for *Microcystis*  
9 growth. Additionally, these hydrodynamics conditions typically only occur when the potential for  
10 *Microcystis* blooms to occur upstream of, and thus potentially seed *Microcystis* to, San Pablo Bay are  
11 minimal. Alternative 4 is not expected to result in significant modification to net Delta outflows or  
12 the timing of high outflow events related to wet season runoff. Thus, the effects of Alternative 4 on  
13 *Microcystis* levels in San Francisco Bay are expected to be negligible.

14 **NEPA Effects:** Based on the discussion above, Alternative 4, relative to the No Action Alternative,  
15 would not cause further degradation to water quality with respect to boron, bromide, chloride,  
16 dissolved oxygen, DOC, EC, mercury, pathogens, pesticides, selenium, nutrients (ammonia, nitrate,  
17 phosphorus), trace metals, or turbidity and TSS in the San Francisco Bay. Further, changes in these  
18 constituent concentrations in Delta outflow would not be expected to cause changes in Bay  
19 concentrations of frequency, magnitude, and geographic extent that would adversely affect any  
20 beneficial uses. In summary, based on the discussion above, effects on the San Francisco Bay from  
21 implementation of CM1–CM21 are considered to be not adverse.

22 **CEQA Conclusion:** Based on the above, Alternative 4 would not be expected to cause long-term  
23 degradation of water quality in San Francisco Bay resulting in sufficient use of available assimilative  
24 capacity such that occasionally exceeding water quality objectives/criteria would be likely and  
25 would result in substantially increased risk for adverse effects to one or more beneficial uses.  
26 Further, based on the above, this alternative would not be expected to cause additional exceedance  
27 of applicable water quality objectives/criteria in the San Francisco Bay by frequency, magnitude,  
28 and geographic extent that would cause significant impacts on any beneficial uses of waters in the  
29 affected environment. Any changes in boron, bromide, chloride, and DOC in the San Francisco Bay  
30 would not adversely affect beneficial uses, because the uses most affected by changes in these  
31 parameters, MUN and AGR, are not beneficial uses of the Bay. Further, no substantial changes in  
32 dissolved oxygen, pathogens, pesticides, trace metals or turbidity or TSS are anticipated in the Delta,  
33 relative to Existing Conditions, therefore, no substantial changes these constituents levels in the Bay  
34 are anticipated. Changes in Delta salinity would not contribute to measurable changes in Bay  
35 salinity, as the change in Delta outflow would two to three orders of magnitude lower than (and thus  
36 minimal compared to) the Bay's tidal flow. Adverse changes in *Microcystis* levels that could occur in  
37 the Delta would not cause adverse *Microcystis* blooms in the Bay, because *Microcystis* are intolerant  
38 of the Bay's high salinity and, thus not have not been detected downstream of Suisun Bay. The 24–  
39 28% decrease in total nitrogen load and -1–+5% increase in phosphorus load, relative to Existing  
40 Conditions, are expected to have minimal effect on water quality degradation, primary productivity,  
41 or phytoplankton community composition. The estimated increase in mercury load (1–5 kg/yr; <1–  
42 2%) and methylmercury load (0.00–0.13 kg/yr; 0–4%), relative to Existing Conditions, is within the  
43 level of uncertainty in the mass load estimate and not expected to contribute to water quality  
44 degradation, make the CWA section 303(d) mercury impairment measurably worse or cause  
45 mercury/methylmercury to bioaccumulate to greater levels in aquatic organisms that would, in  
46 turn, pose substantial health risks to fish, wildlife, or humans. The estimated increase in selenium

1 load would be 6–11%, but estimated total and dissolved selenium concentrations under this  
2 alternative would be nearly the same as Existing Conditions, and less than the target associated with  
3 white sturgeon whole-body fish tissue levels for the North Bay. Thus, the small increase in selenium  
4 load is not expected to contribute to water quality degradation, or make the CWA section 303(d)  
5 selenium impairment measurably worse or cause selenium to bioaccumulate to greater levels in  
6 aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This  
7 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-

1 term average bromide concentration increases would similarly be greatest at Barker Slough, where  
2 long-term average concentrations are predicted to increase by 27% (83% for the modeled drought  
3 period) relative to the No Action Alternative. However, unlike the Existing Conditions comparison,  
4 long-term average bromide concentrations at Buckley Cove, Rock Slough, and Contra Costa PP No. 1  
5 would increase relative to No Action Alternative, although the increases would be relatively small  
6 ( $\leq 4\%$ ). Unlike the comparison to Existing Conditions, this comparison to the No Action Alternative  
7 reflects changes in bromide due only to Alternative 5 operations.

8 At Barker Slough, modeled long-term average bromide concentrations for the two baseline  
9 conditions are very similar (Appendix 8E, *Bromide*, Table 12). Such similarity demonstrates that the  
10 modeled Alternative 5 change in bromide is almost entirely due to Alternative 5 operations, and not  
11 climate change/sea level rise. Therefore, operations are the primary driver of effects on bromide at  
12 Barker Slough, regardless whether Alternative 5 is compared to Existing Conditions, or compared to  
13 the No Action Alternative.

14 Results of the modeling approach which used relationships between EC and chloride and between  
15 chloride and bromide (see Section 8.3.1.3) differed somewhat from what is presented above for the  
16 mass-balance approach (see Appendix 8E, *Bromide*, Table 13). For most locations, the frequency of  
17 exceedance of the 50  $\mu\text{g/L}$  and 100  $\mu\text{g/L}$  were similar. The greatest difference between the methods  
18 was predicted for Barker Slough. The increases in frequency of exceedance of the 100  $\mu\text{g/L}$   
19 threshold, relative to Existing Conditions and the No Action Alternative, were not as great using this  
20 alternative EC to chloride and chloride to bromide relationship modeling approach as compared to  
21 that presented above from the mass-balance modeling approach. However, there were still  
22 substantial increases, resulting in 9% exceedance over the modeled period under Alternative 5, as  
23 compared to 1% under Existing Conditions and 2% under the No Action Alternative. For the drought  
24 period, exceedance frequency increased from 0% under Existing Conditions and the No Action  
25 Alternative, to 20% under Alternative 5. Because the mass-balance approach predicts a greater level  
26 of impact at Barker Slough, determination of impacts was based on the mass-balance results.

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

42 The seasonal intakes at Mallard Slough and City of Antioch are infrequently used due to water  
43 quality constraints related to sea water intrusion. On a long-term average basis, bromide at these  
44 locations is in excess of 3,000  $\mu\text{g/L}$ , but during seasonal periods of high Delta outflow can be  $< 300$   
45  $\mu\text{g/L}$ . Based on modeling using the mass-balance approach, use of the seasonal intakes at Mallard

1 Slough and City of Antioch under Alternative 5 would experience a period average increase in  
 2 bromide during the months when these intakes would most likely be utilized. For those wet and  
 3 above normal water year types where mass balance modeling would predict water quality typically  
 4 suitable for diversion, predicted long-term average bromide would increase from 103 µg/L to 128  
 5 µg/L (25% increase) at City of Antioch and would increase from 150 µg/L to 194 µg/L (30%  
 6 increase) at Mallard Slough relative to Existing Conditions (Appendix 8E, *Bromide*, Table 23).  
 7 Increases would be similar for the No Action Alternative comparison. Modeling results using the EC  
 8 to chloride and chloride to bromide relationships show increases during these months, but the  
 9 relative magnitude of the increases is much lower (Appendix 8E, *Bromide*, Table 24). Regardless of  
 10 the differences in the data between the two modeling approaches, the decisions surrounding the use  
 11 of these seasonal intakes is largely driven by acceptable water quality, and thus have historically  
 12 been opportunistic. Opportunity to use these intakes would remain, and the predicted increases in  
 13 bromide concentrations at the City of Antioch and Mallard Slough intake would not be expected to  
 14 adversely affect MUN beneficial uses, or any other beneficial use, at these locations.

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

## 27 **Impact WQ-7: Effects on Chloride Concentrations Resulting from Facilities Operations and** 28 **Maintenance (CM1)**

### 29 ***Delta***

30 Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2  
 31 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter  
 32 hydrodynamics within the Delta region, which affects mixing of source waters, these effects are  
 33 included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of  
 34 ~~CM2-22~~CM2-CM21 not attributable to hydrodynamics, for example, additional loading of a  
 35 constituent to the Delta, are discussed within the impact header for ~~CM2-22~~CM2-CM21. See section  
 36 8.3.1.3 for more information.

37 Relative to Existing Conditions, modeling predicts that Alternative 5 would result in similar or  
 38 reduced long-term average chloride concentrations for the 16-year period modeled at most of the  
 39 assessment locations, and, depending on modeling approach (see Section 8.3.1.3), would result in  
 40 increased concentrations at the North Bay Aqueduct at Barker Slough (i.e., ≤18%), Sacramento River  
 41 at Emmaton (i.e., ≤3%), and ~~San Joaquin River at Staten Island~~SF Mokelumne at Staten Island (i.e.,  
 42 ≤16%) (Appendix 8G, *Chloride*, Table Cl-31 and Table Cl-32). Additionally, implementation of tidal  
 43 habitat restoration under CM4 would increase the tidal exchange volume in the Delta, and thus may  
 44 contribute to increased chloride concentrations in the Bay source water as a result of increased

1 salinity intrusion. More discussion of this phenomenon is included in Section 8.3.1.3. Consequently,  
 2 while uncertain, the magnitude of chloride increases may be greater than indicated herein and  
 3 would affect the western Delta assessment locations the most which are influenced to the greatest  
 4 extent by the Bay source water. This comparison to Existing Conditions reflects changes in chloride  
 5 due to both Alternative 5 operations (including north Delta intake capacity of 3,000 cfs and  
 6 numerous other operational components of Scenario C) and climate change/sea level rise.

7 Relative to the No Action Alternative conditions, the mass balance analysis of modeling results  
 8 indicated that Alternative 5 would result in similar or reduced long-term average chloride  
 9 concentrations for the 16-year period modeled at four of the assessment locations. Chloride  
 10 concentrations would increase at the SF Mokelumne River at Staten Island (up to 19%) and the  
 11 North Bay Aqueduct at Barker Slough (up to 23%) compared to the No Action Alternative conditions  
 12 and increase only incrementally (3% or less) at five other stations (Appendix 8G, *Chloride*, Table CI-  
 13 31). The comparison to the No Action Alternative reflects changes in chloride due only to operations.

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

#### 16 *Municipal Beneficial Uses—Relative to Existing Conditions*

17 Estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output  
 18 (see Section 8.3.1.3) were used to evaluate the 150 mg/L Bay-Delta WQCP objective for municipal  
 19 and industrial beneficial uses on a basis of the percent of years the chloride objective is exceeded for  
 20 the modeled 16-year period. The objective is exceeded if chloride concentrations exceed 150 mg/L  
 21 for a specified number of days in a given water year at both the Antioch and Contra Costa Pumping  
 22 Plant #1 locations. For Alternative 5, the modeled frequency of objective exceedance would  
 23 ~~approximately double from 6%~~ remain unchanged at 7% of years under Existing Conditions; ~~to 13% of~~  
 24 ~~years under~~ and Alternative 5 (Appendix 8G, *Chloride*, Table CI-64).

25 Similarly, estimates of chloride concentrations generated using EC-chloride relationships and DSM2  
 26 EC output (see Section 8.3.1.3) were also used to evaluate the 250 mg/L Bay-Delta WQCP objective  
 27 for chloride at Contra Costa Pumping Plant #1 where daily average objectives apply. The basis for  
 28 the evaluation was the predicted number of days the objective was exceeded for the modeled 16-  
 29 year period. For Alternative 5, the modeled frequency of objective exceedance would decrease by  
 30 approximately one half, from 6% of modeled days under Existing Conditions, to 3% of modeled days  
 31 under Alternative 5 (Appendix 8G, *Chloride*, Table CI-63).

32 Given the limitations inherent to estimating future chloride concentrations (see Section 8.3.1.3),  
 33 estimation of chloride concentrations through both a mass balance approach and an EC-chloride  
 34 relationship approach was used to evaluate the 250 mg/L Bay-Delta WQCP objectives in terms of  
 35 both frequency of exceedance and use of assimilative capacity. When utilizing the mass balance  
 36 approach to model monthly average chloride concentrations for the 16-year period, the predicted  
 37 frequency of exceeding the 250 mg/L objective would decrease at the Contra Costa Canal at  
 38 Pumping Plant #1 (Appendix 8G, *Chloride*, Table CI-33 and Figure CI-9). The frequency of  
 39 exceedances would increase for the 16-year period modeled at the San Joaquin River at Antioch (i.e.,  
 40 from 66% under Existing Conditions to 72%) and Sacramento River at Mallard Island (i.e., from 85%  
 41 under Existing Conditions to 87%) (Appendix 8G, Table CI-33), and would cause further degradation  
 42 at Antioch in March and April (i.e., maximum reduction of 45% of assimilative capacity for the 16-  
 43 year period modeled, and 100% reduction, or elimination of assimilative capacity, during the  
 44 drought period modeled) (Appendix 8G, Table CI-35 and Figure CI-9).

1 In comparison, when utilizing the chloride-EC relationship to model monthly average chloride  
 2 concentrations for the 16-year period, trends in frequency of exceedance and use of assimilative  
 3 capacity would be similar to that discussed when utilizing the mass balance modeling approach  
 4 (Appendix 8G, *Chloride*, Table Cl-34 and Table Cl-36). However, as with Alternative 1A the modeling  
 5 approach utilizing the chloride-EC relationships predicted changes of lesser magnitude, where  
 6 predictions of change utilizing the mass balance approach were generally of greater magnitude, and  
 7 thus more conservative. As discussed in Section 8.3.1.3, in cases of such disagreement, the approach  
 8 that yielded the more conservative predictions was used as the basis for determining adverse  
 9 impacts.

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

### 15 *303(d) Listed Water Bodies—Relative to Existing Conditions*

16 With respect to the 303(d) listing for chloride in Tom Paine Slough, the monthly average chloride  
 17 concentrations for the 16-year period modeled at Old River at Tracy Road would generally be  
 18 similar compared to Existing Conditions, and thus, would not be further degraded on a long-term  
 19 basis (Appendix 8G, Figure Cl-10). With respect to Suisun Marsh, the monthly average chloride  
 20 concentrations for the 16-year period modeled would generally increase compared to Existing  
 21 Conditions in some months during October through May at the Sacramento River at Collinsville  
 22 (Appendix 8G, Figure Cl-11), Mallard Island (Appendix 8G, Figure Cl-9), and increase substantially at  
 23 the Montezuma Slough at Beldon's Landing (i.e., over a doubling of concentration in December  
 24 through February) (Appendix 8G, Figure Cl-12). However, modeling of Alternative 5 assumed no  
 25 operation of the Montezuma Slough Salinity Control Gates, but the project description assumes  
 26 continued operation of the Salinity Control Gates, consistent with assumptions included in the No  
 27 Action Alternative. A sensitivity analysis modeling run conducted for Alternative 4 with the gates  
 28 operational consistent with the No Action Alternative resulted in substantially lower EC levels than  
 29 indicated in the original Alternative 4 modeling results for Suisun Marsh, but EC levels were still  
 30 somewhat higher than EC levels under Existing Conditions for several locations and months.  
 31 Although chloride was not specifically modeled in these sensitivity analyses, it is expected that  
 32 chloride concentrations would be nearly proportional to EC levels in Suisun Marsh. Another  
 33 modeling run with the gates operational and restoration areas removed resulted in EC levels nearly  
 34 equivalent to Existing Conditions, indicating that design and siting of restoration areas has notable  
 35 bearing on EC levels at different locations within Suisun Marsh (see Appendix 8H Attachment 1 for  
 36 more information on these sensitivity analyses). These analyses also indicate that increases in  
 37 salinity are related primarily to the hydrodynamic effects of CM4, not operational components of  
 38 CM1. Based on the sensitivity analyses, optimizing the design and siting of restoration areas may  
 39 limit the magnitude of long-term chloride increases in the Marsh. However, the chloride  
 40 concentration increases at certain locations could be substantial, depending on siting and design of  
 41 restoration areas. Thus, these increased chloride levels in Suisun Marsh are considered to  
 42 contribute to additional, measureable long-term degradation that potentially would adversely affect  
 43 the necessary actions to reduce chloride loading for any TMDL that is developed, thereby  
 44 contributing to additional, measureable long-term degradation that potentially would adversely  
 45 affect the necessary actions to reduce chloride loading for any TMDL that is developed.

1 *Municipal Beneficial Uses—Relative to No Action Alternative*

2 Similar to the assessment conducted for Existing Conditions, estimates of chloride concentrations  
 3 generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3) were used to  
 4 evaluate the 150 mg/L Bay-Delta WQCP objective for municipal and industrial beneficial uses. For  
 5 Alternative 5, the modeled frequency of objective exceedance would increase from ~~6.0%~~ under the  
 6 No Action Alternative to ~~13.7%~~ of years under Alternative 5 (Appendix 8G, *Chloride*, Table Cl-64).  
 7 The increase was due to a single year, 1977, which fell just short of the required number of days (i.e.,  
 8 was within 6 days minimum number of required days < 150 mg/L). Given the uncertainty in the  
 9 chloride modeling approach, it is likely that real time operations of the SWP and CVP could achieve  
 10 compliance with this objective (see Section 8.3.1.1 for a discussion of chloride compliance modeling  
 11 uncertainties and a description of real time operations of the SWP and CVP).

12 Similarly, estimates of chloride concentrations generated using EC-chloride relationships and DSM2  
 13 EC output (see Section 8.3.1.3) were also used to evaluate the 250 mg/L Bay-Delta WQCP objective  
 14 for chloride at Contra Costa Pumping Plant #1 where daily average objectives apply. For Alternative  
 15 5, the modeled frequency of objective exceedance would decrease slightly from 5% of modeled days  
 16 under the No Action Alternative to 3% of modeled days under Alternative 5 (Appendix 8G, *Chloride*,  
 17 Table Cl-63).

18 Similar to Existing Conditions, a comparative assessment of modeling approaches was utilized to  
 19 evaluate the 250 mg/L Bay-Delta WQCP objectives in terms of both frequency of exceedance and use  
 20 of assimilative capacity on a monthly average basis. When utilizing the mass balance approach to  
 21 model monthly average chloride concentrations for the 16-year period, a small decrease in  
 22 exceedance frequency would be predicted at the San Joaquin River at Antioch (i.e., from 73% for the  
 23 No Action Alternative to 72%), however, available assimilative capacity would be reduced in April  
 24 (i.e., up to 10% for the 16 year period modeled, and 100% [i.e., eliminated] for the drought period  
 25 modeled) (Appendix 8G, *Chloride*, Table Cl-35). The exceedance frequency would increase slightly at  
 26 the Sacramento River at Mallard Island (i.e., from 86% to 87%) and at the Contra Costa Canal at  
 27 Pumping Plant #1 (i.e., from 14% to 18%) (Appendix 8G, Table Cl-33), along with reduced  
 28 assimilative capacity at the Contra Costa Canal at Pumping Plant #1 in September (i.e., up to 56%),  
 29 reflecting substantial degradation during when average concentrations would be near, or exceed,  
 30 the objective (Appendix 8G, Table Cl-35).

31 In comparison, when utilizing the chloride-EC relationship to model monthly average chloride  
 32 concentrations for the 16-year period, trends in frequency of exceedance and use of assimilative  
 33 capacity would be similar to that discussed when utilizing the mass balance modeling approach  
 34 (Appendix 8G, *Chloride*, Table Cl-34 and Table Cl-36). However, as with Alternative 1A, the modeling  
 35 approach utilizing the chloride-EC relationships predicted changes of lesser magnitude, where  
 36 predictions of change utilizing the mass balance approach were generally of greater magnitude, and  
 37 thus more conservative. As discussed in Section 8.3.1.3, in cases of such disagreement, the approach  
 38 that yielded the more conservative predictions was used as the basis for determining adverse  
 39 impacts.

40 Based on the additional predicted annual and seasonal exceedances of ~~one or both~~ the 250 mg/L Bay  
 41 Delta WQCP objectives for chloride, and the associated long-term average water quality degradation  
 42 at interior and western Delta locations, the potential exists for substantial adverse effects on the  
 43 municipal and industrial beneficial uses through reduced opportunity for diversion of water with  
 44 acceptable chloride levels.

1 *303(d) Listed Water Bodies—Relative to No Action Alternative*

2 With respect to the 303(d) listing for chloride, Alternative 5 would generally result in similar  
 3 changes to those discussed for the comparison to Existing Conditions. Monthly average chloride  
 4 concentrations at Tom Paine Slough would not be further degraded on a long-term basis (Appendix  
 5 8G, Figure Cl-10). Monthly average chloride concentrations at source water channel locations for the  
 6 Suisun Marsh (Appendix 8G, *Chloride*, Figures Cl-5, Cl-7, and Cl-8) would increase substantially in  
 7 some months during October through May compared to the No Action Alternative conditions, but  
 8 sensitivity analyses suggest that operation of the Salinity Control Gates and restoration area siting  
 9 and design considerations could reduce these increases. However, the chloride concentration  
 10 increases at certain locations could be substantial, depending on siting and design of restoration  
 11 areas. Thus, these increased chloride levels in Suisun Marsh are considered to contribute to:  
 12 Therefore, additional, measureable long-term degradation would occur in Suisun Marsh that  
 13 potentially would adversely affect the necessary actions to reduce chloride loading for any TMDL  
 14 that is developed.

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

17 *NEPA Effects:* Effects of CM1 on DO under Alternative 5 are the same as those discussed for  
 18 Alternative 1A and are considered to not be adverse.

19 *CEQA Conclusion:* Effects of CM1 on DO under Alternative 5 would be similar to those discussed for  
 20 Alternative 1A, and are summarized here, then compared to the CEQA thresholds of significance  
 21 (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this  
 22 constituent. For additional details on the effects assessment findings that support this CEQA impact  
 23 determination, see the effects assessment discussion under the Alternative 1A.

24 River flow rate and reservoir storage reductions that would occur under Alternative 5, relative to  
 25 Existing Conditions, would not be expected to result in a substantial adverse change in DO levels in  
 26 the reservoirs, because oxygen sources (surface water aeration, aerated inflows, vertical mixing)  
 27 would remain. Similarly, river flow rate reductions that would occur would not be expected to  
 28 result in a substantial adverse change in DO levels in the and rivers upstream of the Delta, given that  
 29 mean monthly flows would remain within the ranges historically seen under Existing Conditions  
 30 and the affected river are large and turbulent. Any reduced DO saturation level that may be caused  
 31 by increased water temperature would not be expected to cause DO levels to be outside of the range  
 32 seen historically. Finally, amounts of oxygen demanding substances and salinity would not be  
 33 expected to change sufficiently to affect DO levels.

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

41 There is not expected to be substantial, if even measurable, changes in DO levels in the SWP/CVP  
 42 Export Service Areas waters under Alternative 5, relative to Existing Conditions, because the  
 43 biochemical oxygen demand of the exported water would not be expected to substantially differ

1 from that under Existing Conditions (due to ever increasing water quality regulations), canal  
 2 turbulence and exposure of the water to the atmosphere and the algal communities that exist within  
 3 the canals would establish an equilibrium for DO levels within the canals. The same would occur in  
 4 downstream reservoirs.

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

### 13 **Impact WQ-11: Effects on Electrical Conductivity Concentrations Resulting from Facilities** 14 **Operations and Maintenance (CM1)**

#### 15 *Delta*

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

23 Relative to Existing Conditions, Alternative 5 would result in an increase in the number of days the  
 24 Bay-Delta WQCP EC objectives would be exceeded in the Sacramento River at Emmaton, San Joaquin  
 25 River at San Andreas Landing, Jersey Point and Prisoners Point, and Old River at Tracy Bridge  
 26 (Appendix 8H, Electrical Conductivity, Table EC-5).

27 The percent of days the Emmaton EC objective would be exceeded for the entire period modeled  
 28 (1976–1991) would increase from 6% under Existing Conditions to 235% under Alternative 5, and  
 29 the percent of days out of compliance would increase from 11% under Existing Conditions to 358%  
 30 under Alternative 5.

31 The percent of days the San Andreas Landing EC objective would be exceeded would increase from  
 32 1% under Existing Conditions to 45% under Alternative 5, and the percent of days out of compliance  
 33 with the EC objective would increase from 1% under Existing Conditions to 79% under Alternative  
 34 5. Sensitivity analyses were performed for Alternative 4 scenario H3, and indicated that many  
 35 similar exceedances were modeling artifacts, and the small number of remaining exceedances were  
 36 small in magnitude, lasted only a few days, and could be addressed with real time operations of the  
 37 SWP and CVP (see Section 8.3.1.1 for a description of real time operations of the SWP and CVP). Due  
 38 to similarities in the nature of the exceedances between alternatives, the findings from these  
 39 analyses can be extended to this alternative as well.

40 The percent of days the Jersey Point fish and wildlife EC objective would be exceeded and the  
 41 percent of days out of compliance for the entire period modeled would increase from 0% under  
 42 Existing Conditions to 3% under Alternative 5. The percent of days the Prisoners Point EC objective



1 would be exceeded for the entire period modeled would increase from 6% under Existing  
 2 Conditions to 98% under Alternative 5, and the percent of days out of compliance with the EC  
 3 objective would increase from 10% under Existing Conditions to 132% under Alternative 5. These  
 4 changes are very small, and are likely within the uncertainty of the modeling approach.  
 5 Nevertheless, further discussion of EC increases relative to this objective can be found in Appendix  
 6 8H Attachment 2.

7 In Old River at Tracy Bridge, the percent of days exceeding the EC objective would increase from 4%  
 8 under Existing Conditions to 5% under Alternative 5; the percent of days out of compliance would  
 9 increase by <1% and would be 10% under both Existing Conditions and Alternative 5. These  
 10 changes are minimal, but regardless, as noted in Section 8.1.3.7, SWP and CVP operations have  
 11 relatively little influence on salinity levels at this location, and the elevated salinity in south Delta  
 12 channels is affected substantially by local salt contributions discharged into the San Joaquin River  
 13 downstream of Vernalis. Thus, the modeling has limited ability to estimate salinity accurately in this  
 14 region.

15 Average EC levels at the western and southern Delta compliance locations, except at Emmaton in the  
 16 western Delta, would decrease from 2–35% for the entire period modeled and 3–32% during the  
 17 drought period modeled (1987–1991) (Appendix 8H, *Electrical Conductivity*, Table EC-16). At  
 18 Emmaton, average EC would increase by 3% for the entire period modeled and 10% for the drought  
 19 period modeled. At the two interior Delta locations, there would be increases in average EC: the S.  
 20 Fork Mokelumne River at Terminous average EC would increase 3% for the entire and drought  
 21 periods modeled; and San Joaquin River at San Andreas Landing average EC would increase 5% for  
 22 the entire period modeled and 10% during the drought period modeled. On average, EC would  
 23 increase at Emmaton during February through August. Average EC would increase at San Andreas  
 24 Landing from January through September. Average EC in the S. Fork Mokelumne River at Terminous  
 25 would increase from March through December (Appendix 8H, Table EC-16). The comparison to  
 26 Existing Conditions reflects changes in EC due to both Alternative 5 operations (including north  
 27 Delta intake capacity of 3,000 cfs and numerous other operational components of Scenario C) and  
 28 climate change/sea level rise.

29 Relative to the No Action Alternative, the percent of days exceeding EC objectives and percent of  
 30 days out of compliance would increase at: Sacramento River at Emmaton, San Joaquin River at  
 31 Jersey Point, San Andreas Landing, and Prisoners Point; and Old River near Middle River and at  
 32 Tracy Bridge (Appendix 8H, *Electrical Conductivity*, Table EC-5). The increase in percent of days  
 33 exceeding the EC objective would be 11% at Emmaton and 87% or less at the remaining locations.  
 34 The increase in percent of days out of compliance would be 13% at Emmaton and 121% or less at  
 35 the remaining locations. For the entire period modeled, average EC levels would increase at:  
 36 Sacramento River at Emmaton (2%), S. Fork Mokelumne River (4%), San Joaquin River at San  
 37 Andreas Landing (10%), and San Joaquin River at Prisoners Point (4%) (Appendix 8H, Table EC-16).  
 38 During the drought period modeled, average EC would increase at these same locations, except at  
 39 Emmaton, by a similar percentage as well as the San Joaquin River at Brandt Bridge (1%). The  
 40 comparison to the No Action Alternative reflects changes in EC due only to Alternative 5 operations  
 41 (including north Delta intake capacity of 3,000 cfs and numerous other operational components of  
 42 Scenario C).

43 For Suisun Marsh, October–May is the period when Bay-Delta WQCP EC objectives for protection of  
 44 fish and wildlife apply. Long-term average EC would increase under Alternative 5, relative to  
 45 Existing Conditions, during the months of March through May by 0.4–0.6 mS/cm in the Sacramento

1 River at Collinsville (Appendix 8H, *Electrical Conductivity*, Table EC-21). Long-term average EC  
 2 would decrease relative to Existing Conditions in Montezuma Slough at National Steel during  
 3 October–May (Appendix 8H, Table EC-22). The most substantial increase would occur near Beldon  
 4 Landing, with long-term average EC levels increasing by 1.6–5.0 mS/cm, depending on the month, at  
 5 least doubling during some months the long-term average EC relative to Existing Conditions  
 6 (Appendix 8H, Table EC-23). Sunrise Duck Club and Volanti Slough also would have long-term  
 7 average EC increases during all months of 0.9–2.8 mS/cm (Appendix 8H, Tables EC-24 and EC-25).  
 8 Modeling of this alternative assumed no operation of the Montezuma Slough Salinity Control Gates,  
 9 but the project description assumes continued operation of the Salinity Control Gates, consistent  
 10 with assumptions included in the No Action Alternative. A sensitivity analysis modeling run  
 11 conducted for Alternative 4 scenario H3 with the gates operational consistent with the No Action  
 12 Alternative resulted in substantially lower EC levels than indicated in the original Alternative 4  
 13 modeling results, but EC levels were still somewhat higher than EC levels under Existing Conditions  
 14 and the No Action Alternative for several locations and months. Another modeling run with the  
 15 gates operational and restoration areas removed resulted in EC levels nearly equivalent to Existing  
 16 Conditions and the No Action Alternative, indicating that design and siting of restoration areas has  
 17 notable bearing on EC levels at different locations within Suisun Marsh (see Appendix 8H  
 18 Attachment 1 for more information on these sensitivity analyses). These analyses also indicate that  
 19 increases are related primarily to the hydrodynamic effects of CM4, not operational components of  
 20 CM1. Based on the sensitivity analyses, optimizing the design and siting of restoration areas may  
 21 limit the magnitude of long-term EC increases to be on the order of 1 mS/cm or less. Due to  
 22 similarities in the nature of the EC increases between alternatives, the findings from these analyses  
 23 can be extended to this alternative as well.

24 The degree to which the long-term average EC increases in Suisun Marsh would cause exceedance of  
 25 Bay-Delta WQCP objectives is unknown, because these objectives are expressed as a monthly  
 26 average of daily high tide EC, which does not have to be met if it can be demonstrated “equivalent or  
 27 better protection will be provided at the location” (State Water Resources Control Board 2006:14).  
 28 The ~~described~~ long-term average EC increase may, or may not, contribute to adverse effects on  
 29 beneficial uses, depending on how and when wetlands are flooded, soil leaching cycles, and how  
 30 agricultural use of water is managed, and future actions taken with respect to the marsh. However,  
 31 the EC increases at certain locations ~~would~~ could be substantial, depending on siting and design of  
 32 restoration areas, and it is uncertain the degree to which current management plans for the Suisun  
 33 Marsh would be able to address these substantially higher EC levels and protect beneficial uses.  
 34 Thus, these increased EC levels in Suisun Marsh are considered to have a potentially adverse effect  
 35 on marsh beneficial uses. Long-term average EC increases in Suisun Marsh under Alternative 5  
 36 relative to the No Action Alternative would be similar to the increases relative to Existing  
 37 Conditions.

38 The western and southern Delta are CWA section 303(d) listed for elevated EC and the increased EC  
 39 that could occur in the western Delta, relative to Existing Conditions and the No Action Alternative  
 40 could lead to water quality degradation that would make beneficial use impairment measurably  
 41 worse. Since there would be very little change in EC levels in the southern Delta and there is not  
 42 expected to be an increase in frequency of exceedances of objectives, this alternative is not expected  
 43 to make beneficial use impairment measurably worse in the southern Delta. Given that the southern  
 44 Delta is Clean Water Act section 303(d) listed as impaired due to elevated EC, the increase in the  
 45 incidence of exceedance of EC objectives under Alternative 5, relative to Existing Conditions and the  
 46 No Action Alternative, has the potential to contribute to additional impairment and potentially

1 ~~adversely affect beneficial uses.~~ Suisun Marsh also is section 303(d) listed as impaired due to  
 2 elevated EC, and the potential increases in long-term average EC concentrations could contribute to  
 3 additional impairment, ~~because the increases would be double that relative to Existing Conditions~~  
 4 ~~and the No Action Alternative.~~

#### 5 **SWP/CVP Export Service Area**

6 **NEPA Effects:** In summary, the increased frequency of exceedance of EC objectives and increased  
 7 long-term and drought period average EC levels that would occur at western, ~~interior, and southern~~  
 8 Delta compliance locations under Alternative 5, relative to the No Action Alternative, would  
 9 contribute to adverse effects on the agricultural beneficial uses. In addition, the increased frequency  
 10 of exceedance of the San Joaquin River at Prisoners Point EC objective and long-term and drought  
 11 period average EC could contribute to adverse effects on fish and wildlife beneficial uses  
 12 ~~(specifically, indirect adverse effects on striped bass spawning), though there is a high degree of~~  
 13 ~~uncertainty associated with this impact.~~ Given that the western ~~and southern Delta are~~ Clean  
 14 Water Act section 303(d) listed as impaired due to elevated EC, the increase in the incidence of  
 15 exceedance of EC objectives and long-term average and drought period average EC in these portions  
 16 of the Delta has the potential to contribute to additional beneficial use impairment. The increases in  
 17 long-term average EC levels that ~~would~~ could occur in Suisun Marsh ~~would~~ could further degrade  
 18 existing EC levels and could contribute additional to adverse effects on the fish and wildlife  
 19 beneficial uses. Suisun Marsh is section 303(d) listed as impaired due to elevated EC, and the  
 20 potential increases in long-term average EC levels could contribute to additional beneficial use  
 21 impairment. These increases in EC constitute an adverse effect on water quality. Mitigation Measure  
 22 WQ-11 would be available to reduce these effects (implementation of this measure along with a  
 23 separate, non-environmental commitment as set forth in EIR/EIS Appendix 3B, *Environmental*  
 24 *Commitments*, relating to the potential EC-related changes would reduce these effects).

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

30 River flow rate and reservoir storage reductions that would occur under Alternative 5, relative to  
 31 Existing Conditions, would not be expected to result in a substantial adverse change in EC levels in  
 32 the reservoirs and rivers upstream of the Delta, given that: changes in the quality of watershed  
 33 runoff and reservoir inflows would not be expected to occur in the future; the state's aggressive  
 34 regulation of point-source discharge effects on Delta salinity-elevating parameters and the expected  
 35 further regulation as salt management plans are developed; the salt-related TMDLs adopted and  
 36 being developed for the San Joaquin River; and the expected improvement in lower San Joaquin  
 37 River average EC levels commensurate with the lower EC of the irrigation water deliveries from the  
 38 Delta.

39 Relative to Existing Conditions, Alternative 5 would not result in any substantial increases in long-  
 40 term average EC levels in the SWP/CVP Export Service Areas. There would be no exceedance of the  
 41 EC objective at the Jones and Banks pumping plants. Average EC levels for the entire period modeled  
 42 would decrease at both plants and, thus, this alternative would not contribute to additional  
 43 beneficial use impairment related to elevated EC in the SWP/CVP Export Service Areas waters.

1 Rather, this alternative would improve long-term EC levels in the SWP/CVP Export Service Areas,  
2 relative to Existing Conditions.

3 In the Plan Area, Alternative 5 would result in an increase in the frequency with which Bay-Delta  
4 WQCP EC objectives are exceeded for the entire period modeled (1976–1991): in the Sacramento  
5 River at Emmaton (agricultural objective; ~~1.79%~~; increase) ~~in the western Delta, in the San Joaquin~~  
6 ~~River at San Andreas Landing (agricultural objective; 34% increase), and at Jersey Point (fish and~~  
7 ~~wildlife objective, 3%), and the San Joaquin River at Prisoners Point (fish and wildlife objective; 32%~~  
8 ~~increase), both in the interior Delta, and in Old River at Tracy Bridge (agricultural objective; 1%~~  
9 ~~increase) in the southern Delta. Further, long-term average EC levels would increase in the~~  
10 Sacramento River at Emmaton by 3% for the entire period modeled and 10% during the drought  
11 period modeled, and in the San Joaquin River at San Andreas Landing by 5% during for the entire  
12 period modeled and 10% during the drought period modeled. The increases in long-term and  
13 drought period average EC levels and increased frequency of exceedance of EC objectives that would  
14 occur in the Sacramento River at Emmaton, ~~and the increased long-term and drought period average~~  
15 ~~EC levels and in the~~ San Joaquin River at San Andreas Landing would potentially contribute to  
16 adverse effects on the agricultural beneficial uses in the western and interior Delta. Further, the  
17 increased frequency of exceedance of the fish and wildlife objective at ~~Jersey Point and~~ Prisoners  
18 Point could contribute to adverse effects on aquatic life ~~(specifically, indirect adverse effects on~~  
19 ~~striped bass spawning), though there is a high degree of uncertainty associated with this impact.~~  
20 Because EC is not bioaccumulative, the increases in long-term average EC levels would not directly  
21 cause bioaccumulative problems in aquatic life or humans. The western ~~and southern~~ Delta ~~are is~~  
22 Clean Water Act section 303(d) listed for elevated EC and the increased frequency of exceedance of  
23 EC objectives that would occur in ~~these this~~ portions of the Delta could make beneficial use  
24 impairment measurably worse. This impact is considered to be significant.

25 Further, relative to Existing Conditions, Alternative 5 ~~would could~~ result in substantial increases in  
26 long-term average EC during the months of October through May in Suisun Marsh, ~~such that EC~~  
27 ~~levels would be double that relative to Existing Conditions.~~ The increases in long-term average EC  
28 levels that would occur in Suisun Marsh could further degrade existing EC levels and thus contribute  
29 additionally to adverse effects on the fish and wildlife beneficial uses. Because EC is not  
30 bioaccumulative, the increases in long-term average EC levels would not directly cause  
31 bioaccumulative problems in fish and wildlife. Suisun Marsh is Clean Water Act section 303(d) listed  
32 for elevated EC and the increases in long-term average EC that would occur in the marsh could make  
33 beneficial use impairment measurably worse. This impact is considered to be significant.

34 Implementation of Mitigation Measure WQ-11 along with a separate, non-environmental  
35 commitment relating to the potential increased costs associated with EC-related changes would  
36 reduce these effects. While mitigation measures to reduce these water quality effects in affected  
37 water bodies to less than significant levels are not available, implementation of Mitigation Measure  
38 WQ-11 is recommended to attempt to reduce the effect that increased EC concentrations may have  
39 on Delta beneficial uses. However, because the effectiveness of this mitigation measure to result in  
40 feasible measures for reducing water quality effects is uncertain, this impact is considered to remain  
41 significant and unavoidable. Please see Mitigation Measure WQ-11 under Impact WQ-11 in the  
42 discussion of Alternative 1A.

43 In addition to and to supplement Mitigation Measure WQ-11, the BDCP proponents have  
44 incorporated into the BDCP, as set forth in EIR/EIS Appendix 3B, *Environmental Commitments*, a  
45 separate, non-environmental commitment to address the potential increased water treatment costs

1 that could result from EC concentration effects on municipal, industrial and agricultural water  
 2 purveyor operations. Potential options for making use of this financial commitment include funding  
 3 or providing other assistance towards acquiring alternative water supplies or towards modifying  
 4 existing operations when EC concentrations at a particular location reduce opportunities to operate  
 5 existing water supply diversion facilities. Please refer to Appendix 3B, *Environmental Commitments*,  
 6 for the full list of potential actions that could be taken pursuant to this commitment in order to  
 7 reduce the water quality treatment costs associated with water quality effects relating to chloride,  
 8 electrical conductivity, and bromide.

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

11 ***Delta***

12 Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2  
 13 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter  
 14 hydrodynamics within the Delta region, which affects mixing of source waters, these effects are  
 15 included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of  
 16 ~~CM2-22CM2-CM21~~ not attributable to hydrodynamics, for example, additional loading of a  
 17 constituent to the Delta, are discussed within the impact header for ~~CM2-22CM2-CM21~~. See section  
 18 8.3.1.3 for more information.

19 The water quality impacts of waterborne concentrations of mercury and methylmercury and fish  
 20 tissue mercury concentrations were evaluated for 9 Delta locations. The analysis of percentage  
 21 change in assimilative capacity of waterborne total mercury of Alternative 5 relative to the 25 ng/L  
 22 ecological risk benchmark as compared to Existing Conditions showed the greatest decrease to be  
 23 0.9% at Old River at Rock Slough and the Contra Costa Pumping Plant, and 0.9% at Franks Tract  
 24 relative to the No Action Alternative (Figures 8-53 and 8-54). These changes are not expected to  
 25 result in adverse effects to beneficial uses. Similarly, changes in methylmercury concentration are  
 26 expected to be very small. The greatest annual average methylmercury concentration for drought  
 27 conditions was 0.165 ng/L for the San Joaquin River at Buckley Cove which was slightly higher than  
 28 Existing Conditions (0.161 ng/L) and slightly lower than the No Action Alternative (0.167  
 29 ng/L) (Appendix 8I, *Mercury*, Table I-6). All modeled input concentrations exceeded the  
 30 methylmercury TMDL guidance objective of 0.06 ng/L, therefore percentage change in assimilative  
 31 capacity was not evaluated for methylmercury.

32 Fish tissue estimates show only small or no increases in exceedance quotients based on long-term  
 33 annual average concentrations for mercury at the Delta locations. The greatest change in exceedance  
 34 quotients of 6–8% is expected for Franks Tract and Old River at Rock Slough relative to Existing  
 35 Conditions and 7% for the Mokelumne River (South Fork) at Staten Island relative to the No Action  
 36 Alternative (Figure ~~8-558-55a,b~~, Appendix 8I, *Mercury*, Table I-12b). Because these increases are  
 37 relatively small, and it is not evident that substantive increases are expected at numerous locations  
 38 throughout the Delta, these changes are expected to be within the uncertainty inherent in the  
 39 modeling approach, and would likely not be measurable in the environment. See Appendix 8I for a  
 40 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-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 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-10A9a). 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 21.3 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, tThe ranges of modeled long-term average selenium concentrations in water (Appendix 8M, Selenium, Table M-10A) for Alternative 5 (range 0.2109–0.7339 µg/L) would be similar to those for Existing Conditions (range 0.2109–0.7641 µg/L), and the No Action Alternative (range 0.2109–0.6938 µg/L), are similar and would be well below the ecological risk benchmark)USEPA draft water quality criterion of {21.3 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 25and Table 8M-2 in the sturgeon addendum to Appendix 8MAddendum M.A to Appendix 8M, Table

1 M.A-2). Level of Concern Exceedance Quotients (i.e., modeled tissue divided by Level of Concern  
2 benchmarks) for selenium concentrations in those biota for all years and for drought years are less  
3 than 1.0 (indicating low probability of adverse effects). Similarly, Advisory Tissue Level Exceedance  
4 Quotients for selenium concentrations in fish fillets for all years and drought years also are less than  
5 1.0. Estimated selenium concentrations in sturgeon for the San Joaquin River at Antioch are  
6 predicted to increase by about 7 percent relative to Existing Conditions and the No Action  
7 Alternative in all years (from about 4.7 to 5.0 mg/kg dry weight [dw]), and those for sturgeon in the  
8 Sacramento River at Mallard Island are predicted to increase by about 4 percent in all years (from  
9 about 4.4 to 4.6 mg/kg dw) (Figure 8-65; Appendix 8M, Tables M-30 and M-31). Selenium  
10 concentrations in sturgeon during drought years are expected to increase by only 2 to 5 percent at  
11 those locations (Appendix 8M, Tables M-30 and M-31). Detection of small changes in whole-body  
12 sturgeon such as those estimated for the western Delta would require very large sample sizes  
13 because of the inherent variability in fish tissue selenium concentrations. Low Toxicity Threshold  
14 Exceedance Quotients for selenium concentrations in sturgeon in the western Delta would exceed  
15 1.0 (indicating a higher probability for adverse effects) for drought years at both locations (as they  
16 do for Existing Conditions and the No Action Alternative; Figure 8-65); however, for the entire  
17 period modeled, the quotient would not be exceeded at either location and for all years in the San  
18 Joaquin River at Antioch (where quotients increase from 0.94 to 1.0) (Appendix 8M, Table M-32).

19 The disparity between larger estimated changes for sturgeon and smaller changes for other biota  
20 are attributable largely to differences in modeling approaches, as described in Appendix 8M,  
21 Selenium. The model for most biota was calibrated to encompass the varying concentration-  
22 dependent uptake from waterborne selenium concentrations (expressed as the  $K_d$ , which is the ratio  
23 of selenium concentrations in particulates [as the lowest level of the food chain] relative to the  
24 waterborne concentration) that was exhibited in data for largemouth bass in 2000, 2005, and 2007  
25 at various locations across the Delta. In contrast, the modeling for sturgeon could not be similarly  
26 calibrated at the two western Delta locations and used literature-derived uptake factors and trophic  
27 transfer factors for the estuary from Presser and Luoma (2013). As noted in the appendix, there was  
28 a significant negative log-log relationship of  $K_d$  to waterborne selenium concentration that reflected  
29 the greater bioaccumulation rates for bass at low waterborne selenium than at higher  
30 concentrations. (There was no difference in bass selenium concentrations in the Sacramento River  
31 at Rio Vista in comparison to the San Joaquin River at Vernalis in 2000, 2005, and 2007 [Foe 2010],  
32 despite a nearly 10-fold difference in waterborne selenium.) Thus, there is more confidence in the  
33 site-specific modeling based on the Delta-wide model that was calibrated for bass data than in the  
34 estimates for sturgeon based on “fixed”  $K_d$ s for all years and for drought years without regard to  
35 waterborne selenium concentration at the two locations in different time periods, the largest  
36 increase of selenium concentrations in biota would be at Barker Slough PP for drought years (except  
37 for bird eggs [assuming a fish diet] at Contra Costa PP for all years) and in sturgeon at the two  
38 western Delta locations in all years, and the largest decrease would be at Buckley Cove for drought  
39 years. Relative to the No Action Alternative, the largest increase would be at Buckley Cove for  
40 drought years (except for bird eggs [assuming a fish diet] at Buckley Cove for all years) and in  
41 sturgeon at the two western Delta locations in all years; the largest decrease would be at Staten  
42 Island for drought years. Except for sturgeon in the western Delta, concentrations of selenium in  
43 whole-body fish and bird eggs (invert and fish diets) would exceed only the lower benchmarks (4  
44 and 6 mg/kg dry weight, respectively, indicating a low potential for effects), under drought  
45 conditions, at Buckley Cove for Existing Conditions and the No Action Alternative and Alternative 5  
46 (Figures 8-61 through 8-63). However, Exceedance Quotients exceedance quotients for these  
47 exceedances of the lower benchmarks are between 1.0 and 1.5, indicating a low risk to biota in the

1 Delta and no substantial difference from Existing Conditions and the No Action Alternative.  
2 Selenium concentrations in fish filets would not exceed the screening value for protection of human  
3 health (Figure 8-64). For sturgeon in the western Delta, whole-body selenium concentrations would  
4 increase from 12.3 mg/kg under Existing Conditions and the No Action Alternative to 12.7 mg/kg  
5 under Alternative 5, a 3% increase (Table 8M-2 in the sturgeon addendum to Appendix 8M Table  
6 M.A-2). Although all of these values exceed both the low and high toxicity benchmarks, it is unlikely  
7 that the modeled increases in whole-body selenium for sturgeon would be measurable in the  
8 environment (see also the discussion of results provided in the sturgeon addendum M.A to Appendix  
9 8M).

10 Increased water residence times could increase the bioaccumulation of selenium in biota, thereby  
11 potentially increasing fish tissue and bird egg concentrations of selenium (see residence time  
12 discussion in Appendix 8M, *Selenium*, and Presser and Luoma [2010b]). Thus, residence time was  
13 assessed for its relevance to selenium bioaccumulation. Table 60a (presented originally in Section  
14 8.3.1.7 in the *Microcystis* subsection) shows the time for neutrally buoyant particles to move through  
15 the Delta (surrogate for flow and residence time). Although an increase in residence time  
16 throughout the Delta is expected under the No Action Alternative, relative to Existing Conditions  
17 (because of climate change and sea level rise), the change is fairly small in most areas of the Delta.  
18 Thus, the changes in residence times between Alternative 5 and the No Action Alternative are very  
19 similar to the changes in residence times between Alternative 5 and the Existing Conditions.

20 Relative to Existing Conditions and the No Action Alternative, increases in residence times for  
21 Alternative 5 would be greater in the East Delta than in other sub-regions. Relative to Existing  
22 Conditions, annual average residence times for Alternative 5 in the East Delta are expected to  
23 increase by more than 16 days (Table 60a). Relative to the No Action Alternative, annual average  
24 residence times for Alternative 5 in the East Delta are expected to increase by less than 9 days.  
25 Increases in residence times for other sub-regions would be smaller, especially as compared to  
26 Existing Conditions and the No Action Alternative (which are longer than those modeled for the  
27 South Delta). As mentioned above, these results incorporate hydrodynamic effects of both CM1 and  
28 CM2 and CM4, and the effects of CM1 cannot be distinguished from the effects of CM2 and CM4.  
29 However, it is expected that CM2 and CM4 are substantial drivers of the increased residence time.

30 Presser and Luoma (2010b) summarized and discussed selenium uptake in the Bay-Delta (including  
31 hydrologic conditions [e.g., Delta outflow and residence time for water],  $K_d$ s [the ratio of selenium  
32 concentrations in particulates, as the lowest level of the food chain, relative to the water-borne  
33 concentration], and associated tissue concentrations [especially in clams and their consumers, such  
34 as sturgeon]). When the Delta Outflow Index (daily average flow per month) decreased by five-fold  
35 (73,732 cubic feet per second [cfs] in June 1998 to 12, 251 cfs in October 1998), residence time  
36 doubled (from 11 to 22 days) and the calculated mean  $K_d$  also doubled (from 3,198 to 6,501).  
37 However, when daily average Delta outflow in November 1999 was only 6,951 cfs (i.e., about one-  
38 half that in October 1998) and residence time was 70 days, the calculated mean  $K_d$  (7,614) did not  
39 increase proportionally.

40 Models are not available to quantitatively estimate the level of changes in selenium bioaccumulation  
41 as related to residence time, but the effects of residence time are incorporated in the  
42 bioaccumulation modeling for selenium that was based on higher  $K_d$  values for drought years in  
43 comparison to wet, normal, or all years; see Appendix 8M, *Selenium*. If increases in fish tissue or bird  
44 egg selenium were to occur, the increases would likely be of concern only where fish tissues or bird  
45 eggs are already elevated in selenium to near or above thresholds of concern. That is, where biota



1 concentrations are currently low and not approaching thresholds of concern (which, as discussed  
 2 above, is the case throughout the Delta, except for sturgeon in the western Delta), changes in  
 3 residence time alone would not be expected to cause them to then approach or exceed thresholds of  
 4 concern. In consideration of this factor, although the Delta as a whole is a CWA Section 303(d)-listed  
 5 water body for selenium, and although monitoring data of fish tissue or bird eggs in the Delta are  
 6 sparse, the most likely area in which biota tissues would be at levels high enough that additional  
 7 bioaccumulation due to increased residence time from restoration areas would be a concern is the  
 8 western Delta and Suisun Bay for sturgeon, as discussed above. As shown in Table 60a, the overall  
 9 increase in residence time estimated in the western Delta is 5 days relative to Existing Conditions,  
 10 and 3 days relative to the No Action Alternative. Given the available information, these increases are  
 11 small enough that they are not expected to substantially affect selenium bioaccumulation in the  
 12 western Delta. Because CM2 and CM4 are expected to be substantial drivers of the increased  
 13 residence times, further discussion is included in Impact WQ-26 below.

14 In summary, Rrelative to Existing Conditions and the No Action Alternative, Alternative 5 would  
 15 result in effectively-essentially no change in selenium concentrations throughout the Delta for most  
 16 biota (less than 1%), although increases in selenium concentrations are predicted for sturgeon in  
 17 the western Delta. Concentrations of selenium in sturgeon would exceed only the lower benchmark,  
 18 indicating a low potential for effects. The modeling of bioaccumulation for sturgeon is less calibrated  
 19 to site-specific conditions than that for other biota, which was calibrated on a robust dataset for  
 20 modeling of bioaccumulation in largemouth bass as a representative species for the Delta. Overall,-  
 21 Alternative 5 would not be expected to substantially increase the frequency with which applicable  
 22 benchmarks would be exceeded in the Delta (there being only a small increase for sturgeon relative  
 23 to the low benchmark and no exceedance of the high benchmark) or substantially degrade the  
 24 quality of water in the Delta, with regard to selenium.

### 25 ***SWP/CVP Export Service Areas***

26 Alternative 5 would result in small changes-decreases in long-term average selenium concentrations  
 27 in water at the two modeled Export Service Area assessment locations Banks and Jones pumping  
 28 plants, relative to Existing Conditions and the No Action Alternative, for the entire period modeled  
 29 (Appendix 8M, *Selenium*, Table M-9a10A). These small changes are reflected in small percent  
 30 changes-decreases in long-term average selenium concentrations in water would result in increases  
 31 (10% or less) in available assimilative capacity for selenium for all years of 2–4%. Furthermore,  
 32 Relative to Existing Conditions and the No Action Alternative, Alternative 5 would result in modeled  
 33 increases in assimilative capacity at Jones PP (3% and 4%, respectively) and at Banks PP (2%,  
 34 Existing Conditions and the No Action Alternative) (Figures 8-59 and 8-60) and generally have a  
 35 small positive effect on the Export Service Area locations. The ranges of modeled long-term average  
 36 selenium concentrations in water (Appendix 8M, Table M-10A) for Alternative 5 (range 0.3719–  
 37 0.5325 µg/L), Existing Conditions (range 0.37–0.58 µg/L), and the No Action Alternative (range  
 38 0.37–0.59 µg/L) are similar, and all would be well below the ecological risk benchmark USEPA draft  
 39 water quality criterion (of 1.32 µg/L) (Appendix 8M, Table M-9a).

40 Relative to Existing Conditions and the No Action Alternative, Alternative 5 would result in very  
 41 small changes (less than 1%) in estimated selenium concentrations in biota (whole-body fish, bird  
 42 eggs [invertebrate diet] bird eggs [fish diet], and fish fillets) (Figures 8-61a through 8-64b; Appendix  
 43 8M, *Selenium*, Table M-1625) at export service areas Banks and Jones pumping plants. Relative to  
 44 Existing Conditions, the largest increase of selenium concentrations in biota would be at Barker  
 45 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 Alternative at 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 [2010ed]) 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 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.

1 ~~Assessment~~ ~~The aAssessment~~ of effects of selenium in the SWP ~~/-and~~ CVP Export Service Areas is  
 2 based on effects on selenium concentrations at the Banks and Jones pumping plants. Relative to  
 3 Existing Conditions, Alternative 5 would ~~slightly decrease~~ ~~cause no increase in~~ the frequency with  
 4 which applicable benchmarks would be exceeded ~~and would~~ slightly improve the quality of water in  
 5 selenium concentrations at the Banks and Jones pumping plants ~~locations~~.

6 Based on the above, selenium concentrations that would occur in water under Alternative 5 would  
 7 not cause additional exceedances of applicable state or federal numeric or narrative water quality  
 8 objectives/criteria, or other relevant water quality effects thresholds identified for this assessment  
 9 (Table 8-54), by frequency, magnitude, and geographic extent that would result in adverse effects to  
 10 one or more beneficial uses within affected water bodies. In comparison to Existing Conditions and  
 11 the No Action Alternative, water quality conditions under this alternative would not increase levels  
 12 of selenium by frequency, magnitude, and geographic extent such that the affected environment  
 13 would be expected to have measurably higher body burdens of selenium in aquatic organisms,  
 14 thereby substantially increasing the health risks to wildlife (including fish) or humans consuming  
 15 those organisms. Water quality conditions under this alternative with respect to selenium would not  
 16 cause long-term degradation of water quality in the affected environment, and therefore would not  
 17 result in use of available assimilative capacity such that exceedances of water quality  
 18 objectives/criteria would be likely and would result in substantially increased risk for adverse  
 19 effects to one or more beneficial uses. This alternative would not further degrade water quality by  
 20 measurable levels, on a long-term basis, for selenium and, thus, cause the 303(d)-listed impairment  
 21 of beneficial use to be made discernibly worse. This impact is considered to be less than significant.  
 22 No mitigation is required.

23 **Impact WQ-26: Effects on Selenium Concentrations Resulting from Implementation of CM2–**  
 24 **CM2–CM21**

25 *NEPA Effects:* Effects of CM2–CM21 on selenium under Alternative 5 are the same as those  
 26 discussed for Alternative 1A and are considered not to be adverse.

27 *CEQA Conclusion:* CM2–CM21 proposed under Alternative 5 would be similar to those proposed  
 28 under Alternative 1A. As such, effects on selenium resulting from the implementation of CM2–CM21  
 29 would be similar to that previously discussed for Alternative 1A. This impact is considered to be less  
 30 than significant. No mitigation is required.

31 ~~*NEPA Effects:* In general, with the possible exception of changes in Delta hydrodynamics resulting~~  
 32 ~~from habitat restoration, CM2–CM11 would not substantially increase selenium concentrations in~~  
 33 ~~the water bodies of the affected environment. Modeling scenarios included assumptions regarding~~  
 34 ~~how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, and~~  
 35 ~~thus such effects of these restoration measures were included in the assessment of CM1 facilities~~  
 36 ~~operations and maintenance (see Impact WQ-25).~~

37 ~~However, i~~Implementation of these conservation measures may increase water residence time  
 38 ~~within the restoration areas. Increased restoration area water residence times could potentially~~  
 39 ~~increase the bioaccumulation of selenium in biota, thereby potentially increasing fish tissue and bird~~  
 40 ~~egg concentrations of selenium, M, but models are not available to quantitatively estimate the level~~  
 41 ~~of changes in residence time and the associated selenium bioavailability. If increases in fish tissue or~~  
 42 ~~bird egg selenium were to occur, the increases would likely be of concern only where fish tissues or~~  
 43 ~~bird eggs are already elevated in selenium to near or above thresholds of concern. That is, where~~  
 44 ~~biota concentrations are currently low and not approaching thresholds of concern, changes in~~

1 residence time alone would not be expected to cause them to then approach or exceed thresholds of  
2 concern. In consideration of this factor, although the Delta as a whole is a 303(d) listed water body  
3 for selenium, and although monitoring data of fish tissue or bird eggs in the Delta are sparse, the  
4 most likely areas in which biota tissues would be at levels high enough that additional  
5 bioaccumulation due to increased residence time from restoration areas would be a concern are the  
6 western Delta and Suisun Bay, and the South Delta in areas that receive San Joaquin River water.

7 The western Delta and Suisun Bay receive elevated selenium loads from North San Francisco Bay  
8 (including San Pablo Bay, Carquinez Strait, and Suisun Bay) and from the San Joaquin River. Point  
9 sources of selenium in North San Francisco Bay (i.e., refineries) that contribute selenium to Suisun  
10 Bay are expected to be reduced through a TMDL under development by the San Francisco Bay Water  
11 Board (San Francisco Bay Water Board 2012) that is expected to result in decreasing discharges of  
12 selenium. Nonpoint sources of selenium in the San Joaquin Valley that contribute selenium to the  
13 San Joaquin River, and thus the Delta and Suisun Bay, will be controlled through a TMDL developed  
14 by the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the  
15 Grassland Bypass Project, and Basin Plan objectives (Central Valley Water Board 2010c, d) that are  
16 expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta. If  
17 selenium levels are not sufficiently reduced via these efforts, it is expected that the State Water  
18 Board and the San Francisco Bay and Central Valley Water Boards would initiate additional actions  
19 to further control sources of selenium.

20 The South Delta receives elevated selenium loads from the San Joaquin River. In contrast to Suisun  
21 Bay and possibly the western Delta in the future, the South Delta lacks the overbite clam (*Corbula*  
22 [*Potamocorbula*] *amurensis*), which is considered a key driver of selenium bioaccumulation in  
23 Suisun Bay, due to its high bioaccumulation of selenium and its role in the benthic food web that  
24 includes long lived sturgeon. The South Delta does have *Corbicula fluminea*, another bivalve that  
25 bioaccumulates selenium, but it is not as invasive as the overbite clam and thus likely makes up a  
26 smaller fraction of sturgeon diet. Also, as mentioned above, nonpoint sources of selenium in the San  
27 Joaquin Valley that contribute selenium to the Delta will be controlled through a TMDL developed by  
28 the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the  
29 Grassland Bypass Project, and Basin Plan objectives (Central Valley Water Board 2010c, d) that are  
30 expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta.  
31 Further, if selenium levels in the San Joaquin River are not sufficiently reduced via these efforts, it is  
32 expected that the State Water Board and Central Valley Water Board would initiate additional  
33 TMDLs to further control nonpoint sources of selenium.

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

42 However, because increases in bioavailable selenium in the habitat restoration areas are uncertain,  
43 proposed avoidance and minimization measures would require evaluating risks of selenium  
44 exposure at a project level for each restoration area, minimizing to the extent practicable potential  
45 risk of additional bioaccumulation, and monitoring selenium levels in fish and/or wildlife to

1 establish whether, or to what extent, additional bioaccumulation is occurring. See Appendix 3B,  
 2 *Environmental Commitments* for a description of the environmental commitment BDCP proponents  
 3 are making with respect to Selenium Management; and Appendix 3.C. of the BDCP for  
 4 additional detail on this avoidance and minimization measure (AMM27). Data generated as part of  
 5 the avoidance and minimization measures will assist the State and Regional Water Boards in  
 6 determining whether beneficial uses are being impacted by selenium, and thus will provide the data  
 7 necessary to support regulatory actions (including additional TMDL development), should such  
 8 actions be warranted.

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

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

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

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

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

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

3 Effects of facilities and operations (CM1) on *Microcystis* abundance, and thus microcystins  
4 concentrations, in water bodies of the affected environment under Alternative 5 would be very  
5 similar (i.e., nearly the same) to those discussed for Alternative 1A. This is because factors that  
6 affect *Microcystis* abundance in waters upstream of the Delta, in the Delta, and in the SWP/CVP  
7 Export Services Areas under Alternative 1A would similarly change under Alternative 5, relative to  
8 Existing Conditions and the No Action Alternative. For the Delta in particular, there are differences  
9 in the direction and magnitude of water residence time changes during the *Microcystis* bloom period  
10 among the six Delta sub-regions under Alternative 5 compared to Alternative 1A, relative to Existing  
11 Conditions and No Action Alternative. However, under Alternative 5, relative to Existing Conditions  
12 and No Action Alternative, water residence times during the *Microcystis* bloom period in various  
13 Delta sub-regions are expected to increase to a degree that could, similar to Alternative 1A, lead to  
14 an increase in the frequency, magnitude, and geographic extent of *Microcystis* blooms throughout  
15 the Delta.

16 Similar to Alternative 1A, elevated ambient water temperatures relative to Existing Conditions  
17 would occur in the Delta under Alternative 5, which could lead to earlier occurrences of *Microcystis*  
18 blooms in the Delta, and increase the overall duration and magnitude of blooms. However, the  
19 degradation of water quality from *Microcystis* blooms due to the expected increases in Delta water  
20 temperatures is driven entirely by climate change, not effects of CM1. While *Microcystis* blooms  
21 have not occurred in the Export Service Areas, conditions in the Export Service Areas under  
22 Alternative 5 may become more conducive to *Microcystis* bloom formation, relative to Existing  
23 Conditions, because water temperatures will increase in the Export Service Areas due to the  
24 expected increase in ambient air temperatures resulting from climate change.

25 **NEPA Effects:** Effects of water facilities and operations (CM1) on *Microcystis* in water bodies of the  
26 affected environment under Alternative 5 would be very similar to (i.e., nearly the same) to those  
27 discussed for Alternative 1A. In summary, Alternative 5 operations and maintenance, relative to the  
28 No Action Alternative, would result in long-term increases in hydraulic residence time of various  
29 Delta sub-regions during the summer and fall *Microcystis* bloom period. During this period, the  
30 increased residence time could result in a concurrent increase in the frequency, magnitude, and  
31 geographic extent of *Microcystis* blooms, and thus microcystin levels, in affected areas of the Delta.  
32 As a result, Alternative 5 operation and maintenance activities would cause further degradation to  
33 water quality with respect to *Microcystis* in the Delta. Under Alternative 5, relative to No Action  
34 Alternative, water exported to the SWP/CVP Export Service Area will be a mixture of *Microcystis*-  
35 affected source water from the south Delta intakes and unaffected source water from the  
36 Sacramento River, diverted at the north Delta intakes. It cannot be determined whether operations  
37 and maintenance under Alternative 5 will result in increased or decreased levels of *Microcystis* and  
38 microcystins in the mixture of source waters exported from Banks and Jones pumping plants.  
39 Mitigation Measure WQ-32a and WQ-32b are available to reduce the effects of degraded water  
40 quality in the Delta. Although there is considerable uncertainty regarding this impact, the effects on  
41 *Microcystis* from implementing CM1 is determined to be adverse.

42 **CEQA Conclusion:** Key findings discussed in the effects assessment provided above are summarized  
43 here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the  
44 purpose of making the CEQA impact determination for this constituent. For additional details on the

1 effects assessment findings that support this CEQA impact determination, see the effects assessment  
2 discussion that immediately precedes this conclusion.

3 Under Alternative 5, additional impacts from *Microcystis* in the reservoirs and watersheds upstream  
4 of the Delta are not expected, relative to Existing Conditions. Operations and maintenance occurring  
5 under Alternative 5 is not expected to change nutrient levels in upstream reservoirs or  
6 hydrodynamic conditions in upstream rivers and streams such that conditions would be more  
7 conductive to *Microcystis* production.

8 Relative to Existing Conditions, water temperatures and hydraulic residence times in the Delta are  
9 expected to increase under Alternative 5, resulting in an increase in the frequency, magnitude and  
10 geographic extent of *Microcystis* blooms in the Delta. However, the degradation of water quality  
11 from *Microcystis* blooms due to the expected increases in Delta water temperatures is driven  
12 entirely by climate change, not effects of CM1. Increases in Delta residence times are expected  
13 throughout the Delta during the summer and fall bloom period, due in small part to climate change  
14 and sea level rise, but due more proportionately to CM1 and the hydrodynamic impacts of  
15 restoration included in CM2 and CM4. The precise change in local residence times and *Microcystis*  
16 production expected within any Delta sub-region is unknown because conditions will vary across  
17 the complex networks of intertwining channels, shallow back water areas, and submerged islands  
18 that compose the Delta. Nonetheless, Delta residence times are, in general, expected to increase due  
19 to Alternative 5. Consequently, it is possible that increases in the frequency, magnitude, and  
20 geographic extent of *Microcystis* blooms in the Delta will occur due to the operations and  
21 maintenance of Alternative 5 and the hydrodynamic impacts of restoration (CM2 and CM4).

22 The assessment of effects of *Microcystis* on SWP/CVP Export Service Areas is based on the  
23 assessment of changes in *Microcystis* levels in export source waters, as well as the effects of  
24 temperature and residence time changes within the Export Service Areas on *Microcystis* production.  
25 Under Alternative 5, relative to Existing Conditions, the potential for *Microcystis* to occur in the  
26 Export Service Area is expected to increase due to increasing water temperature, but this impact is  
27 driven entirely by climate change and not Alternative 5. Water exported from the Delta to the  
28 Export Service Area is expected to be a mixture of *Microcystis*-affected source water from the south  
29 Delta intakes and unaffected source water from the Sacramento River. Because of this, it cannot be  
30 determined whether operations and maintenance under Alternative 5, relative to existing  
31 conditions, will result in increased or decreased levels of *Microcystis* and microcystins in the mixture  
32 of source waters exported from Banks and Jones pumping plants.

33 Based on the above, this alternative would not be expected to cause additional exceedance of  
34 applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that  
35 would cause significant impacts on any beneficial uses of waters in the affected environment.  
36 *Microcystis* and microcystins are not 303(d) listed within the affected environment and thus any  
37 increases that could occur in some areas would not make any existing *Microcystis* impairment  
38 measurably worse because no such impairments currently exist. Because *Microcystis* and  
39 microcystins are not bioaccumulative, increases that could occur in some areas would not  
40 bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health  
41 risks to fish, wildlife, or humans. However, because it is possible that increases in the frequency,  
42 magnitude, and geographic extent of *Microcystis* blooms in the Delta will occur due to the operations  
43 and maintenance of Alternative 5 and the hydrodynamic impacts of restoration (CM2 and CM4),  
44 long-term water quality degradation may occur and, thus, significant impacts on beneficial uses

1 could occur. Although there is considerable uncertainty regarding this impact, the effects on  
 2 Microcystis from implementing CM1 is determined to be significant.

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

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

9 Please see Mitigation Measure WQ-32a under Impact WQ-32 in the discussion of Alternative 1A.

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

12 Please see Mitigation Measure WQ-32b under Impact WQ-32 in the discussion of Alternative 1A.

13 **Impact WQ-33. Effects on Microcystis Bloom Formation Resulting from Other Conservation**  
 14 **Measures (CM2--CM21)**

15 The effects of CM2–CM21 on Microcystis under Alternative 59 are the same as those discussed for  
 16 Alternative 1A. In summary, potential environmental effects related to CM2 and CM4 could result in  
 17 an increase in the frequency, magnitude, and geographic extent of Microcystis blooms in the Delta,  
 18 relative to Existing Conditions and the No Action Alternative, as a result of increased residence times  
 19 for Delta waters from implementing CM2 and CM4 restoration areas. -Because the hydrodynamic  
 20 effects associated with implementing CM2 and CM4 were incorporated into the modeling used to  
 21 assess CM1, a detailed assessment of the effects of implementing CM2 and CM4 on Microcystis  
 22 blooms in the Delta via their effects on Delta water residence time is provided under CM1 (above).  
 23 The effects of CM 2CM2 and CM 4CM4 on Microcystis may be reduced by implementation of  
 24 Mitigation Measures WQ-32A and WQ-32b. The effectiveness of these mitigation measures to result  
 25 in feasible measures for reducing water quality effects is uncertain. Conservation Measures 3 (CM3)  
 26 and CM5-CM21 would not result in an increase in the frequency, magnitude, and geographic extent  
 27 of Microcystis blooms in the Delta.

28 **NEPA Effects:** Effects of CM2–CM21on Microcystis under Alternative 5 are the same as those  
 29 discussed for Alternative 1A and are considered to be adverse.

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



1 beneficial uses, could occur. Although there is considerable uncertainty regarding this impact, the  
 2 effects on Microcystis from implementing CM2–CM21 are determined to be significant.

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

5 The effects analysis presented in the preceding impacts (Impact WQ-1 through WQ-33) concluded  
 6 that Alternative 5 would have a less than significant impact/no adverse effect on the following  
 7 constituents in the Delta:

- 8 ● Boron
- 9 ● Dissolved Oxygen
- 10 ● Pathogens
- 11 ● Pesticides
- 12 ● Trace Metals
- 13 ● Turbidity and TSS

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

22 The effects of Alternative 5 on bromide, chloride, and DOC, in the Delta were determined to be  
 23 significant/adverse. Increases in bromide, chloride, and DOC concentrations are of concern in  
 24 drinking water supplies; however, as described previously, the San Francisco Bay does not have a  
 25 designated MUN use. Thus, changes in bromide, chloride, and DOC in Delta outflow would not  
 26 adversely effect any beneficial uses of San Francisco Bay.

27 Elevated EC, as assessed for this alternative, is of concern for its effects on the agricultural beneficial  
 28 use (AGR) and fish and wildlife beneficial uses. As discussed above, San Francisco Bay does not have  
 29 an AGR beneficial use designation. Further, as discussed for the No Action Alternative, changes in  
 30 Delta salinity would not contribute to measurable changes in Bay salinity, as the change in Delta  
 31 outflow, which would be the primary driver of salinity changes, would two to three orders of  
 32 magnitude lower than (and thus minimal compared to) the Bay's tidal flow.

33 Also, as discussed for the No Action Alternative, adverse changes in Microcystis levels that could  
 34 occur in the Delta would not cause adverse Microcystis blooms in San Francisco Bay, because  
 35 Microcystis are intolerant of the Bay's high salinity and, thus not have not been detected  
 36 downstream of Suisun Bay.

37 While effects of Alternative 5 on the nutrients ammonia, nitrate, and phosphorus were determined  
 38 to be less than significant/not adverse, these constituents are addressed further below because the  
 39 response of the seaward bays to changed nutrient concentrations/loading may differ from the  
 40 response of the Delta. Selenium and mercury are discussed further, because they are

1 bioaccumulative constituents where changes in load due to both changes in Delta concentrations  
2 and exports are of concern.

### 3 **Nutrients: Ammonia, Nitrate, and Phosphorus**

4 Total nitrogen loads in Delta outflow to Suisun and San Pablo Bays under Alternative 5 would be  
5 dominated almost entirely by nitrate, because planned upgrades to the SRWTP will result in >95%  
6 removal of ammonia in its effluent. Total nitrogen loads to Suisun and San Pablo Bays would  
7 decrease by 31%, relative to Existing Conditions, and increase by 2%, relative to the No Action  
8 Alternative (Appendix 80, Table O-1). The change in nitrogen loading to Suisun and San Pablo Bays  
9 under Alternative 5 would not adversely impact primary productivity in these embayments because  
10 light limitation and grazing current limit algal production in these embayments. To the extent that  
11 algal growth increases in relation to a change in ammonia concentration, this would have net  
12 positive benefits, because current algal levels in these embayments are low. Nutrient levels and  
13 ratios are not considered a direct driver of *Microcystis* and cyanobacteria levels in the North Bay.

14 The phosphorus load exported from the Delta to Suisun and San Pablo Bays for Alternative 5 is  
15 estimated to increase by 3%, relative to Existing Conditions, and decrease by 2% relative to the No  
16 Action Alternative (Appendix 80, Table O-1) ). The only postulated effect of changes in phosphorus  
17 loads to Suisun and San Pablo Bays is related to the influence of nutrient stoichiometry on primary  
18 productivity. However, there is uncertainty regarding the impact of nutrient ratios on  
19 phytoplankton community composition and abundance. Any effect on phytoplankton community  
20 composition would likely be small compared to the effects of grazing from introduced clams and  
21 zooplankton in the estuary (Senn and Novick 2014; Kimmerer and Thompson 2014). Therefore, the  
22 projected change in total nitrogen and phosphorus loading that would occur in Delta outflow to San  
23 Francisco Bay is not expected to result in degradation of water quality with regard to nutrients that  
24 would result in adverse effects to beneficial uses.

### 25 **Mercury**

26 The estimated long-term average mercury and methylmercury loads in Delta exports are shown in  
27 Appendix 80, Table O-2. Loads of mercury and methylmercury from the Delta to San Francisco Bay  
28 are estimated to change relatively little due to changes in source water fractions and net Delta  
29 outflow that would occur under Alternative 5. Mercury load to the Bay, relative to Existing  
30 Conditions, is estimated to increase by 3 kg/yr (1%), relative to Existing Conditions, and be  
31 unchanged relative to the No Action Alternative. Methylmercury load is estimated to increase by  
32 0.06 kg/yr (2%), relative to Existing Conditions, and decrease by 0.03 kg/yr (1%) relative to the No  
33 Action Alternative. The estimated total mercury load to the Bay is 263 kg/yr, which would be less  
34 than the San Francisco Bay mercury TMDL WLA for the Delta of 330 kg/yr. The estimated changes in  
35 mercury and methylmercury loads would be within the overall uncertainty associated with the  
36 estimates of long-term average net Delta outflow and the long-term average mercury and  
37 methylmercury concentrations in Delta source waters. The estimated changes in mercury load  
38 under the alternative would also be substantially less than the considerable differences among  
39 estimates in the current mercury load to San Francisco Bay (SFBRWQCB 2006; David et al. 2009).  
40 Similar uncertainty is expected in the existing methylmercury load in net Delta exports, for which  
41 the best available current load estimate is based on approximately one year of monitoring data (Foe  
42 et al. 2008).

43 Given that the estimated incremental ~~decreases~~increases of mercury and methylmercury loading to  
44 San Francisco Bay would fall within the uncertainty of current mercury and methylmercury load

1 estimates, the estimated changes in mercury and methylmercury loads in Delta exports to San  
2 Francisco Bay due to Alternative 5 are not expected to result in adverse effects to beneficial uses or  
3 substantially degrade the water quality with regard to mercury, or make the existing CWA Section  
4 303(d) impairment measurably worse.

#### 5 **Selenium**

6 Changes in source water fraction and net Delta outflow under Alternative 5, relative to Existing  
7 Conditions, are projected to cause the total selenium load to the North Bay to increase by 4%,  
8 relative to Existing Conditions, and increase by 1%, relative to the No Action Alternative (Appendix  
9 80, Table O-3). Changes in long-term average selenium concentrations of the North Bay are assumed  
10 to be proportional to changes in North Bay selenium loads. Under Alternative 5, the long-term  
11 average total selenium concentration of the North Bay is estimated to be 0.13µg/L and the dissolved  
12 selenium concentration is estimated to be 0.11 µg/L, which would be the same as Existing  
13 Conditions and the No Action Alternative (Appendix 80, Table O-3). The dissolved selenium  
14 concentration would be below the target of 0.202 µg/L developed by Presser or Luoma (2013) to  
15 coincide with a white sturgeon whole-body fish tissue selenium concentration not greater than 8  
16 mg/kg in the North Bay. The incremental increase in dissolved selenium concentrations in the  
17 North Bay, relative to Existing Conditions, would be negligible (0.00 µg/L) under this alternative.  
18 Thus, the estimated changes in selenium loads in Delta exports to San Francisco Bay due to  
19 Alternative 5 are not expected to result in adverse effects to beneficial uses or substantially degrade  
20 the water quality with regard to selenium, or make the existing CWA Section 303(d) impairment  
21 measurably worse.

22 **NEPA Effects:** Based on the discussion above, Alternative 5, relative to the No Action Alternative,  
23 would not cause further degradation to water quality with respect to boron, bromide, chloride,  
24 dissolved oxygen, DOC, EC, mercury, pathogens, pesticides, selenium, nutrients (ammonia, nitrate,  
25 phosphorus), trace metals, or turbidity and TSS in the San Francisco Bay. Further, changes in these  
26 constituent concentrations in Delta outflow would not be expected to cause changes in Bay  
27 concentrations of frequency, magnitude, and geographic extent that would adversely affect any  
28 beneficial uses. In summary, based on the discussion above, effects on the San Francisco Bay from  
29 implementation of CM1–CM21 are considered to be not adverse.

30 **CEQA Conclusion:** Based on the above, Alternative 5 would not be expected to cause long-term  
31 degradation of water quality in San Francisco Bay resulting in sufficient use of available assimilative  
32 capacity such that occasionally exceeding water quality objectives/criteria would be likely and  
33 would result in substantially increased risk for adverse effects to one or more beneficial uses.  
34 Further, based on the above, this alternative would not be expected to cause additional exceedance  
35 of applicable water quality objectives/criteria in the San Francisco Bay by frequency, magnitude,  
36 and geographic extent that would cause significant impacts on any beneficial uses of waters in the  
37 affected environment. Any changes in boron, bromide, chloride, and DOC in the San Francisco Bay  
38 would not adversely affect beneficial uses, because the uses most affected by changes in these  
39 parameters, MUN and AGR, are not beneficial uses of the Bay. Further, no substantial changes in  
40 dissolved oxygen, pathogens, pesticides, trace metals or turbidity or TSS are anticipated in the Delta,  
41 relative to Existing Conditions, therefore, no substantial changes these constituents levels in the Bay  
42 are anticipated. Changes in Delta salinity would not contribute to measurable changes in Bay  
43 salinity, as the change in Delta outflow would two to three orders of magnitude lower than (and thus  
44 minimal compared to) the Bay's tidal flow. Adverse changes in Microcystis levels that could occur in  
45 the Delta would not cause adverse Microcystis blooms in the Bay, because Microcystis are intolerant

1 of the Bay's high salinity and, thus not have not been detected downstream of Suisun Bay. The 31%  
 2 decrease in total nitrogen load and 3% increase in phosphorus load, relative to Existing Conditions,  
 3 are expected to have minimal effect on water quality degradation, primary productivity, or  
 4 phytoplankton community composition. The estimated increase in mercury load (3 kg/yr; 1%) and  
 5 methylmercury load (0.06 kg/yr; 2%), relative to Existing Conditions, is within the level of  
 6 uncertainty in the mass load estimate and not expected to contribute to water quality degradation,  
 7 make the CWA section 303(d) mercury impairment measurably worse or cause  
 8 mercury/methylmercury to bioaccumulate to greater levels in aquatic organisms that would, in  
 9 turn, pose substantial health risks to fish, wildlife, or humans. The estimated increase in selenium  
 10 load would be 4%, but estimated total and dissolved selenium concentrations under this alternative  
 11 would be the same as Existing Conditions, and less than the target associated with white sturgeon  
 12 whole-body fish tissue levels for the North Bay. Thus, the small increase in selenium load is not  
 13 expected to contribute to water quality degradation, or make the CWA section 303(d) selenium  
 14 impairment measurably worse or cause selenium to bioaccumulate to greater levels in aquatic  
 15 organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact  
 16 is considered to be less than significant.

### 17 **8.3.3.11 Alternative 6A—Isolated Conveyance with Pipeline/Tunnel and** 18 **Intakes 1–5 (15,000 cfs; Operational Scenario D)**

#### 19 **Impact WQ-5: Effects on Bromide Concentrations Resulting from Facilities Operations and** 20 **Maintenance (CM1)**

##### 21 *Delta*

22 Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2  
 23 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter  
 24 hydrodynamics within the Delta region, which affects mixing of source waters, these effects are  
 25 included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of  
 26 ~~CM2-22CM2-CM21~~ not attributable to hydrodynamics, for example, additional loading of a  
 27 constituent to the Delta, are discussed within the impact header for ~~CM2-22CM2-CM21~~. See section  
 28 8.3.1.3 for more information.

29 Using the mass-balance modeling approach for bromide (see Section 8.3.1.3), relative to Existing  
 30 Conditions, Alternative 6A would result in increases in long-term average bromide concentrations at  
 31 Staten Island and Barker Slough, while long-term average concentrations would decrease at the  
 32 other assessment locations (Appendix 8E, *Bromide*, Table 14). At Barker Slough, predicted long-term  
 33 average bromide concentrations would increase from 51 µg/L to 61 µg/L (19% relative increase)  
 34 for the modeled 16-year hydrologic period and would increase from 54 µg/L to 92 µg/L (73%  
 35 relative increase) for the modeled drought period. At Barker Slough, the predicted 50 µg/L  
 36 exceedance frequency would decrease from 49% under Existing Conditions to 38% under  
 37 Alternative 6A, but would increase from 55% to 63% during the drought period. At Barker Slough,  
 38 the predicted 100 µg/L exceedance frequency would increase from 0% under Existing Conditions to  
 39 17% under Alternative 6A, and would increase from 0% to 37% during the drought period. At  
 40 Staten Island, predicted long-term average bromide concentrations would increase from 50 µg/L to  
 41 70 µg/L (41% relative increase) for the modeled 16-year hydrologic period and would increase  
 42 from 51 µg/L to 70 µg/L (37% relative increase) for the modeled drought period. At Staten Island,  
 43 increases in average bromide concentrations would correspond to an increased frequency of 50 µg/l

1 threshold exceedance, from 47% under Existing Conditions to 85% under Alternative 6A (52% to  
2 88% for the modeled drought period), and an increase from 1% to 10% (0% to 5% for the modeled  
3 drought period) for the 100 µg/L threshold. Changes in exceedance frequency of the 50 µg/L and  
4 100 µg/L concentration thresholds at other assessment locations would be less considerable. This  
5 comparison to Existing Conditions reflects changes in bromide due to both Alternative 6A  
6 operations (including north Delta intake capacity of 15,000 cfs and numerous other operational  
7 components of Scenario D) and climate change/sea level rise.

8 Due to the relatively small differences between modeled Existing Conditions and No Action  
9 baselines, changes in long-term average bromide concentrations and changes in exceedance  
10 frequencies relative to the No Action Alternative are generally of similar magnitude to those  
11 previously described for the existing condition comparison (Appendix 8E, *Bromide*, Table 14).  
12 Modeled long-term average bromide concentration increases at Barker Slough are predicted to  
13 increase by 22% (72% for the modeled drought period) relative to the No Action Alternative.  
14 Modeled long-term average bromide concentration increases at Staten Island are predicted to  
15 increase by 45% (41% for the modeled drought period) relative to the No Action Alternative.  
16 However, unlike the Existing Conditions comparison, long-term average bromide concentrations at  
17 Buckley Cove would increase relative to the No Action Alternative, although the increases would be  
18 relatively small ( $\leq 4\%$ ). Unlike the comparison to Existing Conditions, this comparison to the No  
19 Action Alternative reflects changes in bromide due only to Alternative 6A operations.

20 At Barker Slough, modeled long-term average bromide concentrations for the two baseline  
21 conditions are very similar (Appendix 8E, *Bromide*, Table 14). Such similarity demonstrates that the  
22 modeled Alternative 6A change in bromide is almost entirely due to Alternative 6A operations, and  
23 not climate change/sea level rise. Therefore, operations are the primary driver of effects on bromide  
24 at Barker Slough, regardless whether Alternative 6A is compared to Existing Conditions, or  
25 compared to the No Action Alternative.

26 Results of the modeling approach which used relationships between EC and chloride and between  
27 chloride and bromide (see Section 8.3.1.3) differed somewhat from what is presented above for the  
28 mass-balance approach (see Appendix 8E, *Bromide*, Table 15). For most locations, the frequency of  
29 exceedance of the 50 µg/L and 100 µg/L were similar. The greatest difference between the methods  
30 was predicted for Barker Slough. The increases in frequency of exceedance of the 100 µg/L  
31 threshold, relative to Existing Conditions and the No Action Alternative, were not as great using this  
32 alternative EC to chloride and chloride to bromide relationship modeling approach as compared to  
33 that presented above from the mass-balance modeling approach. However, there were still  
34 substantial increases, resulting in 6% exceedance over the modeled period under Alternative 6A, as  
35 compared to 1% under Existing Conditions and 2% under the No Action Alternative. For the drought  
36 period, exceedance frequency increased from 0% under Existing Conditions and the No Action  
37 Alternative, to 17% under Alternative 6A. Because the mass-balance approach predicts a greater  
38 level of impact at Barker Slough, determination of impacts was based on the mass-balance results.

39 The increase in long-term average bromide concentrations predicted at Barker Slough, principally  
40 the relative increase in 100 µg/L exceedance frequency, would result in a substantial change in  
41 source water quality for existing drinking water treatment plants drawing water from the North Bay  
42 Aqueduct. As discussed for Alternative 1A, drinking water treatment plants obtaining water via the  
43 North Bay Aqueduct utilize a variety of conventional and enhanced treatment technologies in order  
44 to achieve DBP drinking water criteria. While the implications of such a modeled change in bromide  
45 at Barker Slough are difficult to predict, the substantial modeled increases could lead to adverse

1 changes in the formation of disinfection byproducts such that considerable treatment plant  
2 upgrades may be necessary in order to achieve equivalent levels of health protection. Increases at  
3 Staten Island are also considerable, although there are no existing or foreseeable municipal intakes  
4 in the immediate vicinity. Because many of the other modeled locations already frequently exceed  
5 the 100 µg/L threshold under Existing Conditions and the No Action Alternative, these locations  
6 likely already require treatment plant technologies to achieve equivalent levels of health protection,  
7 and thus no additional treatment technologies would be triggered by the small increases in the  
8 frequency of exceeding the 100 µg/L threshold. Hence, no further impact on the drinking water  
9 beneficial use would be expected at these locations.

10 The seasonal intakes at Mallard Slough and City of Antioch are infrequently used due to water  
11 quality constraints related to sea water intrusion. On a long-term average basis, bromide at these  
12 locations is in excess of 3,000 µg/L, but during seasonal periods of high Delta outflow can be <300  
13 µg/L. Based on modeling using the mass-balance approach, use of the seasonal intakes at Mallard  
14 Slough and City of Antioch under Alternative 6A would experience a period average increase in  
15 bromide during the months when these intakes would most likely be utilized. For those wet and  
16 above normal water year types where mass balance modeling would predict water quality typically  
17 suitable for diversion, predicted long-term average bromide would increase from 103 µg/L to 162  
18 µg/L (58% increase) at City of Antioch and would increase from 150 µg/L to 199 µg/L (33%  
19 increase) at Mallard Slough relative to Existing Conditions (Appendix 8E, *Bromide*, Table 23).  
20 Increases would be similar for the No Action Alternative comparison. Modeling results using the EC  
21 to chloride and chloride to bromide relationships show increases during these months, but the  
22 relative magnitude of the increases is much lower (Appendix 8E, *Bromide*, Table 24). Regardless of  
23 the differences in the data between the two modeling approaches, the decisions surrounding the use  
24 of these seasonal intakes is largely driven by acceptable water quality, and thus have historically  
25 been opportunistic. Opportunity to use these intakes would remain, and the predicted increases in  
26 bromide concentrations at the City of Antioch and Mallard Slough intake would not be expected to  
27 adversely affect MUN beneficial uses, or any other beneficial use, at these locations.

28 Based on modeling using the mass-balance approach, relative to existing and No Action Alternative  
29 conditions, Alternative 6A would lead to predicted improvements in long-term average bromide  
30 concentrations at Franks Tract, Rock Slough, and Contra Costa PP No. 1, in addition to Banks and  
31 Jones (discussed below). At these locations, long-term average bromide concentrations would be  
32 predicted to decrease by as much as 41–61%, depending on baseline comparison. Modeling results  
33 using the EC to chloride and chloride to bromide relationships generally do not show similar  
34 decreases for Rock Slough and Contra Costa PP No. 1, but rather, predict small increases. Based on  
35 the small magnitude of increases predicted, these increases would not adversely affect beneficial  
36 uses at those locations.

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

1 [restoration, the estimates are not predictive of the bromide levels that would actually occur in](#)  
 2 [Barker Slough or elsewhere in the Delta.](#)

### 3 **Impact WQ-7: Effects on Chloride Concentrations Resulting from Facilities Operations and** 4 **Maintenance (CM1)**

#### 5 *Delta*

##### 6 *Municipal Beneficial Uses*

7 Estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output  
 8 (see Section 8.3.1.3) were used to evaluate the 150 mg/L Bay-Delta WQCP objective for municipal  
 9 and industrial beneficial uses on a basis of the percent of years the chloride objective is exceeded for  
 10 the modeled 16-year period. The objective is exceeded if chloride concentrations exceed 150 mg/L  
 11 for a specified number of days in a given water year at both the Antioch and Contra Costa Pumping  
 12 Plant #1 locations. For Alternative 6A, the modeled frequency of objective exceedance would  
 13 ~~increase from 6%~~ [remain unchanged at 7%](#) of years under Existing Conditions and ~~6% under the No~~  
 14 ~~Action Alternative to 13% of years under~~ Alternative 6A (Appendix 8G, [Chloride](#), Table Cl-64). [The](#)  
 15 [modeled frequency of objective exceedance would increase from 0% of years under the No Action](#)  
 16 [Alternative to 7% under Alternative 6A. However, the increase was due to a single year, 1977,](#)  
 17 [which fell just short of the required number of days \(i.e., was within 9 days minimum number of](#)  
 18 [required days < 150 mg/L\).](#) [Given the uncertainty in the chloride modeling approach, it is likely that](#)  
 19 [real time operations of the SWP and CVP could achieve compliance with this objective \(see Section](#)  
 20 [8.3.1.1 for a discussion of chloride compliance modeling uncertainties and a description of real time](#)  
 21 [operations of the SWP and CVP\).](#)

22 Similarly, estimates of chloride concentrations generated using EC-chloride relationships and DSM2  
 23 EC output (see Section 8.3.1.3) were also used to evaluate the 250 mg/L Bay-Delta WQCP objective  
 24 for chloride at Contra Costa Pumping Plant #1 where daily average objectives apply. The basis for  
 25 the evaluation was the predicted number of days the objective was exceeded for the modeled 16-  
 26 year period. For Alternative 6A, the modeled frequency of objective exceedance would be  
 27 eliminated, from 6% of modeled days under Existing Conditions and 5% under the No Action  
 28 Alternative to 0% of modeled days under Alternative 6A (Appendix 8G, [Chloride](#), Table Cl-63).

29 Given the limitations inherent to estimating future chloride concentrations (see Section 8.3.1.3),  
 30 estimation of chloride concentrations through both a mass balance approach and an EC-chloride  
 31 relationship approach was used to evaluate the 250 mg/L Bay-Delta WQCP objectives in terms of  
 32 both frequency of exceedance and use of assimilative capacity. When utilizing the mass balance  
 33 approach to model monthly average chloride concentrations for the 16-year period, the predicted  
 34 frequency of exceeding the 250 mg/L objective would be eliminated at the Contra Costa Canal at  
 35 Pumping Plant #1 (24% for Existing Conditions to 0% for Alternative 6A), thus indicating complete  
 36 compliance with this objective would be achieved (Appendix 8G, [Chloride](#), Table Cl-39 and Figure Cl-  
 37 9). The frequency of exceedances at the San Joaquin River at Antioch also would decrease compared  
 38 to all of the alternative scenarios (i.e., 9% from 66% for Existing Conditions to 57%) with no  
 39 substantial change predicted for Mallard Island (i.e., maximum increase of 1%) (Appendix 8G, Table  
 40 Cl-39). However, available assimilative capacity would be reduced relative to Existing Conditions in  
 41 April (i.e., up to 21%) (Appendix 8G, Table Cl-41) reflecting substantial degradation during a month  
 42 when average concentrations would be near, or exceed, the objective.

1 In comparison, when utilizing the chloride-EC relationship to model monthly average chloride  
 2 concentrations for the 16-year period, trends in frequency of exceedance generally agreed, but use  
 3 of assimilative capacity were predicted to be larger at some locations (Appendix 8G, Chloride, Table  
 4 Cl-40 and Table Cl-42). Specifically, while the model predicted exceedance frequency would  
 5 decrease at the Contra Costa Canal at Pumping Plant #1 and Rock Slough locations, use of  
 6 assimilative capacity would increase substantially for the months of February through June. (i.e.,  
 7 maximum of 81% in March for the modeled drought period). Due to such seasonal long-term  
 8 average water quality degradation at these locations, the potential exists for substantial adverse  
 9 effects on the municipal and industrial beneficial uses through reduced opportunity for diversion of  
 10 water with acceptable chloride levels. ~~Moreover, due to the increased frequency of exceeding the  
 11 150 mg/L Bay Delta WQCP objective, the potential exists for additional adverse effects on the  
 12 municipal and industrial beneficial uses at Contra Costa Pumping Plant #1 and Antioch.~~

### 13 *303(d) Listed Water Bodies*

14 With respect to the 303(d) listing for chloride in Tom Paine Slough, the monthly average chloride  
 15 concentrations for the 16-year period modeled at Old River at Tracy Road would generally be  
 16 similar compared to Existing Conditions, and thus, would not be further degraded on a long-term  
 17 basis (Appendix 8G, Figure Cl-10). With respect to Suisun Marsh, the monthly average chloride  
 18 concentrations for the 16-year period modeled would generally increase compared to Existing  
 19 Conditions and No Action Alternative in some months during October through May at the  
 20 Sacramento River at Collinsville (Appendix 8G, Figure Cl-11), Mallard Island (Appendix 8G, Figure  
 21 Cl-9), and increase substantially at Montezuma Slough at Beldon's Landing (i.e., over a doubling of  
 22 concentration in December through February) (Appendix 8G, Figure Cl-12), ~~However, modeling of  
 23 Alternative 6A assumed no operation of the Montezuma Slough Salinity Control Gates, but the  
 24 project description assumes continued operation of the Salinity Control Gates, consistent with  
 25 assumptions included in the No Action Alternative. A sensitivity analysis modeling run conducted  
 26 for Alternative 4 with the gates operational consistent with the No Action Alternative resulted in  
 27 substantially lower EC levels than indicated in the original Alternative 4 modeling results for Suisun  
 28 Marsh, but EC levels were still somewhat higher than EC levels under Existing Conditions for several  
 29 locations and months. Although chloride was not specifically modeled in these sensitivity analyses,  
 30 it is expected that chloride concentrations would be nearly proportional to EC levels in Suisun  
 31 Marsh. Another modeling run with the gates operational and restoration areas removed resulted in  
 32 EC levels nearly equivalent to Existing Conditions, indicating that design and siting of restoration  
 33 areas has notable bearing on EC levels at different locations within Suisun Marsh (see Appendix 8H  
 34 Attachment 1 for more information on these sensitivity analyses). These analyses also indicate that  
 35 increases in salinity are related primarily to the hydrodynamic effects of CM4, not operational  
 36 components of CM1. Based on the sensitivity analyses, optimizing the design and siting of  
 37 restoration areas may limit the magnitude of long-term chloride increases in the Marsh. However,  
 38 the chloride concentration increases at certain locations could be substantial, depending on siting  
 39 and design of restoration areas. Thus, these increased chloride levels in Suisun Marsh are  
 40 considered to contribute to additional, measureable long-term degradation that potentially would  
 41 adversely affect the necessary actions to reduce chloride loading for any TMDL that is  
 42 developed, thereby contributing to additional, measureable long-term degradation that potentially  
 43 would adversely affect the necessary actions to reduce chloride loading for any TMDL that is  
 44 developed.~~

45 **NEPA Effects:** In summary, relative to the No Action Alternative conditions, Alternative 6A would  
 46 result in ~~increased frequency of exceedance of the 150 mg/L Bay Delta WQCP objective at Contra~~



1 ~~Costa Pumping Plant #1 and Antioch~~, substantial seasonal use of assimilative capacity at Contra  
2 Costa Pumping Plant #1, Antioch, and Rock Slough, and ~~could result in~~ increased concentrations  
3 with respect to the 303(d) impairment in Suisun Marsh. The predicted chloride increases constitute  
4 an adverse effect on water quality(see Mitigation Measure WQ-7 below; implementation of this  
5 measure along with a separate, non-environmental commitment relating to the potential increased  
6 chloride treatment costs would reduce these effects).Additionally, the predicted changes relative to  
7 the No Action Alternative conditions indicate that in addition to the effects of climate change/sea  
8 level rise, implementation of CM1 and CM4 under Alternative 6A would contribute substantially to  
9 the adverse water quality effects.

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

15 Chloride is not a constituent of concern in the Sacramento River watershed upstream of the Delta,  
16 thus river flow rate and reservoir storage reductions that would occur under the Alternative 6A,  
17 relative to Existing Conditions, would not be expected to result in a substantial adverse change in  
18 chloride levels. Additionally, relative to Existing Conditions, the Alternative 6A would not result in  
19 reductions in river flow rates (i.e., less dilution) or increased chloride loading such that there would  
20 be any substantial increase in chloride concentrations upstream of the Delta in the San Joaquin River  
21 watershed.

22 Relative to Existing Conditions, Alternative 6A operations would result in substantially reduced  
23 chloride concentrations in the Delta such that exceedances of the 250 mg/L Bay-Delta WQCP  
24 objective at the San Joaquin River at Antioch and Mallard Slough would be reduced. Nevertheless,  
25 due to the ~~predicted increased frequency of exceeding the 150 mg/L Bay-Delta WQCP objective at~~  
26 ~~Contra Costa Pumping Plant #1 and Antioch, and the~~ substantial seasonal use of assimilative  
27 capacity at Contra Costa Pumping Plant #1 and Rock Slough, the potential exists for adverse effects  
28 on the municipal and industrial beneficial uses at these locations(see Mitigation Measure WQ-7  
29 below; implementation of this measure along with a separate, non-environmental commitment  
30 relating to the potential increased chloride treatment costs would reduce these effects). Moreover,  
31 the modeled increased chloride concentrations and degradation in the western Delta could still  
32 occur and further contribute, at measurable levels (~~i.e., over a doubling of concentration~~), to the  
33 existing 303(d) listed impairment due to chloride in Suisun Marsh for the protection of fish and  
34 wildlife. Based on these findings, this impact is determined to be significant due to increased  
35 ~~frequency of exceedance of the 150 mg/L Bay-Delta WQCP objective as well as potential adverse~~  
36 ~~effects on fish and wildlife beneficial uses~~~~degradation relative to the 250 mg/L objective in the~~  
37 ~~western Delta as well as potential increased degradation relative to the 303(d) listing~~ in Suisun  
38 Marsh.

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

42 Chloride is not a bioaccumulative constituent, thus any increased concentrations under Alternative  
43 6A would not result in substantial chloride bioaccumulation impacts on aquatic life or humans.  
44 Alternative 6A maintenance would not result in any substantial changes in chloride concentration

1 upstream of the Delta or in the SWP/CVP Export Service Areas. However, based on these findings,  
 2 this impact is determined to be significant due to increased chloride concentrations and degradation  
 3 in Suisun Marsh and its effects on fish and wildlife beneficial uses.

4 While mitigation measures to reduce these water quality effects in affected water bodies to less than  
 5 significant levels are not available, implementation of Mitigation Measure WQ-7 is recommended to  
 6 attempt to reduce the effect that increased chloride concentrations may have on Delta beneficial  
 7 uses. However, because the effectiveness of this mitigation measure to result in feasible measures  
 8 for reducing water quality effects is uncertain, this impact is considered to remain significant and  
 9 unavoidable. Please see Mitigation Measure WQ-7 under Impact WQ-7 in the discussion of  
 10 Alternative 1A.

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

### 22 **Impact WQ-9: Effects on Dissolved Oxygen Resulting from Facilities Operations and** 23 **Maintenance (CM1)**

24 **NEPA Effects:** Effects of CM1 on dissolved oxygen under Alternative 6A are the same as those  
 25 discussed for Alternative 1A and are considered to not be adverse.

26 **CEQA Conclusion:** Effects of CM1 on DO under Alternative 6A would be similar to those discussed for  
 27 Alternative 1A, and are summarized here, then compared to the CEQA thresholds of significance  
 28 (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this  
 29 constituent. For additional details on the effects assessment findings that support this CEQA impact  
 30 determination, see the effects assessment discussion under the Alternative 1A.

31 ~~River flow rate and r~~Reservoir storage reductions that would occur under Alternative 6A, relative to  
 32 Existing Conditions, would not be expected to result in a substantial adverse change in DO levels in  
 33 the reservoirs, ~~because oxygen sources (surface water aeration, aerated inflows, vertical mixing)~~  
 34 ~~would remain. Similarly, river flow rate reductions that would occur would not be expected to~~  
 35 ~~result in a substantial adverse change in DO levels in the -and-~~ rivers upstream of the Delta, given that  
 36 mean monthly flows would remain within the ranges historically seen under Existing Conditions  
 37 and the affected river are large and turbulent. Any reduced DO saturation level that may be caused  
 38 by increased water temperature would not be expected to cause DO levels to be outside of the range  
 39 seen historically. Finally, amounts of oxygen demanding substances and salinity would not be  
 40 expected to change sufficiently to affect DO levels.

41 It is expected there would be no substantial change in Delta DO levels in response to a shift in the  
 42 Delta source water percentages under this alternative or substantial degradation of these water  
 43 bodies, with regard to DO. DO levels would be affected by nutrient loading, which the state has

1 begun to aggressively regulate the discharges of, and this loading would not be expected to lower DO  
 2 levels relative to Existing Conditions based on historical DO levels. Further, the anticipated changes  
 3 in salinity would have relatively minor effects on DO levels, and tidal exchange, which contribute to  
 4 the reaeration of Delta waters would not be expected to change substantially.

5 There is not expected to be substantial, if even measurable, changes in DO levels in the SWP/CVP  
 6 Export Service Areas waters under Alternative 6A, relative to Existing Conditions, because the  
 7 biochemical oxygen demand of the exported water would not be expected to substantially differ  
 8 from that under Existing Conditions (due to ever increasing water quality regulations), canal  
 9 turbulence and exposure of the water to the atmosphere and the algal communities that exist within  
 10 the canals would establish an equilibrium for DO levels within the canals. The same would occur in  
 11 downstream reservoirs.

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

## 20 **Impact WQ-11: Effects on Electrical Conductivity Concentrations Resulting from Facilities** 21 **Operations and Maintenance (CM1)**

### 22 ***Delta***

23 Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2  
 24 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter  
 25 hydrodynamics within the Delta region, which affects mixing of source waters, these effects are  
 26 included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of  
 27 ~~CM2-22CM2-CM21~~ not attributable to hydrodynamics, for example, additional loading of a  
 28 constituent to the Delta, are discussed within the impact header for ~~CM2-22CM2-CM21~~. See section  
 29 8.3.1.3 for more information.

30 Relative to Existing Conditions, Alternative 6A would result in an increase in the number of days the  
 31 Bay-Delta WQCP EC objectives for fish and wildlife protection (which apply during April and May in  
 32 all but critical water year types) would be exceeded in the San Joaquin River at Jersey Point and  
 33 Prisoners Point (Appendix 8H, Electrical Conductivity, Table EC-6), and an increase in exceedance of  
 34 the agricultural EC objective for the Sacramento River at Emmaton.

35 The percent of days the fish and wildlife EC objective would be exceeded at Jersey Point for the  
 36 entire period modeled (1976–1991) would increase from 0% under Existing Conditions to 3%  
 37 under Alternative 6A, and the percent of days out of compliance with the EC objective would  
 38 increase from 0% under Existing Conditions to 5% under Alternative 6A. The percent of days the EC  
 39 objective would be exceeded at Prisoners Point for the entire period modeled would increase from  
 40 6% under Existing Conditions to ~~34~~0% under Alternative 6A, and the percent of days out of  
 41 compliance with the EC objective would increase from 10% under Existing Conditions to ~~34~~0%  
 42 under Alternative 6A. Sensitivity analyses conducted for Alternative 4 scenario H3 indicated that  
 43 removing all tidal restoration areas would reduce the number of exceedances, but there would still

1 be substantially more exceedances than under Existing Conditions or the No Action Alternative.  
 2 Results of the sensitivity analyses indicate that the exceedances are partially a function of the  
 3 operations of the alternative itself, perhaps due to Head of Old River Barrier assumptions and south  
 4 Delta export differences (see Appendix 8H Attachment 1 for more discussion of these sensitivity  
 5 analyses). Due to similarities in the nature of the exceedances between alternatives, the findings  
 6 from these analyses can be extended to this alternative as well. Appendix 8H Attachment 2 contains  
 7 a more detailed assessment of the likelihood of these exceedances impacting aquatic life beneficial  
 8 uses. Specifically, Appendix 8H Attachment 2 discusses whether these exceedances might have  
 9 indirect effects on striped bass spawning in the Delta, and concludes that the high level of  
 10 uncertainty precludes making a definitive determination.

11 At Emmaton, the percent of days the EC objective would be exceeded would increase from 6% under  
 12 Existing Conditions to 328% under Alternative 6A, and the percent of days out of compliance would  
 13 increase from 11% under Existing Conditions to 440% under Alternative 6A.

14 Average EC levels at the western and southern Delta compliance locations and San Joaquin River at  
 15 San Andreas Landing (an interior Delta location) would decrease from 2–56% for the entire period  
 16 modeled and 3–52% during the drought period modeled (1987–1991) (Appendix 8H, Electrical  
 17 Conductivity, Table EC-17). In the S. Fork Mokelumne River at Terminous, average EC would  
 18 increase 7% for the entire period modeled and 6% during the drought period modeled. Average EC  
 19 in the S. Fork Mokelumne River at Terminous (an interior Delta location) would increase during all  
 20 months (Appendix 8H, Table EC-17). The western Delta is Clean Water Act section 303(d) listed as  
 21 impaired due to elevated EC and there would be an increased exceedance of the EC objective at  
 22 Emmaton. Thus, relative to Existing Conditions, Alternative 6A could contribute to additional  
 23 impairment of section 303(d) listed waters. The comparison to Existing Conditions reflects changes  
 24 in EC due to both Alternative 6A operations (including north Delta intake capacity of 15,000 cfs and  
 25 numerous other operational components of Scenario D) and climate change/sea level rise.

26 Relative to the No Action Alternative, the change in percent compliance with Bay-Delta WQCP EC  
 27 objectives under Alternative 6A would be similar to that described above relative to Existing  
 28 Conditions for the Sacramento River at Emmaton, and the San Joaquin River at Jersey Point and  
 29 Prisoners Point. In addition, there would also be a slight increase (<1%) in the percent of days the  
 30 EC objective would be exceeded in Old River at Tracy Bridge for the entire period modeled. For the  
 31 entire period modeled, average EC levels would increase at: S. Fork Mokelumne River at Terminous;  
 32 San Joaquin River at Brandt Bridge and Prisoners Point; and Old River at Tracy Bridge. The greatest  
 33 average EC increase would occur in the S. Fork Mokelumne River at Terminous (8%); the average EC  
 34 increase at the other locations would be <1–3% (Appendix 8H, Electrical Conductivity, Table EC-17).  
 35 During the drought period modeled, average EC would increase at the same locations, except San  
 36 Joaquin River at Prisoners Point. The greatest average EC increase during the drought period  
 37 modeled would occur in the S. Fork Mokelumne River at Terminous (7%); the increase at the other  
 38 locations would be 1–2% (Appendix 8H, Table EC-17). Given that the western ~~and southern~~ Delta  
 39 ~~are is~~ Clean Water Act section 303(d) listed as impaired due to elevated EC, the increase in the  
 40 incidence of exceedance of EC objectives ~~and increase in long-term and drought period average EC~~  
 41 ~~under Alternative 6A at southern Delta compliance locations and increase in exceedance of EC~~  
 42 ~~objectives~~ at Emmaton, relative to the No Action Alternative, has the potential to contribute to  
 43 additional impairment and potentially adversely affect beneficial uses. The comparison to the No  
 44 Action Alternative reflects changes in EC due only to Alternative 6A operations (including north  
 45 Delta intake capacity of 15,000 cfs and numerous other operational components of Scenario D).

1 For Suisun Marsh, October–May is the period when Bay-Delta WQCP EC objectives for protection of  
 2 fish and wildlife apply. Long-term average EC would increase under Alternative 6A, relative to  
 3 Existing Conditions, during the months of April and May by 0.2–0.4 mS/cm in the Sacramento River  
 4 at Collinsville (Appendix 8H, *Electrical Conductivity*, Table EC-21). Long-term average EC would  
 5 decrease relative to Existing Conditions in Montezuma Slough at National Steel during October–May  
 6 (Appendix 8H, Table EC-22). The most substantial increase would occur near Beldon Landing, with  
 7 long-term average EC levels increasing by 0.8–2.2 mS/cm, depending on the month, nearly doubling  
 8 during some months the long-term average EC relative to Existing Conditions (Appendix 8H, Table  
 9 EC-23). Sunrise Duck Club and Volanti Slough also would have long-term average EC increases  
 10 during February–May of 0.4–1.7 mS/cm (Appendix 8H, Tables EC-24 and EC-25). Modeling of this  
 11 alternative assumed no operation of the Montezuma Slough Salinity Control Gates, but the project  
 12 description assumes continued operation of the Salinity Control Gates, consistent with assumptions  
 13 included in the No Action Alternative. A sensitivity analysis modeling run conducted for Alternative  
 14 4 scenario H3 with the gates operational consistent with the No Action Alternative resulted in  
 15 substantially lower EC levels than indicated in the original Alternative 4 modeling results, but EC  
 16 levels were still somewhat higher than EC levels under Existing Conditions and the No Action  
 17 Alternative for several locations and months. Another modeling run with the gates operational and  
 18 restoration areas removed resulted in EC levels nearly equivalent to Existing Conditions and the No  
 19 Action Alternative, indicating that design and siting of restoration areas has notable bearing on EC  
 20 levels at different locations within Suisun Marsh (see Appendix 8H Attachment 1 for more  
 21 information on these sensitivity analyses). These analyses also indicate that increases are related  
 22 primarily to the hydrodynamic effects of CM4, not operational components of CM1. Based on the  
 23 sensitivity analyses, optimizing the design and siting of restoration areas may limit the magnitude of  
 24 long-term EC increases to be on the order of 1 mS/cm or less. Due to similarities in the nature of the  
 25 EC increases between alternatives, the findings from these analyses can be extended to this  
 26 alternative as well.

27 The degree to which the long-term average EC increases in Suisun Marsh would cause exceedance of  
 28 Bay-Delta WQCP objectives is unknown, because these objectives are expressed as a monthly  
 29 average of daily high tide EC, which does not have to be met if it can be demonstrated “equivalent or  
 30 better protection will be provided at the location” (State Water Resources Control Board 2006:14).  
 31 The ~~described~~ long-term average EC increase may, or may not, contribute to adverse effects on  
 32 beneficial uses, depending on how and when wetlands are flooded, soil leaching cycles, and how  
 33 agricultural use of water is managed, and future actions taken with respect to the marsh. However,  
 34 the EC increases at certain locations ~~would~~ could be substantial, depending on siting and design of  
 35 restoration areas, and it is uncertain the degree to which current management plans for the Suisun  
 36 Marsh would be able to address these substantially higher EC levels and protect beneficial uses.  
 37 Thus, these increased EC levels in Suisun Marsh are considered to have a potentially adverse effect  
 38 on marsh beneficial uses. Long-term average EC increases in Suisun Marsh under Alternative 6A  
 39 relative to the No Action Alternative would be similar to the increases relative to Existing  
 40 Conditions. Suisun Marsh also is section 303(d) listed as impaired due to elevated EC, and the  
 41 potential increases in long-term average EC concentrations could contribute to additional  
 42 impairment, ~~because the increases would be double that relative to Existing Conditions and the No~~  
 43 ~~Action Alternative.~~

44 **NEPA Effects:** In summary, the increased frequency of exceedance of EC objectives ~~and increased~~  
 45 ~~long-term and drought period average EC levels that would occur at southern Delta compliance~~  
 46 ~~locations, and increased exceedance of objectives~~ in the western Delta under Alternative 6A, relative

1 to the No Action Alternative, would contribute to adverse effects on the agricultural beneficial uses.  
 2 In addition, the increased frequency of exceedance of the San Joaquin River at Prisoners Point and  
 3 Jersey Point EC objectives and long-term and drought period average EC at Prisoners Point could  
 4 contribute to adverse effects on fish and wildlife beneficial uses (specifically, indirect adverse effects  
 5 on striped bass spawning), though there is a high degree of uncertainty associated with this impact.  
 6 The western and southern Delta are CWA section 303(d) listed as impaired due to elevated EC, and  
 7 the increase in incidence of exceedance of EC objectives in the western portion of the Delta have the  
 8 potential to contribute to additional beneficial use impairment. ~~Given that the western and southern~~  
 9 ~~Delta are Clean Water Act section 303(d) listed as impaired due to elevated EC, the increase in the~~  
 10 ~~incidence of exceedance of EC objectives and long-term average and drought period average EC in~~  
 11 ~~these portions of the Delta has the potential to contribute to additional beneficial use impairment.~~  
 12 The increases in long-term average EC levels that ~~would~~ could occur in Suisun Marsh would further  
 13 degrade existing EC levels and could contribute ~~additional~~ to adverse effects on the fish and wildlife  
 14 beneficial uses. Suisun Marsh is section 303(d) listed as impaired due to elevated EC, and the  
 15 potential increases in long-term average EC levels could contribute to additional beneficial use  
 16 impairment. These increases in EC constitute an adverse effect on water quality. Mitigation Measure  
 17 WQ-11 would be available to reduce these effects (implementation of this measure along with a  
 18 separate, non-environmental commitment as set forth in EIR/EIS Appendix 3B, *Environmental*  
 19 *Commitments*, relating to the potential EC-related changes would reduce these effects).

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

25 River flow rate and reservoir storage reductions that would occur under Alternative 6A, relative to  
 26 Existing Conditions, would not be expected to result in a substantial adverse change in EC levels in  
 27 the reservoirs and rivers upstream of the Delta, given that: changes in the quality of watershed  
 28 runoff and reservoir inflows would not be expected to occur in the future; the state's aggressive  
 29 regulation of point-source discharge effects on Delta salinity-elevating parameters and the expected  
 30 further regulation as salt management plans are developed; the salt-related TMDLs adopted and  
 31 being developed for the San Joaquin River; and the expected improvement in lower San Joaquin  
 32 River average EC levels commensurate with the lower EC of the irrigation water deliveries from the  
 33 Delta.

34 Relative to Existing Conditions, Alternative 6A would not result in any substantial increases in long-  
 35 term average EC levels in the SWP/CVP Export Service Areas. There would be no exceedance of the  
 36 EC objective at the Jones and Banks pumping plants. Average EC levels for the entire period modeled  
 37 would decrease at both plants and, thus, this alternative would not contribute to additional  
 38 beneficial use impairment related to elevated EC in the SWP/CVP Export Service Areas waters.  
 39 Rather, this alternative would improve long-term EC levels in the SWP/CVP Export Service Areas,  
 40 relative to Existing Conditions.

41 Alternative 6A would result in an increase in the frequency with which Bay-Delta WQCP EC  
 42 objectives for fish and wildlife protection are exceeded in the San Joaquin River at Jersey Point (from  
 43 0% under Existing Conditions to 3% under Alternative 6A) and Prisoners Point (from 6% under  
 44 Existing Conditions to ~~34~~0% under Alternative 6A), and an increase in the EC agricultural objectives  
 45 at Emmaton for the entire period modeled (1976–1991). Because EC is not bioaccumulative, the

1 increases in long-term average EC levels would not directly cause bioaccumulative problems in  
 2 aquatic life or humans. Portions of the Delta on the Clean Water Act section 303(d) list as impaired  
 3 due to elevated EC would not have increased long-term average EC levels relative to Existing  
 4 Conditions, However, at Emmaton, which is in the western Delta, there would be an increased  
 5 frequency of exceedance of the EC objective. Thus, Alternative 6A could contribute to additional  
 6 impairment of section 303(d) listed waters. The increased frequency of exceedance of fish and  
 7 wildlife EC objectives at Prisoners Point and Jersey Point could adversely affect aquatic life  
 8 beneficial uses specifically, indirect adverse effects on striped bass spawning), though there is a high  
 9 degree of uncertainty associated with this impact. This impact is considered to be significant.

10 Further, relative to Existing Conditions, Alternative 6A would could result in substantial increases in  
 11 long-term average EC during the months of October through May in Suisun Marsh, ~~such that EC~~  
 12 ~~levels would nearly double that relative to Existing Conditions.~~ The increases in long-term average  
 13 EC levels that would occur in Suisun Marsh could further degrade existing EC levels and thus  
 14 contribute additionally to adverse effects on the fish and wildlife beneficial uses. Because EC is not  
 15 bioaccumulative, the increases in long-term average EC levels would not directly cause  
 16 bioaccumulative problems in wildlife. Suisun Marsh is Clean Water Act section 303(d) listed for  
 17 elevated EC and the increases in long-term average EC that would occur in the marsh could make  
 18 beneficial use impairment measurably worse. This impact is considered to be significant.

19 Implementation of Mitigation Measure WQ-11 along with a separate, non-environmental  
 20 commitment relating to the potential increased costs associated with EC-related changes would  
 21 reduce these effects. While mitigation measures to reduce these water quality effects in affected  
 22 water bodies to less than significant levels are not available, implementation of Mitigation Measure  
 23 WQ-11 is recommended to attempt to reduce the effect that increased EC concentrations may have  
 24 on Delta beneficial uses. However, because the effectiveness of this mitigation measure to result in  
 25 feasible measures for reducing water quality effects is uncertain, this impact is considered to remain  
 26 significant and unavoidable. Please see Mitigation Measure WQ-11 under Impact WQ-11 in the  
 27 discussion of Alternative 1A.

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

### 39 **Impact WQ-13: Effects on Mercury Concentrations Resulting from Facilities Operations and** 40 **Maintenance (CM1)**

#### 41 ***Delta***

42 Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2  
 43 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter

1 hydrodynamics within the Delta region, which affects mixing of source waters, these effects are  
2 included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of  
3 ~~CM2-22CM2-CM21~~ not attributable to hydrodynamics, for example, additional loading of a  
4 constituent to the Delta, are discussed within the impact header for ~~CM2-22CM2-CM21~~. See section  
5 8.3.1.3 for more information.

6 The water quality impacts of waterborne concentrations of mercury and methylmercury and fish  
7 tissue mercury concentrations were evaluated for 9 Delta locations. The analysis of percentage  
8 change in assimilative capacity of waterborne total mercury of Alternative 6A relative to the 25 ng/L  
9 ecological risk benchmark as compared to Existing Conditions showed the greatest decrease to be  
10 9.2% at the Contra Costa Pumping Plant, 9.1% at the Contra Costa Pumping Plant relative to the No  
11 Action Alternative (Figures 8-53 and 8-54). These changes are not expected to result in adverse  
12 effects to beneficial use. Similarly, changes in methylmercury concentration are expected to be  
13 relatively small. The greatest annual average methylmercury concentration for drought conditions  
14 was 0.165 ng/L for the San Joaquin River at Buckley Cove which was slightly higher than Existing  
15 Conditions (0.161 ng/L) and slightly lower than the No Action Alternative (0.167 ng/L)(Appendix  
16 8I, Table I-6).All modeled input concentrations exceeded the methylmercury TMDL guidance  
17 objective of 0.06 ng/L, therefore percentage change in assimilative capacity was not evaluated for  
18 methylmercury.

19 Fish tissue estimates show substantial percentage increases in concentration and exceedance  
20 quotients for mercury at some Delta locations. The greatest increases in exceedance quotients  
21 (ranging from 33 to 64%) are expected for Franks Tract and Old River at Rock Slough relative to  
22 Existing Conditions and the No Action Alternative (Figure ~~8-558-55a,b~~, Appendix 8I, Table I-13b).  
23 Because these increases are substantial, and it is evident that substantive increases are expected at  
24 numerous locations throughout the Delta, these changes may be measurable in the environment.  
25 See Appendix 8I for a discussion of the uncertainty associated with the fish tissue estimates.

#### 26 ***SWP/CVP Export Service Areas***

27 The analysis of mercury and methylmercury in the SWP/CVP Export Service Areas was based on  
28 concentrations estimated at the Banks and Jones pumping plants. Both waterborne total and  
29 methylmercury concentrations for Alternative 6A are projected to be lower than Existing Conditions  
30 and the No Action Alternative (Appendix 8I, Mercury, Figures 8I-4 and 8I-5). Therefore, mercury  
31 shows an increased assimilative capacity at these locations (Figures 8-53 and 8-54).

32 The largest improvements in bass tissue mercury concentrations and exceedance quotients for  
33 Alternative 6A, relative to Existing Conditions and the No Action Alternative at any location within  
34 the Delta are expected for the export pump locations (specifically, at Jones Pumping plant, 41%  
35 improvement relative to Existing Conditions, 43% relative to the No Action Alternative) (Figure ~~8-~~  
36 ~~558-55a,b~~, Appendix 8I, Mercury, Table I-13b).

37 ***NEPA Effects:*** Based on the above discussion, the effects of mercury and methylmercury in  
38 comparison of Alternative 6A to the No Action Alternative (as waterborne and bioaccumulated  
39 forms) are considered to be adverse for the case of fish tissue bioaccumulation at some locations.

40 ***CEQA Conclusion:*** Key findings discussed in the effects assessment provided above are summarized  
41 here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the  
42 purpose of making the CEQA impact determination for this constituent. For additional details on the



1 effects assessment findings that support this CEQA impact determination, see the effects assessment  
2 discussion that immediately precedes this conclusion.

3 Under Alternative 6A, greater water demands and climate change would alter the magnitude and  
4 timing of reservoir releases and river flows upstream of the Delta in the Sacramento River  
5 watershed and east-side tributaries, relative to Existing Conditions. Concentrations of mercury and  
6 methylmercury upstream of the Delta will not be substantially different relative to Existing  
7 Conditions due to the lack of important relationships between mercury/methylmercury  
8 concentrations and flow for the major rivers.

9 Methylmercury concentrations exceed criteria at all locations in the Delta and no assimilative  
10 capacity exists. Monthly average waterborne concentrations of total and methylmercury, over the  
11 period of record, are very similar to Existing Conditions, but showed notable increases at some  
12 locations. Estimates of fish tissue mercury concentrations show substantial increases would occur  
13 for several sites for ~~Methylmercury concentrations exceed criteria at all locations in the Delta and no~~  
14 ~~assimilative capacity exists. However, monthly average waterborne concentrations of total and~~  
15 ~~methylmercury, over the period of record, are very similar to Existing Conditions. Similarly,~~  
16 ~~estimates of fish tissue mercury concentrations show almost no differences would occur among~~  
17 ~~sites for~~ Alternative 6A as compared to Existing Conditions for Delta sites.

18 Assessment of effects of mercury in the SWP and CVP Export Service Areas were based on effects on  
19 mercury concentrations and fish tissue mercury concentrations at the Banks and Jones pumping  
20 plants. The Banks and Jones pumping plants are expected to show increased assimilative capacity  
21 for waterborne mercury and decreased fish tissue concentrations of mercury for Alternative 6A as  
22 compared to Existing Conditions.

23 As such, this alternative is not expected to cause additional exceedance of applicable water quality  
24 objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects  
25 on any beneficial uses of waters in the affected environment. However, increases in fish tissue  
26 mercury concentrations are substantial, and changes in fish tissue mercury concentrations would  
27 make existing mercury-related impairment in the Delta measurably worse. In comparison to  
28 Existing Conditions, Alternative 6A would increase levels of mercury by frequency, magnitude, and  
29 geographic extent such that the affected environment would be expected to have measurably higher  
30 body burdens of mercury in aquatic organisms, thereby substantially increasing the health risks to  
31 wildlife (including fish) or humans consuming those organisms. This impact is considered to be  
32 significant. Feasible or effective actions to reduce the effects on mercury resulting from CM1 are  
33 unknown. General mercury management measures through CM12, or actions taken by other entities  
34 or programs such as TMDL implementation, may minimize or reduce sources and inputs of mercury  
35 to the Delta and methylmercury formation. However, it is uncertain whether this impact would be  
36 reduced to a level that would be less than significant as a result of CM12 or other future actions.  
37 Therefore, the impact would be significant and unavoidable.

### 38 **Impact WQ-25: Effects on Selenium Concentrations Resulting from Facilities Operations and** 39 **Maintenance (CM1)**

#### 40 ***Delta***

41 Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2  
42 and CM4) would affect Delta hydrodynamics. To the extent that restoration actions alter  
43 hydrodynamics within the Delta region, which affects mixing of source waters, these effects are

1 included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of  
 2 ~~CM2-22CM2-CM21~~ not attributable to hydrodynamics, ~~for example, such as~~ additional loading of a  
 3 constituent to the Delta, are discussed within the impact header for ~~CM2-22CM2-CM21~~. See ~~section~~  
 4 ~~Section 8.3.1.3~~ for more information.

5 ~~Selenium concentrations and threshold comparisons for each of the 11 modeled Delta assessment~~  
 6 ~~locations under Alternative 5, relative to Existing Conditions and the No Action Alternative, are~~  
 7 ~~presented in Appendix 8M, Selenium, Table M-9a for water, Tables M-16 and M-26 for most biota~~  
 8 ~~(whole-body fish [excluding sturgeon], bird eggs [invertebrate diet], bird eggs [fish diet], and fish~~  
 9 ~~fillets) throughout the Delta, and Tables M-30 through M-32 for sturgeon at the two western Delta~~  
 10 ~~locations. Figures 8-59a and 8-60a present graphical distributions of predicted selenium~~  
 11 ~~concentration changes (shown as changes in available assimilative capacity based on 1.3 µg/L) in~~  
 12 ~~water at each modeled assessment location for all years. Appendix 8M, Figure M-23 provides more~~  
 13 ~~detail in the form of monthly patterns of selenium concentrations in water during the modeling~~  
 14 ~~period.~~

15 Alternative 6A would result in small to moderate changes in average selenium concentrations in  
 16 water at all modeled Delta assessment locations relative to Existing Conditions and the No Action  
 17 Alternative (Appendix 8M, ~~Selenium, Table M-9a~~10A). ~~Long-term average concentrations at interior~~  
 18 ~~and western Delta locations would increase by 0.01–0.17 µg/L for the entire period modeled (1976–~~  
 19 ~~1991). These changes-increases in selenium concentrations in water are reflected in small (10% or~~  
 20 ~~less) to moderate (between 11% and 50%) percent changes-would result in reductions in available~~  
 21 ~~assimilative capacity of 1–16%, for selenium (based on relative to the 21.3 µg/L ecological risk~~  
 22 ~~benchmarkUSEPA draft water quality criterion (Figures 8-59a and 8-60a)) for all years. Relative to~~  
 23 ~~Existing Conditions, Alternative 6A would result in the largest modeled increase in available~~  
 24 ~~assimilative capacity at Buckley Cove (2%); relative to the No Action Alternative, the largest~~  
 25 ~~increase would be at Staten Island (1%), and the largest decreases relative to Existing Conditions~~  
 26 ~~and the No Action Alternative would be at Contra Costa PP (16% and 15%, respectively) (Figures 8-~~  
 27 ~~59 and 8-60). Although there would be moderate negative changes in assimilative capacity at two~~  
 28 ~~locations (Contra Costa PP and Rock Slough [15% decrease in available assimilative capacity for~~  
 29 ~~Existing Conditions and the No Action Alternative]), the changes are small (10% or less decrease) at~~  
 30 ~~the other locations and the available assimilative capacity at all locations would remain substantial;~~  
 31 ~~therefore, the effect of Alternative 6A is generally minimal for the Delta. The long-term average~~  
 32 ~~Furthermore, the modeled selenium concentrations in water (Appendix 8M, Table M-19~~10A) for  
 33 Alternative 6A (range 0.2409–0.740 µg/L) ~~would be similar to~~ Existing Conditions (range 0.2409–  
 34 0.7641 µg/L); and the No Action Alternative (range 0.2409–0.6938 µg/L) ~~are generally similar~~, and  
 35 all would be below the ~~ecological risk benchmarkUSEPA draft water quality criterion of 1.3(2 µg/L)~~  
 36 ~~(Appendix 8M, Table M-9a).~~

37 Relative to Existing Conditions and the No Action Alternative, Alternative 6A would generally result  
 38 in small ~~changes-increases (less than 54%)~~ in estimated selenium concentrations in ~~most~~ biota  
 39 (whole-body fish ~~(excluding sturgeon)~~, bird eggs [invertebrate diet], bird eggs [fish diet], and fish  
 40 fillets) ~~throughout the Delta, with little difference among locations (Figures 8-61a through 8-64b;~~  
 41 ~~Appendix 8M, Selenium, Table M-17-26and Table 8M-2 in the sturgeon addendum to Appendix~~  
 42 ~~8MAddendum M.A, Selenium in Sturgeon, to Appendix 8M, Table M.A-2). Despite the small~~  
 43 ~~changesincreases in selenium concentrations in biota, Level of Concern Exceedance Quotients (i.e.,~~  
 44 ~~modeled tissue divided by Level of Concern benchmarks) for selenium concentrations in those biota~~  
 45 ~~for all years and for drought years are less than 1.0 (indicating low probability of adverse effects).~~  
 46 ~~Similarly, Advisory Tissue Level Exceedance Quotients for selenium concentrations in fish fillets for~~

1 all years and drought years also are less than 1.0. Estimated selenium concentrations in sturgeon for  
 2 the San Joaquin River at Antioch are predicted to increase by about 41 percent relative  
 3 Existing Conditions and 42 percent relative to the No Action Alternative in all years (from about 4.7  
 4 to 6.6 mg/kg dry weight [dw]). Likewise, those for sturgeon in the Sacramento River at Mallard  
 5 Island are predicted to increase by about 24 percent in all years (from about 4.4 to 5.5 mg/kg dw)  
 6 (Figure 8-65; Appendix 8M, Tables M-30 and M-31). Selenium concentrations in sturgeon during  
 7 drought years are expected to increase by about 14 or about and 28 percent at those locations.  
 8 Detection of small changes in whole-body sturgeon such as those estimated for the western Delta  
 9 may require large sample sizes because of the inherent variability in fish tissue selenium  
 10 concentrations. Low Toxicity Threshold Exceedance Quotients for selenium concentrations in  
 11 sturgeon in the western Delta would exceed 1.0 for drought years at both locations (as they do for  
 12 Existing Conditions and the No Action Alternative; Figure 8-65) and for all years at both locations,  
 13 whereas Existing Conditions and the No Action Alternative do not (quotients increase from 0.94 to  
 14 1.3 at San Joaquin at Antioch, to 1.3 and from 0.88 to 1.1 at Sacramento River at Mallard Island to  
 15 1.1) (Appendix 8M, Table M-32). High Toxicity Threshold Exceedance Quotients for selenium  
 16 concentrations in sturgeon in the western Delta would exceed 1.0 for drought years in the San  
 17 Joaquin River at Antioch, whereas Existing Conditions and the No Action Alternative do not  
 18 (quotient s-increases from about 0.8;5-0.86 to 1.1) (Figure 8-65; Appendix 8M, Table M-32).

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

36 Increased water residence times could increase the bioaccumulation of selenium in biota, thereby  
 37 potentially increasing fish tissue and bird egg concentrations of selenium (see residence time  
 38 discussion in Appendix 8M, Selenium, and Presser and Luoma [2010b]). Thus, residence time was  
 39 assessed for its relevance to selenium bioaccumulation. Table 60a (presented originally in Section  
 40 8.3.1.7 in the Microcystis subsection) shows the time for neutrally buoyant particles to move through  
 41 the Delta (surrogate for flow and residence time). Although an increase in residence time  
 42 throughout the Delta is expected under the No Action Alternative, relative to Existing Conditions  
 43 (because of climate change and sea level rise), the change is fairly small in most areas of the Delta.  
 44 Thus, the changes in residence times between Alternative 6A and the No Action Alternative are very  
 45 similar to the changes in residence times between Alternative 6A and the Existing Conditions.

1 Relative to Existing Conditions and the No Action Alternative, increases in residence times for  
2 Alternative 6A would be greater in the South Delta and East Delta than in other sub-regions. Relative  
3 to Existing Conditions, annual average residence times for Alternative 6A in the South Delta are  
4 expected to increase by more than 53 days (Table 60a), and in the East Delta increase by more than  
5 32 days. Increases in residence times for other sub-regions would be smaller, especially as  
6 compared to Existing Conditions and the No Action Alternative (which are longer than those  
7 modeled for the South Delta). As mentioned above, these results incorporate hydrodynamic effects  
8 of both CM1 and CM2 and CM4, and the effects of CM1 cannot be distinguished from the effects of  
9 CM2 and CM4. However, it is expected that CM2 and CM4 are substantial drivers of the increased  
10 residence time.

11 Presser and Luoma (2010b) summarized and discussed selenium uptake in the Bay-Delta (including  
12 hydrologic conditions [e.g., Delta outflow and residence time for water],  $K_d$ s [the ratio of selenium  
13 concentrations in particulates, as the lowest level of the food chain, relative to the water-borne  
14 concentration], and associated tissue concentrations [especially in clams and their consumers, such  
15 as sturgeon]). When the Delta Outflow Index (daily average flow per month) decreased by five-fold  
16 (73,732 cubic feet per second [cfs] in June 1998 to 12,251 cfs in October 1998), residence time  
17 doubled (from 11 to 22 days) and the calculated mean  $K_d$  also doubled (from 3,198 to 6,501).  
18 However, when daily average Delta outflow in November 1999 was only 6,951 cfs (i.e., about one-  
19 half that in October 1998) and residence time was 70 days, the calculated mean  $K_d$  (7,614) did not  
20 increase proportionally.

21 Models are not available to quantitatively estimate the level of changes in selenium bioaccumulation  
22 as related to residence time, but the effects of residence time are incorporated in the  
23 bioaccumulation modeling for selenium that was based on higher  $K_d$  values for drought years in  
24 comparison to wet, normal, or all years; see Appendix 8M, *Selenium*. If increases in fish tissue or bird  
25 egg selenium were to occur, the increases would likely be of concern only where fish tissues or bird  
26 eggs are already elevated in selenium to near or above thresholds of concern. That is, where biota  
27 concentrations are currently low and not approaching thresholds of concern (which, as discussed  
28 above, is the case throughout the Delta, except for sturgeon in the western Delta), changes in  
29 residence time alone would not be expected to cause them to then approach or exceed thresholds of  
30 concern. In consideration of this factor, although the Delta as a whole is a CWA Section 303(d)-listed  
31 water body for selenium, and although monitoring data of fish tissue or bird eggs in the Delta are  
32 sparse, the most likely area in which biota tissues would be at levels high enough that additional  
33 bioaccumulation due to increased residence time from restoration areas would be a concern is the  
34 western Delta and Suisun Bay for sturgeon, as discussed above. As shown in Table 60a, the overall  
35 increase in residence time estimated in the western Delta is 6 days relative to Existing Conditions,  
36 and 4 days relative to the No Action Alternative. Given the available information, these increases are  
37 small enough that they are not expected to substantially affect selenium bioaccumulation in the  
38 western Delta. Because CM2 and CM4 are expected to be substantial drivers of the increased  
39 residence times, further discussion is included in Impact WQ-26 below.

40 In summary, -and the No Action Alternative, the largest increase of selenium concentrations in biota  
41 would be at Contra Costa PP for drought years and in sturgeon at the two western Delta locations in  
42 all as well as drought years. Relative to Existing Conditions, the largest decrease in selenium  
43 concentrations in biota would be at Buckley Cove for drought years; relative to the No Action  
44 Alternative, the largest decrease would be at Staten Island for drought years. Except for sturgeon in  
45 the western Delta, concentrations of selenium in whole-body fish and bird eggs (invertebrate and  
46 fish diets) would exceed only the lower benchmarks (4 and 6 mg/kg dry weight, respectively,

1 indicating a low potential for effects), under drought conditions, at Buckley Cove for Alternative 6A  
 2 and for Existing Conditions and the No Action Alternative (Figures 8-61 through 8-63). However,  
 3 Exceedance Quotients exceedance quotients for these exceedances of the lower benchmarks are  
 4 between 1.0 and 1.5, indicating a low risk to biota in the Delta, with Alternative 6A being similar to  
 5 Existing Conditions and the No Action Alternative. Selenium concentrations in fish fillets would not  
 6 exceed the screening value for protection of human health (Figure 8-64). For sturgeon in the  
 7 western Delta, whole-body selenium concentrations would increase from 12.3 mg/kg under Existing  
 8 Conditions and the No Action Alternative to 15.1 mg/kg under Alternative 6A, a 23% increase (Table  
 9 M.A-2 Table 8M-2 in the sturgeon addendum to Appendix 8M). All of these values exceed both the  
 10 low and high toxicity benchmarks. The predicted increases are high enough that they may represent  
 11 a measurable increase in body burdens of sturgeon, which would constitute an adverse impact.

12 Relative to Existing Conditions and the No Action Alternative, Alternative 6A would result in small  
 13 changes in increases in selenium concentrations throughout the Delta for most biota (less than 54%),  
 14 although although larger increases in selenium concentrations are predicted for sturgeon in the  
 15 western Delta. The Low Toxicity Threshold Exceedance Quotient for selenium concentrations in  
 16 sturgeon for all years in the San Joaquin River at Antioch would increase from 0.94 for Existing  
 17 Conditions and the No Action Alternative to 1.3, and from 0.88 to 1.1 at Sacramento River at Mallard  
 18 Island. Concentrations of selenium in sturgeon would exceed only the lower benchmark, indicating a  
 19 low potential for effects, with the exception of San Joaquin at Antioch for drought years. The High  
 20 Toxicity Threshold Exceedance Quotient for selenium concentrations for sturgeon in the western  
 21 Delta at Antioch in drought years would increase from about 0.85 for Existing Conditions and 0.86  
 22 for the No Action Alternative to 1.1, indicating a high potential for effects. The modeling of  
 23 bioaccumulation for sturgeon is less calibrated to site-specific conditions than that for other biota,  
 24 which was calibrated on a robust dataset for modeling of bioaccumulation in largemouth bass as a  
 25 representative species for the Delta. Overall, the predicted increases for Alternative 6A are high  
 26 enough that they may represent a measurable increase in body burdens of sturgeon, which would  
 27 constitute an adverse impact.

### 28 **SWP/CVP Export Service Areas**

29 Alternative 6A would result in ~~small to moderate~~ changes in (0.12–0.19 µg/L) decreases in long-  
 30 term average selenium concentrations in water at the Banks and Jones pumping plants, relative to  
 31 Existing Conditions and the No Action Alternative, for the entire period modeled (Appendix 8M,  
 32 Selenium, Table M-10A-9a). These decreases in long-term average selenium concentrations in water  
 33 would result in increases in available assimilative capacity for selenium at these pumping plants of  
 34 11–20%, relative to the 1.3 µg/L ecological risk benchmark USEPA draft water quality criterion  
 35 (Figures 8-59a and 8-60a). Furthermore These changes are reflected in small (10% or less) to  
 36 moderate (between 11% and 50%) percent changes in available assimilative capacity for selenium  
 37 for all years. Relative to Existing Conditions and the No Action Alternative, Alternative 6A would  
 38 result in increases in available assimilative capacity at Banks PP (10% and 9%, respectively) and at  
 39 Jones PP (18% and 19%, respectively) (Figures 8-59 and 8-60), and would have a positive effect at  
 40 the Export Service Area locations. The modeled selenium concentrations in water (Appendix 8M,  
 41 Table M-10A) for Alternative 6A (0.3209 µg/L) would be lower than the ranges for Existing  
 42 Conditions (range 0.37–0.58 µg/L) and the No Action Alternative (range 0.37–0.59 µg/L), and all  
 43 would be below the ecological risk benchmark USEPA draft water quality criterion (of 21.3 µg/L  
 44 (Appendix 8M, Table M-9a).

1 Relative to Existing Conditions and the No Action Alternative, Alternative 6A would result in small  
 2 changes (less than 5%) in estimated selenium concentrations in biota (whole-body fish, bird eggs  
 3 [invertebrate diet], bird eggs [fish diet], and fish fillets) at export service areas (Figures 8-61a  
 4 through 8-64b; Appendix 8M, Selenium, Table M-1726). ~~Relative to Existing Conditions, the largest~~  
 5 ~~increase of selenium concentrations in biota would be at Banks PP for drought years (except for bird~~  
 6 ~~eggs [assuming a fish diet] at Banks PP for all years), and relative to the No Action Alternative, the~~  
 7 ~~largest increase would be at Banks PP for drought years. Relative to Existing Conditions and the No~~  
 8 ~~Action Alternative, the largest decrease of selenium concentration in biota would be at Jones PP for~~  
 9 ~~drought years. However, c~~Concentrations in biota would not exceed any selenium benchmarks for  
 10 Alternative 6A (Figures 8-61a through 8-64a).

~~Thus, relative to Existing Conditions and the No Action Alternative, Alternative 6A would result in~~  
 11 ~~small to moderate changes in selenium concentrations in water and minimal changes in selenium~~  
 12 ~~concentrations in biota at the Export Service Area locations. Selenium concentrations in water and~~  
 13 ~~biota would generally decrease under Alternative 6A and would not exceed ecological benchmarks~~  
 14 ~~at either location, whereas the lower benchmark for bird eggs (fish diet) would be exceeded under~~  
 15 ~~Existing Conditions and the No Action Alternative at Jones PP for drought years. This small positive~~  
 16 ~~change in selenium concentrations under Alternative 6A would be expected to slightly decrease the~~  
 17 ~~frequency with which applicable benchmarks would be exceeded or slightly improve the quality of~~  
 18 ~~water at the Export Service Area locations, with regard to selenium.~~

20 **NEPA Effects:** Based on the discussion above, the effects on selenium from Alternative 6A are  
 21 considered to be adverse. This determination is reached because selenium concentrations in whole-  
 22 body sturgeon modeled at two western Delta locations would increase by an estimated average of  
 23 2327%, which may represent a measurable increase in the environment. Because both low and high  
 24 toxicity benchmarks ~~are would be already~~ exceeded ~~under the No Action Alternative~~, these  
 25 potentially measurable increases represent an adverse impact.

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

31 There are no substantial point sources of selenium in watersheds upstream of the Delta, and no  
 32 substantial nonpoint sources of selenium in the watersheds of the Sacramento River and the eastern  
 33 tributaries. Nonpoint sources in the San Joaquin Valley that contribute selenium to the Delta will be  
 34 controlled through a TMDL developed by the Central Valley Water Board (2001) for the lower San  
 35 Joaquin River, established limits for the Grassland Bypass Project, and Basin Plan objectives (Central  
 36 Valley Water Board [2010ed]) and State Water Board ([2010eb, 2010ec]) that are expected to result  
 37 in decreasing discharges of selenium from the San Joaquin River to the Delta. Consequently, any  
 38 modified reservoir operations and subsequent changes in river flows under Alternative 6A, relative  
 39 to Existing Conditions, are expected to cause negligible changes in selenium concentrations in water.  
 40 Any negligible changes in selenium concentrations that may occur in the water bodies of the affected  
 41 environment located upstream of the Delta would not be of frequency, magnitude, and geographic  
 42 extent that would adversely affect any beneficial uses or substantially degrade the quality of these  
 43 water bodies as related to selenium.

1 Relative to Existing Conditions, modeling estimates indicate that Alternative 6A would result in  
 2 essentially no small changes in selenium concentrations in water or most biota throughout the  
 3 Delta, with no exceedances of benchmarks for biological effects. Relative to Existing Conditions,  
 4 modeling estimates indicate that Alternative 6A would increase selenium concentrations in whole-  
 5 body sturgeon modeled at two western Delta locations by an average of 27%, which may represent a  
 6 measurable increase in the environment. Because both low and high toxicity benchmarks are  
 7 already exceeded under Existing Conditions, these potentially measurable increases represent and a  
 8 potential adverse impact to aquatic fish and wildlife life beneficial uses.

9 ~~Relative to Existing Conditions, modeling estimates indicate that Alternative 6A would increase~~  
 10 ~~selenium concentrations in whole body sturgeon modeled at two western Delta locations by an~~  
 11 ~~estimated 23%, which may represent a measurable increase in the environment. Because both low~~  
 12 ~~and high toxicity benchmarks are already exceeded under Existing Conditions, these potentially~~  
 13 ~~measurable increases represent a potential impact to aquatic life beneficial uses.~~

14 Assessment of effects of selenium in the SWP ~~and~~ CVP Export Service Areas is based on effects on  
 15 selenium concentrations at the Banks and Jones pumping plants. Relative to Existing Conditions,  
 16 Alternative 6A would ~~slightly decrease~~ cause no increase in the frequency with which applicable  
 17 benchmarks would be exceeded and ~~would slightly~~ improve the quality of water in selenium  
 18 concentrations at the Banks and Jones pumping plants locations.

19 Based on the above, although waterborne selenium concentrations would not exceed applicable  
 20 water quality objectives/criteria, however, significant impacts on some beneficial uses of waters in  
 21 the Delta could occur because ~~both low and~~ high toxicity benchmarks ~~are already may be~~ exceeded  
 22 (where they are not under Existing Conditions), and uptake of selenium from water to biota may  
 23 measurably increase. In comparison to Existing Conditions, water quality conditions under this  
 24 alternative would increase levels of selenium (a bioaccumulative pollutant) by frequency,  
 25 magnitude, and geographic extent such that the affected environment may have measurably higher  
 26 body burdens of selenium in aquatic organisms, thereby substantially increasing the health risks to  
 27 wildlife (including fish); however, impacts to humans consuming those organisms are not expected  
 28 to occur. Water quality conditions under this alternative with respect to selenium would cause long-  
 29 term degradation of water quality in the western Delta. Except in the vicinity of the western Delta  
 30 for sturgeon, water quality conditions under this alternative would not increase levels of selenium  
 31 by frequency, magnitude, and geographic extent such that the affected environment would be  
 32 expected to have measurably higher body burdens of selenium in aquatic organisms. The greater  
 33 level of selenium bioaccumulation in the western Delta would further degrade water quality by  
 34 measurable levels, on a long-term basis, for selenium and, thus, cause the CWA 303(d)-listed  
 35 impairment of beneficial use to be made discernibly worse. This impact is considered significant.  
 36 Environmental Commitment: Selenium Management (AMM27), which affords for site-specific  
 37 measures to reduce effects, would be available to reduce BDCP-related effects associated with  
 38 selenium. The effectiveness of AMM27 is uncertain and, therefore implementation may not reduce  
 39 the identified impact to a level that would be less than significant, and therefore it is significant and  
 40 unavoidable.

41 The need for, and the feasibility and effectiveness of, post-operation mitigation for the predicted  
 42 level of selenium bioaccumulation is uncertain. The first step shall be to determine the reliability of  
 43 the model in predicting biota selenium concentrations in the affected environment where effects are  
 44 predicted but selenium data are lacking. For that reason, the model shall be validated with site-  
 45 specific sampling before extensive mitigation measures relative to CM1 operations are developed

1 and evaluated for feasibility, as the measures and their evaluation for feasibility are likely to be  
 2 complex. Specifically, it remains to be determined whether the available existing data for transfer of  
 3 selenium from water to particulates and through different trophic levels of the food chain are  
 4 representative of conditions that may occur from implementation of Alternative 6A. Therefore, the  
 5 proposed mitigation measure requires that sampling be conducted to characterize each step of data  
 6 inputs needed for the model, and then the refined model be validated for local conditions. This  
 7 impact is considered significant and unavoidable.

8 **Impact WQ-26: Effects on Selenium Concentrations Resulting from Implementation of CM2-  
 9 CM2-CM21**

10 *NEPA Effects:* Effects of CM2-CM21 on selenium under Alternative 6A are the same as those  
 11 discussed for Alternative 1A and are considered not to be adverse.

12 *CEQA Conclusion:* CM2-CM21 proposed under Alternative 6A would be similar to those proposed  
 13 under Alternative 1A. As such, effects on selenium resulting from the implementation of CM2-CM21  
 14 would be similar to that previously discussed for Alternative 1A. This impact is considered to be less  
 15 than significant. No mitigation is required.

16 ~~*NEPA Effects:*In general, with the possible exception of changes in Delta hydrodynamics resulting  
 17 from habitat restoration, CM2-CM11 would not substantially increase selenium concentrations in  
 18 the water bodies of the affected environment. Modeling scenarios included assumptions regarding  
 19 how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, and  
 20 thus such effects of these restoration measures were included in the assessment of CM1 facilities  
 21 operations and maintenance (see Impact WQ-25).~~

22 ~~However, implementation of these conservation measures may increase water residence time  
 23 within the restoration areas. Increased restoration area water residence times could potentially  
 24 increase the bioaccumulation of selenium in biota, thereby potentially increasing fish tissue and bird  
 25 egg concentrations of selenium, but models are not available to quantitatively estimate the level  
 26 of changes in residence time and the associated selenium bioavailability. If increases in fish tissue or  
 27 bird egg selenium were to occur, the increases would likely be of concern only where fish tissues or  
 28 bird eggs are already elevated in selenium to near or above thresholds of concern. That is, where  
 29 biota concentrations are currently low and not approaching thresholds of concern, changes in  
 30 residence time alone would not be expected to cause them to then approach or exceed thresholds of  
 31 concern. In consideration of this factor, although the Delta as a whole is a 303(d)-listed water body  
 32 for selenium, and although monitoring data of fish tissue or bird eggs in the Delta are sparse, the  
 33 most likely areas in which biota tissues would be at levels high enough that additional  
 34 bioaccumulation due to increased residence time from restoration areas would be a concern are the  
 35 western Delta and Suisun Bay, and the South Delta in areas that receive San Joaquin River water.~~

36 ~~The western Delta and Suisun Bay receive elevated selenium loads from North San Francisco Bay  
 37 (including San Pablo Bay, Carquinez Strait, and Suisun Bay) and from the San Joaquin River. Point  
 38 sources of selenium in North San Francisco Bay (i.e., refineries) that contribute selenium to Suisun  
 39 Bay are expected to be reduced through a TMDL under development by the San Francisco Bay Water  
 40 Board (San Francisco Bay Water Board 2012) that is expected to result in decreasing discharges of  
 41 selenium. Nonpoint sources of selenium in the San Joaquin Valley that contribute selenium to the  
 42 San Joaquin River, and thus the Delta and Suisun Bay, will be controlled through a TMDL developed  
 43 by the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the  
 44 Grassland Bypass Project, and Basin Plan objectives (Central Valley Water Board 2010c, d) that are~~



1 expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta. If  
2 selenium levels are not sufficiently reduced via these efforts, it is expected that the State Water  
3 Board and the San Francisco Bay and Central Valley Water Boards would initiate additional actions  
4 to further control sources of selenium.

5 The South Delta receives elevated selenium loads from the San Joaquin River. In contrast to Suisun  
6 Bay and possibly the western Delta in the future, the South Delta lacks the overbite clam (*Corbula*  
7 [*Potamocorbula*] *amurensis*), which is considered a key driver of selenium bioaccumulation in  
8 Suisun Bay, due to its high bioaccumulation of selenium and its role in the benthic food web that  
9 includes long-lived sturgeon. The South Delta does have *Corbicula fluminea*, another bivalve that  
10 bioaccumulates selenium, but it is not as invasive as the overbite clam and thus likely makes up a  
11 smaller fraction of sturgeon diet. Also, as mentioned above, nonpoint sources of selenium in the San  
12 Joaquin Valley that contribute selenium to the Delta will be controlled through a TMDL developed by  
13 the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the  
14 Grassland Bypass Project, and Basin Plan objectives (Central Valley Water Board 2010c, d) that are  
15 expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta.  
16 Further, if selenium levels in the San Joaquin River are not sufficiently reduced via these efforts, it is  
17 expected that the State Water Board and Central Valley Water Board would initiate additional  
18 TMDLs to further control nonpoint sources of selenium.

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

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

39 Given the factors discussed in the assessment above, any increases in bioaccumulation rates from  
40 water-borne selenium that could occur in some areas as a result of increased water residence time  
41 would not be of sufficient magnitude and geographic extent that any portion of the Delta would be  
42 expected to have measurably higher body burdens of selenium in aquatic organisms and, therefore,  
43 would not substantially increase risk for adverse effects to beneficial uses. Furthermore, although  
44 the Delta is a 303(d)-listed water body for selenium, given the discussion in the assessment above, it

1 is unlikely that restoration areas would result in measurable increases in selenium in fish tissues or  
2 bird eggs such that the beneficial use impairment would be made discernibly worse.

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

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

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

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

### 30 **Impact WQ-32. Effects on *Microcystis* Bloom Formation Resulting from Facilities Operations** 31 **and Maintenance (CM1).**

32 Effects of facilities and operations (CM1) on *Microcystis* abundance, and thus microcystins  
33 concentrations, in water bodies of the affected environment under Alternative 6A would be very  
34 similar (i.e., nearly the same) to those discussed for Alternative 1A. This is because factors that  
35 affect *Microcystis* abundance in waters upstream of the Delta, in the Delta, and in the SWP/CVP  
36 Export Services Areas under Alternative 1A would similarly change under Alternative 6A, relative to  
37 Existing Conditions and the No Action Alternative. For the Delta in particular, there are differences  
38 in the direction and magnitude of water residence time changes during the *Microcystis* bloom  
39 period among the six Delta sub-regions under Alternative 6A compared to Alternative 1A, relative to  
40 Existing Conditions and No Action Alternative. However, under Alternative 6A, relative to Existing  
41 Conditions and No Action Alternative, water residence times during the *Microcystis* bloom period in  
42 various Delta sub-regions are expected to increase to a degree that could, similar to Alternative 1A,  
43 lead to an increase in the frequency, magnitude, and geographic extent of *Microcystis* blooms  
44 throughout the Delta. Water exported from the Delta under Alternative 1A will be a mixture of

1 Microcystis-affected water from the existing south Delta intake and unaffected Sacramento River  
2 water from the north Delta intake, which contrasts to Alternative 6, under which water exported to  
3 the SWP/CVP Export Service Areas consist entirely of water from the Sacramento River from the  
4 north Delta that is in unaffected by Microcystis. Because of this, the effects of Microcystis on and the  
5 microcystin concentrations of water exported to the SWP/CVP Export Service Areas could decrease  
6 under Alternative 6A, relative to Existing Conditions.

7 Similar to Alternative 1A, elevated ambient water temperatures relative to Existing Conditions  
8 would occur in the Delta under Alternative 6A, which could lead to earlier occurrences of  
9 Microcystis blooms in the Delta, and increase the overall duration and magnitude of blooms.  
10 However, the degradation of water quality from Microcystis blooms due to the expected increases in  
11 Delta water temperatures is driven entirely by climate change, not effects of CM1. While Microcystis  
12 blooms have not occurred in the Export Service Areas, conditions in the Export Service Areas under  
13 Alternative 6A may become more conducive to Microcystis bloom formation, relative to Existing  
14 Conditions, because water temperatures will increase in the Export Service Areas due to the  
15 expected increase in ambient air temperatures resulting from climate change.

16 **NEPA Effects:** Effects of water facilities and operations (CM1) on Microcystis in water bodies of the  
17 affected environment under Alternative 6A would be very similar to (i.e., nearly the same) to those  
18 discussed for Alternative 1A. In summary, Alternative 6A operations and maintenance, relative to  
19 the No Action Alternative, would result in long-term increases in hydraulic residence time of various  
20 Delta sub-regions during the summer and fall Microcystis bloom period. During this period, the  
21 increased residence time could result in a concurrent increase in the frequency, magnitude, and  
22 geographic extent of Microcystis blooms, and thus microcystin levels, in affected areas of the Delta.  
23 As a result, Alternative 6A operation and maintenance activities would cause further degradation to  
24 water quality with respect to Microcystis in the Delta. Under Alternative 6A, relative to No Action  
25 Alternative, water exported to the SWP/CVP Export Service Area will be a mixture of Microcystis-  
26 affected source water from the south Delta intakes and unaffected source water from the  
27 Sacramento River, diverted at the north Delta intakes. It cannot be determined whether operations  
28 and maintenance under Alternative 6A will result in increased or decreased levels of Microcystis  
29 and microcystins in the mixture of source waters exported from Banks and Jones pumping plants.  
30 Mitigation Measure WQ-32a and WQ-32b are available to reduce the effects of degraded water  
31 quality in the Delta. Although there is considerable uncertainty regarding this impact, the effects on  
32 Microcystis from implementing CM1 is determined to be adverse.

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

38 Under Alternative 6A, additional impacts from Microcystis in the reservoirs and watersheds  
39 upstream of the Delta are not expected, relative to Existing Conditions. Operations and maintenance  
40 occurring under Alternative 6A is not expected to change nutrient levels in upstream reservoirs or  
41 hydrodynamic conditions in upstream rivers and streams such that conditions would be more  
42 conductive to Microcystis production.

43 Relative to Existing Conditions, water temperatures and hydraulic residence times in the Delta are  
44 expected to increase under Alternative 6A, resulting in an increase in the frequency, magnitude and

1 geographic extent of Microcystis blooms in the Delta. However, the degradation of water quality  
2 from Microcystis blooms due to the expected increases in Delta water temperatures is driven  
3 entirely by climate change, not effects of CM1. Increases in Delta residence times are expected  
4 throughout the Delta during the summer and fall bloom period, due in small part to climate change  
5 and sea level rise, but due more proportionately to CM1 and the hydrodynamic impacts of  
6 restoration included in CM2 and CM4. The precise change in local residence times and Microcystis  
7 production expected within any Delta sub-region is unknown because conditions will vary across  
8 the complex networks of intertwining channels, shallow back water areas, and submerged islands  
9 that compose the Delta. Nonetheless, Delta residence times are, in general, expected to increase due  
10 to Alternative 6A. Consequently, it is possible that increases in the frequency, magnitude, and  
11 geographic extent of Microcystis blooms in the Delta will occur due to the operations and  
12 maintenance of Alternative 6A and the hydrodynamic impacts of restoration (CM2 and CM4).

13 The assessment of effects of Microcystis on SWP/CVP Export Service Areas is based on the  
14 assessment of changes in Microcystis levels in export source waters, as well as the effects of  
15 temperature and residence time changes within the Export Service Areas on Microcystis production.  
16 Under Alternative 6A, relative to Existing Conditions, the potential for Microcystis to occur in the  
17 Export Service Area is expected to increase due to increasing water temperature, but this impact is  
18 driven entirely by climate change and not Alternative 6A. Water exported from the Delta to the  
19 Export Service Area will consist entirely of Sacramento River water from the north Delta which is  
20 unaffected by Microcystis. Operations and maintenance (CM1) under Alternative 6A, relative to  
21 existing conditions, is not expected to result in increased levels of Microcystis and microcystins in  
22 the mixture of source waters exported from Banks and Jones pumping plants.

23 Based on the above, this alternative would not be expected to cause additional exceedance of  
24 applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that  
25 would cause significant impacts on any beneficial uses of waters in the affected environment.  
26 Microcystis and microcystins are not 303(d) listed within the affected environment and thus any  
27 increases that could occur in some areas would not make any existing Microcystis impairment  
28 measurably worse because no such impairments currently exist. Because Microcystis and  
29 microcystins are not bioaccumulative, increases that could occur in some areas would not  
30 bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health  
31 risks to fish, wildlife, or humans. However, because it is possible that increases in the frequency,  
32 magnitude, and geographic extent of Microcystis blooms in the Delta will occur due to the  
33 operations and maintenance of Alternative 6A and the hydrodynamic impacts of restoration (CM2  
34 and CM4), long-term water quality degradation may occur and, thus, significant impacts on  
35 beneficial uses could occur. Although there is considerable uncertainty regarding this impact, the  
36 effects on Microcystis from implementing CM1 is determined to be significant.

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

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

43 Please see Mitigation Measure WQ-32a under Impact WQ-32 in the discussion of Alternative 1A.

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

3           Please see Mitigation Measure WQ-32b under Impact WQ-32 in the discussion of Alternative 1A.

4           **Impact WQ-33. Effects on *Microcystis* Bloom Formation Resulting from Other Conservation**  
 5           **Measures (CM2--CM21).**

6           The effects of CM2–CM21 on *Microcystis* under Alternative 96A are the same as those discussed for  
 7           Alternative 1A. In summary, potential environmental effects related to CM2 and CM4 could result in  
 8           an increase in the frequency, magnitude, and geographic extent of *Microcystis* blooms in the Delta,  
 9           relative to Existing Conditions and the No Action Alternative, as a result of increased residence times  
 10          for Delta waters from implementing CM2 and CM4 restoration areas. -Because the hydrodynamic  
 11          effects associated with implementing CM2 and CM4 were incorporated into the modeling used to  
 12          assess CM1, a detailed assessment of the effects of implementing CM2 and CM4 on *Microcystis*  
 13          blooms in the Delta via their effects on Delta water residence time is provided under CM1 (above).  
 14          The effects of ~~CM 2~~CM2 and ~~CM 4~~CM4 on *Microcystis* may be reduced by implementation of  
 15          Mitigation Measures WQ-32A and WQ-32b. The effectiveness of these mitigation measures to result  
 16          in feasible measures for reducing water quality effects is uncertain. Conservation Measures 3 (CM3)  
 17          and CM5-CM21 would not result in an increase in the frequency, magnitude, and geographic extent  
 18          of *Microcystis* blooms in the Delta.

19          **NEPA Effects:** Effects of CM2–CM21 on *Microcystis* under Alternative 6A are the same as those  
 20          discussed for Alternative 1A and are considered to be adverse.

21          **CEQA Conclusion:** Based on the above, this alternative would not be expected to cause additional  
 22          exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic  
 23          extent that would cause significant impacts on any beneficial uses of waters in the affected  
 24          environment. *Microcystis* and microcystins are not 303(d) listed within the affected environment  
 25          and thus any increases that could occur in some areas would not make any existing *Microcystis*  
 26          impairment measurably worse because no such impairments currently exist. Because *Microcystis*  
 27          and microcystins are not bioaccumulative, increases that could occur in some areas would not  
 28          bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health  
 29          risks to fish, wildlife, or humans. Because restoration actions implemented under CM2 and CM4 will  
 30          increase residence time throughout the Delta and create local areas of warmer water during the  
 31          bloom season, it is possible that increases in the frequency, magnitude, and geographic extent of  
 32          *Microcystis* blooms, and thus long-term water quality degradation and significant impacts on  
 33          beneficial uses, could occur. Although there is considerable uncertainty regarding this impact, the  
 34          effects on *Microcystis* from implementing CM2–CM21 are determined to be significant.

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

37          The effects analysis presented in the preceding impacts (Impact WQ-1 through WQ-33) concluded  
 38          that Alternative 6A would have a less than significant impact/no adverse effect on the following  
 39          constituents in the Delta:

- 40          ● Boron
- 41          ● Dissolved Oxygen

1     • Pathogens

2     • Pesticides

3     • Trace Metals

4     • Turbidity and TSS

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

13    The effects of Alternative 6A on bromide, chloride, and DOC, in the Delta were determined to be  
 14    significant/adverse. Increases in bromide, chloride, and DOC concentrations are of concern in  
 15    drinking water supplies; however, as described previously, the San Francisco Bay does not have a  
 16    designated MUN use. Thus, changes in bromide, chloride, and DOC in Delta outflow would not  
 17    adversely effect any beneficial uses of San Francisco Bay.

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

24    While effects of Alternative 6A on the nutrients ammonia, nitrate, and phosphorus were determined  
 25    to be less than significant/not adverse, these constituents are addressed further below because the  
 26    response of the seaward bays to changed nutrient concentrations/loading may differ from the  
 27    response of the Delta. Selenium and mercury are discussed further, because they are  
 28    bioaccumulative constituents where changes in load due to both changes in Delta concentrations  
 29    and exports are of concern.

30    **Nutrients: Ammonia, Nitrate, and Phosphorus**

31    Total nitrogen loads in Delta outflow to Suisun and San Pablo Bays under Alternative 6A would be  
 32    dominated almost entirely by nitrate, because planned upgrades to the SRWTP will result in >95%  
 33    removal of ammonia in its effluent. Total nitrogen loads to Suisun and San Pablo Bays would  
 34    decrease by 5%, relative to Existing Conditions, and increase by 40%, relative to the No Action  
 35    Alternative (Appendix 80, Table O-1). The change in nitrogen loading to Suisun and San Pablo Bays  
 36    under Alternative 6A would not adversely impact primary productivity in these embayments  
 37    because light limitation and grazing current limit algal production in these embayments. To the  
 38    extent that algal growth increases in relation to a change in ammonia concentration, this would have  
 39    net positive benefits, because current algal levels in these embayments are low. Nutrient levels and  
 40    ratios are not considered a direct driver of *Microcystis* and cyanobacteria levels in the North Bay.

41    The phosphorus load exported from the Delta to Suisun and San Pablo Bays for Alternative 6A is  
 42    estimated to increase by 9%, relative to Existing Conditions, and increase by 4% relative to the No

1 Action Alternative (Appendix 80, Table O-1) ). The only postulated effect of changes in phosphorus  
2 loads to Suisun and San Pablo Bays is related to the influence of nutrient stoichiometry on primary  
3 productivity. However, there is uncertainty regarding the impact of nutrient ratios on  
4 phytoplankton community composition and abundance. Any effect on phytoplankton community  
5 composition would likely be small compared to the effects of grazing from introduced clams and  
6 zooplankton in the estuary (Senn and Novick 2014; Kimmerer and Thompson 2014). Therefore, the  
7 projected change in total nitrogen and phosphorus loading that would occur in Delta outflow to San  
8 Francisco Bay is not expected to result in degradation of water quality with regard to nutrients that  
9 would result in adverse effects to beneficial uses.

### 10 Mercury

11 The estimated long-term average mercury and methylmercury loads in Delta exports are shown in  
12 Appendix 80, Table O-2. Loads of mercury and methylmercury from the Delta to San Francisco Bay  
13 are estimated to change relatively little due to changes in source water fractions and net Delta  
14 outflow that would occur under Alternative 6A. Mercury load to the Bay, relative to Existing  
15 Conditions, is estimated to increase by 12 kg/yr (5%), relative to Existing Conditions, and 9 kg/yr  
16 (3%), relative to the No Action Alternative. Methylmercury load is estimated to increase by 0.37  
17 kg/yr (10%), relative to Existing Conditions, and increase by 0.28 kg/yr (7%) relative to the No  
18 Action Alternative. The estimated total mercury load to the Bay is 272 kg/yr, which would be less  
19 than the San Francisco Bay mercury TMDL WLA for the Delta of 330 kg/yr. The estimated changes in  
20 mercury and methylmercury loads would be within the overall uncertainty associated with the  
21 estimates of long-term average net Delta outflow and the long-term average mercury and  
22 methylmercury concentrations in Delta source waters. The estimated changes in mercury load  
23 under the alternative would also be substantially less than the considerable differences among  
24 estimates in the current mercury load to San Francisco Bay (SFBRWQCB 2006; David et al. 2009).  
25 Similar uncertainty is expected in the existing methylmercury load in net Delta exports, for which  
26 the best available current load estimate is based on approximately one year of monitoring data (Foe  
27 et al. 2008).

28 Given that the estimated incremental ~~decreases~~increases of mercury and methylmercury loading to  
29 San Francisco Bay would fall within the uncertainty of current mercury and methylmercury load  
30 estimates, the estimated changes in mercury and methylmercury loads in Delta exports to San  
31 Francisco Bay due to Alternative 6A are not expected to result in adverse effects to beneficial uses or  
32 substantially degrade the water quality with regard to mercury, or make the existing CWA Section  
33 303(d) impairment measurably worse.

### 34 Selenium

35 Changes in source water fraction and net Delta outflow under Alternative 6A, relative to Existing  
36 Conditions, are projected to cause the total selenium load to the North Bay to increase by 24%,  
37 relative to Existing Conditions, and increase by 20%, relative to the No Action Alternative (Appendix  
38 80, Table O-3). Changes in long-term average selenium concentrations of the North Bay are assumed  
39 to be proportional to changes in North Bay selenium loads. Under Alternative 6A, the long-term  
40 average total selenium concentration of the North Bay is estimated to be 0.16µg/L and the dissolved  
41 selenium concentration is estimated to be 0.14 µg/L, which would be a 0.03 µg/L increase relative to  
42 Existing Conditions and the No Action Alternative (Appendix 80, Table O-3). The dissolved selenium  
43 concentration would be below the target of 0.202 µg/L developed by Presser or Luoma (2013) to

1 coincide with a white sturgeon whole-body fish tissue selenium concentration not greater than 8  
2 mg/kg in the North Bay.

3 The incremental increase in dissolved selenium concentrations projected to occur under Alternative  
4 6A, relative to Existing Conditions and the No Action Alternative, would be higher than under  
5 Alternatives 1–5, but still low (0.03 µg/L). The increased dissolved selenium concentration would be  
6 within the overall uncertainty of the analytical methods used to measure selenium in water column  
7 samples; however, it also would be within the uncertainty associated with estimating numeric water  
8 column selenium thresholds (Pressor and Luoma 2013). As described in Section 8.3.1.8, there have  
9 been improvements in selenium concentrations in the tissue of diving ducks and muscle of white  
10 sturgeon since the initial CWA Section 303(d) listing of the North Bay for selenium impairments, and  
11 selenium concentrations in white sturgeon muscle have also generally been below the USEPA’s draft  
12 recommended fish muscle tissue concentration of 11.8 mg/kg dry weight (SFEI 2014). However, as  
13 described under Impact WQ-25, though there is some uncertainty in the estimate of sturgeon  
14 concentrations at western Delta locations, the predicted increases for Alternative 6A are high  
15 enough that they may represent measurably higher body burdens of selenium in aquatic organisms,  
16 thereby substantially increasing the health risks to wildlife (including fish). Because the projected  
17 incremental increases in dissolved selenium could cause measurable changes in water column  
18 concentrations, and these incremental increases would be within the uncertainty in the target water  
19 column threshold for dissolved selenium for protection against adverse bioaccumulative effects in  
20 the North Bay ecosystem, and modeling predicts concentrations in the western Delta may represent  
21 a measurable increase in body burdens of sturgeon, there is potential that the incremental increase  
22 in dissolved selenium concentration projected to occur in the North Bay under Alternative 6A could  
23 result in adverse effects beneficial uses.

24 **NEPA Effects:** Based on the discussion above, Alternative 6A, relative to the No Action Alternative,  
25 would not cause further degradation to water quality with respect to boron, bromide, chloride,  
26 dissolved oxygen, DOC, EC, mercury, pathogens, pesticides, nutrients (ammonia, nitrate,  
27 phosphorus), trace metals, or turbidity and TSS in the San Francisco Bay. Further, changes in these  
28 constituent concentrations in Delta outflow would not be expected to cause changes in Bay  
29 concentrations of frequency, magnitude, and geographic extent that would adversely affect any  
30 beneficial uses. In summary, based on the discussion above, effects on the San Francisco Bay from  
31 implementation of CM1–CM21 are considered to be not adverse with respect to boron, bromide,  
32 chloride, dissolved oxygen, DOC, EC, mercury, pathogens, pesticides, nutrients (ammonia, nitrate,  
33 phosphorus), trace metals, or turbidity and TSS. However, Alternative 6A could result in increases in  
34 selenium concentrations in the North San Francisco Bay that could result in adverse effects to fish  
35 and wildlife beneficial uses. This effect is considered to be adverse.

36 **CEQA Conclusion:** Based on the above, Alternative 6A would not be expected to cause long-term  
37 degradation of water quality in San Francisco Bay resulting in sufficient use of available assimilative  
38 capacity such that occasionally exceeding water quality objectives/criteria would be likely and  
39 would result in substantially increased risk for adverse effects to one or more beneficial uses with  
40 respect to boron, bromide, chloride, dissolved oxygen, DOC, EC, mercury, pathogens, pesticides,  
41 nutrients (ammonia, nitrate, phosphorus), trace metals, or turbidity and TSS. Further, based on the  
42 above, this alternative would not be expected to cause additional exceedance of applicable water  
43 quality objectives/criteria in the San Francisco Bay by frequency, magnitude, and geographic extent  
44 that would cause significant impacts on any beneficial uses of waters in the affected environment  
45 with respect to boron, bromide, chloride, dissolved oxygen, DOC, EC, mercury, pathogens, pesticides,  
46 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).

1 At Barker Slough, predicted long-term average bromide concentrations would decrease from 51  
2 µg/L to 50 µg/L (2% relative decrease) for the modeled 16-year hydrologic period, but would  
3 increase from 54 µg/L to 72 µg/L (34% relative increase) for the modeled drought period. At Barker  
4 Slough, the predicted 50 µg/L exceedance frequency would decrease from 49% under Existing  
5 Conditions to 29% under Alternative 7, but would increase slightly from 55% to 57% during the  
6 drought period. At Barker Slough, the predicted 100 µg/L exceedance frequency would increase  
7 from 0% under Existing Conditions to 8% under Alternative 7, and would increase from 0% to 22%  
8 during the drought period. At Staten Island, predicted long-term average bromide concentrations  
9 would increase from 50 µg/L to 63 µg/L (27% relative increase) for the modeled 16-year hydrologic  
10 period and would increase from 51 µg/L to 64 µg/L (25% relative increase) for the modeled  
11 drought period. At Staten Island, increases in average bromide concentrations would correspond to  
12 an increased frequency of 50 µg/l threshold exceedance, from 47% under Existing Conditions to  
13 80% under Alternative 7 (52% to 88% for the modeled drought period), and an increase from 1% to  
14 2% (0% to 0% for the modeled drought period) for the 100 µg/L threshold. Changes in exceedance  
15 frequency of the 50 µg/L and 100 µg/L concentration thresholds at other assessment locations  
16 would be less considerable, with exception to Franks Tract. Although long-term average bromide  
17 concentrations were modeled to decrease at Franks Tract, exceedances of the 100 µg/L threshold  
18 would increase slightly, from 82% under Existing Conditions to 99% under Alternative 7 (78% to  
19 97% for the modeled drought period). This comparison to Existing Conditions reflects changes in  
20 bromide due to both Alternative 7 operations (including north Delta intake capacity of 9,000 cfs and  
21 numerous other operational components of Scenario E) and climate change/sea level rise.

22 Due to the relatively small differences between modeled Existing Conditions and No Action  
23 baselines, changes in long-term average bromide concentrations and changes in exceedance  
24 frequencies relative to the No Action Alternative are generally of similar magnitude to those  
25 previously described for the existing condition comparison (Appendix 8E, Bromide, Table  
26 16). Modeled long-term average bromide concentration at Barker Slough is predicted to increase by  
27 1% (34% for the modeled drought period) relative to the No Action Alternative. Modeled long-term  
28 average bromide concentration increases at Staten Island are predicted to increase by 31% (29% for  
29 the modeled drought period) relative to the No Action Alternative. However, unlike the Existing  
30 Conditions comparison, long-term average bromide concentrations at Buckley Cove would increase  
31 relative to the No Action Alternative, although the increases would be relatively small ( $\leq 9\%$ ). Unlike  
32 the comparison to Existing Conditions, this comparison to the No Action Alternative reflects changes  
33 in bromide due only to Alternative 7 operations.

34 At Barker Slough, modeled long-term average bromide concentrations for the two baseline  
35 conditions are very similar (Appendix 8E, Bromide, Table 16). Such similarity demonstrates that the  
36 modeled Alternative 7 change in bromide is almost entirely due to Alternative 7 operations, and not  
37 climate change/sea level rise. Therefore, operations are the primary driver of effects on bromide at  
38 Barker Slough, regardless whether Alternative 7 is compared to Existing Conditions, or compared to  
39 the No Action Alternative.

40 Results of the modeling approach which used relationships between EC and chloride and between  
41 chloride and bromide (see Section 8.3.1.3) differed somewhat from what is presented above for the  
42 mass-balance approach (see Appendix 8E, Bromide, Table 17). For most locations, the frequency of  
43 exceedance of the 50 µg/L and 100 µg/L were similar. The greatest difference between the methods  
44 was predicted for Barker Slough. The increases in frequency of exceedance of the 100 µg/L  
45 threshold, relative to Existing Conditions and the No Action Alternative, were not as great using this  
46 alternative EC to chloride and chloride to bromide relationship modeling approach as compared to

1 that presented above from the mass-balance modeling approach. Results indicate 2% exceedance  
2 over the modeled period under Alternative 7, as compared to 1% under Existing Conditions and 2%  
3 under the No Action Alternative. For the drought period, exceedance frequency increased from 0%  
4 under Existing Conditions and the No Action Alternative, to 7% under Alternative 7. Because the  
5 mass-balance approach predicts a greater level of impact at Barker Slough, determination of impacts  
6 was based on the mass-balance results.

7 While the increase in long-term average bromide concentrations at Barker Slough are relatively  
8 small when modeled over a representative 16-year hydrologic period, increases during the modeled  
9 drought period, principally the relative increase in 100 µg/L exceedance frequency, would represent  
10 a substantial change in source water quality during a season of drought. As discussed for Alternative  
11 1A, drinking water treatment plants obtaining water via the North Bay Aqueduct utilize a variety of  
12 conventional and enhanced treatment technologies in order to achieve DBP drinking water criteria.  
13 While the implications of such a modeled drought period change in bromide concentrations at  
14 Barker Slough is difficult to predict, the substantial modeled increases could lead to adverse changes  
15 in the formation of disinfection byproducts such that considerable treatment plant upgrades may be  
16 necessary in order to achieve equivalent levels of health protection during seasons of drought.  
17 Increases at Staten Island are also considerable, although there are no existing or foreseeable  
18 municipal intakes in the immediate vicinity. Because many of the other modeled locations already  
19 frequently exceed the 100 µg/L threshold under Existing Conditions and the No Action Alternative,  
20 these locations likely already require treatment plant technologies to achieve equivalent levels of  
21 health protection, and thus no additional treatment technologies would be triggered by the small  
22 increases in the frequency of exceeding the 100 µg/L threshold. Hence, no further impact on the  
23 drinking water beneficial use would be expected at these locations.

24 The seasonal intakes at Mallard Slough and City of Antioch are infrequently used due to water  
25 quality constraints related to sea water intrusion. On a long-term average basis, bromide at these  
26 locations is in excess of 3,000 µg/L, but during seasonal periods of high Delta outflow can be <300  
27 µg/L. Based on modeling using the mass-balance approach, use of the seasonal intakes at Mallard  
28 Slough and City of Antioch under Alternative 7 would experience a period average increase in  
29 bromide during the months when these intakes would most likely be utilized. For those wet and  
30 above normal water year types where mass balance modeling would predict water quality typically  
31 suitable for diversion, predicted long-term average bromide would increase from 103 µg/L to 152  
32 µg/L (48% increase) at City of Antioch and would increase from 150 µg/L to 204 µg/L (36%  
33 increase) at Mallard Slough relative to Existing Conditions (Appendix 8E, Bromide, Table 23).  
34 Increases would be similar for the No Action Alternative comparison. Modeling results using the EC  
35 to chloride and chloride to bromide relationships show increases during these months, but the  
36 relative magnitude of the increases is much lower (Appendix 8E, Bromide, Table 24). Regardless of  
37 the differences in the data between the two modeling approaches, the decisions surrounding the use  
38 of these seasonal intakes is largely driven by acceptable water quality, and thus have historically  
39 been opportunistic. Opportunity to use these intakes would remain, and the predicted increases in  
40 bromide concentrations at the City of Antioch and Mallard Slough intake would not be expected to  
41 adversely affect MUN beneficial uses, or any other beneficial use, at these locations.

42 Based on modeling using the mass-balance approach, relative to existing and No Action Alternative  
43 conditions, Alternative 7 would lead to predicted improvements in long-term average bromide  
44 concentrations at Franks Tract, Rock Slough, and Contra Costa PP No. 1, in addition to Banks and  
45 Jones (discussed below). At these locations, long-term average bromide concentrations would be  
46 predicted to decrease by as much as 16–32%, depending on baseline comparison. Modeling results

1 using the EC to chloride and chloride to bromide relationships generally do not show similar  
 2 decreases for Rock Slough and Contra Costa PP No. 1, but rather, predict small increases. Based on  
 3 the small magnitude of increases predicted, these increases would not adversely affect beneficial  
 4 uses at those locations.

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

## 17 **Impact WQ-7: Effects on Chloride Concentrations Resulting from Facilities Operations and** 18 **Maintenance (CM1)**

### 19 ***Delta***

20 Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2  
 21 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter  
 22 hydrodynamics within the Delta region, which affects mixing of source waters, these effects are  
 23 included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of  
 24 ~~CM2-22CM2-CM21~~ not attributable to hydrodynamics, for example, additional loading of a  
 25 constituent to the Delta, are discussed within the impact header for ~~CM2-22CM2-CM21~~. See section  
 26 8.3.1.3 for more information.

27 Relative to the Existing Conditions and No Action Alternative, Alternative 7 would result in similar  
 28 or reduced long-term average chloride concentrations for the 16-year period modeled at most of the  
 29 assessment locations, and, depending on modeling approach (see Section 8.3.1.3) increased  
 30 concentrations at the Contra Costa Canal at Pumping Plant #1 (i.e., up to 29% compared to No  
 31 Action Alternative), Rock Slough (i.e., up to 22% compared to No Action Alternative), and the ~~San~~  
 32 ~~Joaquin River at Staten Island~~~~SF Mokelumne at Staten Island~~ (i.e., up to 28% compared to Existing  
 33 Conditions and No Action Alternative) (Appendix 8G, Chloride, Table CI-43 and Table CI-44).  
 34 Moreover, the direction and magnitude of predicted changes for Alternative 7 are similar between  
 35 the alternatives, thus, the effects relative to Existing Conditions and the No Action Alternative are  
 36 discussed together. Additionally, implementation of tidal habitat restoration under CM4 would  
 37 increase the tidal exchange volume in the Delta, and thus may contribute to increased chloride  
 38 concentrations in the Bay source water as a result of increased salinity intrusion. More discussion of  
 39 this phenomenon is included in Section 8.3.1.3. Consequently, while uncertain, the magnitude of  
 40 chloride increases may be greater than indicated herein and would affect the western Delta  
 41 assessment locations the most which are influenced to the greatest extent by the Bay source water.  
 42 The comparison to Existing Conditions reflects changes in chloride due to both Alternative 7  
 43 operations (including north Delta intake capacity of 9,000 cfs and numerous other operational  
 44 components of Scenario E) and climate change/sea level rise. The comparison to the No Action

1 Alternative reflects changes in chloride due only to operations. The following outlines the modeled  
2 chloride changes relative to the applicable objectives and beneficial uses of Delta waters.

### 3 *Municipal Beneficial Uses*

4 Estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output  
5 (see Section 8.3.1.3) were used to evaluate the 150 mg/L Bay-Delta WQCP objective for municipal  
6 and industrial beneficial uses on a basis of the percent of years the chloride objective is exceeded for  
7 the modeled 16-year period. The objective is exceeded if chloride concentrations exceed 150 mg/L  
8 for a specified number of days in a given water year at both the Antioch and Contra Costa Pumping  
9 Plant #1 locations. For Alternative 7, the modeled frequency of objective exceedance would increase  
10 from ~~67~~% of years under Existing Conditions and ~~60~~% under the No Action Alternative to ~~2520~~% of  
11 years under Alternative 7 (Appendix 8G, [Chloride](#), Table Cl-64).

12 Similarly, estimates of chloride concentrations generated using EC-chloride relationships and DSM2  
13 EC output (see Section 8.3.1.3) were also used to evaluate the 250 mg/L Bay-Delta WQCP objective  
14 for chloride at Contra Costa Pumping Plant #1 where daily average objectives apply. The basis for  
15 the evaluation was the predicted number of days the objective was exceeded for the modeled 16-  
16 year period. For Alternative 7, the modeled frequency of objective exceedance would decrease, from  
17 6% of modeled days under Existing Conditions and 5% under the No Action Alternative to 1% of  
18 modeled days under Alternative 7 (Appendix 8G, [Chloride](#), Table Cl-63).

19 Given the limitations inherent to estimating future chloride concentrations (see Section 8.3.1.3),  
20 estimation of chloride concentrations through both a mass balance approach and an EC-chloride  
21 relationship approach was used to evaluate the 250 mg/L Bay-Delta WQCP objectives in terms of  
22 both frequency of exceedance and use of assimilative capacity. When utilizing the mass balance  
23 approach to model monthly average chloride concentrations for the 16-year period, the predicted  
24 frequency of exceeding the 250 mg/L objective would decrease up to 12% (i.e., 24% for Existing  
25 Conditions to 12%) at the Contra Costa Canal at Pumping Plant #1 (Appendix 8G, [Chloride](#), Table Cl-  
26 45 and Figure Cl-13). The frequency of exceedances would decrease at the San Joaquin River at  
27 Antioch (i.e., from 66% under Existing Conditions to 60%) with no substantial change predicted for  
28 Mallard Island (i.e., maximum increase of 1%) (Appendix 8G, Table Cl-45) and no substantial long-  
29 term degradation (Appendix 8G, Table Cl-47). However, relative to the No Action conditions,  
30 available assimilative capacity for chloride at the Contra Costa Canal at Pumping Plant #1 would be  
31 substantially reduced in August through October (i.e., reduction ranging from 35% to 74% for the 16  
32 year period modeled, and 100% in August and September [i.e., eliminated]) (Appendix 8G, Table Cl-  
33 47), thus reflecting substantial degradation when concentrations would be near, or exceed, the  
34 objective.

35 In comparison, when utilizing the chloride-EC relationship to model monthly average chloride  
36 concentrations for the 16-year period, trends in frequency of exceedance generally agreed, but use  
37 of assimilative capacity were predicted to be larger at some locations (Appendix 8G, [Chloride](#), Table  
38 Cl-46 and Table Cl-48). Specifically, while the model predicted exceedance frequency would  
39 decrease at the Contra Costa Canal at Pumping Plant #1 and Rock Slough locations, use of  
40 assimilative capacity would increase substantially for the months of February through June as well  
41 as September (i.e., maximum of 82% in March for the modeled drought period). Due to such  
42 seasonal long-term average water quality degradation at these locations, the potential exists for  
43 substantial adverse effects on the municipal and industrial beneficial uses through reduced  
44 opportunity for diversion of water with acceptable chloride levels. Moreover, due to the increased

1 frequency of exceeding the 150 mg/L Bay-Delta WQCP objective, the potential exists for adverse  
 2 effects on the municipal and industrial beneficial uses at Contra Costa Pumping Plant #1 and  
 3 Antioch.

#### 4 *303(d) Listed Water Bodies*

5 With respect to the 303(d) listing for chloride in Tom Paine Slough, the monthly average chloride  
 6 concentrations for the 16-year period modeled at Old River at Tracy Road would generally be  
 7 similar compared to Existing Conditions, and thus, would not be further degraded on a long-term  
 8 basis (Appendix 8G, Figure Cl-14. With respect to Suisun Marsh, the monthly average chloride  
 9 concentrations for the 16-year period modeled would generally increase compared to Existing  
 10 Conditions in some months during October through May at the Sacramento River at Collinsville  
 11 (Appendix 8G, Figure Cl-15), Mallard Island (Appendix 8G, Figure Cl-13), and increase substantially  
 12 at Montezuma Slough at Beldon's Landing (i.e., over a doubling of concentration in December  
 13 through February) (Appendix 8G, Figure Cl-16). However, modeling of Alternative 7 assumed no  
 14 operation of the Montezuma Slough Salinity Control Gates, but the project description assumes  
 15 continued operation of the Salinity Control Gates, consistent with assumptions included in the No  
 16 Action Alternative. A sensitivity analysis modeling run conducted for Alternative 4 with the gates  
 17 operational consistent with the No Action Alternative resulted in substantially lower EC levels than  
 18 indicated in the original Alternative 4 modeling results for Suisun Marsh, but EC levels were still  
 19 somewhat higher than EC levels under Existing Conditions for several locations and months.  
 20 Although chloride was not specifically modeled in these sensitivity analyses, it is expected that  
 21 chloride concentrations would be nearly proportional to EC levels in Suisun Marsh. Another  
 22 modeling run with the gates operational and restoration areas removed resulted in EC levels nearly  
 23 equivalent to Existing Conditions, indicating that design and siting of restoration areas has notable  
 24 bearing on EC levels at different locations within Suisun Marsh (see Appendix 8H Attachment 1 for  
 25 more information on these sensitivity analyses). These analyses also indicate that increases in  
 26 salinity are related primarily to the hydrodynamic effects of CM4, not operational components of  
 27 CM1. Based on the sensitivity analyses, optimizing the design and siting of restoration areas may  
 28 limit the magnitude of long-term chloride increases in the Marsh. However, the chloride  
 29 concentration increases at certain locations could be substantial, depending on siting and design of  
 30 restoration areas. Thus, these increased chloride levels in Suisun Marsh are considered to  
 31 contribute to additional, measureable long-term degradation that potentially would adversely affect  
 32 the necessary actions to reduce chloride loading for any TMDL that is developed.

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

#### 35 **Impact WQ-9: Effects on Dissolved Oxygen Resulting from Facilities Operations and** 36 **Maintenance (CM1)**

37 **NEPA Effects:** Effects of CM1 on dissolved oxygen under Alternative 7 are the same as those  
 38 discussed for Alternative 1A and are considered to not be adverse.

39 **CEQA Conclusion:** Effects of CM1 on DO under Alternative 7 would be similar to those discussed for  
 40 Alternative 1A, and are summarized here, then compared to the CEQA thresholds of significance  
 41 (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this  
 42 constituent. For additional details on the effects assessment findings that support this CEQA impact  
 43 determination, see the effects assessment discussion under Alternative 1A.

1 ~~River flow rate and r~~Reservoir storage reductions that would occur under Alternative 7, relative to  
 2 Existing Conditions, would not be expected to result in a substantial adverse change in DO levels in  
 3 the reservoirs, ~~because oxygen sources (surface water aeration, aerated inflows, vertical mixing)~~  
 4 ~~would remain. Similarly, river flow rate reductions that would occur would not be expected to~~  
 5 ~~result in a substantial adverse change in DO levels in the and~~ rivers upstream of the Delta, given that  
 6 mean monthly flows would remain within the ranges historically seen under Existing Conditions  
 7 and the affected river are large and turbulent. Any reduced DO saturation level that may be caused  
 8 by increased water temperature would not be expected to cause DO levels to be outside of the range  
 9 seen historically. Finally, amounts of oxygen demanding substances and salinity would not be  
 10 expected to change sufficiently to affect DO levels.

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

18 There is not expected to be substantial, if even measurable, changes in DO levels in the SWP/CVP  
 19 Export Service Areas waters under Alternative 7, relative to Existing Conditions, because the  
 20 biochemical oxygen demand of the exported water would not be expected to substantially differ  
 21 from that under Existing Conditions (due to ever increasing water quality regulations), canal  
 22 turbulence and exposure of the water to the atmosphere and the algal communities that exist within  
 23 the canals would establish an equilibrium for DO levels within the canals. The same would occur in  
 24 downstream reservoirs.

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

### 33 **Impact WQ-11: Effects on Electrical Conductivity Concentrations Resulting from Facilities** 34 **Operations and Maintenance (CM1)**

#### 35 ***Delta***

36 Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2  
 37 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter  
 38 hydrodynamics within the Delta region, which affects mixing of source waters, these effects are  
 39 included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of  
 40 ~~CM2-22CM2-CM21~~ not attributable to hydrodynamics, for example, additional loading of a  
 41 constituent to the Delta, are discussed within the impact header for ~~CM2-22CM2-CM21~~. See section  
 42 8.3.1.3 for more information.

1 Relative to Existing Conditions, Alternative 7 would result in an increase in the number of days the  
 2 Bay-Delta WQCP EC objectives would be exceeded in the Sacramento River at Emmaton, and the San  
 3 Joaquin River at San Andreas Landing, Prisoners Point, and Brandt Bridge (Appendix 8H, Electrical  
 4 Conductivity, Table EC-7).

5 The percent of days the Emmaton EC objective would be exceeded for the entire period modeled  
 6 (1976–1991) would increase from 6% under Existing Conditions to ~~16~~9% under Alternative 7, and  
 7 the percent of days out of compliance would increase from 11% under Existing Conditions to ~~26~~9%  
 8 under Alternative 7.

9 The percent of days the San Andreas Landing EC objective would be exceeded would increase from  
 10 1% under Existing Conditions to ~~4~~3% under Alternative 7, and the percent of days out of compliance  
 11 with the EC objective would increase from 1% under Existing Conditions to ~~6~~7% under Alternative  
 12 7. Sensitivity analyses were performed for Alternative 4 scenario H3, and indicated that many  
 13 similar exceedances were modeling artifacts, and the small number of remaining exceedances were  
 14 small in magnitude, lasted only a few days, and could be addressed with real time operations of the  
 15 SWP and CVP (see Section 8.3.1.1 for a description of real time operations of the SWP and CVP). Due  
 16 to similarities in the nature of the exceedances between alternatives, the findings from these  
 17 analyses can be extended to this alternative as well.

18 The percent of days the Prisoners Point EC objective would be exceeded for the entire period  
 19 modeled would increase from 6% under Existing Conditions to ~~35~~40% under Alternative 7, and the  
 20 percent of days out of compliance with the EC objective would increase from 10% under Existing  
 21 Conditions to ~~35~~40% under Alternative 7. Sensitivity analyses conducted for Alternative 4 scenario  
 22 H3 indicated that removing all tidal restoration areas would reduce the number of exceedances, but  
 23 there would still be substantially more exceedances than under Existing Conditions or the No Action  
 24 Alternative. Results of the sensitivity analyses indicate that the exceedances are partially a function  
 25 of the operations of the alternative itself, perhaps due to Head of Old River Barrier assumptions and  
 26 south Delta export differences (see Appendix 8H Attachment 1 for more discussion of these  
 27 sensitivity analyses). Due to similarities in the nature of the exceedances between alternatives, the  
 28 findings from these analyses can be extended to this alternative as well. Appendix 8H Attachment 2  
 29 contains a more detailed assessment of the likelihood of these exceedances impacting aquatic life  
 30 beneficial uses. Specifically, Appendix 8H Attachment 2 discusses whether these exceedances might  
 31 have indirect effects on striped bass spawning in the Delta, and concludes that the high level of  
 32 uncertainty precludes making a definitive determination.

33 In the San Joaquin River at Brandt Bridge, the percent of days exceeding the EC objective would  
 34 increase from 3% under Existing Conditions to 4% under Alternative 7; the percent of days out of  
 35 compliance would increase from 8% under Existing Conditions to 9% under Alternative 7. These  
 36 changes are minimal, and are not considered substantial in light of overall modeling uncertainty.

37 Average EC levels at the western and southern Delta compliance locations and San Joaquin River at  
 38 San Andreas Landing (an interior Delta location) would decrease from 0–46% for the entire period  
 39 modeled and 2–45% during the drought period modeled (1987–1991) (Appendix 8H, Table EC-18).  
 40 In the S. Fork Mokelumne River at Terminous, average EC would increase 6% for the entire period  
 41 modeled and 5% during the drought period modeled. Average EC in the S. Fork Mokelumne River at  
 42 Terminous would increase during all months (Appendix 8H, Table EC-18). Average EC in the San  
 43 Joaquin River at Prisoners Point would increase by 1% during the drought period (Appendix 8H,  
 44 Table EC-18). Given that the western ~~and southern~~-Delta ~~are is~~ Clean Water Act section 303(d) listed



1 as impaired due to elevated EC, the increase in the incidence of exceedance of EC objectives under  
 2 Alternative 7, relative to Existing Conditions, has the potential to contribute to additional  
 3 impairment and potentially adversely affect beneficial uses. The comparison to Existing Conditions  
 4 reflects changes in EC due to both Alternative 7 operations (including north Delta intake capacity of  
 5 9,000 cfs and numerous other operational components of Scenario E) and climate change/sea level  
 6 rise.

7 Relative to the No Action Alternative, the percent of days exceeding EC objectives and percent of  
 8 days out of compliance would increase at: Sacramento River at Emmaton, San Joaquin River at  
 9 Jersey Point, San Andreas Landing, Vernalis, Brandt Bridge, and Prisoners Point; and Old River near  
 10 Middle River and at Tracy Bridge (Appendix 8H, *Electrical Conductivity*, Table EC-7). The increase in  
 11 percent of days exceeding the EC objective would be 349% at Prisoners Point and 105% or less at  
 12 the remaining locations. The increase in percent of days out of compliance would be 340% at  
 13 Prisoners Point and 156% or less at the remaining locations. For the entire period modeled, average  
 14 EC levels would increase at: S. Fork Mokelumne River (6%), Old River at Tracy Bridge (1%), and San  
 15 Joaquin River at Prisoners Point (10%) (Appendix 8H, Table EC-18). During the drought period  
 16 modeled, average EC would increase at: S. Fork Mokelumne River (6%), San Joaquin River at Brandt  
 17 Bridge (1%) and Prisoners Point (8%), and Old River at Tracy Bridge 1%) (Appendix 8H, Table EC-  
 18 18). Given that the western and southern Delta are Clean Water Act section 303(d) listed as  
 19 impaired due to elevated EC, the increase in the incidence of exceedance of EC objectives under  
 20 Alternative 7, relative to the No Action Alternative, has the potential to contribute to additional  
 21 impairment and potentially adversely affect beneficial uses. The comparison to the No Action  
 22 Alternative reflects changes in EC due only to Alternative 7 operations (including north Delta intake  
 23 capacity of 9,000 cfs and numerous other operational components of Scenario E).

24 For Suisun Marsh, October–May is the period when Bay-Delta WQCP EC objectives for protection of  
 25 fish and wildlife apply. Long-term average EC would increase under Alternative 7, relative to  
 26 Existing Conditions, during the months of April and May by 0.2 mS/cm in the Sacramento River at  
 27 Collinsville (Appendix 8H, *Electrical Conductivity*, Table EC-21). Long-term average EC would  
 28 decrease relative to Existing Conditions in Montezuma Slough at National Steel during October–May  
 29 (Appendix 8H, Table EC-22). The most substantial increase would occur near Beldon Landing, with  
 30 long-term average EC levels increasing by 0.8–3.3 mS/cm, depending on the month, nearly doubling  
 31 during some months the long-term average EC relative to Existing Conditions (Appendix 8H, Table  
 32 EC-23). Sunrise Duck Club and Volanti Slough also would have long-term average EC increases of  
 33 0.1–1.6 mS/cm (Appendix 8H, Tables EC-24 and EC-25). Modeling of this alternative assumed no  
 34 operation of the Montezuma Slough Salinity Control Gates, but the project description assumes  
 35 continued operation of the Salinity Control Gates, consistent with assumptions included in the No  
 36 Action Alternative. A sensitivity analysis modeling run conducted for Alternative 4 scenario H3 with  
 37 the gates operational consistent with the No Action Alternative resulted in substantially lower EC  
 38 levels than indicated in the original Alternative 4 modeling results, but EC levels were still  
 39 somewhat higher than EC levels under Existing Conditions and the No Action Alternative for several  
 40 locations and months. Another modeling run with the gates operational and restoration areas  
 41 removed resulted in EC levels nearly equivalent to Existing Conditions and the No Action  
 42 Alternative, indicating that design and siting of restoration areas has notable bearing on EC levels at  
 43 different locations within Suisun Marsh (see Appendix 8H Attachment 1 for more information on  
 44 these sensitivity analyses). These analyses also indicate that increases are related primarily to the  
 45 hydrodynamic effects of CM4, not operational components of CM1. Based on the sensitivity analyses,  
 46 optimizing the design and siting of restoration areas may limit the magnitude of long-term EC

1 increases to be on the order of 1 mS/cm or less. Due to similarities in the nature of the EC increases  
 2 between alternatives, the findings from these analyses can be extended to this alternative as well.

3 The degree to which the long-term average EC increases in Suisun Marsh would cause exceedance of  
 4 Bay-Delta WQCP objectives is unknown, because these objectives are expressed as a monthly  
 5 average of daily high tide EC, which does not have to be met if it can be demonstrated “equivalent or  
 6 better protection will be provided at the location” (State Water Resources Control Board 2006:14).  
 7 The ~~described~~ long-term average EC increase may, or may not, contribute to adverse effects on  
 8 beneficial uses, depending on how and when wetlands are flooded, soil leaching cycles, and how  
 9 agricultural use of water is managed, and future actions taken with respect to the marsh. However,  
 10 the EC increases at certain locations ~~would-could~~ be substantial, depending on siting and design of  
 11 restoration areas, and it is uncertain the degree to which current management plans for the Suisun  
 12 Marsh would be able to address these substantially higher EC levels and protect beneficial uses.  
 13 Thus, these increased EC levels in Suisun Marsh are considered to have a potentially adverse effect  
 14 on marsh beneficial uses. Long-term average EC increases in Suisun Marsh under Alternative 7  
 15 relative to the No Action Alternative would be similar to the increases relative to Existing  
 16 Conditions. Suisun Marsh is section 303(d) listed as impaired due to elevated EC, and the potential  
 17 increases in long-term average EC concentrations could contribute to additional impairment,  
 18 ~~because the increases would be double that relative to Existing Conditions and the No Action~~  
 19 ~~Alternative.~~

20 **NEPA Effects:** In summary, ~~the increased frequency of exceedance of EC objectives and increased~~  
 21 ~~long-term and drought period average EC levels that would occur at interior and southern Delta~~  
 22 ~~compliance locations, and~~ the increased frequency of exceedance of EC objectives in the western  
 23 Delta under Alternative 7, relative to the No Action Alternative, would contribute to adverse effects  
 24 on the agricultural beneficial uses. In addition, the increased frequency of exceedance of the San  
 25 Joaquin River at Prisoners Point EC objective and long-term and drought period average EC could  
 26 contribute to adverse effects on fish and wildlife beneficial uses (specifically, indirect adverse effects  
 27 on striped bass spawning), though there is a high degree of uncertainty associated with this impact.  
 28 Given that the western ~~and southern~~ Delta ~~are is~~ Clean Water Act section 303(d) listed as impaired  
 29 due to elevated EC, the increase in the incidence of exceedance of EC objectives ~~and long-term~~  
 30 ~~average and drought period average EC in these~~ in this portions of the Delta has the potential to  
 31 contribute to additional beneficial use impairment. The increases in long-term average EC levels that  
 32 ~~would-could~~ occur in Suisun Marsh would further degrade existing EC levels and could contribute  
 33 ~~additional~~ to adverse effects on the fish and wildlife beneficial uses. Suisun Marsh is section 303(d)  
 34 listed as impaired due to elevated EC, and the potential increases in long-term average EC levels  
 35 could contribute to additional beneficial use impairment. These increases in EC constitute an  
 36 adverse effect on water quality. Mitigation Measure WQ-11 would be available to reduce these  
 37 effects (implementation of this measure along with a separate, non-environmental commitment as  
 38 set forth in EIR/EIS Appendix 3B, *Environmental Commitments*, relating to the potential EC-related  
 39 changes would reduce these effects).

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

1 River flow rate and reservoir storage reductions that would occur under Alternative 7, relative to  
 2 Existing Conditions, would not be expected to result in a substantial adverse change in EC levels in  
 3 the reservoirs and rivers upstream of the Delta, given that: changes in the quality of watershed  
 4 runoff and reservoir inflows would not be expected to occur in the future; the state's aggressive  
 5 regulation of point-source discharge effects on Delta salinity-elevating parameters and the expected  
 6 further regulation as salt management plans are developed; the salt-related TMDLs adopted and  
 7 being developed for the San Joaquin River; and the expected improvement in lower San Joaquin  
 8 River average EC levels commensurate with the lower EC of the irrigation water deliveries from the  
 9 Delta.

10 Relative to Existing Conditions, Alternative 7 would not result in any substantial increases in long-  
 11 term average EC levels in the SWP/CVP Export Service Areas. There would be no exceedance of the  
 12 EC objective at the Jones and Banks pumping plants. Average EC levels for the entire period modeled  
 13 would decrease at both plants and, thus, this alternative would not contribute to additional  
 14 beneficial use impairment related to elevated EC in the SWP/CVP Export Service Areas waters.  
 15 Rather, this alternative would improve long-term EC levels in the SWP/CVP Export Service Areas,  
 16 relative to Existing Conditions.

17 In the Plan Area, Alternative 7 would result in an increase in the frequency with which Bay-Delta  
 18 WQCP EC objectives are exceeded in the Sacramento River at Emmaton (agricultural objective;  
 19 ~~103%~~ increase), ~~San Joaquin River at San Andreas Landing (agricultural objective; 23% increase)~~  
 20 ~~and Brandt Bridge (agricultural objective; 1% increase) in the southern Delta,~~ and San Joaquin River  
 21 at Prisoners Point (fish and wildlife objective; ~~2934%~~ increase) in the interior Delta for the entire  
 22 period modeled (1976–1991). The increased frequency of exceedance of the fish and wildlife  
 23 objective at Prisoners Point could contribute to adverse effects on aquatic life (specifically, indirect  
 24 adverse effects on striped bass spawning), though there is a high degree of uncertainty associated  
 25 with this impact. ~~and t~~The increased frequency of the EC exceedance at Emmaton could contribute  
 26 to adverse effects on agricultural uses. Because EC is not bioaccumulative, the increases in long-term  
 27 average EC levels would not directly cause bioaccumulative problems in aquatic life or humans. The  
 28 western ~~and southern~~ Delta ~~are is~~ Clean Water Act section 303(d) listed for elevated EC and the  
 29 increased frequency of exceedance of EC objectives that would occur in ~~these this~~ portions of the  
 30 Delta could make beneficial use impairment measurably worse. This impact is considered to be  
 31 significant.

32 Further, relative to Existing Conditions, Alternative 7 ~~would could~~ result in substantial increases in  
 33 long-term average EC during the months of October through May in Suisun Marsh, ~~such that EC~~  
 34 ~~levels would be double that relative to Existing Conditions.~~ The increases in long-term average EC  
 35 levels that ~~would could~~ occur in Suisun Marsh could further degrade existing EC levels and thus  
 36 contribute additionally to adverse effects on the fish and wildlife beneficial uses. Because EC is not  
 37 bioaccumulative, the increases in long-term average EC levels would not directly cause  
 38 bioaccumulative problems in wildlife. Suisun Marsh is Clean Water Act section 303(d) listed for  
 39 elevated EC and the increases in long-term average EC that would occur in the marsh could make  
 40 beneficial use impairment measurably worse. This impact is considered to be significant.

41 Implementation of Mitigation Measure WQ-11 along with a separate, non-environmental  
 42 commitment relating to the potential increased costs associated with EC-related changes would  
 43 reduce these effects. While mitigation measures to reduce these water quality effects in affected  
 44 water bodies to less than significant levels are not available, implementation of Mitigation Measure  
 45 WQ-11 is recommended to attempt to reduce the effect that increased EC concentrations may have

1 on Delta beneficial uses. However, because the effectiveness of this mitigation measure to result in  
 2 feasible measures for reducing water quality effects is uncertain, this impact is considered to remain  
 3 significant and unavoidable. Please see Mitigation Measure WQ-11 under Impact WQ-11 in the  
 4 discussion of Alternative 1A.

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

### 16 **Impact WQ-13: Effects on Mercury Concentrations Resulting from Facilities Operations and** 17 **Maintenance (CM1)**

#### 18 ***Delta***

19 Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2  
 20 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter  
 21 hydrodynamics within the Delta region, which affects mixing of source waters, these effects are  
 22 included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of  
 23 ~~CM2-22CM2-CM21~~ not attributable to hydrodynamics, for example, additional loading of a  
 24 constituent to the Delta, are discussed within the impact header for ~~CM2-22CM2-CM21~~. See section  
 25 8.3.1.3 for more information.

26 The water quality impacts of waterborne concentrations of mercury and methylmercury and fish  
 27 tissue mercury concentrations were evaluated for 9 Delta locations. The analysis of percentage  
 28 change in assimilative capacity of waterborne total mercury of Alternative 7 relative to the 25 ng/L  
 29 ecological risk benchmark as compared to Existing Conditions showed a 6.7% reduction at Old River  
 30 at Rock Slough and Contra Costa Pumping Plant, and a 6.6% reduction at those same locations  
 31 relative to the No Action Alternative. These changes are not expected to result in adverse effects to  
 32 beneficial use (Figures 8-53 and 8-54). Similarly, changes in methylmercury concentration are  
 33 expected to be relatively small. The greatest annual average methylmercury concentration for  
 34 drought conditions was 0.164 ng/L for the San Joaquin River at Buckley Cove which was slightly  
 35 higher than Existing Conditions (0.161 ng/L), and slightly lower than the No Action Alternative  
 36 (0.167 ng/L) (Appendix 8I, *Mercury*, Table I-6). All modeled input concentrations exceeded the  
 37 methylmercury TMDL guidance objective of 0.06 ng/L, therefore percentage change in assimilative  
 38 capacity was not evaluated for methylmercury.

39 Fish tissue estimates show substantial percentage increases in concentration and exceedance  
 40 quotients for mercury at some Delta locations. The greatest changes in exceedance quotients  
 41 relative to Existing Conditions and the No Action Alternative are 30--39% at the Contra Costa  
 42 Pumping Plant and 32-45% for Old River at Rock Slough (Figure ~~8-558-55a,b~~, Appendix 8I, Table I-  
 43 14b). Because these increases are substantial, and it is evident that substantive increases are

1 expected at numerous locations throughout the Delta, these changes may be measurable in the  
 2 environment. See Appendix 8I for a discussion of the uncertainty associated with the fish tissue  
 3 estimates.

4 **NEPA Effects:** Based on the above discussion, the effects of mercury and methylmercury in  
 5 comparison of Alternative 7 to the No Action Alternative (as waterborne and bioaccumulated forms)  
 6 are considered to be adverse for the case of fish tissue bioaccumulation at some locations.

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

12 Under Alternative 7, greater water demands and climate change would alter the magnitude and  
 13 timing of reservoir releases and river flows upstream of the Delta in the Sacramento River  
 14 watershed and east-side tributaries, relative to Existing Conditions. Concentrations of mercury and  
 15 methylmercury upstream of the Delta will not be substantially different relative to Existing  
 16 Conditions due to the lack of important relationships between mercury/methylmercury  
 17 concentrations and flow for the major rivers.

18 Methylmercury concentrations exceed criteria at all locations in the Delta and no assimilative  
 19 capacity exists. Monthly average waterborne concentrations of total and methylmercury, over the  
 20 period of record, are very similar to Existing Conditions, but showed notable increases at some  
 21 locations. Estimates of fish tissue mercury concentrations show substantial increases would occur  
 22 for several sites for ~~Methylmercury concentrations exceed criteria at all locations in the Delta and no~~  
 23 ~~assimilative capacity exists. However, monthly average waterborne concentrations of total and~~  
 24 ~~methylmercury, over the period of record, are very similar to Existing Conditions. Similarly,~~  
 25 ~~estimates of fish tissue mercury concentrations show almost no differences would occur among~~  
 26 ~~sites for~~ Alternative 7 as compared to Existing Conditions for Delta sites.

27 Assessment of effects of mercury in the SWP and CVP Export Service Areas were based on effects on  
 28 mercury concentrations and fish tissue mercury concentrations at the Banks and Jones pumping  
 29 plants. The Banks and Jones pumping plants are expected to show increased assimilative capacity  
 30 for waterborne mercury and decreased fish tissue concentrations of mercury for Alternative 7 as  
 31 compared to Existing Conditions.

32 As such, this alternative is not expected to cause additional exceedance of applicable water quality  
 33 objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects  
 34 on any beneficial uses of waters in the affected environment. However, increases in fish tissue  
 35 mercury concentrations are substantial, and changes in fish tissue mercury concentrations would  
 36 make existing mercury-related impairment in the Delta measurably worse. In comparison to  
 37 Existing Conditions, Alternative 7 would increase levels of mercury by frequency, magnitude, and  
 38 geographic extent such that the affected environment would be expected to have measurably higher  
 39 body burdens of mercury in aquatic organisms, thereby substantially increasing the health risks to  
 40 wildlife (including fish) or humans consuming those organisms. This impact is considered to be  
 41 significant. Feasible or effective actions to reduce the effects on mercury resulting from CM1 are  
 42 unknown. General mercury management measures through CM12, or actions taken by other entities  
 43 or programs such as TMDL implementation, may minimize or reduce sources and inputs of mercury  
 44 to the Delta and methylmercury formation. However, it is uncertain whether this impact would be

1 reduced to a level that would be less than significant as a result of CM12 or other future actions.  
 2 Therefore, the impact would be significant and unavoidable.

### 3 **Impact WQ-25: Effects on Selenium Concentrations Resulting from Facilities Operations and** 4 **Maintenance (CM1)**

#### 5 *Delta*

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

13 ~~Selenium concentrations and threshold comparisons for each of the 11 modeled Delta assessment~~  
 14 ~~locations under Alternative 7, relative to Existing Conditions and the No Action Alternative, are~~  
 15 ~~presented in Appendix 8M, Selenium, Table M-9a for water, Tables M-17 and M-27 for most biota~~  
 16 ~~(whole-body fish [excluding sturgeon], bird eggs [invertebrate diet], bird eggs [fish diet], and fish~~  
 17 ~~fillets) throughout the Delta, and Tables M-30 through M-32 for sturgeon at the two western Delta~~  
 18 ~~locations. Figures 8-59a and 8-60a present graphical distributions of predicted selenium~~  
 19 ~~concentration changes (shown as changes in available assimilative capacity based on 1.3 µg/L) in~~  
 20 ~~water at each modeled assessment location for all years. Appendix 8M, Figure M-24 provides more~~  
 21 ~~detail in the form of monthly patterns of selenium concentrations in water during the modeling~~  
 22 ~~period.~~

23 Alternative 7 would result in small to moderate changes in average selenium concentrations in  
 24 water at all modeled Delta assessment locations relative to Existing Conditions and the No Action  
 25 Alternative (Appendix 8M, ~~Selenium~~, Table M-10A9a). ~~Long-term average concentrations at some~~  
 26 ~~interior and western Delta locations would increase by 0.01–0.13 µg/L for the entire period~~  
 27 ~~modeled. The increases in selenium concentrations in water would result in reductions~~ ~~Changes in~~  
 28 ~~selenium concentrations in water are reflected in small (10% or less) to moderate (between 11%~~  
 29 ~~and 50%) percent changes in available assimilative capacity for selenium of 1–12%, relative to the~~  
 30 ~~(based on 2.1.3 µg/L ecological risk benchmark USEPA draft water quality criterion (Figures 8-59a~~  
 31 ~~and 8-60a), for all years. Relative to Existing Conditions, Alternative 7 would result in the largest~~  
 32 ~~modeled increases in available assimilative capacity at Buckley Cove (4%); relative to the No Action~~  
 33 ~~Alternative, the largest increase would be at Staten Island (1%), and the largest decreases for~~  
 34 ~~Existing Conditions and the No Action Alternative would be at Rock Slough and Contra Costa PP~~  
 35 ~~(12%) (Figures 8-59 and 8-60). Although moderate negative changes in assimilative capacity would~~  
 36 ~~occur at two locations (Rock Slough and Contra Costa PP), the changes are minimal at the other~~  
 37 ~~locations and the available assimilative capacity at all locations would remain substantial; therefore,~~  
 38 ~~the effect of Alternative 7 is generally minimal for the Delta. Furthermore, t~~ ~~The long-term average~~  
 39 ~~selenium concentrations in water ranges of modeled selenium concentrations in water under~~  
 40 ~~(Appendix 8M, Table M-10A) for Alternative 7 (range 0.2409–0.7138 µg/L) would be similar to~~  
 41 ~~those for~~ Existing Conditions (range 0.2409–0.7641 µg/L); and the No Action Alternative (range  
 42 0.2409–0.6938 µg/L) are similar, and all would be well below the ~~ecological risk benchmark USEPA~~  
 43 ~~draft water quality criterion of (1.32 µg/L) (Appendix 8M, Table 9a).~~

1 Relative to Existing Conditions and the No Action Alternative, Alternative 7 would generally result in  
 2 small changes (less than 45%) in estimated selenium concentrations in most biota (whole-body fish  
 3 (excluding sturgeon), bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets) throughout  
 4 the Delta, with little difference among locations (Figures 8-61a through 8-64b; Appendix 8M,  
 5 Selenium, Table M-18-27) Table 8M-2 in the sturgeon addendum to Appendix 8M and Addendum M.A,  
 6 Selenium in Sturgeon, to Appendix 8M, Table M.A-2). Despite the small changes in selenium  
 7 concentrations in biota, Level of Concern Exceedance Quotients (i.e., modeled tissue divided by  
 8 Level of Concern benchmarks) for selenium concentrations in those biota for all years and for  
 9 drought years are less than 1.0 (indicating low probability of adverse effects). Similarly, Advisory  
 10 Tissue Level Exceedance Quotients for selenium concentrations in fish fillets for all years and  
 11 drought years also are less than 1.0. Estimated selenium concentrations in sturgeon for the San  
 12 Joaquin River at Antioch are predicted to increase by about 30 percent relative Relative to Existing  
 13 Conditions and to the No Action Alternative in all years (from about 4.7 to 6.1 mg/kg dry weight  
 14 [dw]). Likewise, those for sturgeon in the Sacramento River at Mallard Island are predicted to  
 15 increase by about 18 percent in all years (from about 4.4 to 5.2 mg/kg dw) (Figure 8-65; Appendix  
 16 8M, Tables M-30 and M-31). Selenium concentrations in sturgeon during drought years are expected  
 17 to increase by 11 to 24 percent at those locations. Detection of changes in whole-body sturgeon such  
 18 as those estimated for the western Delta may require large sample sizes because of the inherent  
 19 variability in fish tissue selenium concentrations. Low Toxicity Threshold Exceedance Quotients for  
 20 selenium concentrations in sturgeon in the western Delta would exceed 1.0 for drought years at  
 21 both locations (as they do for Existing Conditions and the No Action Alternative; Figure 8-65) and  
 22 for all years at the San Joaquin River at Antioch both locations, whereas Existing Conditions and the  
 23 No Action Alternative do not (quotients increases from 0.94 to 1.2 at San Joaquin at Antioch to 1.2  
 24 and from 0.88 at Sacramento River at Mallard Island to 1.0) (Appendix 8M, Table M-32). High  
 25 Toxicity Threshold Exceedance Quotients for selenium concentrations in sturgeon in the western  
 26 Delta would exceed 1.0 for drought years in the San Joaquin River at Antioch, whereas Existing  
 27 Conditions and the No Action Alternative do not (quotients increases from about 8-0.85 to 1.1)  
 28 (Figure 8-65; Appendix 8M, Table M-32), and the No Action Alternative, the largest increase of  
 29 selenium concentrations in biota would be at Contra Costa PP for drought years and in sturgeon at  
 30 the two western Delta locations in all as well as drought years. Relative to Existing Conditions, the  
 31 largest decrease would be at Buckley Cove for drought years. Relative to the No Action Alternative,  
 32 the largest decrease would be at Staten Island for drought years (except for bird eggs [assuming a  
 33 fish diet] at Buckley Cove for drought years). Except for sturgeon in the western Delta,  
 34 concentrations of selenium in whole-body fish and bird eggs (invertebrate and fish diets) would  
 35 exceed only the lower benchmarks (4 and 6 mg/kg dry weight, respectively, indicating a low  
 36 potential for effects), under drought conditions, at Buckley Cove for Alternative 7 and Existing  
 37 Conditions and the No Action Alternative (Figures 8-61 through 8-63). Exceedance Quotients for  
 38 these exceedances of the lower benchmarks are between 1.0 and 1.5, indicating a low risk to biota in  
 39 the Delta and no substantial difference for Alternative 7 from Existing Conditions and the No Action  
 40 Alternative. Selenium concentrations in fish fillets would not exceed the screening value for  
 41 protection of human health (Figure 8-64). For sturgeon in the western Delta, whole-body selenium  
 42 concentrations would increase from 12.3 mg/kg under Existing Conditions and the No Action  
 43 Alternative to 14.7 mg/kg under Alternative 7, a 20% increase (Table M.A-2). All of these values  
 44 exceed both the low and high toxicity benchmarks. These increases are high enough that they may  
 45 represent a measurable increase in body burdens of sturgeon, which would constitute an adverse  
 46 impact (see also the discussion of results provided in addendum M.A to Appendix 8M).

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

18 Increased water residence times could increase the bioaccumulation of selenium in biota, thereby  
19 potentially increasing fish tissue and bird egg concentrations of selenium (see residence time  
20 discussion in Appendix 8M, Selenium, and Presser and Luoma [2010b]). Thus, residence time was  
21 assessed for its relevance to selenium bioaccumulation. Table 60a (presented originally in Section  
22 8.3.1.7 in the *Microcystis* subsection) shows the time for neutrally buoyant particles to move through  
23 the Delta (surrogate for flow and residence time). Although an increase in residence time  
24 throughout the Delta is expected under the No Action Alternative, relative to Existing Conditions  
25 (because of climate change and sea level rise), the change is fairly small in most areas of the Delta.  
26 Thus, the changes in residence times between Alternative 7 and the No Action Alternative are very  
27 similar to the changes in residence times between Alternative 7 and the Existing Conditions.

28 Relative to Existing Conditions and the No Action Alternative, increases in residence times for  
29 Alternative 7 would be greater in the South Delta and East Delta than in other sub-regions. Relative  
30 to Existing Conditions, annual average residence times for Alternative 7 in the South Delta are  
31 expected to increase by more than 35 days (Table 60a), and in the East Delta increase by more than  
32 20 days. Increases in residence times for other sub-regions would be smaller, especially as  
33 compared to Existing Conditions and the No Action Alternative (which are longer than those  
34 modeled for the South Delta). As mentioned above, these results incorporate hydrodynamic effects  
35 of both CM1 and CM2 and CM4, and the effects of CM1 cannot be distinguished from the effects of  
36 CM2 and CM4. However, it is expected that CM2 and CM4 are substantial drivers of the increased  
37 residence time.

38 Presser and Luoma (2010b) summarized and discussed selenium uptake in the Bay-Delta (including  
39 hydrologic conditions [e.g., Delta outflow and residence time for water],  $K_d$ s [the ratio of selenium  
40 concentrations in particulates, as the lowest level of the food chain, relative to the water-borne  
41 concentration], and associated tissue concentrations [especially in clams and their consumers, such  
42 as sturgeon]). When the Delta Outflow Index (daily average flow per month) decreased by five-fold  
43 (73,732 cubic feet per second [cfs] in June 1998 to 12, 251 cfs in October 1998), residence time  
44 doubled (from 11 to 22 days) and the calculated mean  $K_d$  also doubled (from 3,198 to 6,501).  
45 However, when daily average Delta outflow in November 1999 was only 6,951 cfs (i.e., about one-



1 half that in October 1998) and residence time was 70 days, the calculated mean  $K_d$  (7,614) did not  
 2 increase proportionally.

3 Models are not available to quantitatively estimate the level of changes in selenium bioaccumulation  
 4 as related to residence time, but the effects of residence time are incorporated in the  
 5 bioaccumulation modeling for selenium that was based on higher  $K_d$  values for drought years in  
 6 comparison to wet, normal, or all years; see Appendix 8M, *Selenium*. If increases in fish tissue or bird  
 7 egg selenium were to occur, the increases would likely be of concern only where fish tissues or bird  
 8 eggs are already elevated in selenium to near or above thresholds of concern. That is, where biota  
 9 concentrations are currently low and not approaching thresholds of concern (which, as discussed  
 10 above, is the case throughout the Delta, except for sturgeon in the western Delta), changes in  
 11 residence time alone would not be expected to cause them to then approach or exceed thresholds of  
 12 concern. In consideration of this factor, although the Delta as a whole is a CWA Section 303(d)-listed  
 13 water body for selenium, and although monitoring data of fish tissue or bird eggs in the Delta are  
 14 sparse, the most likely area in which biota tissues would be at levels high enough that additional  
 15 bioaccumulation due to increased residence time from restoration areas would be a concern is the  
 16 western Delta and Suisun Bay for sturgeon, as discussed above. As shown in Table 60a, the overall  
 17 increase in residence time estimated in the western Delta is 3 days relative to Existing Conditions,  
 18 and 1 day relative to the No Action Alternative. Given the available information, these increases are  
 19 small enough that they are not expected to substantially affect selenium bioaccumulation in the  
 20 western Delta. Because CM2 and CM4 are expected to be substantial drivers of the increased  
 21 residence times, further discussion is included in Impact WQ-26 below.

22 In summary, relative to Existing Conditions and the No Action Alternative, Alternative 7 would  
 23 result in small changes (less than 54%) in selenium concentrations throughout the Delta for most  
 24 biota, although larger increases in selenium concentrations are predicted for sturgeon in the  
 25 western Delta. The Low Toxicity Threshold Exceedance Quotient for selenium concentrations in  
 26 sturgeon for all years in the San Joaquin River at Antioch would increase from 0.94 for Existing  
 27 Conditions and the No Action Alternative to 1.2, and from 0.88 to 1.0 at Sacramento River at Mallard  
 28 Island. The High Toxicity Threshold Exceedance Quotient for selenium concentrations for sturgeon  
 29 at Antioch would increase from about 0.85 for Existing Conditions and 0.86 for the No Action  
 30 Alternative to 1.1. Concentrations of selenium in sturgeon would exceed the higher benchmark for  
 31 Antioch only in drought years, indicating a high potential for effects. The modeling of  
 32 bioaccumulation for sturgeon is less calibrated to site-specific conditions than that for other biota,  
 33 which was calibrated on a robust dataset for modeling of bioaccumulation in largemouth bass as a  
 34 representative species for the Delta. Overall the predicted increase for Alternative 7 is high enough  
 35 that it may represent a measureable increase in body burdens of sturgeon, which would constitute  
 36 an adverse impact.

### 37 **SWP/CVP Export Service Areas**

38 Alternative 7 would result in ~~small to moderate~~ (0.09–0.15 µg/L) changes-decreases in average  
 39 selenium concentrations in water at the Banks and Jones pumping plants, relative to the Existing  
 40 Conditions and the No Action Alternative, for the entire period modeled (Appendix 8M, *Selenium*,  
 41 Table M-~~10A9a~~). These decreases in long-term average selenium concentrations in water would  
 42 result increases in ~~These changes in selenium concentrations in water are reflected in small (10% or~~  
 43 ~~less) to moderate (between 11% and 50%) percent changes in~~ available assimilative capacity for  
 44 selenium ~~for all years at these pumping plants of 9–16%, relative to the USEPA draft water quality~~  
 45 criterion of 1.3 µg/L. Relative to Existing Conditions and the No Action Alternative, Alternative 7

1 would result in modeled increases in available assimilative capacity at Jones PP (14% and 15%,  
 2 respectively) and at Banks PP (8%) (Figures 8-59 and 8-60) and would have a positive effect at the  
 3 Export Service Area locations. Furthermore, the ranges of modeled long-term average selenium  
 4 concentrations in water (Appendix 8M, Table M-10A) for Alternative 7 (range 0.312–0.137 µg/L);  
 5 Existing Conditions (range 0.37–0.58 µg/L), and the No Action Alternative (range 0.37–0.59 µg/L)  
 6 are similar, and all would be well below the ecological risk benchmark USEPA draft water quality  
 7 criterion of (21.3 µg/L) (Appendix 8M, Table 9a).

8 Relative to Existing Conditions and the No Action Alternative, Alternative 7 would result in small  
 9 changes (less than 53%) in estimated selenium concentrations in biota (whole-body fish, bird eggs  
 10 [invertebrate diet], bird eggs [fish diet], and fish fillets) at export service areas Banks and Jones  
 11 pumping plants (Figures 8-61a through 8-64b; Appendix 8M, Selenium, Table M-1827). Relative to  
 12 Existing Conditions and the No Action Alternative, the largest increase of selenium concentrations in  
 13 biota would be at Banks PP for drought years (except for bird eggs [assuming a fish diet] at Banks PP  
 14 for all years), and the largest decrease would be at Jones PP for drought years. However,  
 15 concentrations in biota would not exceed any selenium benchmarks for Alternative 7 (Figures 8-  
 16 61a through 8-64a).

17 Thus, relative to Existing Conditions and the No Action Alternative, Alternative 7 would result in  
 18 small to moderate changes in selenium concentrations in water and minimal changes in selenium  
 19 concentrations in biota at the Export Service Area locations. Selenium concentrations in water and  
 20 biota generally would decrease under Alternative 7 and would not exceed ecological benchmarks at  
 21 either location, whereas the lower benchmark for bird eggs (fish diet) would be exceeded under  
 22 Existing Conditions and the No Action Alternative at Jones PP for drought years. This small positive  
 23 change in selenium concentrations under Alternative 7 would be expected to slightly decrease the  
 24 frequency with which applicable benchmarks would be exceeded or slightly improve the quality of  
 25 water in the Export Services Areas, with regard to selenium.

26 **NEPA Effects:** Based on the discussion above, the effects on selenium from Alternative 7 are  
 27 considered to be adverse. This determination is reached because selenium concentrations in whole-  
 28 body sturgeon modeled at two western Delta locations would increase by an average of estimated  
 29 210%, which may represent a measurable increase in the environment. Because both low and high  
 30 toxicity benchmarks are already exceeded under the No Action Alternative, these potentially  
 31 measurable increases represent an adverse impact.

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

37 There are no substantial point sources of selenium in watersheds upstream of the Delta, and no  
 38 substantial nonpoint sources of selenium in the watersheds of the Sacramento River and the eastern  
 39 tributaries. Nonpoint sources in the San Joaquin Valley that contribute selenium to the Delta will be  
 40 controlled through a TMDL developed by the Central Valley Water Board (2001) for the lower San  
 41 Joaquin River, established limits for the Grassland Bypass Project, and Basin Plan objectives (Central  
 42 Valley Water Board [2010ed]) and State Water Board ([2010eb, 2010ec]) that are expected to result  
 43 in decreasing discharges of selenium from the San Joaquin River to the Delta. Consequently, any  
 44 modified reservoir operations and subsequent changes in river flows under Alternative 7, relative to

1 Existing Conditions, are expected to cause negligible changes in selenium concentrations in water.  
 2 Any negligible changes in selenium concentrations that may occur in the water bodies of the affected  
 3 environment located upstream of the Delta would not be of frequency, magnitude, and geographic  
 4 extent that would adversely affect any beneficial uses or substantially degrade the quality of these  
 5 water bodies as related to selenium.

6 Relative to Existing Conditions, modeling estimates indicate that Alternative 7 would result in  
 7 essentially no change in selenium concentrations in water or most biota throughout the Delta, with  
 8 no exceedances of benchmarks for biological effects. Relative to Existing Conditions, modeling  
 9 estimates indicate that Alternative 7 would increase selenium concentrations in whole-body  
 10 sturgeon modeled at two western Delta locations by an estimated 210%, which may represent a  
 11 measurable increase in the environment. Because both low and high toxicity benchmarks are  
 12 ~~already exceeded under Existing Conditions~~, these potentially measurable increases represent a  
 13 potential impact to ~~aquatic fish and wildlife life~~-beneficial uses.

14 ~~Assessment~~ The aAssessment of effects of selenium in the SWP ~~and~~ /CVP Export Service Areas is  
 15 based on effects on selenium concentrations at the Banks and Jones pumping plants. Relative to  
 16 Existing Conditions, Alternative 7 would ~~slightly decrease~~ cause no change-increase in the frequency  
 17 with which applicable benchmarks would be exceeded, ~~(there would be none) or and would~~ slightly  
 18 improve the quality of water in selenium concentrations at the Banks and Jones pumping plants  
 19 ~~locations~~.

20 Based on the above, although waterborne selenium concentrations would not exceed applicable  
 21 water quality objectives/criteria, however, significant impacts on some beneficial uses of waters in  
 22 the Delta could occur because ~~both low and high toxicity benchmarks are already would be~~  
 23 ~~exceeded (where they are not under Existing Conditions)~~, and uptake of selenium from water to  
 24 biota may measurably increase. In comparison to Existing Conditions, water quality conditions  
 25 under this alternative would increase levels of selenium (a bioaccumulative pollutant) by frequency,  
 26 magnitude, and geographic extent such that the affected environment may have measurably higher  
 27 body burdens of selenium in aquatic organisms, thereby substantially increasing the health risks to  
 28 wildlife (including fish); however, impacts to humans consuming those organisms are not expected  
 29 to occur. Water quality conditions under this alternative with respect to selenium would cause long-  
 30 term degradation of water quality in the western Delta. Except in the vicinity of the western Delta  
 31 for sturgeon, water quality conditions under this alternative would not increase levels of selenium  
 32 by frequency, magnitude, and geographic extent such that the affected environment would be  
 33 expected to have measurably higher body burdens of selenium in aquatic organisms. The greater  
 34 level of selenium bioaccumulation in the western Delta would further degrade water quality by  
 35 measurable levels, on a long-term basis, for selenium and, thus, cause the CWA Section 303(d)-listed  
 36 impairment of beneficial use to be made discernibly worse. This impact is considered significant.  
 37 Environmental Commitment: Selenium Management (AMM27), which affords for site-specific  
 38 measures to reduce effects, would be available to reduce BDCP-related effects associated with  
 39 selenium. The effectiveness of AMM27 is uncertain and, therefore implementation may not reduce  
 40 the identified impact to a level that would be less than significant, and therefore it is significant and  
 41 unavoidable.

42 The need for, and the feasibility and effectiveness of, post-operation mitigation for the predicted  
 43 level of selenium bioaccumulation is uncertain. The first step shall be to determine the reliability of  
 44 the model in predicting biota selenium concentrations in the affected environment where effects are  
 45 predicted but selenium data are lacking. For that reason, the model shall be validated with site-

1 specific sampling before extensive mitigation measures relative to CM1 operations are developed  
 2 and evaluated for feasibility, as the measures and their evaluation for feasibility are likely to be  
 3 complex. Specifically, it remains to be determined whether the available existing data for transfer of  
 4 selenium from water to particulates and through different trophic levels of the food chain are  
 5 representative of conditions that may occur from implementation of Alternative 7. Therefore, the  
 6 proposed mitigation measure requires that sampling be conducted to characterize each step of data  
 7 inputs needed for the model, and then the refined model be validated for local conditions. This  
 8 impact is considered significant and unavoidable.

9 **Impact WQ-26: Effects on Selenium Concentrations Resulting from Implementation of CM2-  
 10 CM2-CM21**

11 *NEPA Effects:* Effects of CM2-CM21 on selenium under Alternative 7 are the same as those  
 12 discussed for Alternative 1A and are considered not to be adverse.

13 *CEQA Conclusion:* CM2-CM21 proposed under Alternative 7 would be similar to those proposed  
 14 under Alternative 1A. As such, effects on selenium resulting from the implementation of CM2-CM21  
 15 would be similar to that previously discussed for Alternative 1A. This impact is considered to be less  
 16 than significant. No mitigation is required.

17 ~~*NEPA Effects:* In general, with the possible exception of changes in Delta hydrodynamics resulting  
 18 from habitat restoration, CM2-CM11 would not substantially increase selenium concentrations in  
 19 the water bodies of the affected environment. Modeling scenarios included assumptions regarding  
 20 how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, and  
 21 thus such effects of these restoration measures were included in the assessment of CM1 facilities  
 22 operations and maintenance (see Impact WQ-25).~~

23 ~~However, implementation of these conservation measures may increase water residence time  
 24 within the restoration areas. Increased restoration area water residence times could potentially  
 25 increase the bioaccumulation of selenium in biota, thereby potentially increasing fish tissue and bird  
 26 egg concentrations of selenium, but models are not available to quantitatively estimate the level  
 27 of changes in residence time and the associated selenium bioavailability. If increases in fish tissue or  
 28 bird egg selenium were to occur, the increases would likely be of concern only where fish tissues or  
 29 bird eggs are already elevated in selenium to near or above thresholds of concern. That is, where  
 30 biota concentrations are currently low and not approaching thresholds of concern, changes in  
 31 residence time alone would not be expected to cause them to then approach or exceed thresholds of  
 32 concern. In consideration of this factor, although the Delta as a whole is a 303(d)-listed water body  
 33 for selenium, and although monitoring data of fish tissue or bird eggs in the Delta are sparse, the  
 34 most likely areas in which biota tissues would be at levels high enough that additional  
 35 bioaccumulation due to increased residence time from restoration areas would be a concern are the  
 36 western Delta and Suisun Bay, and the South Delta in areas that receive San Joaquin River water.~~

37 ~~The western Delta and Suisun Bay receive elevated selenium loads from North San Francisco Bay  
 38 (including San Pablo Bay, Carquinez Strait, and Suisun Bay) and from the San Joaquin River. Point  
 39 sources of selenium in North San Francisco Bay (i.e., refineries) that contribute selenium to Suisun  
 40 Bay are expected to be reduced through a TMDL under development by the San Francisco Bay Water  
 41 Board (San Francisco Bay Water Board 2012) that is expected to result in decreasing discharges of  
 42 selenium. Nonpoint sources of selenium in the San Joaquin Valley that contribute selenium to the  
 43 San Joaquin River, and thus the Delta and Suisun Bay, will be controlled through a TMDL developed  
 44 by the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the~~

1 Grassland Bypass Project, and Basin Plan objectives (Central Valley Water Board 2010c, d) that are  
2 expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta. If  
3 selenium levels are not sufficiently reduced via these efforts, it is expected that the State Water  
4 Board and the San Francisco Bay and Central Valley Water Boards would initiate additional actions  
5 to further control sources of selenium.

6 The South Delta receives elevated selenium loads from the San Joaquin River. In contrast to Suisun  
7 Bay and possibly the western Delta in the future, the South Delta lacks the overbite clam (*Corbula*  
8 [*Potamocorbula*] *amurensis*), which is considered a key driver of selenium bioaccumulation in  
9 Suisun Bay, due to its high bioaccumulation of selenium and its role in the benthic food web that  
10 includes long lived sturgeon. The South Delta does have *Corbicula fluminea*, another bivalve that  
11 bioaccumulates selenium, but it is not as invasive as the overbite clam and thus likely makes up a  
12 smaller fraction of sturgeon diet. Also, as mentioned above, nonpoint sources of selenium in the San  
13 Joaquin Valley that contribute selenium to the Delta will be controlled through a TMDL developed by  
14 the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the  
15 Grassland Bypass Project, and Basin Plan objectives (Central Valley Water Board 2010c, d) that are  
16 expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta.  
17 Further, if selenium levels in the San Joaquin River are not sufficiently reduced via these efforts, it is  
18 expected that the State Water Board and Central Valley Water Board would initiate additional  
19 TMDLs to further control nonpoint sources of selenium.

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

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

40 Given the factors discussed in the assessment above, any increases in bioaccumulation rates from  
41 water-borne selenium that could occur in some areas as a result of increased water residence time  
42 would not be of sufficient magnitude and geographic extent that any portion of the Delta would be  
43 expected to have measurably higher body burdens of selenium in aquatic organisms and, therefore,  
44 would not substantially increase risk for adverse effects to beneficial uses. Furthermore, although  
45 the Delta is a 303(d) listed water body for selenium, given the discussion in the assessment above, it

1 is unlikely that restoration areas would result in measurable increases in selenium in fish tissues or  
 2 bird eggs such that the beneficial use impairment would be made discernibly worse.

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

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

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

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

### 30 **Impact WQ-32. Effects on *Microcystis* Bloom Formation Resulting from Facilities Operations** 31 **and Maintenance (CM1).**

32 Effects of facilities and operations (CM1) on *Microcystis* abundance, and thus microcystins  
 33 concentrations, in water bodies of the affected environment under Alternative 7 would be very  
 34 similar (i.e., nearly the same) to those discussed for Alternative 1A. This is because factors that  
 35 affect *Microcystis* abundance in waters upstream of the Delta, in the Delta, and in the SWP/CVP  
 36 Export Services Areas under Alternative 1A would similarly change under Alternative 7, relative to  
 37 Existing Conditions and the No Action Alternative. For the Delta in particular, there are differences  
 38 in the direction and magnitude of water residence time changes during the *Microcystis* bloom  
 39 period among the six Delta sub-regions under Alternative 7 compared to Alternative 1A, relative to  
 40 Existing Conditions and No Action Alternative. However, under Alternative 7, relative to Existing  
 41 Conditions and No Action Alternative, water residence times during the *Microcystis* bloom period in  
 42 various Delta sub-regions are expected to increase to a degree that could, similar to Alternative 1A,  
 43 lead to an increase in the frequency, magnitude, and geographic extent of *Microcystis* blooms  
 44 throughout the Delta.

1 Similar to Alternative 1A, elevated ambient water temperatures relative to Existing Conditions  
2 would occur in the Delta under Alternative 7, which could lead to earlier occurrences of Microcystis  
3 blooms in the Delta, and increase the overall duration and magnitude of blooms. However, the  
4 degradation of water quality from Microcystis blooms due to the expected increases in Delta water  
5 temperatures is driven entirely by climate change, not effects of CM1. While Microcystis blooms  
6 have not occurred in the Export Service Areas, conditions in the Export Service Areas under  
7 Alternative 7 may become more conducive to Microcystis bloom formation, relative to Existing  
8 Conditions, because water temperatures will increase in the Export Service Areas due to the  
9 expected increase in ambient air temperatures resulting from climate change.

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

15 Under Alternative 7, additional impacts from Microcystis in the reservoirs and watersheds upstream  
16 of the Delta are not expected, relative to Existing Conditions. Operations and maintenance occurring  
17 under Alternative 7 is not expected to change nutrient levels in upstream reservoirs or  
18 hydrodynamic conditions in upstream rivers and streams such that conditions would be more  
19 conductive to Microcystis production.

20 Relative to Existing Conditions, water temperatures and hydraulic residence times in the Delta are  
21 expected to increase under Alternative 7, resulting in an increase in the frequency, magnitude and  
22 geographic extent of Microcystis blooms in the Delta. However, the degradation of water quality  
23 from Microcystis blooms due to the expected increases in Delta water temperatures is driven  
24 entirely by climate change, not effects of CM1. Increases in Delta residence times are expected  
25 throughout the Delta during the summer and fall bloom period, due in small part to climate change  
26 and sea level rise, but due more proportionately to CM1 and the hydrodynamic impacts of  
27 restoration included in CM2 and CM4. The precise change in local residence times and Microcystis  
28 production expected within any Delta sub-region is unknown because conditions will vary across  
29 the complex networks of intertwining channels, shallow back water areas, and submerged islands  
30 that compose the Delta. Nonetheless, Delta residence times are, in general, expected to increase due  
31 to Alternative 7. Consequently, it is possible that increases in the frequency, magnitude, and  
32 geographic extent of Microcystis blooms in the Delta will occur due to the operations and  
33 maintenance of Alternative 7 and the hydrodynamic impacts of restoration (CM2 and CM4).

34 The assessment of effects of Microcystis on SWP/CVP Export Service Areas is based on the  
35 assessment of changes in Microcystis levels in export source waters, as well as the effects of  
36 temperature and residence time changes within the Export Service Areas on Microcystis production.  
37 Under Alternative 7, relative to Existing Conditions, the potential for Microcystis to occur in the  
38 Export Service Area is expected to increase due to increasing water temperature, but this impact is  
39 driven entirely by climate change and not Alternative 7. Water exported from the Delta to the  
40 Export Service Area is expected to be a mixture of Microcystis-affected source water from the south  
41 Delta intakes and unaffected source water from the Sacramento River. Because of this, it cannot be  
42 determined whether operations and maintenance under Alternative 7, relative to existing  
43 conditions, will result in increased or decreased levels of Microcystis and microcystins in the  
44 mixture of source waters exported from Banks and Jones pumping plants.

1 Based on the above, this alternative would not be expected to cause additional exceedance of  
 2 applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that  
 3 would cause significant impacts on any beneficial uses of waters in the affected environment.  
 4 Microcystis and microcystins are not 303(d) listed within the affected environment and thus any  
 5 increases that could occur in some areas would not make any existing Microcystis impairment  
 6 measurably worse because no such impairments currently exist. Because Microcystis and  
 7 microcystins are not bioaccumulative, increases that could occur in some areas would not  
 8 bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health  
 9 risks to fish, wildlife, or humans. However, because it is possible that increases in the frequency,  
 10 magnitude, and geographic extent of Microcystis blooms in the Delta will occur due to the  
 11 operations and maintenance of Alternative 7 and the hydrodynamic impacts of restoration (CM2  
 12 and CM4), long-term water quality degradation may occur and, thus, significant impacts on  
 13 beneficial uses could occur. Although there is considerable uncertainty regarding this impact, the  
 14 effects on Microcystis from implementing CM1 is determined to be significant.

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

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

21 Please see Mitigation Measure WQ-32a under Impact WQ-32 in the discussion of Alternative 1A.

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

24 Please see Mitigation Measure WQ-32b under Impact WQ-32 in the discussion of Alternative 1A.

25 **Impact WQ-33. Effects on Microcystis Bloom Formation Resulting from Other Conservation**  
 26 **Measures (CM2--CM21).**

27 The effects of CM2–CM21 on *Microcystis* under Alternative 7 are the same as those discussed for  
 28 Alternative 1A. In summary, potential environmental effects related to CM2 and CM4 could result in  
 29 an increase in the frequency, magnitude, and geographic extent of *Microcystis* blooms in the Delta,  
 30 relative to Existing Conditions and the No Action Alternative, as a result of increased residence times  
 31 for Delta waters from implementing CM2 and CM4 restoration areas. -Because the hydrodynamic  
 32 effects associated with implementing CM2 and CM4 were incorporated into the modeling used to  
 33 assess CM1, a detailed assessment of the effects of implementing CM2 and CM4 on *Microcystis*  
 34 blooms in the Delta via their effects on Delta water residence time is provided under CM1 (above).  
 35 The effects of ~~CM 2~~CM2 and ~~CM 4~~CM4 on *Microcystis* may be reduced by implementation of  
 36 Mitigation Measures WQ-32A and WQ-32b. The effectiveness of these mitigation measures to result  
 37 in feasible measures for reducing water quality effects is uncertain. Conservation Measures 3 (CM3)  
 38 and CM5-CM21 would not result in an increase in the frequency, magnitude, and geographic extent  
 39 of *Microcystis* blooms in the Delta.

40 **NEPA Effects:** Effects of CM2–CM21 on *Microcystis* under Alternative 7 are the same as those  
 41 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

1 outflow, which would be the primary driver of salinity changes, would two to three orders of  
2 magnitude lower than (and thus minimal compared to) the Bay's tidal flow.

3 Also, as discussed for the No Action Alternative, adverse changes in Microcystis levels that could  
4 occur in the Delta would not cause adverse Microcystis blooms in San Francisco Bay, because  
5 Microcystis are intolerant of the Bay's high salinity and, thus not have not been detected  
6 downstream of Suisun Bay.

7 While effects of Alternative 7 on the nutrients ammonia, nitrate, and phosphorus were determined  
8 to be less than significant/not adverse, these constituents are addressed further below because the  
9 response of the seaward bays to changed nutrient concentrations/loading may differ from the  
10 response of the Delta. Selenium and mercury are discussed further, because they are  
11 bioaccumulative constituents where changes in load due to both changes in Delta concentrations  
12 and exports are of concern.

### 13 **Nutrients: Ammonia, Nitrate, and Phosphorus**

14 Total nitrogen loads in Delta outflow to Suisun and San Pablo Bays under Alternative 7 would be  
15 dominated almost entirely by nitrate, because planned upgrades to the SRWTP will result in >95%  
16 removal of ammonia in its effluent. Total nitrogen loads to Suisun and San Pablo Bays would  
17 decrease by 13%, relative to Existing Conditions, and increase by 28%, relative to the No Action  
18 Alternative (Appendix 80, Table O-1). The change in nitrogen loading to Suisun and San Pablo Bays  
19 under Alternative 7 would not adversely impact primary productivity in these embayments because  
20 light limitation and grazing current limit algal production in these embayments. To the extent that  
21 algal growth increases in relation to a change in ammonia concentration, this would have net  
22 positive benefits, because current algal levels in these embayments are low. Nutrient levels and  
23 ratios are not considered a direct driver of Microcystis and cyanobacteria levels in the North Bay.

24 The phosphorus load exported from the Delta to Suisun and San Pablo Bays for Alternative 7 is  
25 estimated to increase by 9%, relative to Existing Conditions, and increase by 4% relative to the No  
26 Action Alternative (Appendix 80, Table O-1) ). The only postulated effect of changes in phosphorus  
27 loads to Suisun and San Pablo Bays is related to the influence of nutrient stoichiometry on primary  
28 productivity. However, there is uncertainty regarding the impact of nutrient ratios on  
29 phytoplankton community composition and abundance. Any effect on phytoplankton community  
30 composition would likely be small compared to the effects of grazing from introduced clams and  
31 zooplankton in the estuary (Senn and Novick 2014; Kimmerer and Thompson 2014). Therefore, the  
32 projected change in total nitrogen and phosphorus loading that would occur in Delta outflow to San  
33 Francisco Bay is not expected to result in degradation of water quality with regard to nutrients that  
34 would result in adverse effects to beneficial uses.

### 35 **Mercury**

36 The estimated long-term average mercury and methylmercury loads in Delta exports are shown in  
37 Appendix 80, Table O-2. Loads of mercury and methylmercury from the Delta to San Francisco Bay  
38 are estimated to change relatively little due to changes in source water fractions and net Delta  
39 outflow that would occur under Alternative 7. Mercury load to the Bay, relative to Existing  
40 Conditions, is estimated to increase by 10 kg/yr (4%), relative to Existing Conditions, and 7 kg/yr  
41 (3%), relative to the No Action Alternative. Methylmercury load is estimated to increase by 0.29  
42 kg/yr (8%), relative to Existing Conditions, and increase by 0.20 kg/yr (5%) relative to the No  
43 Action Alternative. The estimated total mercury load to the Bay is 270 kg/yr, which would be less

1 than the San Francisco Bay mercury TMDL WLA for the Delta of 330 kg/yr. The estimated changes in  
2 mercury and methylmercury loads would be within the overall uncertainty associated with the  
3 estimates of long-term average net Delta outflow and the long-term average mercury and  
4 methylmercury concentrations in Delta source waters. The estimated changes in mercury load  
5 under the alternative would also be substantially less than the considerable differences among  
6 estimates in the current mercury load to San Francisco Bay (SFBRWQCB 2006; David et al. 2009).  
7 Similar uncertainty is expected in the existing methylmercury load in net Delta exports, for which  
8 the best available current load estimate is based on approximately one year of monitoring data (Foe  
9 et al. 2008).

10 Given that the estimated incremental decreases/increases of mercury and methylmercury loading to  
11 San Francisco Bay would fall within the uncertainty of current mercury and methylmercury load  
12 estimates, the estimated changes in mercury and methylmercury loads in Delta exports to San  
13 Francisco Bay due to Alternative 7 are not expected to result in adverse effects to beneficial uses or  
14 substantially degrade the water quality with regard to mercury, or make the existing CWA Section  
15 303(d) impairment measurably worse.

### 16 Selenium

17 Changes in source water fraction and net Delta outflow under Alternative 7, relative to Existing  
18 Conditions, are projected to cause the total selenium load to the North Bay to increase by 20%,  
19 relative to Existing Conditions, and increase by 16%, relative to the No Action Alternative (Appendix  
20 80, Table O-3). Changes in long-term average selenium concentrations of the North Bay are assumed  
21 to be proportional to changes in North Bay selenium loads. Under Alternative 7, the long-term  
22 average total selenium concentration of the North Bay is estimated to be 0.15 µg/L and the dissolved  
23 selenium concentration is estimated to be 0.13 µg/L, which would be a 0.02 µg/L increase relative to  
24 Existing Conditions and the No Action Alternative (Appendix 80, Table O-3). The dissolved selenium  
25 concentration would be below the target of 0.202 µg/L developed by Presser or Luoma (2013) to  
26 coincide with a white sturgeon whole-body fish tissue selenium concentration not greater than 8  
27 mg/kg in the North Bay.

28 The incremental increase in dissolved selenium concentrations in water projected to occur under  
29 Alternative 7, relative to Existing Conditions and the No Action Alternative, would be higher than  
30 under Alternatives 1–5, but still low (0.02 µg/L). The increased dissolved selenium concentration  
31 would be within the overall uncertainty of the analytical methods used to measure selenium in  
32 water column samples; however, it also would be within the uncertainty associated with estimating  
33 numeric water column selenium thresholds (Presser and Luoma 2013). As described in Section  
34 8.3.1.8, there have been improvements in selenium concentrations in the tissue of diving ducks and  
35 muscle of white sturgeon since the initial CWA Section 303(d) listing of the North Bay for selenium  
36 impairments, and selenium concentrations in white sturgeon muscle have also generally been  
37 below the USEPA's draft recommended fish muscle tissue concentration of 11.8 mg/kg dry weight  
38 (SFEI 2014). However, as described under Impact WQ-25, though there is some uncertainty in the  
39 estimate of sturgeon concentrations at western Delta locations, the predicted increases for  
40 Alternative 7 are high enough that they may represent measurably higher body burdens of selenium  
41 in aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish).  
42 Because the projected incremental increases in dissolved selenium could cause measurable changes  
43 in water column concentrations, and these incremental increases would be within the uncertainty in  
44 the target water column threshold for dissolved selenium for protection against adverse  
45 bioaccumulative effects in the North Bay ecosystem, and modeling predicts concentrations in the

1 western Delta may represent a measurable increase in body burdens of sturgeon, there is potential  
2 that the incremental increase in dissolved selenium concentration projected to occur in the North  
3 Bay under Alternative 7 could result in adverse effects beneficial uses.

4 ***NEPA Effects:*** Based on the discussion above, Alternative 7, relative to the No Action Alternative,  
5 would not cause further degradation to water quality with respect to boron, bromide, chloride,  
6 dissolved oxygen, DOC, EC, mercury, pathogens, pesticides, nutrients (ammonia, nitrate,  
7 phosphorus), trace metals, or turbidity and TSS in the San Francisco Bay. Further, changes in these  
8 constituent concentrations in Delta outflow would not be expected to cause changes in Bay  
9 concentrations of frequency, magnitude, and geographic extent that would adversely affect any  
10 beneficial uses. In summary, based on the discussion above, effects on the San Francisco Bay from  
11 implementation of CM1–CM21 are considered to be not adverse with respect to boron, bromide,  
12 chloride, dissolved oxygen, DOC, EC, mercury, pathogens, pesticides, nutrients (ammonia, nitrate,  
13 phosphorus), trace metals, or turbidity and TSS. However, Alternative 7 could result in increases in  
14 selenium concentrations in the North San Francisco Bay that could result in adverse effects to fish  
15 and wildlife beneficial uses. This effect is considered to be adverse.

16 ***CEQA Conclusion:*** Based on the above, Alternative 7 would not be expected to cause long-term  
17 degradation of water quality in San Francisco Bay resulting in sufficient use of available assimilative  
18 capacity such that occasionally exceeding water quality objectives/criteria would be likely and  
19 would result in substantially increased risk for adverse effects to one or more beneficial uses with  
20 respect to boron, bromide, chloride, dissolved oxygen, DOC, EC, mercury, pathogens, pesticides,  
21 nutrients (ammonia, nitrate, phosphorus), trace metals, or turbidity and TSS. Further, based on the  
22 above, this alternative would not be expected to cause additional exceedance of applicable water  
23 quality objectives/criteria in the San Francisco Bay by frequency, magnitude, and geographic extent  
24 that would cause significant impacts on any beneficial uses of waters in the affected environment  
25 with respect to boron, bromide, chloride, dissolved oxygen, DOC, EC, mercury, pathogens, pesticides,  
26 nutrients (ammonia, nitrate, phosphorus), trace metals, or turbidity and TSS. Any changes in boron,  
27 bromide, chloride, and DOC in the San Francisco Bay would not adversely affect beneficial uses,  
28 because the uses most affected by changes in these parameters, MUN and AGR, are not beneficial  
29 uses of the Bay. Further, no substantial changes in dissolved oxygen, pathogens, pesticides, trace  
30 metals or turbidity or TSS are anticipated in the Delta, relative to Existing Conditions, therefore, no  
31 substantial changes these constituents levels in the Bay are anticipated. Changes in Delta salinity  
32 would not contribute to measurable changes in Bay salinity, as the change in Delta outflow would  
33 two to three orders of magnitude lower than (and thus minimal compared to) the Bay's tidal flow.  
34 Adverse changes in Microcystis levels that could occur in the Delta would not cause adverse  
35 Microcystis blooms in the Bay, because Microcystis are intolerant of the Bay's high salinity and, thus  
36 not have not been detected downstream of Suisun Bay. The 13% decrease in total nitrogen load and  
37 9% increase in phosphorus load, relative to Existing Conditions, are expected to have minimal effect  
38 on water quality degradation, primary productivity, or phytoplankton community composition. The  
39 estimated increase in mercury load (10 kg/yr; 4%) and methylmercury load (0.29 kg/yr; 8%),  
40 relative to Existing Conditions, is within the level of uncertainty in the mass load estimate and not  
41 expected to contribute to water quality degradation, make the CWA section 303(d) mercury  
42 impairment measurably worse or cause mercury/methylmercury to bioaccumulate to greater levels  
43 in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans.

44 hough there is some uncertainty in the estimate of sturgeon concentrations at western Delta  
45 locations, the predicted increases are high enough that they may represent measurably higher body  
46 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 ~~CM2-22CM2-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.

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.

1 Due to the relatively small differences between modeled Existing Conditions and the No Action  
2 baseline, changes in long-term average bromide concentrations and changes in exceedance  
3 frequencies relative to the No Action Alternative are generally of similar magnitude to those  
4 previously described for the existing condition comparison (Appendix 8E, Bromide, Table 18).  
5 Modeled long-term average bromide concentration at Barker Slough is predicted to increase by 8%  
6 (50% for the modeled drought period) relative to the No Action Alternative. Modeled long-term  
7 average bromide concentration increases at Staten Island are predicted to increase by 33% (30% for  
8 the modeled drought period) relative to the No Action Alternative. However, unlike the Existing  
9 Conditions comparison, long-term average bromide concentrations at Buckley Cove would increase  
10 relative to the No Action Alternative, although the increases would be relatively small ( $\leq 2\%$ ). Unlike  
11 the comparison to Existing Conditions, this comparison to the No Action Alternative reflects changes  
12 in bromide due only to Alternative 8 operations.

13 At Barker Slough, modeled long-term average bromide concentrations for the two baseline  
14 conditions are very similar (Appendix 8E, Bromide, Table 18). Such similarity demonstrates that the  
15 modeled Alternative 8 change in bromide is almost entirely due to Alternative 8 operations, and not  
16 climate change/sea level rise. Therefore, operations are the primary driver of effects on bromide at  
17 Barker Slough, regardless whether Alternative 8 is compared to Existing Conditions, or compared to  
18 the No Action Alternative.

19 Results of the modeling approach which used relationships between EC and chloride and between  
20 chloride and bromide (see Section 8.3.1.3) differed somewhat from what is presented above for the  
21 mass-balance approach (see Appendix 8E, Bromide, Table 19). For most locations, the frequency of  
22 exceedance of the 50  $\mu\text{g}/\text{L}$  and 100  $\mu\text{g}/\text{L}$  were similar. The greatest difference between the methods  
23 was predicted for Barker Slough. The increases in frequency of exceedance of the 100  $\mu\text{g}/\text{L}$   
24 threshold, relative to Existing Conditions and the No Action Alternative, were not as great using this  
25 alternative EC to chloride and chloride to bromide relationship modeling approach as compared to  
26 that presented above from the mass-balance modeling approach. Results indicate 4% exceedance  
27 over the modeled period under Alternative 8, as compared to 1% under Existing Conditions and 2%  
28 under the No Action Alternative. For the drought period, exceedance frequency increased from 0%  
29 under Existing Conditions and the No Action Alternative, to 12% under Alternative 8. Because the  
30 mass-balance approach predicts a greater level of impact at Barker Slough, determination of impacts  
31 was based on the mass-balance results.

32 While the increase in long-term average bromide concentrations at Barker Slough are relatively  
33 small when modeled over a representative 16-year hydrologic period, increases during the modeled  
34 drought period, principally the relative increase in 100  $\mu\text{g}/\text{L}$  exceedance frequency, would represent  
35 a substantial change in source water quality during a season of drought. As discussed for Alternative  
36 1A, drinking water treatment plants obtaining water via the North Bay Aqueduct utilize a variety of  
37 conventional and enhanced treatment technologies in order to achieve DBP drinking water criteria.  
38 While the implications of such a modeled drought period change in bromide concentrations at  
39 Barker Slough is difficult to predict, the substantial modeled increases could lead to adverse changes  
40 in the formation of disinfection byproducts such that considerable treatment plant upgrades may be  
41 necessary in order to achieve equivalent levels of health protection during seasons of drought.  
42 Increases at Staten Island are also considerable, although there are no existing or foreseeable  
43 municipal intakes in the immediate vicinity. Because many of the other modeled locations already  
44 frequently exceed the 100  $\mu\text{g}/\text{L}$  threshold under Existing Conditions and the No Action Alternative,  
45 these locations likely already require treatment plant technologies to achieve equivalent levels of  
46 health protection, and thus no additional treatment technologies would be triggered by the small

1 increases in the frequency of exceeding the 100 µg/L threshold. Hence, no further impact on the  
2 drinking water beneficial use would be expected at these locations.

3 The seasonal intakes at Mallard Slough and City of Antioch are infrequently used due to water  
4 quality constraints related to sea water intrusion. On a long-term average basis, bromide at these  
5 locations is in excess of 3,000 µg/L, but during seasonal periods of high Delta outflow can be <300  
6 µg/L. Based on modeling using the mass-balance approach, use of the seasonal intakes at Mallard  
7 Slough and City of Antioch under Alternative 8 would experience a period average increase in  
8 bromide during the months when these intakes would most likely be utilized. For those wet and  
9 above normal water year types where mass balance modeling would predict water quality typically  
10 suitable for diversion, predicted long-term average bromide would increase from 103 µg/L to 146  
11 µg/L (42% increase) at City of Antioch and would increase from 150 µg/L to 193 µg/L (29%  
12 increase) at Mallard Slough relative to Existing Conditions (Appendix 8E, Bromide, Table 23).  
13 Increases would be similar for the No Action Alternative comparison. Modeling results using the EC  
14 to chloride and chloride to bromide relationships show increases during these months, but the  
15 relative magnitude of the increases is much lower (Appendix 8E, Bromide, Table 24). Regardless of  
16 the differences in the data between the two modeling approaches, the decisions surrounding the use  
17 of these seasonal intakes is largely driven by acceptable water quality, and thus have historically  
18 been opportunistic. Opportunity to use these intakes would remain, and the predicted increases in  
19 bromide concentrations at the City of Antioch and Mallard Slough intake would not be expected to  
20 adversely affect MUN beneficial uses, or any other beneficial use, at these locations.

21 Based on modeling using the mass-balance approach, relative to existing and No Action Alternative  
22 conditions, Alternative 8 would lead to predicted improvements in long-term average bromide  
23 concentrations at Franks Tract, Rock Slough, and Contra Costa PP No. 1, in addition to Banks and  
24 Jones (discussed below). At these locations, long-term average bromide concentrations would be  
25 predicted to decrease by as much as 11–37%, depending on baseline comparison. Modeling results  
26 using the EC to chloride and chloride to bromide relationships generally do not show similar  
27 decreases for Rock Slough and Contra Costa PP No. 1, but rather, predict small increases. Based on  
28 the small magnitude of increases predicted, these increases would not adversely affect beneficial  
29 uses at those locations.

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

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

3 ***Delta***

4 Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2  
 5 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter  
 6 hydrodynamics within the Delta region, which affects mixing of source waters, these effects are  
 7 included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of  
 8 ~~CM2-22~~CM2-CM21 not attributable to hydrodynamics, for example, additional loading of a  
 9 constituent to the Delta, are discussed within the impact header for ~~CM2-22~~CM2-CM21. See section  
 10 8.3.1.3 for more information.

11 Relative to the Existing Conditions and No Action Alternative, Alternative 8 would result in similar  
 12 or reduced long-term average chloride concentrations for the 16-year period modeled at most of the  
 13 assessment locations, and, depending on the modeling approach (see Section 8.3.1.3), increased  
 14 concentrations at the North Bay Aqueduct at Barker Slough (i.e., up to 6% compared to No Action  
 15 Alternative), Contra Costa Canal at Pumping Plant #1 (i.e., up to 24% compared to No Action  
 16 Alternative), Rock Slough (i.e., up to 18% compared to No Action Alternative), and the ~~San Joaquin~~  
 17 ~~River at Staten Island~~SF Mokelumne at Staten Island (i.e., up to 29% compared to No Action  
 18 Alternative) (Appendix 8G, Chloride, Table Cl-49 and Table Cl-50). Moreover, the direction and  
 19 magnitude of predicted changes for Alternative 8 are similar between the alternatives, thus, the  
 20 effects relative to Existing Conditions and the No Action Alternative are discussed together.  
 21 Additionally, implementation of tidal habitat restoration under CM4 would increase the tidal  
 22 exchange volume in the Delta, and thus may contribute to increased chloride concentrations in the  
 23 Bay source water as a result of increased salinity intrusion. More discussion of this phenomenon is  
 24 included in Section 8.3.1.3. Consequently, while uncertain, the magnitude of chloride increases may  
 25 be greater than indicated herein and would affect the western Delta assessment locations the most  
 26 which are influenced to the greatest extent by the Bay source water. The comparison to Existing  
 27 Conditions reflects changes in chloride due to both Alternative 8 operations (including north Delta  
 28 intake capacity of 9,000 cfs and numerous other operational components of Scenario E) and climate  
 29 change/sea level rise. The comparison to the No Action Alternative reflects changes in chloride due  
 30 only to operations. The following outlines the modeled chloride changes relative to the applicable  
 31 objectives and beneficial uses of Delta waters.

32 ***Municipal Beneficial Uses***

33 Estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output  
 34 (see Section 8.3.1.3) were used to evaluate the 150 mg/L Bay-Delta WQCP objective for municipal  
 35 and industrial beneficial uses on a basis of the percent of years the chloride objective is exceeded for  
 36 the modeled 16-year period. The objective is exceeded if chloride concentrations exceed 150 mg/L  
 37 for a specified number of days in a given water year at both the Antioch and Contra Costa Pumping  
 38 Plant #1 locations. For Alternative 8, the modeled frequency of objective exceedance would increase  
 39 from ~~67~~% of years under Existing Conditions and ~~60~~% under the No Action Alternative to ~~1913~~% of  
 40 years under Alternative 8 (Appendix 8G, Chloride, Table Cl-64).

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



1 year period. For Alternative 8, the modeled frequency of objective exceedance would decrease, from  
2 6% of modeled days under Existing Conditions and 5% under the No Action Alternative to 1% of  
3 modeled days under Alternative 8 (Appendix 8G, [Chloride](#), Table Cl-63).

4 Given the limitations inherent to estimating future chloride concentrations (see Section 8.3.1.3),  
5 estimation of chloride concentrations through both an mass balance approach and an EC-chloride  
6 relationship approach was used to evaluate the 250 mg/L Bay-Delta WQCP objectives in terms of  
7 both frequency of exceedance and use of assimilative capacity. When utilizing the mass balance  
8 approach to model monthly average chloride concentrations for the 16-year period, the predicted  
9 frequency of exceeding the 250 mg/L objective would decrease up to 15% (i.e., 24% for Existing  
10 Conditions to 9%) at the Contra Costa Canal at Pumping Plant #1 (Appendix 8G, [Chloride](#), Table Cl-  
11 51 and Figure Cl-13). The frequency of exceedances would decrease at the San Joaquin River at  
12 Antioch (i.e., from 66% under Existing Conditions to 58%) with no substantial change predicted for  
13 Mallard Island (i.e., maximum increase of 1%) (Appendix 8G, Table Cl-51) and no substantial long-  
14 term degradation (Appendix 8G, Table Cl-53). However, relative to the No Action conditions,  
15 available assimilative capacity for chloride at the Contra Costa Canal at Pumping Plant #1 would be  
16 substantially reduced in September and October (i.e., up to 100%, or eliminated, for the drought  
17 period modeled) (Appendix 8G, Table Cl-53), reflecting substantial degradation when  
18 concentrations would be near, or exceed, the objective.

19 In comparison, when utilizing the chloride-EC relationship to model monthly average chloride  
20 concentrations for the 16-year period, trends in frequency of exceedance generally agreed, but use  
21 of assimilative capacity were predicted to be larger at some locations (Appendix 8G, Table Cl-52 and  
22 Table Cl-54). Specifically, while the model predicted exceedance frequency would decrease at the  
23 Contra Costa Canal at Pumping Plant #1 and Rock Slough locations, use of assimilative capacity  
24 would increase substantially for the months of February through June as well as September (i.e.,  
25 maximum of 82% in March for the modeled drought period). Due to such seasonal long-term  
26 average water quality degradation at these locations, the potential exists for substantial adverse  
27 effects on the municipal and industrial beneficial uses through reduced opportunity for diversion of  
28 water with acceptable chloride levels. Moreover, due to the increased frequency of exceeding the  
29 150 mg/L Bay-Delta WQCP objective, the potential exists for adverse effects on the municipal and  
30 industrial beneficial uses at Contra Costa Pumping Plant #1 and Antioch.

### 31 *303(d) Listed Water Bodies*

32 With respect to the 303(d) listing for chloride in Tom Paine Slough, the monthly average chloride  
33 concentrations for the 16-year period modeled at Old River at Tracy Road would generally be  
34 similar compared to Existing Conditions, and thus, would not be further degraded on a long-term  
35 basis (Appendix 8G, Figure Cl-14). With respect to Suisun Marsh, the monthly average chloride  
36 concentrations for the 16-year period modeled would generally be similar, or decrease, compared to  
37 Existing Conditions in some months during October through May at the Sacramento River at  
38 Collinsville (Appendix 8G, Figure Cl-15), Mallard Island (Appendix 8G, Figure Cl-13). However,  
39 chloride concentrations would increase substantially at Montezuma Slough at Beldon's Landing (i.e.,  
40 over a doubling of concentration in December through February) (Appendix 8G, Figure Cl-16).  
41 [However, modeling of Alternative 8 assumed no operation of the Montezuma Slough Salinity Control](#)  
42 [Gates, but the project description assumes continued operation of the Salinity Control Gates,](#)  
43 [consistent with assumptions included in the No Action Alternative. A sensitivity analysis modeling](#)  
44 [run conducted for Alternative 4 with the gates operational consistent with the No Action Alternative](#)  
45 [resulted in substantially lower EC levels than indicated in the original Alternative 4 modeling results](#)

1 for Suisun Marsh, but EC levels were still somewhat higher than EC levels under Existing Conditions  
 2 for several locations and months. Although chloride was not specifically modeled in these  
 3 sensitivity analyses, it is expected that chloride concentrations would be nearly proportional to EC  
 4 levels in Suisun Marsh. Another modeling run with the gates operational and restoration areas  
 5 removed resulted in EC levels nearly equivalent to Existing Conditions, indicating that design and  
 6 siting of restoration areas has notable bearing on EC levels at different locations within Suisun  
 7 Marsh (see Appendix 8H Attachment 1 for more information on these sensitivity analyses). These  
 8 analyses also indicate that increases in salinity are related primarily to the hydrodynamic effects of  
 9 CM4, not operational components of CM1. Based on the sensitivity analyses, optimizing the design  
 10 and siting of restoration areas may limit the magnitude of long-term chloride increases in the Marsh.  
 11 However, the chloride concentration increases at certain locations could be substantial, depending  
 12 on siting and design of restoration areas. Thus, these increased chloride levels in Suisun Marsh are  
 13 considered to contribute to additional, measureable long-term degradation that potentially would  
 14 adversely affect the necessary actions to reduce chloride loading for any TMDL that is developed.  
 15 ~~thereby contributing to additional, measureable long-term degradation that potentially would~~  
 16 ~~adversely affect the necessary actions to reduce chloride loading for any TMDL that is developed.~~

#### 17 **Impact WQ-9: Effects on Dissolved Oxygen Resulting from Facilities Operations and** 18 **Maintenance (CM1)**

19 *NEPA Effects:* Effects of CM1 on dissolved oxygen under Alternative 8 are the same as those  
 20 discussed for Alternative 1A and are considered not to be adverse.

21 *CEQA Conclusion:* Effects of CM1 on DO under Alternative 8 would be similar to those discussed for  
 22 Alternative 1A, and are summarized here, then compared to the CEQA thresholds of significance  
 23 (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this  
 24 constituent. For additional details on the effects assessment findings that support this CEQA impact  
 25 determination, see the effects assessment discussion under Alternative 1A.

26 River flow rate and reservoir storage reductions that would occur under Alternative 8, relative to  
 27 Existing Conditions, would not be expected to result in a substantial adverse change in DO levels in  
 28 the reservoirs, because oxygen sources (surface water aeration, aerated inflows, vertical mixing)  
 29 would remain. Similarly, river flow rate reductions that would occur would not be expected to  
 30 result in a substantial adverse change in DO levels in the and rivers upstream of the Delta, given that  
 31 mean monthly flows would remain within the ranges historically seen under Existing Conditions  
 32 and the affected river are large and turbulent. Any reduced DO saturation level that may be caused  
 33 by increased water temperature would not be expected to cause DO levels to be outside of the range  
 34 seen historically. Finally, amounts of oxygen demanding substances and salinity would not be  
 35 expected to change sufficiently to affect DO levels.

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

1 There is not expected to be substantial, if even measurable, changes in DO levels in the SWP/CVP  
 2 Export Service Areas waters under Alternative 8, relative to Existing Conditions, because the  
 3 biochemical oxygen demand of the exported water would not be expected to substantially differ  
 4 from that under Existing Conditions (due to ever increasing water quality regulations), canal  
 5 turbulence and exposure of the water to the atmosphere and the algal communities that exist within  
 6 the canals would establish an equilibrium for DO levels within the canals. The same would occur in  
 7 downstream reservoirs.

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

## 16 **Impact WQ-11: Effects on Electrical Conductivity Concentrations Resulting from Facilities** 17 **Operations and Maintenance (CM1)**

### 18 ***Delta***

19 Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2  
 20 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter  
 21 hydrodynamics within the Delta region, which affects mixing of source waters, these effects are  
 22 included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of  
 23 ~~CM2-22CM2-CM21~~ not attributable to hydrodynamics, for example, additional loading of a  
 24 constituent to the Delta, are discussed within the impact header for ~~CM2-22CM2-CM21~~. See section  
 25 8.3.1.3 for more information.

26 Relative to Existing Conditions, Alternative 8 would result in an increase in the number of days the  
 27 Bay-Delta WQCP EC objectives would be exceeded in the Sacramento River at Emmaton, and the San  
 28 Joaquin River at Vernalis, Prisoners Point, and Brandt Bridge, and in the Old River near Middle River  
 29 (Appendix 8H, *Electrical Conductivity*, Table EC-8).

30 The percent of days the Emmaton EC objective would be exceeded for the entire period modeled  
 31 (1976–1991) would increase from 6% under Existing Conditions to ~~1622~~% under Alternative 8, and  
 32 the percent of days out of compliance would increase from 11% under Existing Conditions to ~~2834~~%  
 33 under Alternative 7.

34 The increase in the percent of days the Vernalis EC objective would be exceeded would be <1%, and  
 35 the percent of days out of compliance with the EC objective would increase from 7% under Existing  
 36 Conditions to 8% under Alternative 8. These increases are minimal, and are not considered  
 37 substantial, in light of the overall modeling uncertainty.

38 The percent of days the Prisoners Point EC objective would be exceeded for the entire period  
 39 modeled would increase from 6% under Existing Conditions to ~~328~~% under Alternative 8, and the  
 40 percent of days out of compliance with the EC objective would increase from 10% under Existing  
 41 Conditions to ~~328~~% under Alternative 8. Sensitivity analyses conducted for Alternative 4 scenario  
 42 H3 indicated that removing all tidal restoration areas would reduce the number of exceedances, but

1 there would still be substantially more exceedances than under Existing Conditions or the No Action  
 2 Alternative. Results of the sensitivity analyses indicate that the exceedances are partially a function  
 3 of the operations of the alternative itself, perhaps due to Head of Old River Barrier assumptions and  
 4 south Delta export differences (see Appendix 8H Attachment 1 for more discussion of these  
 5 sensitivity analyses). Due to similarities in the nature of the exceedances between alternatives, the  
 6 findings from these analyses can be extended to this alternative as well. Appendix 8H Attachment 2  
 7 contains a more detailed assessment of the likelihood of these exceedances impacting aquatic life  
 8 beneficial uses. Specifically, Appendix 8H Attachment 2 discusses whether these exceedances might  
 9 have indirect effects on striped bass spawning in the Delta, and concludes that the high level of  
 10 uncertainty precludes making a definitive determination.

11 In the San Joaquin River at Brandt Bridge, the percent of days exceeding the EC objective would  
 12 increase from 3% under Existing Conditions to 4% under Alternative 8; the percent of days out of  
 13 compliance would increase from 8% under Existing Conditions to 9% under Alternative 8. The  
 14 increase in the percent of days the Old River EC objective would be exceeded and out of compliance  
 15 for the entire period modeled (1976–1991) would be <1%. These increases are minimal, and are not  
 16 considered substantial, in light of the overall modeling uncertainty.

17 Average EC levels at the western and southern Delta compliance locations and San Joaquin River at  
 18 San Andreas Landing (an interior Delta location) would decrease from 0–44% for the entire period  
 19 modeled and 2–43% during the drought period modeled (1987–1991) (Appendix 8H, Table EC-19).  
 20 In the S. Fork Mokelumne River at Terminous, average EC would increase 5% for the entire period  
 21 modeled and drought period modeled. Average EC in the S. Fork Mokelumne River at Terminous  
 22 would increase during all months (Appendix 8H, Table EC-19). Given that the western ~~and southern~~  
 23 Delta ~~are is~~ Clean Water Act section 303(d) listed as impaired due to elevated EC, the increase in the  
 24 incidence of exceedance of EC objectives under Alternative 8, relative to Existing Conditions has the  
 25 potential to contribute to additional impairment and potentially adversely affect beneficial uses. The  
 26 comparison to Existing Conditions reflects changes in EC due to both Alternative 8 operations  
 27 (including north Delta intake capacity of 9,000 cfs and numerous other operational components of  
 28 Scenario F) and climate change/sea level rise.

29 Relative to the No Action Alternative, the change in percent compliance with Bay-Delta WQCP EC  
 30 objectives under Alternative 8 would be similar to that described above relative to Existing  
 31 Conditions. The exception is that there would also be a slight increase (<1%) in the percent of days  
 32 the EC objective would be exceeded in the Old River at Tracy for the entire period modeled. Also, Old  
 33 River at Tracy also would have an increase in the number of days out of compliance with the EC  
 34 objectives. The percent of days out of compliance with Tracy Bridge EC objectives would increase  
 35 from 8% to 9% for the entire period modeled. For the entire period modeled, average EC levels  
 36 would increase at all Delta compliance locations relative to the No Action Alternative, except in  
 37 ~~Three Mile Slough near the Sacramento River, and~~ the San Joaquin River at San Andreas Landing and  
 38 Jersey Point. The greatest average EC increase would occur in the San Joaquin River at Prisoners  
 39 Point (7%); the increase at the other locations would be <1–6% (Appendix 8H, Chloride, Table EC-  
 40 19). Similarly, during the drought period modeled, average EC would increase at all locations, except  
 41 ~~Three Mile Slough and the~~ San Joaquin River at San Andreas Landing and Jersey Point. The greatest  
 42 average EC increase during the drought period modeled would occur in the S. Fork Mokelumne  
 43 River at Terminous (6%); the increases at the other locations would be 1–4% (Appendix 8H, Table  
 44 EC-19). Given that the western and southern Delta are Clean Water Act section 303(d) listed as  
 45 impaired due to elevated EC, the increase in the incidence of exceedance of EC objectives under  
 46 Alternative 7, relative to the No Action Alternative, has the potential to contribute to additional

1 impairment and potentially adversely affect beneficial uses. The comparison to the No Action  
 2 Alternative reflects changes in EC due only to Alternative 8 operations (including north Delta intake  
 3 capacity of 9,000 cfs and numerous other operational components of Scenario F).

4 For Suisun Marsh, October–May is the period when Bay-Delta WQCP EC objectives for protection of  
 5 fish and wildlife apply. Long-term average EC would decrease under Alternative 8, relative to  
 6 Existing Conditions, during October–May in the Sacramento River at Collinsville and Montezuma  
 7 Slough at National Steel (Appendix 8H, [Electrical Conductivity](#), Table EC-21 [and EC-22](#)). The most  
 8 substantial increase would occur near Beldon Landing, with long-term average EC levels increasing  
 9 by 0.1–3.5 mS/cm, depending on the month (Appendix 8H, Table EC-23). Sunrise Duck Club would  
 10 have long-term average EC increases of 0.2–0.8 mS/cm (Appendix 8H, Table EC-24) and Volanti  
 11 Slough would have long-term average EC increases of 0.1–1.1 mS/cm. The degree to which the long-  
 12 term average EC increases would cause exceedance of Bay-Delta WQCP objectives is unknown,  
 13 because objectives are expressed as a monthly average of daily high tide EC, which does not have to  
 14 be met if it can be demonstrated “equivalent or better protection will be provided at the location”  
 15 (State Water Resources Control Board 2006:14). [Modeling of this alternative assumed no operation](#)  
 16 [of the Montezuma Slough Salinity Control Gates, but the project description assumes continued](#)  
 17 [operation of the Salinity Control Gates, consistent with assumptions included in the No Action](#)  
 18 [Alternative. A sensitivity analysis modeling run conducted for Alternative 4 scenario H3 with the](#)  
 19 [gates operational consistent with the No Action Alternative resulted in substantially lower EC levels](#)  
 20 [than indicated in the original Alternative 4 modeling results, but EC levels were still somewhat](#)  
 21 [higher than EC levels under Existing Conditions and the No Action Alternative for several locations](#)  
 22 [and months. Another modeling run with the gates operational and restoration areas removed](#)  
 23 [resulted in EC levels nearly equivalent to Existing Conditions and the No Action Alternative,](#)  
 24 [indicating that design and siting of restoration areas has notable bearing on EC levels at different](#)  
 25 [locations within Suisun Marsh \(see Appendix 8H Attachment 1 for more information on these](#)  
 26 [sensitivity analyses\). These analyses also indicate that increases are related primarily to the](#)  
 27 [hydrodynamic effects of CM4, not operational components of CM1. Based on the sensitivity analyses,](#)  
 28 [optimizing the design and siting of restoration areas may limit the magnitude of long-term EC](#)  
 29 [increases to be on the order of 1 mS/cm or less. Due to similarities in the nature of the EC increases](#)  
 30 [between alternatives, the findings from these analyses can be extended to this alternative as well.](#)

31 The ~~described~~ long-term average EC increase [in Suisun Marsh](#) may, or may not, contribute to  
 32 adverse effects on beneficial uses, depending on how and when wetlands are flooded, soil leaching  
 33 cycles, and how agricultural use of water is managed, and future actions taken with respect to the  
 34 marsh. However, the EC increases at certain locations ~~would~~ could be substantial and it is uncertain  
 35 the degree to which current management plans for the Suisun Marsh would be able to address these  
 36 substantially higher EC levels and protect beneficial uses. Thus, these increased EC levels in Suisun  
 37 Marsh are considered to have a potentially adverse effect on marsh beneficial uses. Long-term  
 38 average EC increases in Suisun Marsh under Alternative 8 relative to the No Action Alternative  
 39 would be similar to the increases relative to Existing Conditions. Suisun Marsh is section 303(d)  
 40 listed as impaired due to elevated EC, and the potential increases in long-term average EC  
 41 concentrations could contribute to additional impairment relative to Existing Conditions and the No  
 42 Action Alternative.

43 **NEPA Effects:** In summary, the increased frequency of exceedance of EC objectives ~~and increased~~  
 44 ~~long-term and drought period average EC levels that would occur at southern Delta compliance~~  
 45 ~~locations, and increased frequency of exceedance of EC objectives~~ in the western Delta under  
 46 Alternative 8, relative to the No Action Alternative, would contribute to adverse effects on the

1 agricultural beneficial uses. In addition, the increased frequency of exceedance of the San Joaquin  
 2 River at Prisoners Point EC objective and long-term and drought period average EC could contribute  
 3 to adverse effects on fish and wildlife beneficial uses (specifically, indirect adverse effects on striped  
 4 bass spawning), though there is a high degree of uncertainty associated with this impact. Given that  
 5 the western ~~and southern~~ Delta ~~are is~~ Clean Water Act section 303(d) listed as impaired due to  
 6 elevated EC, the increase in the incidence of exceedance of EC objectives ~~and long-term average and~~  
 7 ~~drought period average EC~~ in ~~these this~~ portions of the Delta has the potential to contribute to  
 8 additional beneficial use impairment. The increases in long-term average EC levels that ~~would could~~  
 9 occur in Suisun Marsh would further degrade existing EC levels and could contribute additional to  
 10 adverse effects on the fish and wildlife beneficial uses. Suisun Marsh is section 303(d) listed as  
 11 impaired due to elevated EC, and the potential increases in long-term average EC levels could  
 12 contribute to additional beneficial use impairment. These increases in EC constitute an adverse  
 13 effect on water quality. Mitigation Measure WQ-11 would be available to reduce these effects  
 14 (implementation of this measure along with a separate, non-environmental commitment as set forth  
 15 in EIR/EIS Appendix 3B, *Environmental Commitments*, relating to the potential EC-related changes  
 16 would reduce these effects).

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

22 River flow rate and reservoir storage reductions that would occur under Alternative 8, relative to  
 23 Existing Conditions, would not be expected to result in a substantial adverse change in EC levels in  
 24 the reservoirs and rivers upstream of the Delta, given that: changes in the quality of watershed  
 25 runoff and reservoir inflows would not be expected to occur in the future; the state's aggressive  
 26 regulation of point-source discharge effects on Delta salinity-elevating parameters and the expected  
 27 further regulation as salt management plans are developed; the salt-related TMDLs adopted and  
 28 being developed for the San Joaquin River; and the expected improvement in lower San Joaquin  
 29 River average EC levels commensurate with the lower EC of the irrigation water deliveries from the  
 30 Delta.

31 Relative to Existing Conditions, Alternative 8 would not result in any substantial increases in long-  
 32 term average EC levels in the SWP/CVP Export Service Areas. There would be no exceedance of the  
 33 EC objective at the Jones and Banks pumping plants. Average EC levels for the entire period modeled  
 34 would decrease at both plants and, thus, this alternative would not contribute to additional  
 35 beneficial use impairment related to elevated EC in the SWP/CVP Export Service Areas waters.  
 36 Rather, this alternative would improve long-term EC levels in the SWP/CVP Export Service Areas,  
 37 relative to Existing Conditions.

38 In the Plan Area, Alternative 8 would result in an increase in the frequency with which Bay-Delta  
 39 WQCP EC objectives are exceeded in the Sacramento River at Emmaton (agricultural objective;  
 40 ~~106%~~ increase), ~~San Joaquin River at Vernalis (agricultural objective; <1% increase) and Brandt~~  
 41 ~~Bridge (agricultural objective; 1% increase), and in the Old River near Middle River (agricultural~~  
 42 ~~objective; <1% increase), all in the southern Delta,~~ and Prisoners Point (fish and wildlife objective;  
 43 ~~326%~~ increase) in the interior Delta for the entire period modeled (1976–1991). The increased  
 44 frequency of exceedance of the fish and wildlife objective at Prisoners Point could contribute to  
 45 adverse effects on aquatic life; (specifically, indirect adverse effects on striped bass spawning).

1 ~~though there is a high degree of uncertainty associated with this impact.~~ and ~~the~~ increased  
 2 frequency of the EC exceedance at Emmaton could contribute to adverse effects on agricultural uses.  
 3 Because EC is not bioaccumulative, the increases in long-term average EC levels would not directly  
 4 cause bioaccumulative problems in aquatic life or humans. The western ~~and southern~~ Delta ~~are is~~  
 5 Clean Water Act section 303(d) listed for elevated EC and the increased frequency of exceedance of  
 6 EC objectives that would occur in ~~these this~~ portions of the Delta could make beneficial use  
 7 impairment measurably worse. This impact is considered to be significant.

8 Further, relative to Existing Conditions, Alternative 8 ~~would could~~ result in substantial increases in  
 9 long-term average EC during the months of October through May in Suisun Marsh. The increases in  
 10 long-term average EC levels that would occur in Suisun Marsh could further degrade existing EC  
 11 levels and thus contribute additionally to adverse effects on the fish and wildlife beneficial uses.  
 12 Because EC is not bioaccumulative, the increases in long-term average EC levels would not directly  
 13 cause bioaccumulative problems in wildlife. Suisun Marsh is Clean Water Act section 303(d) listed  
 14 for elevated EC and the increases in long-term average EC that would occur in the marsh could make  
 15 beneficial use impairment measurably worse. This impact is considered to be significant.

16 Implementation of Mitigation Measure WQ-11 along with a separate, non-environmental  
 17 commitment relating to the potential increased costs associated with EC-related changes would  
 18 reduce these effects. While mitigation measures to reduce these water quality effects in affected  
 19 water bodies to less than significant levels are not available, implementation of Mitigation Measure  
 20 WQ-11 is recommended to attempt to reduce the effect that increased EC concentrations may have  
 21 on Delta beneficial uses. However, because the effectiveness of this mitigation measure to result in  
 22 feasible measures for reducing water quality effects is uncertain, this impact is considered to remain  
 23 significant and unavoidable. Please see Mitigation Measure WQ-11 under Impact WQ-11 in the  
 24 discussion of Alternative 1A.

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

### 36 **Impact WQ-13: Effects on Mercury Concentrations Resulting from Facilities Operations and** 37 **Maintenance (CM1)**

#### 38 ***Delta***

39 Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2  
 40 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter  
 41 hydrodynamics within the Delta region, which affects mixing of source waters, these effects are  
 42 included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of  
 43 ~~CM2-22~~~~CM2-CM21~~ not attributable to hydrodynamics, for example, additional loading of a

1 constituent to the Delta, are discussed within the impact header for ~~CM2-22~~CM2-CM21. See section  
2 8.3.1.3 for more information.

3 The water quality impacts of waterborne concentrations of mercury and methylmercury and fish  
4 tissue mercury concentrations were evaluated for 9 Delta locations. The analysis of percentage  
5 change in assimilative capacity of waterborne total mercury of Alternative 8 relative to the 25 ng/L  
6 ecological risk benchmark as compared to Existing Conditions showed the greatest decrease of 7%  
7 for the Contra Costa Pumping Plant, and 6.9% at the same location for the No Action Alternative  
8 (Figures 8-53 and 8-54). Similarly, changes in methylmercury concentration are expected to be  
9 relatively small. ~~The greatest annual average methylmercury concentration for drought conditions~~  
10 ~~was 0.165 ng/L for the San Joaquin River at Buckley Cove, which was slightly higher than Existing~~  
11 ~~Conditions and slightly lower than the No Action Alternative. The highest methylmercury~~  
12 ~~concentration is 0.229 ng/L at the North Bay Aqueduct at Barker Slough, which is about 100%~~  
13 ~~greater than Existing Conditions or the No Action Alternative~~ (Appendix 8I, Figure I-9). All modeled  
14 input concentrations exceeded the methylmercury TMDL guidance objective of 0.06 ng/L, therefore  
15 percentage change in assimilative capacity was not evaluated for methylmercury.

16 Fish tissue estimates show more substantial percentage increases in concentration and exceedance  
17 quotients for mercury at some Delta locations. ~~The greatest changes in exceedance quotients~~  
18 ~~relative to Existing Conditions and the No Action Alternative are 33-40% at the Contra Costa~~  
19 ~~Pumping Plant and 34-46% for Old River at Rock Slough. The highest exceedance quotients for any~~  
20 ~~modeled location are predicted for the North Bay Aqueduct pump site at Barker Slough (EQ = 7.6),~~  
21 ~~with an increase relative to Existing Conditions, and the No Action Alternative ranging from 221 to~~  
22 ~~224% at that location~~ (Figure 8-558-55a,b, Appendix 8I, *Mercury*, Table I-15b). ~~As mentioned above,~~  
23 ~~these changes mirror and enhance the pattern of increased concentrations in methylmercury~~  
24 ~~projected for that location. The Sacramento River at Emmaton site also shows a relatively large~~  
25 ~~percentage increase in tissue concentrations over Existing Conditions and the No Action Alternative~~  
26 ~~(122 to 124%) and a relatively elevated exceedance quotient of 4.6 (Appendix 8I, Table I-15b).~~  
27 ~~Because these increases are substantial, and it is evident that substantive increases are expected at~~  
28 ~~numerous locations throughout the Delta, these changes may be measurable in the environment.~~  
29 ~~See Appendix 8I for a discussion of the uncertainty associated with the fish tissue estimates.~~

30 **NEPA Effects:** Based on the above discussion, the effects of mercury and methylmercury in  
31 comparison of Alternative 8 to the No Action Alternative (as waterborne and bioaccumulated forms)  
32 are considered to be adverse for the case of fish tissue bioaccumulation at some locations.

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

38 Under Alternative 8, greater water demands and climate change would alter the magnitude and  
39 timing of reservoir releases and river flows upstream of the Delta in the Sacramento River  
40 watershed and east-side tributaries, relative to Existing Conditions. Concentrations of mercury and  
41 methylmercury upstream of the Delta will not be substantially different relative to Existing  
42 Conditions due to the lack of important relationships between mercury/methylmercury  
43 concentrations and flow for the major rivers.



1 Methylmercury concentrations exceed criteria at all locations in the Delta and no assimilative  
 2 capacity exists. Monthly average waterborne concentrations of total and methylmercury, over the  
 3 period of record, are very similar to Existing Conditions, but showed notable increases at some  
 4 locations. Estimates of fish tissue mercury concentrations show substantial increases would occur  
 5 for several sites for Methylmercury concentrations exceed criteria at all locations in the Delta and no  
 6 assimilative capacity exists. However, monthly average waterborne concentrations of total and  
 7 methylmercury, over the period of record, are very similar to Existing Conditions. Estimates of fish  
 8 tissue mercury concentrations at some locations show substantial increases under Alternative 8,  
 9 relative to Existing Conditions, particularly at North Bay Aqueduct and Sacramento River at  
 10 Emmaton.

11 Assessment of effects of mercury in the SWP and CVP Export Service Areas were based on effects on  
 12 mercury concentrations and fish tissue mercury concentrations at the Banks and Jones pumping  
 13 plants. The Banks and Jones pumping plants are expected to show increased assimilative capacity  
 14 for waterborne mercury and decreased fish tissue concentrations of mercury for Alternative 8 as  
 15 compared to Existing Conditions.

16 As such, this alternative is not expected to cause additional exceedance of applicable water quality  
 17 objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects  
 18 on any beneficial uses of waters in the affected environment. However, increases in fish tissue  
 19 mercury concentrations are substantial, and changes in fish tissue mercury concentrations would  
 20 make existing mercury-related impairment in the Delta measurably worse. In comparison to  
 21 Existing Conditions, Alternative 8 would increase levels of mercury by frequency, magnitude, and  
 22 geographic extent such that the affected environment would be expected to have measurably higher  
 23 body burdens of mercury in aquatic organisms, thereby substantially increasing the health risks to  
 24 wildlife (including fish) or humans consuming those organisms.

25 This impact is considered to be significant. Feasible or effective actions to reduce the effects on  
 26 mercury resulting from CM1 are unknown. General mercury management measures through CM12,  
 27 or actions taken by other entities or programs such as TMDL implementation, may minimize or  
 28 reduce sources and inputs of mercury to the Delta and methylmercury formation. However, it is  
 29 uncertain whether this impact would be reduced to a level that would be less than significant as a  
 30 result of CM12 or other future actions. Therefore, the impact would be significant and unavoidable.

### 31 **Impact WQ-25: Effects on Selenium Concentrations Resulting from Facilities Operations and** 32 **Maintenance (CM1)**

#### 33 ***Delta***

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

41 Selenium concentrations and threshold comparisons for each of the 11 modeled Delta assessment  
 42 locations under Alternative 8, relative to Existing Conditions and the No Action Alternative, are  
 43 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-10A9a). 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 21.3 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, The ranges of modeled long-term average selenium concentrations in water (Appendix 8M, Table M-10A) for Alternative 8 (range 0.2409–0.7239 µg/L) would be similar to Existing Conditions (range 0.2409–0.7641 µg/L), and the No Action Alternative (range 0.2409–0.6938 µg/L) are similar, and all would be below the ecological risk benchmark USEPA draft water quality criterion of (21.3 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 8M 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 301 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

1 selenium concentrations. Low Toxicity Threshold Exceedance Quotients for selenium concentrations  
2 in sturgeon in the western Delta would exceed 1.0 for drought years at both locations (as they do for  
3 Existing Conditions and the No Action Alternative; Figure 8-65) and for all years at both  
4 locations Antioch, whereas Existing Conditions and the No Action Alternative do not (quotients  
5 increases from 0.94 to 1.2 at Antioch and from 0.88 at Sacramento River at Mallard Island 1.0)  
6 (Appendix 8M, Table M-32). High Toxicity Threshold Exceedance Quotients for selenium  
7 concentrations in sturgeon in the western Delta would exceed 1.0 for drought years at Antioch  
8 unlike Existing Conditions and the No Action Alternative (where quotient increases from 0.85 to 1.1)  
9 (Appendix 8M, Table M-32), and the No Action Alternative, the largest increase of selenium  
10 concentrations in biota would be at Contra Costa PP for drought years and in sturgeon at the two  
11 western Delta locations in all as well as drought years. Relative to Existing Conditions, the largest  
12 decrease in selenium concentration in biota would be at Buckley Cove for drought years; relative to  
13 the No Action Alternative, the largest decrease would be at Staten Island for drought years. Except  
14 for sturgeon in the western Delta, concentrations of selenium in whole-body fish and bird eggs  
15 (invertebrate and fish diets) would exceed only the lower benchmarks (4 and 6 mg/kg dry weight,  
16 respectively, indicating a low potential for effects), under drought conditions, at Buckley Cove for  
17 Alternative 8 and Existing Conditions and the No Action Alternative (Figures 8-61 through 8-63).  
18 Exceedance Quotients Exceedance quotients for these exceedances of the lower benchmarks are all  
19 between 1.0 and 1.5, indicating a low risk to biota in the Delta and the similarity of Alternative 8 to  
20 Existing Conditions and the No Action Alternative. Selenium concentrations in fish fillets would not  
21 exceed the screening value for protection of human health (Figure 8-64). For sturgeon in the  
22 western Delta, whole-body selenium concentrations would increase from 12.3 mg/kg under Existing  
23 Conditions and the No Action Alternative to 14.7 mg/kg under Alternative 8, a 20% increase (Table  
24 8M-2 in the sturgeon addendum to Appendix 8M Table M.A-2). All of these values exceed both the  
25 low and high toxicity benchmarks. The predicted increases are high enough that they may represent  
26 a measurable increase in body burdens of sturgeon, which would constitute an adverse impact (see  
27 also the discussion of results provided in the sturgeon addendum M.A to Appendix 8M).

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

45 Increased water residence times could increase the bioaccumulation of selenium in biota, thereby  
46 potentially increasing fish tissue and bird egg concentrations of selenium (see residence time

1 discussion in Appendix 8M, *Selenium*, and Presser and Luoma [2010b]). Thus, residence time was  
2 assessed for its relevance to selenium bioaccumulation. Table 60a (presented originally in Section  
3 8.3.1.7 in the *Microcystis* subsection) shows the time for neutrally buoyant particles to move through  
4 the Delta (surrogate for flow and residence time). Although an increase in residence time  
5 throughout the Delta is expected under the No Action Alternative, relative to Existing Conditions  
6 (because of climate change and sea level rise), the change is fairly small in most areas of the Delta.  
7 Thus, the changes in residence times between Alternative 8 and the No Action Alternative are very  
8 similar to the changes in residence times between Alternative 8 and the Existing Conditions.

9 Relative to Existing Conditions and the No Action Alternative, increases in residence times for  
10 Alternative 8 would be greater in the South Delta and East Delta than in other sub-regions. Relative  
11 to Existing Conditions, annual average residence times for Alternative 8 in the South Delta are  
12 expected to increase by more than 37 days (Table 60a), and in the East Delta increase by more than  
13 23 days. Increases in residence times for other sub-regions would be smaller, especially as  
14 compared to Existing Conditions and the No Action Alternative (which are longer than those  
15 modeled for the South Delta). As mentioned above, these results incorporate hydrodynamic effects  
16 of both CM1 and CM2 and CM4, and the effects of CM1 cannot be distinguished from the effects of  
17 CM2 and CM4. However, it is expected that CM2 and CM4 are substantial drivers of the increased  
18 residence time.

19 Presser and Luoma (2010b) summarized and discussed selenium uptake in the Bay-Delta (including  
20 hydrologic conditions [e.g., Delta outflow and residence time for water],  $K_d$ s [the ratio of selenium  
21 concentrations in particulates, as the lowest level of the food chain, relative to the water-borne  
22 concentration], and associated tissue concentrations [especially in clams and their consumers, such  
23 as sturgeon]). When the Delta Outflow Index (daily average flow per month) decreased by five-fold  
24 (73,732 cubic feet per second [cfs] in June 1998 to 12, 251 cfs in October 1998), residence time  
25 doubled (from 11 to 22 days) and the calculated mean  $K_d$  also doubled (from 3,198 to 6,501).  
26 However, when daily average Delta outflow in November 1999 was only 6,951 cfs (i.e., about one-  
27 half that in October 1998) and residence time was 70 days, the calculated mean  $K_d$  (7,614) did not  
28 increase proportionally.

29 Models are not available to quantitatively estimate the level of changes in selenium bioaccumulation  
30 as related to residence time, but the effects of residence time are incorporated in the  
31 bioaccumulation modeling for selenium that was based on higher  $K_d$  values for drought years in  
32 comparison to wet, normal, or all years; see Appendix 8M, *Selenium*. If increases in fish tissue or bird  
33 egg selenium were to occur, the increases would likely be of concern only where fish tissues or bird  
34 eggs are already elevated in selenium to near or above thresholds of concern. That is, where biota  
35 concentrations are currently low and not approaching thresholds of concern (which, as discussed  
36 above, is the case throughout the Delta, except for sturgeon in the western Delta), changes in  
37 residence time alone would not be expected to cause them to then approach or exceed thresholds of  
38 concern. In consideration of this factor, although the Delta as a whole is a CWA Section 303(d)-listed  
39 water body for selenium, and although monitoring data of fish tissue or bird eggs in the Delta are  
40 sparse, the most likely area in which biota tissues would be at levels high enough that additional  
41 bioaccumulation due to increased residence time from restoration areas would be a concern is the  
42 western Delta and Suisun Bay for sturgeon, as discussed above. As shown in Table 60a, the overall  
43 increase in residence time estimated in the western Delta is 4 days relative to Existing Conditions,  
44 and 2 days relative to the No Action Alternative. Given the available information, these increases are  
45 small enough that they are not expected to substantially affect selenium bioaccumulation in the

1 western Delta. Because CM2 and CM4 are expected to be substantial drivers of the increased  
 2 residence times, further discussion is included in Impact WQ-26 below.

3 In summary, Rrelative to Existing Conditions and the No Action Alternative, Alternative 8 would  
 4 result in a minimal-small changes in selenium concentrations throughout the Delta for most biota  
 5 (less than 54%), although larger increases in selenium concentrations are predicted for sturgeon in  
 6 the western Delta. Concentrations of selenium in sturgeon would exceed the lower benchmark for  
 7 both western Delta locations for all years and drought years, indicating a low potential for effects.  
 8 Concentrations of selenium in sturgeon would exceed the higher benchmark for Antioch only in  
 9 drought years, indicating a high potential for effects. The modeling of bioaccumulation for sturgeon  
 10 is less calibrated to site-specific conditions than that for other biota, which was calibrated on a  
 11 robust dataset for modeling of bioaccumulation in largemouth bass as a representative species for  
 12 the Delta. Overall, the predicted increases for Alternative 8 are high enough that they may represent  
 13 a measureable increase in body burdens of sturgeon, which would constitute an adverse impact  
 14 . Alternative 8 would not be expected to substantially increase the frequency with which applicable  
 15 benchmarks would be exceeded in the Delta or substantially degrade the quality of water in the  
 16 Delta, with regard to selenium.

### 17 **SWP/CVP Export Service Areas**

18 Alternative 8 would result in small to moderate (0.08–0.15 µg/L) changes decreases in average  
 19 selenium concentrations at the Banks and Jones pumping plants, relative to Existing Conditions and  
 20 the No Action Alternative, for the entire period modeled (Appendix 8M, *Selenium*, Table M-10A9a).  
 21 These decreases in long-term average ~~These changes in~~ selenium concentrations in water are  
 22 reflected in small (10% or less) to moderate (between 11% and 50%) changes would result in  
 23 increases in available assimilative capacity for selenium at these pumping plants of 8–16%, relative  
 24 to the 1.3 µg/L ecological benchmark for all years (Figures 8-59a and 8-60a). Relative to Existing  
 25 Conditions and the No Action Alternative, Alternative 8 would result in increases in assimilative  
 26 capacity at Jones PP (14% and 15%, respectively) and at Banks PP (7%) (Figures 8-59 and 8-60) and  
 27 would have a positive effect at the Export Service Area locations. Furthermore, The ranges of  
 28 modeled long-term average selenium concentrations in water (Appendix 8M, Table M-10Ae) for  
 29 Alternative 8 (range 0.3209–0.379 µg/L), Existing Conditions (range 0.37–0.58 µg/L), and the No  
 30 Action Alternative (range 0.37–0.59 µg/L) are similar, and all would be well below the ecological  
 31 risk benchmark USEPA draft water quality criterion of 1.3(2 µg/L (Appendix 8M, Table M-9a).

32 Relative to Existing Conditions and the No Action Alternative, Alternative 8 would result in small  
 33 changes (less than 54%) in estimated selenium concentrations in biota (whole-body fish, bird eggs  
 34 [invertebrate diet], bird eggs [fish diet], and fish fillets) at SWP/CVP service areas (Figures 8-61a  
 35 through 8-64b; Appendix 8M, *Selenium*, Table M-1928). Relative to Existing Conditions and the No  
 36 Action Alternative, the largest increase of selenium concentrations in biota would be at Banks PP for  
 37 drought years (except for bird eggs [assuming a fish diet] at Banks PP for all years), and the largest  
 38 decrease would be at Jones PP for drought years. Concentrations in biota would not exceed any  
 39 selenium benchmarks for Alternative 8 (Figures 8-61a through 8-64b).

40 Thus, relative to Existing Conditions and the No Action Alternative, Alternative 8 would result in  
 41 small to moderate changes in selenium concentrations in water and minimal changes in selenium  
 42 concentrations in biota at the Export Service Area locations. Selenium concentrations in water and  
 43 biota generally would decrease under Alternative 8 and would not exceed ecological benchmarks at  
 44 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 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 20~~average 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, 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 ~~[2010ed]~~ 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 aquatic fish 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

1 applicable benchmarks would be exceeded, ~~(there would be none) or and would~~ slightly improve  
2 the quality of water in selenium concentrations at the Banks and Jones pumping plants locations.

3 Based on the above, although waterborne selenium concentrations would not exceed applicable  
4 water quality objectives/criteria, however, significant impacts on some beneficial uses of waters in  
5 the Delta could occur because ~~both low and high toxicity benchmarks are already exceeded under~~  
6 ~~Existing Conditions, and~~ uptake of selenium from water to biota may measurably increase such that  
7 high toxicity benchmarks may be exceeded. In comparison to Existing Conditions, water quality  
8 conditions under this alternative would increase levels of selenium (a bioaccumulative pollutant) by  
9 frequency, magnitude, and geographic extent such that the affected environment may have  
10 measurably higher body burdens of selenium in aquatic organisms, thereby substantially increasing  
11 the health risks to wildlife (including fish); however, impacts to humans consuming those organisms  
12 are not expected to occur. Water quality conditions under this alternative with respect to selenium  
13 would cause long-term degradation of water quality in the western Delta. Except in the vicinity of  
14 the western Delta for sturgeon, water quality conditions under this alternative would not increase  
15 levels of selenium by frequency, magnitude, and geographic extent such that the affected  
16 environment would be expected to have measurably higher body burdens of selenium in aquatic  
17 organisms. The greater level of selenium bioaccumulation in the western Delta would further  
18 degrade water quality by measurable levels, on a long-term basis, for selenium and, thus, cause the  
19 CWA Section 303(d)-listed impairment of beneficial use to be made discernibly worse. This impact  
20 is considered significant. Environmental Commitment: Selenium Management (AMM27), which  
21 affords for site-specific measures to reduce effects, would be available to reduce BDCP-related  
22 effects associated with selenium. The effectiveness of AMM27 is uncertain and, therefore  
23 implementation may not reduce the identified impact to a level that would be less than significant,  
24 and therefore it is significant and unavoidable.

25 The need for, and the feasibility and effectiveness of, post-operation mitigation for the predicted  
26 level of selenium bioaccumulation is uncertain. The first step shall be to determine the reliability of  
27 the model in predicting biota selenium concentrations in the affected environment where effects are  
28 predicted but selenium data are lacking. For that reason, the model shall be validated with site-  
29 specific sampling before extensive mitigation measures relative to CM1 operations are developed  
30 and evaluated for feasibility, as the measures and their evaluation for feasibility are likely to be  
31 complex. Specifically, it remains to be determined whether the available existing data for transfer of  
32 selenium from water to particulates and through different trophic levels of the food chain are  
33 representative of conditions that may occur from implementation of Alternative 8. Therefore, the  
34 proposed mitigation measure requires that sampling be conducted to characterize each step of data  
35 inputs needed for the model, and then the refined model be validated for local conditions. This  
36 impact is considered significant and unavoidable.

37 **Impact WQ-26: Effects on Selenium Concentrations Resulting from Implementation of CM2-**  
38 **CM2-CM21**

39 NEPA Effects: Effects of CM2-CM21 on selenium under Alternative 8 are the same as those  
40 discussed for Alternative 1A and are considered not to be adverse.

41 CEQA Conclusion: CM2-CM21 proposed under Alternative 8 would be similar to those proposed  
42 under Alternative 1A. As such, effects on selenium resulting from the implementation of CM2-CM21  
43 would be similar to that previously discussed for Alternative 1A. This impact is considered to be less  
44 than significant. No mitigation is required.

1 ~~**NEPA Effects:** In general, with the possible exception of changes in Delta hydrodynamics resulting~~  
2 ~~from habitat restoration, CM2–CM11 would not substantially increase selenium concentrations in~~  
3 ~~the water bodies of the affected environment. Modeling scenarios included assumptions regarding~~  
4 ~~how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, and~~  
5 ~~thus such effects of these restoration measures were included in the assessment of CM1 facilities~~  
6 ~~operations and maintenance (see Impact WQ-25).~~

7 ~~However, implementation of these conservation measures may increase water residence time~~  
8 ~~within the restoration areas. Increased restoration area water residence times could potentially~~  
9 ~~increase the bioaccumulation of selenium in biota, thereby potentially increasing fish tissue and bird~~  
10 ~~egg concentrations of selenium, but models are not available to quantitatively estimate the level of~~  
11 ~~changes in residence time and the associated selenium bioavailability, but the effects of residence~~  
12 ~~time are incorporated in the bioaccumulation modeling for selenium that was based on higher Kd~~  
13 ~~values (the ratio of selenium concentrations in particulates [as the lowest level of the food chain]~~  
14 ~~relative to the water-borne concentration) for drought years in comparison to wet, normal, or all~~  
15 ~~years; see Appendix 8M, Selenium. If increases in fish tissue or bird-egg selenium were to occur, the~~  
16 ~~increases would likely be of concern only where fish tissues or bird eggs are already elevated in~~  
17 ~~selenium to near or above thresholds of concern. That is, where biota concentrations are currently~~  
18 ~~low and not approaching thresholds of concern, changes in residence time alone would not be~~  
19 ~~expected to cause them to then approach or exceed thresholds of concern. In consideration of this~~  
20 ~~factor, although the Delta as a whole is a 303(d)-listed water body for selenium, and although~~  
21 ~~monitoring data of fish tissue or bird eggs in the Delta are sparse, the most likely areas in which~~  
22 ~~biota tissues would be at levels high enough that additional bioaccumulation due to increased~~  
23 ~~residence time from restoration areas would be a concern are the western Delta and Suisun Bay, and~~  
24 ~~the South Delta in areas that receive San Joaquin River water.~~

25 ~~The western Delta and Suisun Bay receive elevated selenium loads from North San Francisco Bay~~  
26 ~~(including San Pablo Bay, Carquinez Strait, and Suisun Bay) and from the San Joaquin River. Point~~  
27 ~~sources of selenium in North San Francisco Bay (i.e., refineries) that contribute selenium to Suisun~~  
28 ~~Bay are expected to be reduced through a TMDL under development by the San Francisco Bay Water~~  
29 ~~Board (San Francisco Bay Water Board 2012) that is expected to result in decreasing discharges of~~  
30 ~~selenium. Nonpoint sources of selenium in the San Joaquin Valley that contribute selenium to the~~  
31 ~~San Joaquin River, and thus the Delta and Suisun Bay, will be controlled through a TMDL developed~~  
32 ~~by the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the~~  
33 ~~Grassland Bypass Project, and Basin Plan objectives (Central Valley Water Board 2010c, d) that are~~  
34 ~~expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta. If~~  
35 ~~selenium levels are not sufficiently reduced via these efforts, it is expected that the State Water~~  
36 ~~Board and the San Francisco Bay and Central Valley Water Boards would initiate additional actions~~  
37 ~~to further control sources of selenium.~~

38 ~~The South Delta receives elevated selenium loads from the San Joaquin River. In contrast to Suisun~~  
39 ~~Bay and possibly the western Delta in the future, the South Delta lacks the overbite clam (*Corbula*~~  
40 ~~[*Potamocorbula*] *amurensis*), which is considered a key driver of selenium bioaccumulation in~~  
41 ~~Suisun Bay, due to its high bioaccumulation of selenium and its role in the benthic food web that~~  
42 ~~includes long-lived sturgeon. The South Delta does have *Corbicula fluminea*, another bivalve that~~  
43 ~~bioaccumulates selenium, but it is not as invasive as the overbite clam and thus likely makes up a~~  
44 ~~smaller fraction of sturgeon diet. Also, as mentioned above, nonpoint sources of selenium in the San~~  
45 ~~Joaquin Valley that contribute selenium to the Delta will be controlled through a TMDL developed by~~  
46 ~~the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the~~



1 Grassland Bypass Project, and Basin Plan objectives (Central Valley Water Board 2010c, d) that are  
2 expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta.  
3 Further, if selenium levels in the San Joaquin River are not sufficiently reduced via these efforts, it is  
4 expected that the State Water Board and Central Valley Water Board would initiate additional  
5 TMDLs to further control nonpoint sources of selenium.

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

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

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

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

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

43 Given the factors discussed in the assessment above, any increases in bioaccumulation rates from  
44 water-borne selenium that could occur in some areas as a result of increased water residence times

1 would not be of sufficient magnitude and geographic extent that any portion of the Delta would be  
 2 expected to have measurably higher body burdens of selenium in aquatic organisms, and therefore  
 3 would not substantially increase risk for adverse effects to beneficial uses. CM2-22 would not cause  
 4 long-term degradation of water quality resulting in sufficient use of available assimilative capacity  
 5 such that occasionally exceeding water quality objectives/criteria would be likely. Also, CM2-22  
 6 would not result in substantially increased risk for adverse effects to any beneficial uses.  
 7 Furthermore, although the Delta is a 303(d)-listed water body for selenium, given the discussion in  
 8 the assessment above, it is unlikely that restoration areas would result in measurable increases in  
 9 selenium in fish tissues or bird eggs such that the beneficial use impairment would be made  
 10 discernibly worse.

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

### 17 **Impact WQ-32. Effects on *Microcystis* Bloom Formation Resulting from Facilities Operations** 18 **and Maintenance (CM1).**

19 Effects of facilities and operations (CM1) on *Microcystis* abundance, and thus microcystins  
 20 concentrations, in water bodies of the affected environment under Alternative 8 would be very  
 21 similar (i.e., nearly the same) to those discussed for Alternative 1A. This is because factors that  
 22 affect *Microcystis* abundance in waters upstream of the Delta, in the Delta, and in the SWP/CVP  
 23 Export Services Areas under Alternative 1A would similarly change under Alternative 8, relative to  
 24 Existing Conditions and the No Action Alternative. For the Delta in particular, there are differences  
 25 in the direction and magnitude of water residence time changes during the *Microcystis* bloom period  
 26 among the six Delta sub-regions under Alternative 8 compared to Alternative 1A, relative to Existing  
 27 Conditions and No Action Alternative. However, under Alternative 8, relative to Existing Conditions  
 28 and No Action Alternative, water residence times during the *Microcystis* bloom period in various  
 29 Delta sub-regions are expected to increase to a degree that could, similar to Alternative 1A, lead to  
 30 an increase in the frequency, magnitude, and geographic extent of *Microcystis* blooms throughout  
 31 the Delta.

32 Similar to Alternative 1A, elevated ambient water temperatures relative to Existing Conditions  
 33 would occur in the Delta under Alternative 8, which could lead to earlier occurrences of *Microcystis*  
 34 blooms in the Delta, and increase the overall duration and magnitude of blooms. However, the  
 35 degradation of water quality from *Microcystis* blooms due to the expected increases in Delta water  
 36 temperatures is driven entirely by climate change, not effects of CM1. While *Microcystis* blooms  
 37 have not occurred in the Export Service Areas, conditions in the Export Service Areas under  
 38 Alternative 8 may become more conducive to *Microcystis* bloom formation, relative to Existing  
 39 Conditions, because water temperatures will increase in the Export Service Areas due to the  
 40 expected increase in ambient air temperatures resulting from climate change.

41 **NEPA Effects:** Effects of water facilities and operations (CM1) on *Microcystis* in water bodies of the  
 42 affected environment under Alternative 8 would be very similar to (i.e., nearly the same) to those  
 43 discussed for Alternative 1A. In summary, Alternative 8 operations and maintenance, relative to the  
 44 No Action Alternative, would result in long-term increases in hydraulic residence time of various

1 Delta sub-regions during the summer and fall *Microcystis* bloom period. During this period, the  
2 increased residence time could result in a concurrent increase in the frequency, magnitude, and  
3 geographic extent of *Microcystis* blooms, and thus microcystin levels, in affected areas of the Delta.  
4 As a result, Alternative 8 operation and maintenance activities would cause further degradation to  
5 water quality with respect to *Microcystis* in the Delta. Under Alternative 8, relative to No Action  
6 Alternative, water exported to the SWP/CVP Export Service Area will be a mixture of *Microcystis*-  
7 affected source water from the south Delta intakes and unaffected source water from the  
8 Sacramento River, diverted at the north Delta intakes. It cannot be determined whether operations  
9 and maintenance under Alternative 8 will result in increased or decreased levels of *Microcystis* and  
10 microcystins in the mixture of source waters exported from Banks and Jones pumping plants.  
11 Mitigation Measure WQ-32a and WQ-32b are available to reduce the effects of degraded water  
12 quality in the Delta. Although there is considerable uncertainty regarding this impact, the effects on  
13 *Microcystis* from implementing CM1 is determined to be adverse.

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

19 Under Alternative 8, additional impacts from *Microcystis* in the reservoirs and watersheds upstream  
20 of the Delta are not expected, relative to Existing Conditions. Operations and maintenance occurring  
21 under Alternative 8 is not expected to change nutrient levels in upstream reservoirs or  
22 hydrodynamic conditions in upstream rivers and streams such that conditions would be more  
23 conductive to *Microcystis* production.

24 Relative to Existing Conditions, water temperatures and hydraulic residence times in the Delta are  
25 expected to increase under Alternative 8, resulting in an increase in the frequency, magnitude and  
26 geographic extent of *Microcystis* blooms in the Delta. However, the degradation of water quality  
27 from *Microcystis* blooms due to the expected increases in Delta water temperatures is driven  
28 entirely by climate change, not effects of CM1. Increases in Delta residence times are expected  
29 throughout the Delta during the summer and fall bloom period, due in small part to climate change  
30 and sea level rise, but due more proportionately to CM1 and the hydrodynamic impacts of  
31 restoration included in CM2 and CM4. The precise change in local residence times and *Microcystis*  
32 production expected within any Delta sub-region is unknown because conditions will vary across  
33 the complex networks of intertwining channels, shallow back water areas, and submerged islands  
34 that compose the Delta. Nonetheless, Delta residence times are, in general, expected to increase due  
35 to Alternative 8. Consequently, it is possible that increases in the frequency, magnitude, and  
36 geographic extent of *Microcystis* blooms in the Delta will occur due to the operations and  
37 maintenance of Alternative 8 and the hydrodynamic impacts of restoration (CM2 and CM4).

38 The assessment of effects of *Microcystis* on SWP/CVP Export Service Areas is based on the  
39 assessment of changes in *Microcystis* levels in export source waters, as well as the effects of  
40 temperature and residence time changes within the Export Service Areas on *Microcystis* production.  
41 Under Alternative 8, relative to Existing Conditions, the potential for *Microcystis* to occur in the  
42 Export Service Area is expected to increase due to increasing water temperature, but this impact is  
43 driven entirely by climate change and not Alternative 8. Water exported from the Delta to the  
44 Export Service Area is expected to be a mixture of *Microcystis*-affected source water from the south  
45 Delta intakes and unaffected source water from the Sacramento River. Because of this, it cannot be

1 determined whether operations and maintenance under Alternative 8, relative to existing  
 2 conditions, will result in increased or decreased levels of *Microcystis* and microcystins in the mixture  
 3 of source waters exported from Banks and Jones pumping plants.

4 Based on the above, this alternative would not be expected to cause additional exceedance of  
 5 applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that  
 6 would cause significant impacts on any beneficial uses of waters in the affected environment.  
 7 *Microcystis* and microcystins are not 303(d) listed within the affected environment and thus any  
 8 increases that could occur in some areas would not make any existing *Microcystis* impairment  
 9 measurably worse because no such impairments currently exist. Because *Microcystis* and  
 10 microcystins are not bioaccumulative, increases that could occur in some areas would not  
 11 bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health  
 12 risks to fish, wildlife, or humans. However, because it is possible that increases in the frequency,  
 13 magnitude, and geographic extent of *Microcystis* blooms in the Delta will occur due to the operations  
 14 and maintenance of Alternative 8 and the hydrodynamic impacts of restoration (CM2 and CM4),  
 15 long-term water quality degradation may occur and, thus, significant impacts on beneficial uses  
 16 could occur. Although there is considerable uncertainty regarding this impact, the effects on  
 17 *Microcystis* from implementing CM1 is determined to be significant.

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

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

24 Please see Mitigation Measure WQ-32a under Impact WQ-32 in the discussion of Alternative 1A.

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

27 Please see Mitigation Measure WQ-32b under Impact WQ-32 in the discussion of Alternative 1A.

28 **Impact WQ-33. Effects on *Microcystis* Bloom Formation Resulting from Other Conservation**  
 29 **Measures (CM2--CM21).**

30 The effects of CM2--CM21 on *Microcystis* under Alternative 98 are the same as those discussed for  
 31 Alternative 1A. In summary, potential environmental effects related to CM2 and CM4 could result in  
 32 an increase in the frequency, magnitude, and geographic extent of *Microcystis* blooms in the Delta,  
 33 relative to Existing Conditions and the No Action Alternative, as a result of increased residence times  
 34 for Delta waters from implementing CM2 and CM4 restoration areas. -Because the hydrodynamic  
 35 effects associated with implementing CM2 and CM4 were incorporated into the modeling used to  
 36 assess CM1, a detailed assessment of the effects of implementing CM2 and CM4 on *Microcystis*  
 37 blooms in the Delta via their effects on Delta water residence time is provided under CM1 (above).  
 38 The effects of CM2 and CM4 on *Microcystis* may be reduced by implementation of  
 39 Mitigation Measures WQ-32A and WQ-32b. The effectiveness of these mitigation measures to result  
 40 in feasible measures for reducing water quality effects is uncertain. Conservation Measures 3 (CM3)  
 41 and CM5-CM21 would not result in an increase in the frequency, magnitude, and geographic extent  
 42 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

1 an AGR beneficial use designation. Further, as discussed for the No Action Alternative, changes in  
2 Delta salinity would not contribute to measurable changes in Bay salinity, as the change in Delta  
3 outflow, which would be the primary driver of salinity changes, would two to three orders of  
4 magnitude lower than (and thus minimal compared to) the Bay's tidal flow.

5 Also, as discussed for the No Action Alternative, adverse changes in Microcystis levels that could  
6 occur in the Delta would not cause adverse Microcystis blooms in San Francisco Bay, because  
7 Microcystis are intolerant of the Bay's high salinity and, thus not have not been detected  
8 downstream of Suisun Bay.

9 While effects of Alternative 8 on the nutrients ammonia, nitrate, and phosphorus were determined  
10 to be less than significant/not adverse, these constituents are addressed further below because the  
11 response of the seaward bays to changed nutrient concentrations/loading may differ from the  
12 response of the Delta. Selenium and mercury are discussed further, because they are  
13 bioaccumulative constituents where changes in load due to both changes in Delta concentrations  
14 and exports are of concern.

#### 15 **Nutrients: Ammonia, Nitrate, and Phosphorus**

16 Total nitrogen loads in Delta outflow to Suisun and San Pablo Bays under Alternative 8 would be  
17 dominated almost entirely by nitrate, because planned upgrades to the SRWTP will result in >95%  
18 removal of ammonia in its effluent. Total nitrogen loads to Suisun and San Pablo Bays would  
19 decrease by 9%, relative to Existing Conditions, and increase by 33%, relative to the No Action  
20 Alternative (Appendix 80, Table O-1). The change in nitrogen loading to Suisun and San Pablo Bays  
21 under Alternative 8 would not adversely impact primary productivity in these embayments because  
22 light limitation and grazing current limit algal production in these embayments. To the extent that  
23 algal growth increases in relation to a change in ammonia concentration, this would have net  
24 positive benefits, because current algal levels in these embayments are low. Nutrient levels and  
25 ratios are not considered a direct driver of *Microcystis* and cyanobacteria levels in the North Bay.

26 The phosphorus load exported from the Delta to Suisun and San Pablo Bays for Alternative 8 is  
27 estimated to increase by 14%, relative to Existing Conditions, and increase by 9% relative to the No  
28 Action Alternative (Appendix 80, Table O-1) ). The only postulated effect of changes in phosphorus  
29 loads to Suisun and San Pablo Bays is related to the influence of nutrient stoichiometry on primary  
30 productivity. However, there is uncertainty regarding the impact of nutrient ratios on  
31 phytoplankton community composition and abundance. Any effect on phytoplankton community  
32 composition would likely be small compared to the effects of grazing from introduced clams and  
33 zooplankton in the estuary (Senn and Novick 2014; Kimmerer and Thompson 2014). Therefore, the  
34 projected change in total nitrogen and phosphorus loading that would occur in Delta outflow to San  
35 Francisco Bay is not expected to result in degradation of water quality with regard to nutrients that  
36 would result in adverse effects to beneficial uses.

#### 37 **Mercury**

38 The estimated long-term average mercury and methylmercury loads in Delta exports are shown in  
39 Appendix 80, Table O-2. Loads of mercury and methylmercury from the Delta to San Francisco Bay  
40 are estimated to change relatively little due to changes in source water fractions and net Delta  
41 outflow that would occur under Alternative 8. Mercury load to the Bay, relative to Existing  
42 Conditions, is estimated to increase by 16 kg/yr (6%), relative to Existing Conditions, and 13 kg/yr  
43 (5%), relative to the No Action Alternative. Methylmercury load is estimated to increase by 0.40

1 kg/yr (11%), relative to Existing Conditions, and increase by 0.31 kg/yr (8%) relative to the No  
2 Action Alternative. The estimated total mercury load to the Bay is 276 kg/yr, which would be less  
3 than the San Francisco Bay mercury TMDL WLA for the Delta of 330 kg/yr. The estimated changes in  
4 mercury and methylmercury loads would be within the overall uncertainty associated with the  
5 estimates of long-term average net Delta outflow and the long-term average mercury and  
6 methylmercury concentrations in Delta source waters. The estimated changes in mercury load  
7 under the alternative would also be substantially less than the considerable differences among  
8 estimates in the current mercury load to San Francisco Bay (SFBRWQCB 2006; David et al. 2009).  
9 Similar uncertainty is expected in the existing methylmercury load in net Delta exports, for which  
10 the best available current load estimate is based on approximately one year of monitoring data (Foe  
11 et al. 2008).

12 Given that the estimated incremental decreases/increases of mercury and methylmercury loading to  
13 San Francisco Bay would fall within the uncertainty of current mercury and methylmercury load  
14 estimates, the estimated changes in mercury and methylmercury loads in Delta exports to San  
15 Francisco Bay due to Alternative 8 are not expected to result in adverse effects to beneficial uses or  
16 substantially degrade the water quality with regard to mercury, or make the existing CWA Section  
17 303(d) impairment measurably worse.

### 18 Selenium

19 Changes in source water fraction and net Delta outflow under Alternative 8, relative to Existing  
20 Conditions, are projected to cause the total selenium load to the North Bay to increase by 24%,  
21 relative to Existing Conditions, and increase by 20%, relative to the No Action Alternative (Appendix  
22 80, Table O-3). Changes in long-term average selenium concentrations of the North Bay are assumed  
23 to be proportional to changes in North Bay selenium loads. Under Alternative 8, the long-term  
24 average total selenium concentration of the North Bay is estimated to be 0.16µg/L and the dissolved  
25 selenium concentration is estimated to be 0.14 µg/L, which would be a 0.03 µg/L increase relative to  
26 Existing Conditions and the No Action Alternative (Appendix 80, Table O-3). The dissolved selenium  
27 concentration would be below the target of 0.202 µg/L developed by Presser or Luoma (2013) to  
28 coincide with a white sturgeon whole-body fish tissue selenium concentration not greater than 8  
29 mg/kg in the North Bay.

30 The incremental increase in dissolved selenium concentrations projected to occur under Alternative  
31 8, relative to Existing Conditions and the No Action Alternative, would be higher than under  
32 Alternatives 1–5, but still low (0.03 µg/L). The increased dissolved selenium concentration would be  
33 within the overall uncertainty of the analytical methods used to measure selenium in water column  
34 samples; however, it also would be within the uncertainty associated with estimating numeric water  
35 column selenium thresholds (Presser and Luoma 2013). As described in Section 8.3.1.8, there have  
36 been improvements in selenium concentrations in the tissue of diving ducks and muscle of white  
37 sturgeon since the initial CWA Section 303(d) listing of the North Bay for selenium impairments, and  
38 selenium concentrations in white sturgeon muscle have also generally been below the USEPA's draft  
39 recommended fish muscle tissue concentration of 11.8 mg/kg dry weight (SFEI 2014). However, as  
40 described under Impact WQ-25, though there is some uncertainty in the estimate of sturgeon  
41 concentrations at western Delta locations, the predicted increases for Alternative 8 are high enough  
42 that they may represent measurably higher body burdens of selenium in aquatic organisms, thereby  
43 substantially increasing the health risks to wildlife (including fish). Because the projected  
44 incremental increases in dissolved selenium could cause measurable changes in water column  
45 concentrations, and these incremental increases would be within the uncertainty in the target water

1 column threshold for dissolved selenium for protection against adverse bioaccumulative effects in  
2 the North Bay ecosystem, and modeling predicts concentrations in the western Delta may represent  
3 a measurable increase in body burdens of sturgeon, there is potential that the incremental increase  
4 in dissolved selenium concentration projected to occur in the North Bay under Alternative 8 could  
5 result in adverse effects beneficial uses.

6 Based on the discussion above, Alternative 8, relative to the No Action Alternative, would not cause  
7 further degradation to water quality with respect to boron, bromide, chloride, dissolved oxygen,  
8 DOC, EC, mercury, pathogens, pesticides, nutrients (ammonia, nitrate, phosphorus), trace metals, or  
9 turbidity and TSS in the San Francisco Bay. Further, changes in these constituent concentrations in  
10 Delta outflow would not be expected to cause changes in Bay concentrations of frequency,  
11 magnitude, and geographic extent that would adversely affect any beneficial uses. In summary,  
12 based on the discussion above, effects on the San Francisco Bay from implementation of CM1–CM21  
13 are considered to be not adverse with respect to boron, bromide, chloride, dissolved oxygen, DOC,  
14 EC, mercury, pathogens, pesticides, nutrients (ammonia, nitrate, phosphorus), trace metals, or  
15 turbidity and TSS. However, Alternative 8 could result in increases in selenium concentrations in the  
16 North San Francisco Bay that could result in adverse effects to fish and wildlife beneficial uses. This  
17 effect is considered to be adverse.

18 **CEQA Conclusion:** Based on the above, Alternative 8 would not be expected to cause long-term  
19 degradation of water quality in San Francisco Bay resulting in sufficient use of available assimilative  
20 capacity such that occasionally exceeding water quality objectives/criteria would be likely and  
21 would result in substantially increased risk for adverse effects to one or more beneficial uses with  
22 respect to boron, bromide, chloride, dissolved oxygen, DOC, EC, mercury, pathogens, pesticides,  
23 nutrients (ammonia, nitrate, phosphorus), trace metals, or turbidity and TSS. Further, based on the  
24 above, this alternative would not be expected to cause additional exceedance of applicable water  
25 quality objectives/criteria in the San Francisco Bay by frequency, magnitude, and geographic extent  
26 that would cause significant impacts on any beneficial uses of waters in the affected environment  
27 with respect to boron, bromide, chloride, dissolved oxygen, DOC, EC, mercury, pathogens, pesticides,  
28 nutrients (ammonia, nitrate, phosphorus), trace metals, or turbidity and TSS. Any changes in boron,  
29 bromide, chloride, and DOC in the San Francisco Bay would not adversely affect beneficial uses,  
30 because the uses most affected by changes in these parameters, MUN and AGR, are not beneficial  
31 uses of the Bay. Further, no substantial changes in dissolved oxygen, pathogens, pesticides, trace  
32 metals or turbidity or TSS are anticipated in the Delta, relative to Existing Conditions, therefore, no  
33 substantial changes these constituents levels in the Bay are anticipated. Changes in Delta salinity  
34 would not contribute to measurable changes in Bay salinity, as the change in Delta outflow would  
35 two to three orders of magnitude lower than (and thus minimal compared to) the Bay's tidal flow.  
36 Adverse changes in Microcystis levels that could occur in the Delta would not cause adverse  
37 Microcystis blooms in the Bay, because Microcystis are intolerant of the Bay's high salinity and, thus  
38 not have not been detected downstream of Suisun Bay. The 9% decrease in total nitrogen load and  
39 14% increase in phosphorus load, relative to Existing Conditions, are expected to have minimal  
40 effect on water quality degradation, primary productivity, or phytoplankton community  
41 composition. The estimated increase in mercury load (16 kg/yr; 6%) and methylmercury load (0.40  
42 kg/yr; 11), relative to Existing Conditions, is within the level of uncertainty in the mass load  
43 estimate and not expected to contribute to water quality degradation, make the CWA section 303(d)  
44 mercury impairment measurably worse or cause mercury/methylmercury to bioaccumulate to  
45 greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife,  
46 or humans.



1 hough there is some uncertainty in the estimate of sturgeon concentrations at western Delta  
 2 locations, the predicted increases are high enough that they may represent measurably higher body  
 3 burdens of selenium in aquatic organisms, thereby substantially increasing the health risks to  
 4 wildlife (including fish). Environmental Commitment: Selenium Management (AMM27), which  
 5 affords for site-specific measures to reduce effects, would be available to reduce BDCP-related  
 6 effects associated with selenium. The effectiveness of AMM27 is uncertain and, therefore  
 7 implementation may not reduce the identified impact to a level that would be less than significant,  
 8 and therefore it is significant and unavoidable.

### 9 **8.3.3.16 Alternative 9—Through Delta/Separate Corridors (15,000 cfs;** 10 **Operational Scenario G)**

#### 11 **Impact WQ-5: Effects on Bromide Concentrations Resulting from Facilities Operations and** 12 **Maintenance (CM1)**

##### 13 *Delta*

14 Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2  
 15 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter  
 16 hydrodynamics within the Delta region, which affects mixing of source waters, these effects are  
 17 included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of  
 18 ~~CM2-22CM2-CM21~~ not attributable to hydrodynamics, for example, additional loading of a  
 19 constituent to the Delta, are discussed within the impact header for ~~CM2-22CM2-CM21~~. See section  
 20 8.3.1.3 for more information.

21 Using the mass-balance modeling approach for bromide (see Section 8.3.1.3), relative to Existing  
 22 Conditions, Alternative 9 would result in increases in long-term average bromide concentrations at  
 23 Buckley Cove (for the modeled drought period only), Emmaton, and Barker Slough, while long-term  
 24 average concentrations would decrease at the other assessment locations (Appendix 8E, *Bromide*,  
 25 Table 20). With regard to bromide, Emmaton is a suitable source of raw drinking water on a  
 26 seasonal basis. While the relative change in long-term average bromide concentration at Emmaton is  
 27 considerable ( $\leq 32\%$ ), the increase in the average would be due to more frequent seasonal peak  
 28 concentrations in excess of 1,000  $\mu\text{g/L}$  relative to Existing Conditions (Appendix 8E, *Bromide*, Figure  
 29 2). At Emmaton the predicted 50  $\mu\text{g/L}$  exceedance frequency would increase only slightly from 82%  
 30 under Existing Conditions to 86% under Alternative 9 (98% to 100% for the modeled drought  
 31 period), and the predicted 100  $\mu\text{g/L}$  exceedance frequency would increase from 72% under Existing  
 32 Conditions to 81% under Alternative 9 (93% to 97% for the modeled drought period), indicative of  
 33 very small changes during seasonally suitable periods of potential use. At Barker Slough, predicted  
 34 long-term average bromide concentrations would increase from 51  $\mu\text{g/L}$  to 61  $\mu\text{g/L}$  (19% relative  
 35 increase) for the modeled 16-year hydrologic period and 54  $\mu\text{g/L}$  to 100  $\mu\text{g/L}$  (88% relative  
 36 increase) for the modeled drought period. At Barker Slough, the predicted 50  $\mu\text{g/L}$  exceedance  
 37 frequency would decrease from 49% under Existing Conditions to 41% under Alternative 9, but  
 38 would increase from 55% to 80% during the drought period. At Barker Slough, the predicted 100  
 39  $\mu\text{g/L}$  exceedance frequency would increase from 0% under Existing Conditions to 16% under  
 40 Alternative 9, and would increase from 0% to 42% during the drought period. At Buckley Cove,  
 41 predicted long-term average bromide concentrations would remain the same (i.e., 259  $\mu\text{g/L}$ ), but  
 42 would increase from 272  $\mu\text{g/L}$  to 330  $\mu\text{g/L}$  (21% relative increase) for the modeled drought period.  
 43 At Buckley Cove, the predicted 50  $\mu\text{g/L}$  exceedance frequency would not change (i.e., 100%

1 exceedance), but the modeled 100 µg/L exceedance frequency would decrease from 100% under  
2 Existing Conditions to 90% under Alternative 9 (100% to 87% for the modeled drought period).  
3 This comparison to Existing Conditions reflects changes in bromide due to both Alternative 9  
4 operations (including use of operable barriers and numerous other operational components of  
5 Scenario G) and climate change/sea level rise.

6 Due to the relatively small differences between modeled Existing Conditions and No Action  
7 baselines, changes in long-term average bromide concentrations and changes in exceedance  
8 frequencies relative to the No Action Alternative are generally of similar magnitude to those  
9 previously described for the existing condition comparison (Appendix 8E, *Bromide*, Table 20).  
10 Modeled long-term average bromide concentration at Emmaton would increase by as much as 36%,  
11 but change in 50 and 100 µg/L exceedance thresholds would be smaller than that described for the  
12 existing condition comparison, indicative of very small changes during seasonally suitable periods of  
13 potential use. Modeled long-term average bromide concentration at Barker Slough is predicted to  
14 increase by 23% (87% for the modeled drought period) relative to the No Action Alternative.  
15 Modeled long-term average bromide concentration increases at Buckley Cove are predicted to  
16 increase by 7% (36% for the modeled drought period) relative to the No Action Alternative. Unlike  
17 the comparison to Existing Conditions, this comparison to the No Action Alternative reflects changes  
18 in bromide due only to Alternative 9 operations.

19 At Barker Slough, modeled long-term average bromide concentrations for the various baseline  
20 conditions are very similar ( $\leq 4\%$ ) (Appendix 8E, *Bromide*, Table 20). Such similarity demonstrates  
21 that the modeled Alternative 9 change in bromide is almost entirely due to Alternative 9 operations,  
22 and not climate change/sea level rise. Therefore, operations are the primary driver of effects on  
23 bromide at Barker Slough, regardless whether Alternative 9 is compared to Existing Conditions, or  
24 compared to the No Action Alternative.

25 Results of the modeling approach which used relationships between EC and chloride and between  
26 chloride and bromide (see Section 8.3.1.3) differed somewhat from what is presented above for the  
27 mass-balance approach (see Appendix 8E, *Boron*, Table 21). For most locations, the frequency of  
28 exceedance of the 50 µg/L and 100 µg/L were similar. The greatest difference between the methods  
29 was predicted for Barker Slough. The increases in frequency of exceedance of the 100 µg/L  
30 threshold, relative to Existing Conditions and the No Action Alternative, were not as great using this  
31 alternative EC to chloride and chloride to bromide relationship modeling approach as compared to  
32 that presented above from the mass-balance modeling approach. However, there were still  
33 substantial increases, resulting in 9% exceedance over the modeled period under Alternative 9, as  
34 compared to 1% under Existing Conditions and 2% under the No Action Alternative. For the drought  
35 period, exceedance frequency increased from 0% under Existing Conditions and the No Action  
36 Alternative, to 23% under Alternative 9. Furthermore, concentrations predicted at Buckley Cove also  
37 differed. The EC to chloride and chloride to bromide relationship modeling approach predicted that  
38 concentrations at Buckley cove would decrease under Alternative 9 on both a long term basis and  
39 under the modeled drought period, relative to Existing Conditions and the No Action Alternative.  
40 This is in contrast to the mass-balance approach presented above, which predicted an increase in  
41 concentrations under the drought period. Because the mass-balance approach predicts a greater  
42 level of impact at Barker Slough, determination of impacts was based on the mass-balance results.

43 While the increase in long-term average bromide concentrations at Buckley Cove are relatively  
44 small when modeled over a representative 16-year hydrologic period, increases during the modeled  
45 drought period, principally the long-term average bromide concentration greater than 300 µg/L,

1 would represent a substantial change in source water quality to the City of Stockton during a season  
2 of drought. Additionally, the increase in long-term average bromide concentrations predicted at  
3 Barker Slough, principally the relative increase in 100 µg/L exceedance frequency, would result in a  
4 substantial change in source water quality for existing drinking water treatment plants drawing  
5 water from the North Bay Aqueduct. While the implications of such modeled changes in bromide  
6 concentrations at Buckley Cove and Barker Slough is difficult to predict, the substantial modeled  
7 increases could lead to adverse changes in the formation of disinfection byproducts such that  
8 considerable treatment plant upgrades may be necessary in order to achieve equivalent levels of  
9 health protection. Because many of the other modeled locations already frequently exceed the 100  
10 µg/L threshold under Existing Conditions and the No Action Alternative, these locations likely  
11 already require treatment plant technologies to achieve equivalent levels of health protection, and  
12 thus no additional treatment technologies would be triggered by the small increases in the  
13 frequency of exceeding the 100 µg/L threshold. Hence, no further impact on the drinking water  
14 beneficial use would be expected at these locations.

15 The seasonal intakes at Mallard Slough and City of Antioch are infrequently used due to water  
16 quality constraints related to sea water intrusion. On a long-term average basis, bromide at these  
17 locations is in excess of 3,000 µg/L, but during seasonal periods of high Delta outflow can be <300  
18 µg/L. Based on modeling using the mass-balance approach, use of the seasonal intakes at Mallard  
19 Slough and City of Antioch under Alternative 9 would experience a period average increase in  
20 bromide during the months when these intakes would most likely be utilized. For those wet and  
21 above normal water year types where mass balance modeling would predict water quality typically  
22 suitable for diversion, predicted long-term average bromide would increase from 103 µg/L to 140  
23 µg/L (37% increase) at City of Antioch and would decrease from 150 µg/L to 146 µg/L (3%  
24 decrease) at Mallard Slough relative to Existing Conditions (Appendix 8E, *Bromide*, Table 23).  
25 Changes would be similar for the No Action Alternative comparison. Modeling results using the EC to  
26 chloride and chloride to bromide relationships show increases during these months, but the relative  
27 magnitude of the increases is much lower (Appendix 8E, *Bromide*, Table 24). Regardless of the  
28 differences in the data between the two modeling approaches, the decisions surrounding the use of  
29 these seasonal intakes is largely driven by acceptable water quality, and thus have historically been  
30 opportunistic. Opportunity to use these intakes would remain, and the predicted increases in  
31 bromide concentrations at the City of Antioch and Mallard Slough intake would not be expected to  
32 adversely affect MUN beneficial uses, or any other beneficial use, at these locations.

33 Based on modeling using the mass-balance approach, relative to existing and No Action Alternative  
34 conditions, Alternative 9 would lead to predicted improvements in long-term average bromide  
35 concentrations at Staten Island, Franks Tract, Rock Slough, and Contra Costa PP No. 1, in addition to  
36 Banks and Jones (discussed below). At Staten Island and Franks Tract, long-term average bromide  
37 concentrations would be predicted to decrease by 4–21% depending on baseline comparison, while  
38 at Rock Slough and Contra Costa PP No.1, long-term average bromide concentrations would be  
39 predicted to decrease by 40–45%, depending on baseline comparison. Modeling results using the EC  
40 to chloride and chloride to bromide relationships generally do not show similar decreases for Rock  
41 Slough and Contra Costa PP No. 1, but rather, predict small increases. Based on the small magnitude  
42 of increases predicted, these increases would not adversely affect beneficial uses at those locations.

43 Important to the results presented above is the assumed habitat restoration footprint on both the  
44 temporal and spatial scales incorporated into the modeling. Modeling sensitivity analyses have  
45 indicated that habitat restoration (which are reflected in the modeling—see Section 8.3.1.3), not  
46 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.~~

1 **NEPA Effects:** In summary, relative to the No Action Alternative conditions, Alternative 9 would  
 2 result in additional exceedances of the 150 mg/L Bay-Delta WCCP objective at Contra Costa  
 3 Pumping Plant #1 and Antioch, substantial seasonal use of assimilative capacity at Contra Costa  
 4 Pumping Plant #1, Rock Slough and Franks Tract, and potentially measureable water quality  
 5 degradation relative to the 303(d) impairment in Suisun Marsh. The predicted chloride increases  
 6 constitute an adverse effect on water quality(see Mitigation Measure WQ-7 below; implementation  
 7 of this measure along with a separate, non-environmental commitment relating to the potential  
 8 increased chloride treatment costs would reduce these effects).Additionally, the predicted changes  
 9 relative to the No Action Alternative conditions indicate that in addition to the effects of climate  
 10 change/sea level rise, implementation of CM1 and CM4 under Alternative 9 would contribute  
 11 substantially to the adverse water quality effects.

### 12 **Impact WQ-9: Effects on Dissolved Oxygen Resulting from Facilities Operations and** 13 **Maintenance (CM1)**

14 **NEPA Effects:** Effects of CM1 on dissolved oxygen under Alternative 9 are the same as those  
 15 discussed for Alternative 1A and are determined to be not adverse.

16 **CEQA Conclusion:** Effects of CM1 on DO under Alternative 9 would be similar to those discussed for  
 17 Alternative 1A, and are summarized here, then compared to the CEQA thresholds of significance  
 18 (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this  
 19 constituent. For additional details on the effects assessment findings that support this CEQA impact  
 20 determination, see the effects assessment discussion under Alternative 1A.

21 River flow rate and rReservoir storage reductions that would occur under Alternative 9, relative to  
 22 Existing Conditions, would not be expected to result in a substantial adverse change in DO levels in  
 23 the reservoirs, because oxygen sources (surface water aeration, aerated inflows, vertical mixing)  
 24 would remain. Similarly, river flow rate reductions that would occur would not be expected to  
 25 result in a substantial adverse change in DO levels in the ~~and~~ rivers upstream of the Delta, given that  
 26 mean monthly flows would remain within the ranges historically seen under Existing Conditions  
 27 and the affected river are large and turbulent. Any reduced DO saturation level that may be caused  
 28 by increased water temperature would not be expected to cause DO levels to be outside of the range  
 29 seen historically. Finally, amounts of oxygen demanding substances and salinity would not be  
 30 expected to change sufficiently to affect DO levels.

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

38 There is not expected to be substantial, if even measurable, changes in DO levels in the SWP/CVP  
 39 Export Service Areas waters under Alternative 9, relative to Existing Conditions, because the  
 40 biochemical oxygen demand of the exported water would not be expected to substantially differ  
 41 from that under Existing Conditions (due to ever increasing water quality regulations), canal  
 42 turbulence and exposure of the water to the atmosphere and the algal communities that exist within  
 43 the canals would establish an equilibrium for DO levels within the canals. The same would occur in  
 44 downstream reservoirs.

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

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

11 ***Delta***

12 Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2  
 13 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter  
 14 hydrodynamics within the Delta region, which affects mixing of source waters, these effects are  
 15 included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of  
 16 ~~CM2-22CM2-CM21~~ not attributable to hydrodynamics, for example, additional loading of a  
 17 constituent to the Delta, are discussed within the impact header for ~~CM2-22CM2-CM21~~. See section  
 18 8.3.1.3 for more information.

19 Relative to Existing Conditions, Alternative 9 would result in an increase in the number of days the  
 20 Bay-Delta WQCP EC objectives would be exceeded in the Sacramento River at Emmaton, and the San  
 21 Joaquin River at San Andreas Landing and Jersey Point (Appendix 8H, Electrical Conductivity, Table  
 22 EC-9).

23 The percent of days the Emmaton EC objective would be exceeded for the entire period modeled  
 24 (1976–1991) would increase from 6% under Existing Conditions to ~~17~~8% under Alternative 9, and  
 25 the percent of days out of compliance would increase from 11% under Existing Conditions to ~~28~~31%  
 26 under Alternative 9.

27 The percent of days the Jersey Point EC objective would be exceeded and the percent of days out of  
 28 compliance would increase from 0% under Existing Conditions to 2% under Alternative 9. The  
 29 increase in percent of days the San Andreas Landing EC objective would be exceeded ~~would be 1%~~  
 30 ~~under Existing Conditions and Alternative 9,~~ and the percent of days out of compliance ~~with the EC~~  
 31 ~~objective would increase from  $\leq$ 1% under Existing Conditions to 2% under Alternative 9. These~~  
 32 increases are minimal, and are not considered substantial, in light of overall modeling uncertainty.

33 Average EC levels at the western and southern Delta compliance locations, except at Emmaton in the  
 34 western Delta, and S. Fork Mokelumne River at Terminous (an interior Delta location) would  
 35 decrease from 1–33% for the entire period modeled and 2–33% during the drought period modeled  
 36 (1987–1991) (Appendix 8H, Electrical Conductivity, Table EC-20). In the Sacramento River at  
 37 Emmaton, average EC would increase 22% for the entire period modeled and 36% during the  
 38 drought period modeled. In the San Joaquin River at San Andreas Landing, average EC would  
 39 increase 16% for the entire period modeled and 33% during the drought period modeled. Average  
 40 EC in the Sacramento River at Emmaton and San Joaquin River at San Andreas Landing would  
 41 increase during all months (Appendix 8H, Table EC-20). In the San Joaquin River at Prisoners Point,  
 42 average EC would increase 2% for the entire period modeled and 16% during the drought period  
 43 modeled. Average EC at Prisoners Point would increase in September through December (Appendix

1 8H, Table EC-20). The western portion of the Delta—which is Clean Water Act section 303(d) listed  
 2 as impaired due to elevated EC—would have an increased frequency of exceedance of the Bay-  
 3 Delta WQCP objectives (Appendix 8H, Table EC-9) and long-term average EC levels at compliance  
 4 locations in this region would increase relative to Existing Conditions (Appendix 8H, Table EC-20).  
 5 Thus, Alternative 9 could contribute to additional impairment and potentially adversely affect  
 6 beneficial uses for section 303(d) listed Delta waterways, relative to Existing Conditions. The  
 7 comparison to Existing Conditions reflects changes in EC due to both Alternative 9 operations  
 8 (including use of operable barriers and numerous other operational components of Scenario G) and  
 9 climate change/sea level rise.

10 Relative to the No Action Alternative, the change in percent compliance with Bay-Delta WQCP EC  
 11 objectives under Alternative 9 would be similar to that described above relative to Existing  
 12 Conditions, except there would not be an increase in objective exceedance in the San Joaquin River  
 13 at Jersey Point. For the entire period modeled, average EC levels would increase in the Sacramento  
 14 River at Emmaton, and San Joaquin River at San Andreas Landing and Prisoners Point. The greatest  
 15 average EC increase would occur in the San Joaquin River at San Andreas Landing (22%); the  
 16 increase at Emmaton would be 21% and at Prisoners Point would be 12% (Appendix 8H, Electrical  
 17 Conductivity, Table EC-20). Similarly, during the drought period modeled, average EC would increase  
 18 at these locations. The greatest average EC increase during the drought period modeled also would  
 19 occur in the San Joaquin River at San Andreas Landing (33%); the average EC increase at Emmaton  
 20 would be 24% and at Prisoners Point would be 25% (Appendix 8H, Table EC-20). The western  
 21 portion of the Delta—which is Clean Water Act section 303(d) listed as impaired due to elevated EC—  
 22 would have an increased frequency of exceedance of the Bay-Delta WQCP objectives (Appendix 8H,  
 23 Table EC-9) and long-term average EC levels at this compliance location would increase relative to  
 24 the No Action Alternative (Appendix 8H, Table EC-20). Thus, Alternative 9 could contribute to  
 25 additional impairment and potentially adversely affect beneficial uses for section 303(d) listed Delta  
 26 waterways, relative to the No Action Alternative. The comparison to the No Action Alternative  
 27 reflects changes in EC due only to Alternative 9 operations (including use of operable barriers and  
 28 numerous other operational components of Scenario G).

29 For Suisun Marsh, October–May is the period when Bay-Delta WQCP EC objectives for protection of  
 30 fish and wildlife apply. Long-term average EC would increase under Alternative 9, relative to  
 31 Existing Conditions, during the months of December through May by 0.2–0.4 mS/cm in the  
 32 Sacramento River at Collinsville (Appendix 8H, Electrical Conductivity, Table EC-21). In Montezuma  
 33 Slough at National Steel during January and February, long-term average EC would increase 0.1–0.2  
 34 mS/cm (Appendix 8H, Table EC-22). The most substantial increase would occur near Beldon  
 35 Landing, with long-term average EC levels increasing by 1.5–6.3 mS/cm, depending on the month,  
 36 nearly doubling and tripling during some months the long-term average EC relative to Existing  
 37 Conditions (Appendix 8H, Table EC-23). Sunrise Duck Club and Volanti Slough also would have long-  
 38 term average EC increases during February–May of 1.5–3.9 mS/cm (Appendix 8H, Tables EC-24 and  
 39 EC-25). Modeling of this alternative assumed no operation of the Montezuma Slough Salinity Control  
 40 Gates, but the project description assumes continued operation of the Salinity Control Gates,  
 41 consistent with assumptions included in the No Action Alternative. A sensitivity analysis modeling  
 42 run conducted for Alternative 4 scenario H3 with the gates operational consistent with the No  
 43 Action Alternative resulted in substantially lower EC levels than indicated in the original Alternative  
 44 4 modeling results, but EC levels were still somewhat higher than EC levels under Existing  
 45 Conditions and the No Action Alternative for several locations and months. Another modeling run  
 46 with the gates operational and restoration areas removed resulted in EC levels nearly equivalent to

1 Existing Conditions and the No Action Alternative, indicating that design and siting of restoration  
 2 areas has notable bearing on EC levels at different locations within Suisun Marsh (see Appendix 8H  
 3 Attachment 1 for more information on these sensitivity analyses). These analyses also indicate that  
 4 increases are related primarily to the hydrodynamic effects of CM4, not operational components of  
 5 CM1. Based on the sensitivity analyses, optimizing the design and siting of restoration areas may  
 6 limit the magnitude of long-term EC increases to be on the order of 1 mS/cm or less. Due to  
 7 similarities in the nature of the EC increases between alternatives, the findings from these analyses  
 8 can be extended to this alternative as well.

9 The degree to which the long-term average EC increases in Suisun Marsh would cause exceedance of  
 10 Bay-Delta WQCP objectives is unknown, because these objectives are expressed as a monthly  
 11 average of daily high tide EC, which does not have to be met if it can be demonstrated “equivalent or  
 12 better protection will be provided at the location” (State Water Resources Control Board 2006:14).  
 13 The ~~described~~ long-term average EC increase may, or may not, contribute to adverse effects on  
 14 beneficial uses, depending on how and when wetlands are flooded, soil leaching cycles, and how  
 15 agricultural use of water is managed, and future actions taken with respect to the marsh. However,  
 16 the EC increases at certain locations ~~would-could~~ be substantial, depending on siting and design of  
 17 restoration areas, and it is uncertain the degree to which current management plans for the Suisun  
 18 Marsh would be able to address these substantially higher EC levels and protect beneficial uses.  
 19 Thus, these increased EC levels in Suisun Marsh are considered to have a potentially adverse effect  
 20 on marsh beneficial uses. Long-term average EC increases in Suisun Marsh under Alternative 9  
 21 relative to the No Action Alternative would be similar to the increases relative to Existing  
 22 Conditions. Suisun Marsh is section 303(d) listed as impaired due to elevated EC, and the potential  
 23 increases in long-term average EC concentrations could contribute to additional impairment,  
 24 ~~because the increases would be double or triple that relative to Existing Conditions and the No~~  
 25 ~~Action Alternative.~~

26 **NEPA Effects:** In summary, the increased ~~frequency of exceedance of EC objectives and increased~~  
 27 long-term and drought period average EC levels that would occur in the San Joaquin River at San  
 28 Andreas Landing (interior Delta), and the increased frequency of exceedance of EC objectives in the  
 29 Sacramento River at Emmaton under Alternative 9, relative to the No Action Alternative, would  
 30 contribute to adverse effects on the agricultural beneficial uses. Given that the western Delta is  
 31 Clean Water Act section 303(d) listed as impaired due to elevated EC, the increased frequency of  
 32 exceedance of the Bay-Delta WQCP objectives and long-term average EC levels at this compliance  
 33 location could contribute to additional impairment and potentially adversely affect beneficial uses  
 34 for section 303(d) listed Delta waterways, relative to the No Action Alternative. The increases in  
 35 long-term average EC levels that ~~would-could~~ occur in Suisun Marsh would further degrade existing  
 36 EC levels and could contribute additional to adverse effects on the fish and wildlife beneficial uses.  
 37 Suisun Marsh is section 303(d) listed as impaired due to elevated EC, and the potential increases in  
 38 long-term average EC levels could contribute to additional beneficial use impairment. These  
 39 increases in EC constitute an adverse effect on water quality. Mitigation Measure WQ-11 would be  
 40 available to reduce these effects (implementation of this measure along with a separate, non-  
 41 environmental commitment as set forth in EIR/EIS Appendix 3B, *Environmental Commitments*,  
 42 relating to the potential EC-related changes would reduce these effects).

43 **CEQA Conclusion:** Key findings discussed in the effects assessment provided above are summarized  
 44 here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the  
 45 purpose of making the CEQA impact determination for this constituent. For additional details on the



1 effects assessment findings that support this CEQA impact determination, see the effects assessment  
2 discussion that immediately precedes this conclusion.

3 River flow rate and reservoir storage reductions that would occur under Alternative 9, relative to  
4 Existing Conditions, would not be expected to result in a substantial adverse change in EC levels in  
5 the reservoirs and rivers upstream of the Delta, given that: changes in the quality of watershed  
6 runoff and reservoir inflows would not be expected to occur in the future; the state's aggressive  
7 regulation of point-source discharge effects on Delta salinity-elevating parameters and the expected  
8 further regulation as salt management plans are developed; the salt-related TMDLs adopted and  
9 being developed for the San Joaquin River; and the expected improvement in lower San Joaquin  
10 River average EC levels commensurate with the lower EC of the irrigation water deliveries from the  
11 Delta.

12 Relative to Existing Conditions, Alternative 9 would not result in any substantial increases in long-  
13 term average EC levels in the SWP/CVP Export Service Areas. There would be no exceedance of the  
14 EC objective at the Jones and Banks pumping plants. Average EC levels for the entire period modeled  
15 would decrease at both plants and, thus, this alternative would not contribute to additional  
16 beneficial use impairment related to elevated EC in the SWP/CVP Export Service Areas waters.  
17 Rather, this alternative would improve long-term EC levels in the SWP/CVP Export Service Areas,  
18 relative to Existing Conditions.

19 In the Plan Area, Alternative 9 would result in an ~~14~~2% increase in the frequency with which the  
20 Bay-Delta WQCP EC objectives are exceeded at Emmaton (western Delta), ~~a 2% increase in the~~  
21 ~~frequency with which fish and wildlife EC objectives are exceeded in the San Joaquin River at Jersey~~  
22 ~~Point, and a <1% increase in the frequency with which EC objectives are exceeded in the San~~  
23 ~~Joaquin River at San Andreas Landing (interior Delta)~~ for the entire period modeled (1976–1991).  
24 Further, average EC levels at Emmaton would increase by 22% for the entire period modeled and  
25 36% during the drought period modeled, and EC levels at San Andreas Landing would increase by  
26 16% for the entire period modeled and 33% during the drought period modeled. Because EC is not  
27 bioaccumulative, the increases in long-term average EC levels would not directly cause  
28 bioaccumulative problems in aquatic life or humans. The interior Delta is not Clean Water Act  
29 section 303(d) listed for elevated EC, however, the western Delta is. The increases in long-term and  
30 drought period average EC levels and increased frequency of exceedance of EC objectives that would  
31 occur in the Sacramento River at Emmaton and San Joaquin River at San Andreas would potentially  
32 contribute to adverse effects on the agricultural beneficial uses in the interior Delta. This impact is  
33 considered to be significant.

34 Further, relative to Existing Conditions, Alternative 9 ~~would could~~ result in substantial increases in  
35 long-term average EC during the months of October through May in Suisun Marsh, ~~such that EC~~  
36 ~~levels would be double or triple that occurring under Existing Conditions.~~ The increases in long-  
37 term average EC levels that would occur in Suisun Marsh could further degrade existing EC levels  
38 and thus contribute additionally to adverse effects on the fish and wildlife beneficial uses. Because  
39 EC is not bioaccumulative, the increases in long-term average EC levels would not directly cause  
40 bioaccumulative problems in wildlife. Suisun Marsh is Clean Water Act section 303(d) listed for  
41 elevated EC and the increases in long-term average EC that would occur in the marsh could make  
42 beneficial use impairment measurably worse. This impact is considered to be significant.

43 Implementation of Mitigation Measure WQ-11 along with a separate, non-environmental  
44 commitment relating to the potential increased costs associated with EC-related changes would

1 reduce these effects. While mitigation measures to reduce these water quality effects in affected  
 2 water bodies to less than significant levels are not available, implementation of Mitigation Measure  
 3 WQ-11 is recommended to attempt to reduce the effect that increased EC concentrations may have  
 4 on Delta beneficial uses. However, because the effectiveness of this mitigation measure to result in  
 5 feasible measures for reducing water quality effects is uncertain, this impact is considered to remain  
 6 significant and unavoidable. Please see Mitigation Measure WQ-11 under Impact WQ-11 in the  
 7 discussion of Alternative 1A.

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

### 19 **Impact WQ-13: Effects on Mercury Concentrations Resulting from Facilities Operations and** 20 **Maintenance (CM1)**

#### 21 ***Delta***

22 Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2  
 23 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter  
 24 hydrodynamics within the Delta region, which affects mixing of source waters, these effects are  
 25 included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of  
 26 ~~CM2-22CM2-CM21~~ not attributable to hydrodynamics, for example, additional loading of a  
 27 constituent to the Delta, are discussed within the impact header for ~~CM2-22CM2-CM21~~. See section  
 28 8.3.1.3 for more information.

29 The water quality impacts of waterborne concentrations of mercury and methylmercury and fish  
 30 tissue mercury concentrations were evaluated for 9 Delta locations. The analysis of percentage  
 31 change in assimilative capacity of waterborne total mercury of Alternative 9 relative to the 25 ng/L  
 32 ecological risk benchmark, as compared to Existing Conditions showed the greatest decrease of  
 33 10.2% at Old River at Rock Slough, and a 10.1% reduction relative to the No Action Alternative at  
 34 that location (Figures 8-53 and 8-54). Similarly, increases in long term annual average  
 35 methylmercury concentration are expected to be greatest (approximately 30%) at the Contra Costa  
 36 Pumping Plant as compared to Existing Conditions and the No Action Alternative (Appendix  
 37 8I, *Mercury*, Figure 8I-9, Table I-6). The concentration of methylmercury is estimated to be 0.163  
 38 ng/L at that location, which is greater than Existing Conditions (0.121 ng/L) and the No Action  
 39 Alternative (0.122 ng/L). All modeled input concentrations exceeded the methylmercury TMDL  
 40 guidance objective of 0.06 ng/L, therefore percentage change in assimilative capacity was not  
 41 evaluated for methylmercury.

42 Fish tissue estimates show some substantial percentage increases in concentration and exceedance  
 43 quotients for mercury at some Delta locations. The greatest change in exceedance quotients are

1 expected for Old River at Rock Slough with changes of 66% over Existing Conditions, and 59% over  
 2 the No Action Alternative (Figure 8-558-55a,b, Appendix 8I, *Mercury*, Table I-16b). The Contra Costa  
 3 Pumping Plant values shows a 62% increase in fish tissue concentrations over Existing Conditions,  
 4 and 59% over the No Action Alternative (Appendix 8I, Table I-16b). Because these increases are  
 5 substantial, and it is evident that substantive increases are expected at numerous locations  
 6 throughout the Delta, these changes may be measurable in the environment. See Appendix 8I for a  
 7 discussion of the uncertainty associated with the fish tissue estimates.

8 **NEPA Effects:** Based on the above discussion, the effects of mercury and methylmercury in  
 9 comparison of Alternative 9 to the No Action Alternative (as waterborne and bioaccumulated forms)  
 10 are considered to be adverse for the case of fish tissue bioaccumulation at some locations.

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

16 Under Alternative 9, greater water demands and climate change would alter the magnitude and  
 17 timing of reservoir releases and river flows upstream of the Delta in the Sacramento River  
 18 watershed and east-side tributaries, relative to Existing Conditions. Concentrations of mercury and  
 19 methylmercury upstream of the Delta will not be substantially different relative to Existing  
 20 Conditions due to the lack of important relationships between mercury/methylmercury  
 21 concentrations and flow for the major rivers.

22 Methylmercury concentrations exceed criteria at all locations in the Delta and no assimilative  
 23 capacity exists. ~~However, m~~Monthly average waterborne concentrations of total and  
 24 methylmercury, over the period of record, are very similar to Existing Conditions, but showed  
 25 notable increases at some locations. ~~Similarly, e~~Estimates of fish tissue mercury concentrations  
 26 show ~~almost no~~substantial increases ~~differences~~ would occur among for several sites for Alternative  
 27 9 as compared to Existing Conditions for Delta sites.

28 Assessment of effects of mercury in the SWP and CVP Export Service Areas were based on effects on  
 29 mercury concentrations and fish tissue mercury concentrations at the Banks and Jones pumping  
 30 plants. The Banks and Jones pumping plants are expected to show increased assimilative capacity  
 31 for waterborne mercury and decreased fish tissue concentrations of mercury for Alternative 9 as  
 32 compared to Existing Conditions.

33 As such, this alternative is not expected to cause additional exceedance of applicable water quality  
 34 objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects  
 35 on any beneficial uses of waters in the affected environment. However, increases in fish tissue  
 36 mercury concentrations are substantial, and changes in fish tissue mercury concentrations would  
 37 make existing mercury-related impairment in the Delta measurably worse. In comparison to  
 38 Existing Conditions, Alternative 9 would increase levels of mercury by frequency, magnitude, and  
 39 geographic extent such that the affected environment would be expected to have measurably higher  
 40 body burdens of mercury in aquatic organisms, thereby substantially increasing the health risks to  
 41 wildlife (including fish) or humans consuming those organisms. This impact is considered to be  
 42 significant. Feasible or effective actions to reduce the effects on mercury resulting from CM1 are  
 43 unknown. General mercury management measures through CM12, or actions taken by other entities  
 44 or programs such as TMDL implementation, may minimize or reduce sources and inputs of mercury

1 to the Delta and methylmercury formation. However, it is uncertain whether this impact would be  
 2 reduced to a level that would be less than significant as a result of CM12 or other future actions.  
 3 Therefore, the impact would be significant and unavoidable.

#### 4 **Impact WQ-25: Effects on Selenium Concentrations Resulting from Facilities Operations and** 5 **Maintenance (CM1)**

##### 6 **Delta**

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

14 ~~Selenium concentrations and threshold comparisons for each of the 11 modeled Delta assessment~~  
 15 ~~locations under Alternative 9, relative to Existing Conditions and the No Action Alternative, are~~  
 16 ~~presented in Appendix 8M, Selenium, Table M-9a for water, Tables M-19 and M-29 for most biota~~  
 17 ~~(whole-body fish [excluding sturgeon], bird eggs [invertebrate diet], bird eggs [fish diet], and fish~~  
 18 ~~fillets) throughout the Delta, and Tables M-30 through M-32 for sturgeon at the two western Delta~~  
 19 ~~locations. Figures 8-59a and 8-60a present graphical distributions of predicted selenium~~  
 20 ~~concentration changes (shown as changes in available assimilative capacity based on 1.3 µg/L) in~~  
 21 ~~water at each modeled assessment location for all years. Appendix 8M, Figure M-24 provides more~~  
 22 ~~detail in the form of monthly patterns of selenium concentrations in water during the modeling~~  
 23 ~~period.~~

24 Alternative 9 would result in small to moderate changes in average selenium concentrations in  
 25 water at modeled Delta assessment locations relative to Existing Conditions and the No Action  
 26 Alternative (Appendix 8M, ~~Selenium, Table M-10A9a~~). ~~Long-term average concentrations at some~~  
 27 ~~interior and western Delta locations would increase by 0.01–0.21 µg/L for the entire period~~  
 28 ~~modeled (1976–1991). The various changes in selenium concentrations in water are reflected in~~  
 29 ~~small (10% or less) to moderate (between 11% and 50%) changes in available assimilative capacity~~  
 30 ~~for selenium (based on 2 µg/L ecological risk benchmark) for all years. Relative to Existing~~  
 31 ~~Conditions, Alternative 9 would result in the largest modeled increase in assimilative capacity at~~  
 32 ~~Buckley Cove (32%) and the three largest decreases would be at Franks Tract (13%), Rock Slough~~  
 33 ~~(19%), and Contra Costa PP (18%) (Figure 8-59). Relative to the No Action Alternative, the largest~~  
 34 ~~modeled increase in assimilative capacity would be at Buckley Cove (26%) and the three largest~~  
 35 ~~decreases would be at Franks Tract (13%), Rock Slough (19%), and Contra Costa PP (18%) (Figure~~  
 36 ~~8-60). Although there would be moderate (greater than 10%) negative changes in assimilative~~  
 37 ~~capacity at three locations (Franks Tract, Rock Slough, and Contra Costa PP), the changes would be~~  
 38 ~~minimal (10% or less decrease) at the other locations and the available assimilative capacity at all~~  
 39 ~~locations would remain substantial; overall, the effect of Alternative 9 would be generally moderate~~  
 40 ~~for portions of the Delta represented by Franks Tract, Rock Slough, and Contra Costa PP.~~  
 41 ~~However, These increases in selenium concentrations in water would result in reductions in available~~  
 42 ~~assimilative capacity of 1–19%, relative to the 1.3 µg/L ecological risk benchmark USEPA draft water~~  
 43 ~~quality criterion (Figures 8-59a and 8-60a). T, the ranges of modeled long-term average selenium~~  
 44 ~~concentrations in water (Appendix 8M, Table M-10A) for Alternative 9 (range 0.2309–0.370 µg/L)~~

1 ~~would be similar to~~ Existing Conditions (range 0.2109–0.7641 µg/L), and the No Action Alternative  
 2 (range 0.2109–0.6938 µg/L) ~~are similar~~, and all would be below the ~~ecological-risk~~  
 3 ~~benchmark~~ USEPA draft water quality criterion of 1.3 (2 µg/L, Appendix 8M, Table M-9a).

4 Relative to Existing Conditions and the No Action Alternative, Alternative 9 would generally result in  
 5 ~~minimal-small to moderate~~ changes (~~less than 54%~~) in estimated selenium concentrations in ~~most~~  
 6 biota (whole-body fish (~~excluding sturgeon~~), bird eggs [invertebrate diet], bird eggs [fish diet], and  
 7 fish fillets) (Figures 8-61a through 8-64b; Appendix 8M, Table M-20-29 and ~~Table 8M-2 in the~~  
 8 ~~sturgeon addendum to Appendix 8M Addendum M.A. Selenium in Sturgeon, to Appendix 8M, Table~~  
 9 ~~M.A-2~~). ~~Despite the small changes in selenium concentrations in biota, Level of Concern~~  
 10 ~~Exceedance Quotients (i.e., modeled tissue divided by Level of Concern benchmarks) for selenium~~  
 11 ~~concentrations in those biota for all years and for drought years are less than 1.0 (indicating low~~  
 12 ~~probability of adverse effects). Similarly, Advisory Tissue Level Exceedance Quotients for selenium~~  
 13 ~~concentrations in fish fillets for all years and drought years also are less than 1.0. Estimated~~  
 14 ~~selenium concentrations in sturgeon for the San Joaquin River at Antioch are predicted to increase~~  
 15 ~~by about 35 percent relative~~ Relative to Existing Conditions and to the No Action Alternative in all  
 16 years (from about 4.7 to 6.4 mg/kg dry weight [dw]). Likewise, those for sturgeon in the Sacramento  
 17 River at Mallard Island are predicted to increase by about 17 percent in all years (from about 4.4 to  
 18 5.2 mg/kg dw) (Figure 8-65; Appendix 9M, Tables M-30 and M-31). Selenium concentrations in  
 19 sturgeon during drought years are expected to increase by about 35 percent at Antioch and 17  
 20 percent at Mallard Island. Detection of changes in whole-body sturgeon such as those estimated for  
 21 the western Delta may require large sample sizes because of the inherent variability in fish tissue  
 22 selenium concentrations. Low Toxicity Threshold Exceedance Quotients for selenium concentrations  
 23 in sturgeon in the western Delta would exceed 1.0 for drought years at both locations (as they do for  
 24 Existing Conditions and the No Action Alternative; Figure 8-65 and Appendix 8M, Table M-32) and  
 25 for all years at both ~~locatons~~ Antioch, whereas Existing Conditions and the No Action Alternative do  
 26 not (quotient increases from 0.94 to 1.3 at Antioch and from 0.88 at Sacramento River at Mallard  
 27 Island to 1.0) (Appendix 8M, Table M-32). High Toxicity Threshold Exceedance Quotients for  
 28 selenium concentrations in sturgeon in the western Delta would exceed 1.0 for drought years at  
 29 Antioch (where quotient increases from 0.85 to 1.2), and at Mallard Island (where quotient  
 30 increases from 0.85 to 1.0) unlike Existing Conditions and the No Action Alternative (Appendix 8M,  
 31 Table M-32) and the No Action Alternative, the largest increase of selenium concentrations in biota  
 32 would be at Rock Slough and Contra Costa PP for drought years and in sturgeon at the two western  
 33 Delta locations in all as well as drought years, and the largest decrease would be at Buckley Cove for  
 34 drought years. Except for sturgeon in the western Delta, concentrations of selenium in whole-body  
 35 fish and in bird eggs (invertebrate and fish diets) would exceed the lower benchmarks (4 and 6  
 36 mg/kg dry weight, respectively, indicating a low potential for effects), under drought conditions, at  
 37 Buckley Cove for Existing Conditions and the No Action Alternative, and at Rock Slough and Contra  
 38 Costa PP for Alternative 9 (Figures 8-61 through 8-63). Exceedance Quotients ~~quotients~~ for these  
 39 comparisons to the lower benchmarks are between 1.0 and 1.5, indicating a low risk to biota in the  
 40 Delta, but modeled selenium concentrations in whole-body fish and in bird eggs (invertebrate and  
 41 fish diets) exceed those benchmarks at two locations where they do not exceed under Existing  
 42 Conditions and the No Action Alternative. Selenium concentrations in fish fillets would not exceed  
 43 the screening value for protection of human health (Figure 8-64). For sturgeon in the western Delta,  
 44 whole-body selenium concentrations would increase from 12.3 mg/kg under Existing Conditions  
 45 and the No Action Alternative to 15.1 mg/kg under Alternative 9, a 23% increase (Table 8M-2 in the  
 46 ~~sturgeon addendum to Appendix 8M Addendum M.A. Selenium in Sturgeon, Table M.A-2~~). All of these  
 47 values exceed both the low and high toxicity benchmarks. The predicted increases are high enough

1 that they may represent a measurable increase in body burdens of sturgeon, which would constitute  
2 an adverse impact (see also the discussion of results provided in the sturgeon addendum M.A.  
3 Selenium in Sturgeon, to Appendix 8M).

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

21 Increased water residence times could increase the bioaccumulation of selenium in biota, thereby  
22 potentially increasing fish tissue and bird egg concentrations of selenium (see residence time  
23 discussion in Appendix 8M, Selenium, and Presser and Luoma [2010b]). Thus, residence time was  
24 assessed for its relevance to selenium bioaccumulation. Table 60a (presented originally in Section  
25 8.3.1.7 in the *Microcystis* subsection) shows the time for neutrally buoyant particles to move through  
26 the Delta (surrogate for flow and residence time). Although an increase in residence time  
27 throughout the Delta is expected under the No Action Alternative, relative to Existing Conditions  
28 (because of climate change and sea level rise), the change is fairly small in most areas of the Delta.  
29 Thus, the changes in residence times between Alternative 9 and the No Action Alternative are very  
30 similar to the changes in residence times between Alternative 9 and the Existing Conditions.

31 Relative to Existing Conditions and the No Action Alternative, increases in residence times for  
32 Alternative 9 would be greater in the South Delta than in other sub-regions. Relative to Existing  
33 Conditions, annual average residence times for Alternative 9 in the South Delta are expected to  
34 increase by more than 18 days (Table 60a) and by more than 16 days relative to the No Action  
35 Alternative. Increases in residence times for other sub-regions would be smaller, especially as  
36 compared to Existing Conditions and the No Action Alternative. As mentioned above, these results  
37 incorporate hydrodynamic effects of both CM1 and CM2 and CM4, and the effects of CM1 cannot be  
38 distinguished from the effects of CM2 and CM4. However, it is expected that CM2 and CM4 are  
39 substantial drivers of the increased residence time.

40 Presser and Luoma (2010b) summarized and discussed selenium uptake in the Bay-Delta (including  
41 hydrologic conditions [e.g., Delta outflow and residence time for water],  $K_{dS}$  [the ratio of selenium  
42 concentrations in particulates, as the lowest level of the food chain, relative to the water-borne  
43 concentration], and associated tissue concentrations [especially in clams and their consumers, such  
44 as sturgeon]). When the Delta Outflow Index (daily average flow per month) decreased by five-fold  
45 (73,732 cubic feet per second [cfs] in June 1998 to 12, 251 cfs in October 1998), residence time

1 doubled (from 11 to 22 days) and the calculated mean  $K_d$  also doubled (from 3,198 to 6,501).  
2 However, when daily average Delta outflow in November 1999 was only 6,951 cfs (i.e., about one-  
3 half that in October 1998) and residence time was 70 days, the calculated mean  $K_d$  (7,614) did not  
4 increase proportionally.

5 Models are not available to quantitatively estimate the level of changes in selenium bioaccumulation  
6 as related to residence time, but the effects of residence time are incorporated in the  
7 bioaccumulation modeling for selenium that was based on higher  $K_d$  values for drought years in  
8 comparison to wet, normal, or all years; see Appendix 8M, *Selenium*. If increases in fish tissue or bird  
9 egg selenium were to occur, the increases would likely be of concern only where fish tissues or bird  
10 eggs are already elevated in selenium to near or above thresholds of concern. That is, where biota  
11 concentrations are currently low and not approaching thresholds of concern (which, as discussed  
12 above, is the case throughout the Delta, except for sturgeon in the western Delta), changes in  
13 residence time alone would not be expected to cause them to then approach or exceed thresholds of  
14 concern. In consideration of this factor, although the Delta as a whole is a CWA Section 303(d)-listed  
15 water body for selenium, and although monitoring data of fish tissue or bird eggs in the Delta are  
16 sparse, the most likely area in which biota tissues would be at levels high enough that additional  
17 bioaccumulation due to increased residence time from restoration areas would be a concern is the  
18 western Delta and Suisun Bay for sturgeon, as discussed above. As shown in Table 60a, the overall  
19 increase in residence time estimated in the western Delta is 3 days relative to Existing Conditions,  
20 and 1 day relative to the No Action Alternative. Given the available information, these increases are  
21 small enough that they are not expected to substantially affect selenium bioaccumulation in the  
22 western Delta. Because CM2 and CM4 are expected to be substantial drivers of the increased  
23 residence times, further discussion is included in Impact WQ-26 below.

24 In summary, relative to Existing Conditions and the No Action Alternative, Alternative 9 would  
25 result in small changes in selenium concentrations throughout the Delta for most biota (less than  
26 54%), although larger increases in selenium concentrations are predicted for sturgeon in the  
27 western Delta. Concentrations of selenium in sturgeon would only exceed the lower benchmark for  
28 both western Delta locations for all years and drought years, indicating a low potential for effects,  
29 with the exception of San Joaquin River at Antioch and Sacramento River at Mallard Island for  
30 drought years. The High Toxicity Threshold Exceedance Quotient for selenium concentrations for  
31 sturgeon in the western Delta in drought years at Antioch would increase from about 0.85 for  
32 Existing Conditions and the No Action Alternative to 1.1 and at Mallard Island from 0.87 to 1.0.  
33 Concentrations of selenium in sturgeon would exceed the higher benchmark for Antioch only in  
34 drought years, indicating a high potential for effects. The modeling of bioaccumulation for sturgeon  
35 is less calibrated to site-specific conditions than that for other biota, which was calibrated on a  
36 robust dataset for modeling of bioaccumulation in largemouth bass as a representative species for  
37 the Delta. Overall, the predicted increase for Alternative 9 are high enough that they may represent a  
38 measurable increase in body burdens of sturgeon, which would constitute an adverse impact.

39 Under Alternative 9, the most notable effect on selenium concentrations in water would be the  
40 increase at Rock Slough, Franks Tract, and Contra Costa PP, decreasing the available assimilative  
41 capacity and increasing the selenium concentrations in biota at those locations. Alternative 9 is the  
42 only action alternative that would exceed benchmarks for biota that are not exceeded under Existing  
43 Conditions and the No Action Alternative (and only at Rock Slough and Contra Costa PP); this level  
44 of bioaccumulation is predicted despite the conclusion that selenium concentrations in water would  
45 not exceed ecological benchmarks at any location and the assimilative capacity would remain  
46 substantial. The foremost difference between Alternative 9 and the other alternatives is the

1 ~~exceedances of risk-based benchmarks for biota at Rock Slough and Contra Costa PP (and a large~~  
 2 ~~increase in tissue concentrations predicted at Franks Tract, although the tissue benchmarks would~~  
 3 ~~not be exceeded) compared to the exceedances at Buckley Cove for Existing Conditions and the No~~  
 4 ~~Action Alternative and the other alternatives. In essence, the location where selenium~~  
 5 ~~bioaccumulation is highest would be displaced from Buckley Cove to Rock Slough, Franks Tract, and~~  
 6 ~~Contra Costa PP. Therefore, selenium concentrations in water and biota within the Delta would also~~  
 7 ~~differ spatially for Alternative 9 compared to Existing Conditions and the No Action Alternative and~~  
 8 ~~the other action alternatives, and under Alternative 9 could increase the frequency with which~~  
 9 ~~applicable benchmarks would be exceeded in some regions of the Delta or substantially degrade the~~  
 10 ~~quality of water with respect to beneficial uses in the Delta.~~

### 11 **SWP/CVP Export Service Areas**

12 Alternative 9 would result in ~~small to moderate~~ changes/decreases in average selenium  
 13 concentrations in water at the Banks and Jones pumping plants, relative to Existing Conditions and  
 14 the No Action Alternative, for the entire period modeled (Appendix 8M, Selenium, Table M-10A9a).  
 15 ~~These changes are reflected in the small (10% or less) to moderate (between 11% and 50%)~~  
 16 ~~changes in available assimilative capacity for selenium for all years. Relative to Existing Conditions~~  
 17 ~~and the No Action Alternative, Alternative 9 would result in increases in assimilative capacity at~~  
 18 ~~Jones PP (12% and 13%, respectively) and at Banks PP (5%) (Figures 8-59 and 8-60), so it would~~  
 19 ~~have a positive effect at the Export Service Area locations. These decreases in long-term average~~  
 20 ~~selenium concentrations in water would result in increases in available assimilative capacity for~~  
 21 ~~selenium at these pumping plants of 5–12%, relative to the 1.3 µg/L ecological risk~~  
 22 ~~benchmark USEPA draft water quality criterion (Figures 8-59a and 8-60a). Furthermore, the ranges~~  
 23 ~~of modeled long-term average selenium concentrations in water (Appendix 8M, Table M-10A) for~~  
 24 ~~Alternative 9 (range 0.3216–0.4017 µg/L), Existing Conditions (range 0.37–0.58 µg/L), and the No~~  
 25 ~~Action Alternative (range 0.37–0.59 µg/L) are similar, and all would be well below the ecological~~  
 26 ~~risk benchmark USEPA draft water quality criterion (of 21.3 µg/L (Appendix 8M, Table M-9a).~~

27 Relative to Existing Conditions and the No Action Alternative, Alternative 9 would result in ~~minimal~~  
 28 small changes (less than 53%) in estimated selenium concentrations in biota (whole-body fish, bird  
 29 eggs [invertebrate diet], bird eggs [fish diet], and fish fillets) at export service areas (Figures 8-61a  
 30 through 8-64b; Appendix 8M, Table M-2029). Relative to Existing Conditions and the No Action  
 31 Alternative, the largest increase of selenium concentrations in biota would be at Banks PP for all  
 32 years. Relative to all Existing Conditions and the No Action Alternative, the largest decrease of  
 33 selenium concentrations in biota would be at Jones PP for drought years. Selenium ~~c~~oncentrations  
 34 in biota would not exceed any selenium benchmarks for Alternative 9 (Figures 8-61a through 8-  
 35 64b).

36 Thus, relative to Existing Conditions and the No Action Alternative, Alternative 9 would result in  
 37 small to moderate changes in selenium concentrations in water and minimal changes in selenium  
 38 concentrations in biota at the Export Service Area locations. Selenium concentrations in water and  
 39 biota generally would decrease under Alternative 9 and would not exceed ecological benchmarks at  
 40 either location, whereas the lower benchmark for bird eggs (fish diet) would be exceeded under  
 41 Existing Conditions and the No Action Alternative at Jones PP under drought conditions. This small  
 42 positive change in selenium concentrations under Alternative 9 would be expected to slightly  
 43 decrease the frequency with which applicable benchmarks would be exceeded or slightly improve  
 44 the quality of water at the Export Service Area locations, with regard to selenium.



1 **NEPA Effects:** Based on the discussion above, the effects on selenium from Alternative 9 are  
 2 considered to be adverse. This determination is reached because ~~1) modeled selenium~~  
 3 ~~concentrations in water would increase at Rock Slough, Franks Tract, and Contra Costa PP,~~  
 4 ~~decreasing the available assimilative capacity by more than 10 percent at each of those locations; 2)~~  
 5 ~~selenium concentrations in whole-body fish and in bird eggs (invertebrate and fish diets) at those~~  
 6 ~~locations would increase so that Level of Concern benchmarks for biota that are not exceeded under~~  
 7 ~~the No Action Alternative would be exceeded at Rock Slough and Contra Costa PP (and approach~~  
 8 ~~exceedance at Franks Tract); and selenium concentrations in whole-body sturgeon modeled at two~~  
 9 western Delta locations would increase by an ~~estimated average of 2326%~~, which may represent a  
 10 measurable increase in the environment. ~~Because both low and high toxicity benchmarks are~~  
 11 ~~already exceeded under the No Action Alternative,~~ these potentially measurable increases  
 12 represent an adverse impact.

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

18 There are no substantial point sources of selenium in watersheds upstream of the Delta, and no  
 19 substantial nonpoint sources of selenium in the watersheds of the Sacramento River and the eastern  
 20 tributaries. Nonpoint sources in the San Joaquin Valley that contribute selenium to the Delta will be  
 21 controlled through a TMDL developed by the Central Valley Water Board (2001) for the lower San  
 22 Joaquin River, established limits for the Grassland Bypass Project, and Basin Plan objectives (Central  
 23 Valley Water Board 2010~~ed~~) and State Water Board (2010~~db~~, 2010~~ec~~) that are expected to result in  
 24 decreasing discharges of selenium from the San Joaquin River to the Delta. Consequently, any  
 25 modified reservoir operations and subsequent changes in river flows under Alternative 9, relative to  
 26 Existing Conditions, are expected to cause negligible changes in selenium concentrations in water.  
 27 Any negligible changes in selenium concentrations that may occur in the water bodies of the affected  
 28 environment located upstream of the Delta would not be of frequency, magnitude, and geographic  
 29 extent that would adversely affect any beneficial uses or substantially degrade the quality of these  
 30 water bodies as related to selenium.

31 ~~Relative to Existing Conditions, modeling estimates indicate that Alternative 9 would result in~~  
 32 ~~essentially no small changes in selenium concentrations in water or most biota through the Delta,~~  
 33 ~~which with no exceedances of benchmarks for biological effects. Relative to Existing Conditions,~~  
 34 ~~modeling estimates indicate that Alternative 9 would result in essentially no change in increase~~  
 35 ~~selenium concentrations in whole-body sturgeon modeled at two western Delta locations by an~~  
 36 ~~average of 26% , which may represent a measurable increase in the environment. Because both low~~  
 37 ~~and high toxicity benchmarks are exceeded, these potentially measurable increases represent a~~  
 38 ~~potential impact to aquatic life-fish and wildlife beneficial uses. Relative to Existing Conditions,~~  
 39 ~~modeling estimates indicate that selenium concentrations in water and biota within the Delta would~~  
 40 ~~differ spatially for Alternative 9 compared to Existing Conditions, and the differences would be~~  
 41 ~~substantial. Under Alternative 9, modeled selenium concentrations in water would increase at Rock~~  
 42 ~~Slough, Franks Tract, and Contra Costa PP, decreasing the available assimilative capacity by more~~  
 43 ~~than 10 percent at each of those locations; consequently, selenium concentrations in whole-body~~  
 44 ~~fish and in bird eggs (invertebrate and fish diets) at those locations would increase so that Level of~~  
 45 ~~Concern benchmarks for biota that are not exceeded under Existing Conditions would be exceeded~~  
 46 ~~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~~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 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

1 proposed mitigation measure requires that sampling be conducted to characterize each step of data  
 2 inputs needed for the model, and then the refined model be validated for local conditions. This  
 3 impact is considered significant and unavoidable.

4 **Impact WQ-26: Effects on Selenium Concentrations Resulting from Implementation of CM2-**  
 5 **CM2-CM21**

6 NEPA Effects: Effects of CM2-CM21 on selenium under Alternative 9 are the same as those  
 7 discussed for Alternative 1A and are considered not to be adverse.

8 CEQA Conclusion: CM2-CM21 proposed under Alternative 9 would be similar to those proposed  
 9 under Alternative 1A. As such, effects on selenium resulting from the implementation of CM2-CM21  
 10 would be similar to that previously discussed for Alternative 1A. This impact is considered to be less  
 11 than significant. No mitigation is required.

12 NEPA Effects: In general, with the possible exception of changes in Delta hydrodynamics resulting  
 13 from habitat restoration, CM2-CM11 would not substantially increase selenium concentrations in  
 14 the water bodies of the affected environment. Modeling scenarios included assumptions regarding  
 15 how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, and  
 16 thus such effects of these restoration measures were included in the assessment of CM1 facilities  
 17 operations and maintenance (see Impact WQ-25).

18 However, implementation of these conservation measures may increase water residence time  
 19 within the restoration areas. Increased restoration area water residence times could potentially  
 20 increase the bioaccumulation of selenium in biota, thereby potentially increasing fish tissue and bird  
 21 egg concentrations of selenium, but models are not available to quantitatively estimate the level  
 22 of changes in residence time and the associated selenium bioavailability, but the effects of residence  
 23 time are incorporated in the bioaccumulation modeling for selenium that was based on higher  $K_d$   
 24 values (the ratio of selenium concentrations in particulates [as the lowest level of the food chain]  
 25 relative to the water borne concentration) for drought years in comparison to wet, normal, or all  
 26 years; see Appendix 8M, *Selenium*. If increases in fish tissue or bird egg selenium were to occur, the  
 27 increases would likely be of concern only where fish tissues or bird eggs are already elevated in  
 28 selenium to near or above thresholds of concern. That is, where biota concentrations are currently  
 29 low and not approaching thresholds of concern, changes in residence time alone would not be  
 30 expected to cause them to then approach or exceed thresholds of concern. In consideration of this  
 31 factor, although the Delta as a whole is a 303(d)-listed water body for selenium, and although  
 32 monitoring data of fish tissue or bird eggs in the Delta are sparse, the most likely areas in which  
 33 biota tissues would be at levels high enough that additional bioaccumulation due to increased  
 34 residence time from restoration areas would be a concern are the western Delta and Suisun Bay, and  
 35 the South Delta in areas that receive San Joaquin River water.

36 The western Delta and Suisun Bay receive elevated selenium loads from North San Francisco Bay  
 37 (including San Pablo Bay, Carquinez Strait, and Suisun Bay) and from the San Joaquin River. Point  
 38 sources of selenium in North San Francisco Bay (i.e., refineries) that contribute selenium to Suisun  
 39 Bay are expected to be reduced through a TMDL under development by the San Francisco Bay Water  
 40 Board (San Francisco Bay Water Board 2012) that is expected to result in decreasing discharges of  
 41 selenium. Nonpoint sources of selenium in the San Joaquin Valley that contribute selenium to the  
 42 San Joaquin River, and thus the Delta and Suisun Bay, will be controlled through a TMDL developed  
 43 by the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the  
 44 Grassland Bypass Project, and Basin Plan objectives (Central Valley Water Board 2010c, d) that are

1 expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta. If  
2 selenium levels are not sufficiently reduced via these efforts, it is expected that the State Water  
3 Board and the San Francisco Bay and Central Valley Water Boards would initiate additional actions  
4 to further control sources of selenium.

5 The South Delta receives elevated selenium loads from the San Joaquin River. In contrast to Suisun  
6 Bay and possibly the western Delta in the future, the South Delta lacks the overbite clam (*Corbula*  
7 [*Potamocorbula*] *amurensis*), which is considered a key driver of selenium bioaccumulation in  
8 Suisun Bay, due to its high bioaccumulation of selenium and its role in the benthic food web that  
9 includes long-lived sturgeon. The South Delta does have *Corbicula fluminea*, another bivalve that  
10 bioaccumulates selenium, but it is not as invasive as the overbite clam and thus likely makes up a  
11 smaller fraction of sturgeon diet. Also, as mentioned above, nonpoint sources of selenium in the San  
12 Joaquin Valley that contribute selenium to the Delta will be controlled through a TMDL developed by  
13 the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the  
14 Grassland Bypass Project, and Basin Plan objectives (Central Valley Water Board 2010c, d) that are  
15 expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta.  
16 Further, if selenium levels in the San Joaquin River are not sufficiently reduced via these efforts, it is  
17 expected that the State Water Board and Central Valley Water Board would initiate additional  
18 TMDLs to further control nonpoint sources of selenium.

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

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

39 Given the factors discussed in the assessment above, any increases in bioaccumulation rates from  
40 water-borne selenium that could occur in some areas as a result of increased water residence time  
41 would not be of sufficient magnitude and geographic extent that any portion of the Delta would be  
42 expected to have measurably higher body burdens of selenium in aquatic organisms and, therefore,  
43 would not substantially increase risk for adverse effects to beneficial uses. Furthermore, although  
44 the Delta is a 303(d)-listed water body for selenium, given the discussion in the assessment above, it

1 is unlikely that restoration areas would result in measurable increases in selenium in fish tissues or  
 2 bird eggs such that the beneficial use impairment would be made discernibly worse.

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

7 ***CEQA Conclusion:*** There would be no substantial, long-term increase in selenium concentrations in  
 8 water in the rivers and reservoirs upstream of the Delta, water in the Delta, or the waters exported  
 9 to the CVP and SWP service areas due to implementation of CM2–CM22CM21 relative to Existing  
 10 Conditions. Waterborne selenium concentrations under this alternative would not exceed applicable  
 11 water quality objectives/criteria.

12 Given the factors discussed in the assessment above, any increases in bioaccumulation rates from  
 13 water-borne selenium that could occur in some areas as a result of increased water residence times  
 14 would not be of sufficient magnitude and geographic extent that any portion of the Delta would be  
 15 expected to have measurably higher body burdens of selenium in aquatic organisms, and therefore  
 16 would not substantially increase risk for adverse effects to beneficial uses. CM2-22 would not cause  
 17 long-term degradation of water quality resulting in sufficient use of available assimilative capacity  
 18 such that occasionally exceeding water quality objectives/criteria would be likely. Also, CM2-22CM2  
 19 through CM22CM2–CM21 would not result in substantially increased risk for adverse effects to any  
 20 beneficial uses. Furthermore, although the Delta is a 303(d) listed water body for selenium, given  
 21 the discussion in the assessment above, it is unlikely that restoration areas would result in  
 22 measurable increases in selenium in fish tissues or bird eggs such that the beneficial use impairment  
 23 would be made discernibly worse.

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

### 30 **Impact WQ-32. Effects on *Microcystis* Bloom Formation Resulting from Facilities Operations** 31 **and Maintenance (CM1).**

32 Effects of facilities and operations (CM1) on *Microcystis* abundance, and thus microcystins  
 33 concentrations, in water bodies of the affected environment under Alternative 9 would be very  
 34 similar (i.e., nearly the same) to those discussed for Alternative 1A. This is because factors that  
 35 affect *Microcystis* abundance in waters upstream of the Delta, in the Delta, and in the SWP/CVP  
 36 Export Services Areas under Alternative 1A would similarly change under Alternative 9, relative to  
 37 Existing Conditions and the No Action Alternative. For the Delta in particular, there are differences  
 38 in the direction and magnitude of water residence time changes during the *Microcystis* bloom period  
 39 among the six Delta sub-regions under Alternative 9 compared to Alternative 1A, relative to Existing  
 40 Conditions and No Action Alternative. However, under Alternative 9, relative to Existing Conditions  
 41 and No Action Alternative, water residence times during the *Microcystis* bloom period in various  
 42 Delta sub-regions are expected to increase to a degree that could, similar to Alternative 1A, lead to  
 43 an increase in the frequency, magnitude, and geographic extent of *Microcystis* blooms throughout  
 44 the Delta.

1 Similar to Alternative 1A, water exported from the Delta to the SWP/CVP Export Service Areas will  
2 consist of a mixture of water from the south Delta that is affected by *Microcystis* and Sacramento  
3 River water diverted from the north Delta that is unaffected by *Microcystis*. Sacramento River water  
4 will be conveyed through existing Delta channels under Alternative 9, in contrast to pipelines or  
5 tunnels which will be constructed to convey this water under Alternative 1A. Under Alternative 9,  
6 Delta channels, gates and barriers will be operated and maintained to convey Sacramento River  
7 water to the south Delta pump intakes in manner to maintain the water quality of this source water.  
8 Thus, it is expected that diverted Sacramento River water will remain relatively unaffected by  
9 *Microcystis* until it mixes with *Microcystis*-affected water from the south Delta at Banks and Jones  
10 pumping plants. For the same reasons described for Alternative 1A, it cannot be determined  
11 whether operations and maintenance under Alternative 9, relative to existing conditions, will result  
12 in increased or decreased levels of *Microcystis* and microcystins in the mixture of source waters  
13 exported from Banks and Jones pumping plants.

14 Similar to Alternative 1A, elevated ambient water temperatures relative to Existing Conditions  
15 would occur in the Delta under Alternative 9, which could lead to earlier occurrences of *Microcystis*  
16 blooms in the Delta, and increase the overall duration and magnitude of blooms. However, the  
17 degradation of water quality from *Microcystis* blooms due to the expected increases in Delta water  
18 temperatures is driven entirely by climate change, not effects of CM1. While *Microcystis* blooms  
19 have not occurred in the Export Service Areas, conditions in the Export Service Areas under  
20 Alternative 9 may become more conducive to *Microcystis* bloom formation, relative to Existing  
21 Conditions, because water temperatures will increase in the Export Service Areas due to the  
22 expected increase in ambient air temperatures resulting from climate change.

23 **NEPA Effects:** Effects of water facilities and operations (CM1) on *Microcystis* in water bodies of the  
24 affected environment under Alternative 9 would be very similar to (i.e., nearly the same) to those  
25 discussed for Alternative 1A. In summary, Alternative 9 operations and maintenance, relative to the  
26 No Action Alternative, would result in long-term increases in hydraulic residence time of various  
27 Delta sub-regions during the summer and fall *Microcystis* bloom period. During this period, the  
28 increased residence time could result in a concurrent increase in the frequency, magnitude, and  
29 geographic extent of *Microcystis* blooms, and thus microcystin levels, in affected areas of the Delta.  
30 As a result, Alternative 9 operation and maintenance activities would cause further degradation to  
31 water quality with respect to *Microcystis* in the Delta. Under Alternative 9, relative to No Action  
32 Alternative, water exported to the SWP/CVP Export Service Area will be a mixture of *Microcystis*-  
33 affected source water from the south Delta intakes and unaffected source water from the  
34 Sacramento River, diverted at the north Delta intakes. It cannot be determined whether operations  
35 and maintenance under Alternative 9 will result in increased or decreased levels of *Microcystis* and  
36 microcystins in the mixture of source waters exported from Banks and Jones pumping plants.  
37 Mitigation Measure WQ-32a and WQ-32b are available to reduce the effects of degraded water  
38 quality in the Delta. Although there is considerable uncertainty regarding this impact, the effects on  
39 *Microcystis* from implementing CM1 is determined to be adverse.

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

1 Under Alternative 9, additional impacts from *Microcystis* in the reservoirs and watersheds upstream  
2 of the Delta are not expected, relative to Existing Conditions. Operations and maintenance occurring  
3 under Alternative 9 is not expected to change nutrient levels in upstream reservoirs or  
4 hydrodynamic conditions in upstream rivers and streams such that conditions would be more  
5 conductive to *Microcystis* production.

6 Relative to Existing Conditions, water temperatures and hydraulic residence times in the Delta are  
7 expected to increase under Alternative 9, resulting in an increase in the frequency, magnitude and  
8 geographic extent of *Microcystis* blooms in the Delta. However, the degradation of water quality  
9 from *Microcystis* blooms due to the expected increases in Delta water temperatures is driven  
10 entirely by climate change, not effects of CM1. Increases in Delta residence times are expected  
11 throughout the Delta during the summer and fall bloom period, due in small part to climate change  
12 and sea level rise, but due more proportionately to CM1 and the hydrodynamic impacts of  
13 restoration included in CM2 and CM4. The precise change in local residence times and *Microcystis*  
14 production expected within any Delta sub-region is unknown because conditions will vary across  
15 the complex networks of intertwining channels, shallow back water areas, and submerged islands  
16 that compose the Delta. Nonetheless, Delta residence times are, in general, expected to increase due  
17 to Alternative 9. Consequently, it is possible that increases in the frequency, magnitude, and  
18 geographic extent of *Microcystis* blooms in the Delta will occur due to the operations and  
19 maintenance of Alternative 9 and the hydrodynamic impacts of restoration (CM2 and CM4).

20 The assessment of effects of *Microcystis* on SWP/CVP Export Service Areas is based on the  
21 assessment of changes in *Microcystis* levels in export source waters, as well as the effects of  
22 temperature and residence time changes within the Export Service Areas on *Microcystis* production.  
23 Under Alternative 9, relative to Existing Conditions, the potential for *Microcystis* to occur in the  
24 Export Service Area is expected to increase due to increasing water temperature, but this impact is  
25 driven entirely by climate change and not Alternative 9. Water exported from the Delta to the  
26 Export Service Area is expected to be a mixture of *Microcystis*-affected source water from the south  
27 Delta intakes and unaffected source water from the Sacramento River. Because of this, it cannot be  
28 determined whether operations and maintenance under Alternative 9, relative to existing  
29 conditions, will result in increased or decreased levels of *Microcystis* and microcystins in the mixture  
30 of source waters exported from Banks and Jones pumping plants.

31 Based on the above, this alternative would not be expected to cause additional exceedance of  
32 applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that  
33 would cause significant impacts on any beneficial uses of waters in the affected environment.  
34 *Microcystis* and microcystins are not 303(d) listed within the affected environment and thus any  
35 increases that could occur in some areas would not make any existing *Microcystis* impairment  
36 measurably worse because no such impairments currently exist. Because *Microcystis* and  
37 microcystins are not bioaccumulative, increases that could occur in some areas would not  
38 bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health  
39 risks to fish, wildlife, or humans. However, because it is possible that increases in the frequency,  
40 magnitude, and geographic extent of *Microcystis* blooms in the Delta will occur due to the operations  
41 and maintenance of Alternative 9 and the hydrodynamic impacts of restoration (CM2 and CM4),  
42 long-term water quality degradation may occur and, thus, significant impacts on beneficial uses  
43 could occur. Although there is considerable uncertainty regarding this impact, the effects on  
44 *Microcystis* from implementing CM1 is determined to be significant.

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

5 **Impact WQ-33. Effects on *Microcystis* Bloom Formation Resulting from Other Conservation**  
 6 **Measures (CM2--CM21).**

7 The effects of CM2–CM21 on *Microcystis* under Alternative 9 are the same as those discussed for  
 8 Alternative 1A. In summary, potential environmental effects related to CM2 and CM4 could result in  
 9 an increase in the frequency, magnitude, and geographic extent of *Microcystis* blooms in the Delta,  
 10 relative to Existing Conditions and the No Action Alternative, as a result of increased residence times  
 11 for Delta waters from implementing CM2 and CM4 restoration areas. -Because the hydrodynamic  
 12 effects associated with implementing CM2 and CM4 were incorporated into the modeling used to  
 13 assess CM1, a detailed assessment of the effects of implementing CM2 and CM4 on *Microcystis*  
 14 blooms in the Delta via their effects on Delta water residence time is provided under CM1 (above).  
 15 The effects of CM-2 and CM-4 on *Microcystis* may be reduced by implementation of Mitigation  
 16 Measures WQ-32A and WQ-32b. The effectiveness of these mitigation measures to result in feasible  
 17 measures for reducing water quality effects is uncertain. Conservation Measures 3 (CM3) and CM5-  
 18 CM21 would not result in an increase in the frequency, magnitude, and geographic extent of  
 19 *Microcystis* blooms in the Delta.

20 **NEPA Effects:** Effects of CM2–CM21 on *Microcystis* under Alternative 9 are the same as those  
 21 discussed for Alternative 1A and are considered to be adverse.

22 **CEQA Conclusion:** Based on the above, this alternative would not be expected to cause additional  
 23 exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic  
 24 extent that would cause significant impacts on any beneficial uses of waters in the affected  
 25 environment. *Microcystis* and microcystins are not 303(d) listed within the affected environment  
 26 and thus any increases that could occur in some areas would not make any existing *Microcystis*  
 27 impairment measurably worse because no such impairments currently exist. Because *Microcystis*  
 28 and microcystins are not bioaccumulative, increases that could occur in some areas would not  
 29 bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health  
 30 risks to fish, wildlife, or humans. Because restoration actions implemented under CM2 and CM4 will  
 31 increase residence time throughout the Delta and create local areas of warmer water during the  
 32 bloom season, it is possible that increases in the frequency, magnitude, and geographic extent of  
 33 *Microcystis* blooms, and thus long-term water quality degradation and significant impacts on  
 34 beneficial uses, could occur. Although there is considerable uncertainty regarding this impact, the  
 35 effects on *Microcystis* from implementing CM2–CM21 are determined to be significant.

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

38 The effects analysis presented in the preceding impacts (Impact WQ-1 through WQ-33) concluded  
 39 that Alternative 9 would have a less than significant impact/no adverse effect on the following  
 40 constituents in the Delta:

- 41 ● Boron
- 42 ● Dissolved Oxygen



1       ● Pathogens

2       ● Pesticides

3       ● Trace Metals

4       ● Turbidity and TSS

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

13       The effects of Alternative 9 on bromide, chloride, and DOC, in the Delta were determined to be  
 14       significant/adverse. Increases in bromide, chloride, and DOC concentrations are of concern in  
 15       drinking water supplies; however, as described previously, the San Francisco Bay does not have a  
 16       designated MUN use. Thus, changes in bromide, chloride, and DOC in Delta outflow would not  
 17       adversely effect any beneficial uses of San Francisco Bay.

18       Elevated EC, as assessed for this alternative, is of concern for its effects on the agricultural beneficial  
 19       use (AGR) and fish and wildlife beneficial uses. As discussed above, San Francisco Bay does not have  
 20       an AGR beneficial use designation. Further, as discussed for the No Action Alternative, c

21       While effects of Alternative 9 on the nutrients ammonia, nitrate, and phosphorus were determined  
 22       to be less than significant/not adverse, these constituents are addressed further below because the  
 23       response of the seaward bays to changed nutrient concentrations/loading may differ from the  
 24       response of the Delta. Selenium and mercury are discussed further, because they are  
 25       bioaccumulative constituents where changes in load due to both changes in Delta concentrations  
 26       and exports are of concern.

27       **Nutrients: Ammonia, Nitrate, and Phosphorus**

28       Total nitrogen loads in Delta outflow to Suisun and San Pablo Bays under Alternative 9 would be  
 29       dominated almost entirely by nitrate, because planned upgrades to the SRWTP will result in >95%  
 30       removal of ammonia in its effluent. Total nitrogen loads to Suisun and San Pablo Bays would  
 31       decrease by 17%, relative to Existing Conditions, and increase by 21%, relative to the No Action  
 32       Alternative (Appendix 80, Table O-1). The change in nitrogen loading to Suisun and San Pablo Bays  
 33       under Alternative 9 would not adversely impact primary productivity in these embayments because  
 34       light limitation and grazing current limit algal production in these embayments. To the extent that  
 35       algal growth increases in relation to a change in ammonia concentration, this would have net  
 36       positive benefits, because current algal levels in these embayments are low. Nutrient levels and  
 37       ratios are not considered a direct driver of *Microcystis* and cyanobacteria levels in the North Bay.

38       The phosphorus load exported from the Delta to Suisun and San Pablo Bays for Alternative 9 is  
 39       estimated to increase by 5%, relative to Existing Conditions, and there would be no change relative  
 40       to the No Action Alternative (Appendix 80, Table O-1) ). The only postulated effect of changes in  
 41       phosphorus loads to Suisun and San Pablo Bays is related to the influence of nutrient stoichiometry  
 42       on primary productivity. However, there is uncertainty regarding the impact of nutrient ratios on

1 phytoplankton community composition and abundance. Any effect on phytoplankton community  
2 composition would likely be small compared to the effects of grazing from introduced clams and  
3 zooplankton in the estuary (Senn and Novick 2014; Kimmerer and Thompson 2014). Therefore, the  
4 projected change in total nitrogen and phosphorus loading that would occur in Delta outflow to San  
5 Francisco Bay is not expected to result in degradation of water quality with regard to nutrients that  
6 would result in adverse effects to beneficial uses.

### 7 **Mercury**

8 The estimated long-term average mercury and methylmercury loads in Delta exports are shown in  
9 Appendix 80, Table O-2. Loads of mercury and methylmercury from the Delta to San Francisco Bay  
10 are estimated to change relatively little due to changes in source water fractions and net Delta  
11 outflow that would occur under Alternative 9. Mercury load to the Bay, relative to Existing  
12 Conditions, is estimated to increase by 8 kg/yr (3%), relative to Existing Conditions, and 5 kg/yr  
13 (2%), relative to the No Action Alternative. Methylmercury load is estimated to increase by 0.14  
14 kg/yr (4%), relative to Existing Conditions, and increase by 0.05 kg/yr (1%) relative to the No  
15 Action Alternative. The estimated total mercury load to the Bay is 268 kg/yr, which would be less  
16 than the San Francisco Bay mercury TMDL WLA for the Delta of 330 kg/yr. The estimated changes in  
17 mercury and methylmercury loads would be within the overall uncertainty associated with the  
18 estimates of long-term average net Delta outflow and the long-term average mercury and  
19 methylmercury concentrations in Delta source waters. The estimated changes in mercury load  
20 under the alternative would also be substantially less than the considerable differences among  
21 estimates in the current mercury load to San Francisco Bay (SFBRWQCB 2006; David et al. 2009).  
22 Similar uncertainty is expected in the existing methylmercury load in net Delta exports, for which  
23 the best available current load estimate is based on approximately one year of monitoring data (Foe  
24 et al. 2008).

25 Given that the estimated incremental decreases/increases of mercury and methylmercury loading to  
26 San Francisco Bay would fall within the uncertainty of current mercury and methylmercury load  
27 estimates, the estimated changes in mercury and methylmercury loads in Delta exports to San  
28 Francisco Bay due to Alternative 9 are not expected to result in adverse effects to beneficial uses or  
29 substantially degrade the water quality with regard to mercury, or make the existing CWA Section  
30 303(d) impairment measurably worse.

### 31 **Selenium**

32 Changes in source water fraction and net Delta outflow under Alternative 9, relative to Existing  
33 Conditions, are projected to cause the total selenium load to the North Bay to increase by 16%,  
34 relative to Existing Conditions, and increase by 13%, relative to the No Action Alternative (Appendix  
35 80, Table O-3). Changes in long-term average selenium concentrations of the North Bay are assumed  
36 to be proportional to changes in North Bay selenium loads. Under Alternative 9, the long-term  
37 average total selenium concentration of the North Bay is estimated to be 0.15 µg/L and the dissolved  
38 selenium concentration is estimated to be 0.13 µg/L, which would be a 0.02 µg/L increase relative to  
39 Existing Conditions and the No Action Alternative (Appendix 80, Table O-3). The dissolved selenium  
40 concentration would be below the target of 0.202 µg/L developed by Presser or Luoma (2013) to  
41 coincide with a white sturgeon whole-body fish tissue selenium concentration not greater than 8  
42 mg/kg in the North Bay.

43 The incremental increase in dissolved selenium concentrations projected to occur under Alternative  
44 9, relative to Existing Conditions and the No Action Alternative, would be higher than under

1 Alternatives 1–5, but still low (0.02 µg/L). The increased dissolved selenium concentration would be  
2 within the overall uncertainty of the analytical methods used to measure selenium in water column  
3 samples; however, it also would be within the uncertainty associated with estimating numeric water  
4 column selenium thresholds (Pressor and Luoma 2013). As described in Section 8.3.1.8, there have  
5 been improvements in selenium concentrations in the tissue of diving ducks and muscle of white  
6 sturgeon since the initial CWA Section 303(d) listing of the North Bay for selenium impairments, and  
7 selenium concentrations in white sturgeon muscle have also generally been below the USEPA’s draft  
8 recommended fish muscle tissue concentration of 11.8 mg/kg dry weight (SFEI 2014). However, as  
9 described under Impact WQ-25, though there is some uncertainty in the estimate of sturgeon  
10 concentrations at western Delta locations, the predicted increases for Alternative 9 are high enough  
11 that they may represent measurably higher body burdens of selenium in aquatic organisms, thereby  
12 substantially increasing the health risks to wildlife (including fish). Because the projected  
13 incremental increases in dissolved selenium could cause measurable changes in water column  
14 concentrations, and these incremental increases would be within the uncertainty in the target water  
15 column threshold for dissolved selenium for protection against adverse bioaccumulative effects in  
16 the North Bay ecosystem, and modeling predicts concentrations in the western Delta may represent  
17 a measurable increase in body burdens of sturgeon, there is potential that the incremental increase  
18 in dissolved selenium concentration projected to occur in the North Bay under Alternative 9 could  
19 result in adverse effects beneficial uses.

20 **NEPA Effects:** Based on the discussion above, Alternative 9, relative to the No Action Alternative,  
21 would not cause further degradation to water quality with respect to boron, bromide, chloride,  
22 dissolved oxygen, DOC, EC, mercury, pathogens, pesticides, nutrients (ammonia, nitrate,  
23 phosphorus), trace metals, or turbidity and TSS in the San Francisco Bay. Further, changes in these  
24 constituent concentrations in Delta outflow would not be expected to cause changes in Bay  
25 concentrations of frequency, magnitude, and geographic extent that would adversely affect any  
26 beneficial uses. In summary, based on the discussion above, effects on the San Francisco Bay from  
27 implementation of CM1–CM21 are considered to be not adverse with respect to boron, bromide,  
28 chloride, dissolved oxygen, DOC, EC, mercury, pathogens, pesticides, nutrients (ammonia, nitrate,  
29 phosphorus), trace metals, or turbidity and TSS. However, Alternative 9 could result in increases in  
30 selenium concentrations in the North San Francisco Bay that could result in adverse effects to fish  
31 and wildlife beneficial uses. This effect is considered to be adverse.

32 **CEQA Conclusion:** Based on the above, Alternative 9 would not be expected to cause long-term  
33 degradation of water quality in San Francisco Bay resulting in sufficient use of available assimilative  
34 capacity such that occasionally exceeding water quality objectives/criteria would be likely and  
35 would result in substantially increased risk for adverse effects to one or more beneficial uses with  
36 respect to boron, bromide, chloride, dissolved oxygen, DOC, EC, mercury, pathogens, pesticides,  
37 nutrients (ammonia, nitrate, phosphorus), trace metals, or turbidity and TSS. Further, based on the  
38 above, this alternative would not be expected to cause additional exceedance of applicable water  
39 quality objectives/criteria in the San Francisco Bay by frequency, magnitude, and geographic extent  
40 that would cause significant impacts on any beneficial uses of waters in the affected environment  
41 with respect to boron, bromide, chloride, dissolved oxygen, DOC, EC, mercury, pathogens, pesticides,  
42 nutrients (ammonia, nitrate, phosphorus), trace metals, or turbidity and TSS. Any changes in boron,  
43 bromide, chloride, and DOC in the San Francisco Bay would not adversely affect beneficial uses,  
44 because the uses most affected by changes in these parameters, MUN and AGR, are not beneficial  
45 uses of the Bay. Further, no substantial changes in dissolved oxygen, pathogens, pesticides, trace  
46 metals or turbidity or TSS are anticipated in the Delta, relative to Existing Conditions, therefore, no

1 substantial changes these constituents levels in the Bay are anticipated. Changes in Delta salinity  
 2 would not contribute to measurable changes in Bay salinity, as the change in Delta outflow would  
 3 two to three orders of magnitude lower than (and thus minimal compared to) the Bay's tidal flow.  
 4 Adverse changes in Microcystis levels that could occur in the Delta would not cause adverse  
 5 Microcystis blooms in the Bay, because Microcystis are intolerant of the Bay's high salinity and, thus  
 6 not have not been detected downstream of Suisun Bay. The 17% decrease in total nitrogen load and  
 7 5% increase in phosphorus load, relative to Existing Conditions, are expected to have minimal effect  
 8 on water quality degradation, primary productivity, or phytoplankton community composition. The  
 9 estimated increase in mercury load (8 kg/yr; 3%) and methylmercury load (0.14 kg/yr; 4%),  
 10 relative to Existing Conditions, is within the level of uncertainty in the mass load estimate and not  
 11 expected to contribute to water quality degradation, make the CWA section 303(d) mercury  
 12 impairment measurably worse or cause mercury/methylmercury to bioaccumulate to greater levels  
 13 in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans.

14 In regard to selenium, the estimated increase in selenium load would be 16% and the estimated  
 15 increase in dissolved selenium concentrations would be 0.02 µg/L. Though there is some  
 16 uncertainty in the estimate of sturgeon concentrations at western Delta locations, the predicted  
 17 increases are high enough that they may represent measurably higher body burdens of selenium in  
 18 aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish). Thus,  
 19 the increase in selenium load may make the CWA section 303(d) selenium impairment measurably  
 20 worse and cause selenium to bioaccumulate to greater levels in aquatic organisms that would, in  
 21 turn, pose substantial health risks to fish and wildlife. This impact is considered to be significant.  
 22 Environmental Commitment: Selenium Management (AMM27), which affords for site-specific  
 23 measures to reduce effects, would be available to reduce BDCP-related effects associated with  
 24 selenium. The effectiveness of AMM27 is uncertain and, therefore implementation may not reduce  
 25 the identified impact to a level that would be less than significant, and therefore it is significant and  
 26 unavoidable.

### 27 **8.3.3.17 Cumulative Analysis**

#### 28 **No Action Alternative**

29 The cumulative effect of the No Action Alternative is as follows. Water quality conditions upstream  
 30 of the Delta, in the Delta Region, and in the SWP/CVP export service areas of the affected  
 31 environment are expected to change as a result of past, present, and reasonably foreseeable future  
 32 projects, population growth, climate change, and changes in water quality regulations (e.g.,  
 33 completion of TMDLs, adoption of new or more restrictive criteria/objectives). Many past, present,  
 34 and reasonably foreseeable future projects are identified and described in Appendix 3D, and specific  
 35 projects or regulatory programs that are either ongoing or proposed for future implementation, and  
 36 thus, could affect future cumulative water quality conditions, are listed in Table 8-73. The combined  
 37 water quality effects of projects considered in the cumulative condition will vary, including potential  
 38 contribution to the degradation of various water quality parameters, whereas others will function to  
 39 improve constituent-specific water quality in certain areas. Future population growth may produce  
 40 increased constituent loadings to the water bodies of the affected environment through increased  
 41 urban stormwater runoff, increased POTW discharges, and changes in land uses. Climate change is  
 42 anticipated to cause salinity increases in the western and southern Delta due to sea level rise. This is  
 43 evidenced by the increase in violations of the D-1641 salinity standard in the Sacramento River at  
 44 Emmaton under the No Action Alternative, relative to Existing Conditions, as described in section

1 8.3.3.1 above. Conversely, changes in water quality regulations generally are in a direction that  
 2 results in improvements in water quality (e.g., increased monitoring and restrictions on urban  
 3 stormwater runoff, completion of TMDLs to lessen or eliminate existing beneficial use impairments  
 4 through improved water quality, more restrictive regulations on POTW discharges, new and/or  
 5 more restrictive water quality criteria/objectives in Basin Plans).

6 Some water quality constituents are at levels under Existing Conditions that cause some impact to  
 7 beneficial uses. These include:

- 8 • Bromide
- 9 • Chloride
- 10 • Electrical Conductivity
- 11 • Mercury
- 12 • Organic Carbon
- 13 • Pesticides and Herbicides
- 14 • Selenium

15 Under the cumulative No Action Alternative, even with consideration of the factors that will affect  
 16 water quality discussed above, these constituents are expected to remain at levels that cause some  
 17 impact to beneficial uses. In addition, the frequency, magnitude, and geographic extent of *Microcystis*  
 18 *blooms in Delta waters may increase in the future as Delta water temperatures increase due to*  
 19 *climate change.* Thus, for the purposes of NEPA, water quality conditions for ~~these~~ constituents  
 20 listed above, and possibly for *Microcystis* blooms in Delta waters as well, under the cumulative No  
 21 Action Alternative constitute an adverse environmental condition. The cumulative effect of the No  
 22 Action Alternative for all other water quality constituents is not adverse.

23 Although the constituents listed above are at levels under Existing Conditions that cause some  
 24 impact to beneficial uses, the only constituents for which the cumulative effects of the No Action  
 25 Alternative are expected to adversely affect beneficial uses, relative to Existing Conditions, ~~is~~ are  
 26 electrical conductivity, chloride, and possibly *Microcystis* blooms in Delta waters, due to the effects  
 27 of climate change and sea level rise. Thus, for the purposes of CEQA, water quality conditions for  
 28 electrical conductivity chloride, and *Microcystis* blooms in Delta waters under the cumulative No  
 29 Action Alternative constitute a significant environmental condition. The cumulative effect of the No  
 30 Action Alternative for all other water quality constituents is less than significant, relative to Existing  
 31 Conditions.

## 32 **Alternatives 1A through 9**

### 33 ***Chloride***

34 The cumulative condition for chloride is considered adverse in the Delta, because of marked  
 35 increases in chloride concentrations anticipated to occur in the western Delta, ~~and including~~  
 36 potentially Suisun Marsh, ~~and the interior Delta~~, but not in the SWP/CVP Export Service Areas south  
 37 of the Delta due to greater source fraction of Sacramento River water on an annual average basis at  
 38 the south Delta pumps under all alternatives.

39 ~~Alternatives 1A–5 and 9 would substantially increase chloride levels in Suisun Marsh relative to~~  
 40 ~~Existing Conditions, primarily during the October through May period, whereas alternatives 6A–8~~

1 ~~would result in somewhat lesser (but still substantial) increases in Suisun Marsh.~~ With regards to  
 2 the frequency of exceeding the 150 mg/L Bay-Delta WQCP objective at Antioch and Contra Costa  
 3 Canal Pumping Plant #1, ~~the modeling and assessment approach indicated that~~ Alternatives ~~1A–~~  
 4 ~~91A, 3, and 7-9~~ would result in a substantial increase in the frequency of objective exceedance. With  
 5 regards to the frequency of exceeding the 250 mg/l chloride objective at Antioch, ~~the modeling and~~  
 6 ~~assessment approach indicated that~~ Alternatives ~~1A–51A, 3, and 5~~ would result in a substantial  
 7 increase in the frequency of exceeding this objective, relative to Existing Conditions, whereas  
 8 Alternative 9 would cause only a minor increase in frequency of exceedance and Alternatives 6A–8  
 9 would result in a reduction in frequency of exceeding the 250 mg/L chloride objective (Appendix 8G,  
 10 *Chloride*). Regarding exceedance of Bay Delta WQCP water quality objectives for chloride, staff from  
 11 DWR and Reclamation constantly monitor Delta water quality conditions and adjust operations of  
 12 the SWP and CVP in real time as necessary to meet water quality objectives. These decisions take  
 13 into account real-time conditions and are able to account for many factors that the best available  
 14 models cannot simulate. DWR and Reclamation have a good history of compliance with water  
 15 quality objectives (see section 8.3.1.4 and 8.3.1.7 for more detail). Considering these real-time  
 16 actions, the good history of compliance with objectives, and the uncertainty inherent in the  
 17 modeling approach (as discussed in section 8.3.1.1 and 8.3.1.3), it is likely that any objective  
 18 exceedance could be avoided through real-time operation of the SWP and CVP. Nevertheless, water  
 19 quality degradation could occur that may not be addressed through real-time operations.

20 Depending on siting and design of tidal restoration areas proposed under CM4, Alternatives 1A–9  
 21 could substantially increase chloride levels in some areas of Suisun Marsh relative to Existing  
 22 Conditions, primarily during the October through May period.

23 Hence, based on their respective effects on increased chloride levels in Suisun Marsh and ~~the~~  
 24 increased ~~frequency of exceeding Bay-Delta WQCP objectives at Antioch and Contra Costa Canal~~  
 25 ~~Pumping Plant #1-water quality degradation in the western Delta~~, implementation of facilities  
 26 operations and maintenance (CM1) under Alternatives 1A–9 would contribute substantially to this  
 27 adverse cumulative condition for chloride. Additionally, implementation of tidal habitat restoration  
 28 under CM4 would increase the tidal exchange volume in the Delta, and thus may contribute to  
 29 increased chloride concentrations in the Bay source water as a result of increased salinity intrusion.  
 30 As such, CM4 is expected to contribute to this adverse cumulative condition. Implementation of CM2,  
 31 CM3, and CM5–~~CM22CM21~~ would not contribute substantially to this adverse cumulative condition.

### 32 **Electrical Conductivity**

33 The cumulative condition for EC is considered to be adverse, at various Delta locations and Suisun  
 34 Marsh, depending on BDCP alternative implemented. EC levels at the south Delta export pumps  
 35 would improve under all alternatives and thus the cumulative EC condition at the export pumps  
 36 would not be adverse. As such, cumulative EC levels in the SWP/CVP Export Service Areas would not  
 37 be adverse.

38 Alternatives 1A-3 and 5-9 are expected to result in more frequent exceedances of the Bay Delta  
 39 WQCP EC objective in the Sacramento River at Emmaton, relative to Existing Conditions. This is due  
 40 in part to the definition of these alternatives, in which the compliance point is moved to Threemile  
 41 Slough. Although modeling of Alternative 4 indicated more frequent exceedance of the Emmaton  
 42 objective as well, these results were for modeling that was originally performed for Alternative 4  
 43 assuming the Emmaton compliance point shifted to Threemile Slough, but Alternative 4 now does  
 44 not include a change in compliance point from Emmaton to Threemile Slough. Sensitivity analyses

1 performed indicated that Alternative 4 is not expected to result in more frequent exceedances of the  
 2 Emmaton objective, but that water supply and water quality conditions could be either under  
 3 greater stress or under stress earlier in the year, and salinity EC levels at Emmaton and in the  
 4 western Delta may increase as a result, leading to EC water quality degradation and increased  
 5 possibility of impacts adverse effects to agricultural beneficial uses. Similarly, water quality  
 6 degradation is expected to occur at Emmaton and other areas of the western Delta under all  
 7 alternatives during parts of the summer, and on an annual average basis for Alternatives 1, 3, 4  
 8 scenarios H1 and H2, and 9. To the extent that exceedances of this objective or substantial water  
 9 quality degradation is expected, these impacts could lead to effects on agricultural beneficial uses.  
 10 Increases in EC in the San Joaquin River at San Andreas Landing are expected for parts of the  
 11 summer under all Alternatives, and depending on the nature of the increases, may result in water  
 12 quality degradation that could lead to effects on agricultural beneficial uses.

13 Alternatives 1A–5 and 9 would substantially increase EC levels in Suisun Marsh relative to Existing  
 14 Conditions, primarily during the October through May period, whereas Alternatives 6A–8 would  
 15 result in somewhat lesser (but still substantial) increases in Suisun Marsh. Moreover, in the central  
 16 Delta at Prisoner’s Point, Alternatives 2A–C, 4 (including all operational scenarios H1 through H4),  
 17 and 6A–8 would result in substantially increased frequency of exceedance of the EC objective,  
 18 whereas Alternative 5 would cause a lesser increase in frequency of exceedance, and Alternatives  
 19 1A–C, 3, and 9 would have little to no effect on frequency of exceedance of the EC objective at  
 20 Prisoner’s Point (Appendix 8H). These exceedances could contribute to adverse effects on fish and  
 21 wildlife beneficial uses (specifically, indirect adverse effects on striped bass spawning), though there  
 22 is a high degree of uncertainty associated with this impact.

23 Alternatives 1A–5 and 9 could substantially increase EC levels in Suisun Marsh relative to Existing  
 24 Conditions, primarily during the October through May period, whereas Alternatives 6A–8 would  
 25 result in somewhat lesser (but still substantial) increases in Suisun Marsh.

26 Based on their adverse effects on EC levels in Suisun Marsh as well as the adverse effects in the  
 27 western and, interior, and/or south Delta, Alternatives 1A–9 would all contribute substantially to  
 28 the adverse cumulative conditions for EC in the Delta and in Suisun Marsh. Additionally,  
 29 implementation of tidal habitat restoration under CM4 would increase the tidal exchange volume in  
 30 the Delta, and thus may contribute to increased EC concentrations in the Bay source water as a  
 31 result of increased salinity intrusion. As such, CM4 is expected to contribute to this adverse  
 32 cumulative condition. Implementation of CM2, CM3, and CM5–~~CM22~~CM21 would not contribute  
 33 substantially to this adverse cumulative condition.

#### 34 **Mercury**

35 Numerous regulatory efforts have been implemented or are under development to control and  
 36 reduce mercury loading to the Delta, Upstream of the Delta and in the SWP/CVP Export Service  
 37 Areas, which include a Delta mercury TMDL, methylmercury TMDL, and their implementation  
 38 strategies (e.g., methylmercury control studies), increased restrictions on point-source discharges  
 39 such as POTWs, greater restrictions on suction dredging in Delta tributary watersheds, and  
 40 continued clean-up actions on mine drainage in the upper watersheds. A key challenge surrounds  
 41 the pool of mercury deposited in the sediments of the Delta which cannot be readily or rapidly  
 42 reduced, despite efforts to reduce future loads in Delta tributaries, and serves as a source for  
 43 continued methylation and bioaccumulation of methylmercury by Delta biota. Consequently,  
 44 mercury levels in Delta waters are considered to be an adverse cumulative condition. Facilities

1 operations and maintenance (CM1) of Alternatives 1A–~~9~~<sup>5</sup> would not be expected to substantially  
 2 alter the cumulative condition for mercury and the mercury impairment in the Delta or contribute  
 3 substantially to the cumulative mercury condition in the SWP/CVP Export Service Areas. Facilities  
 4 operations and maintenance (CM1) of Alternatives 6-9 with the exception of Alternative 8 would be  
 5 expected to contribute substantially to the cumulative condition for mercury in the Delta, since fish  
 6 tissue concentrations are expected to increase measurably at several locations throughout the Delta,  
 7 at selected locations, where fish tissue mercury is expected to increase. Implementation of CM4  
 8 (tidal wetland habitat), CM5 (floodplain habitat), CM10 (freshwater marsh habitat), and possibly  
 9 CM2 (Yolo Bypass fisheries enhancements) could create conditions resulting in increased  
 10 methylation of mercury within the Delta per unit time, increased biotic exposure to and uptake of  
 11 methylmercury, and resulting increased mercury bioaccumulation in fish tissues. The methylation of  
 12 mercury in these restored wetland habitats would contribute substantially to the cumulative  
 13 condition for mercury in the Delta.

#### 14 *Microcystis Blooms*

15 Alternatives 1A–9, including their implementation of CM2 and CM4, would increase water residence  
 16 times in the Delta during the summer period, relative to Existing Conditions and the No Action  
 17 Alternative. An increase in residence time throughout the Delta is also expected due to climate  
 18 change and sea level rise, although this change is believed to be fairly small in most areas of the  
 19 Delta. Longer residence times in portions of the Delta may potentially increase the frequency,  
 20 magnitude, and geographic extent of *Microcystis* blooms in Delta waters, relative to Existing  
 21 Conditions and the No Action Alternative. *Microcystis* blooms can occur in the Delta during the June  
 22 through September period of the year. Siting and design of restoration areas has substantial  
 23 influence on the magnitude of residence time increases that would occur under Alternatives 1A-9.  
 24 However, the expected residence time changes under Alternatives 1A-9, compared to Existing  
 25 Conditions and the No Action Alternative, are in a direction and of magnitude that could lead to an  
 26 increase in Delta *Microcystis* blooms.

27 Climate change projected for the future is expected to cause an increase in average Delta water  
 28 temperatures during the summer and early fall period of the year. Increased water temperatures  
 29 could lead to earlier attainment of the water temperature threshold of 19°C required to initiate  
 30 *Microcystis* bloom formation in the Delta, and thus earlier occurrences of *Microcystis* blooms, relative  
 31 to Existing Conditions. Warmer water temperatures could also increase bloom duration and  
 32 magnitude, relative to Existing Conditions. Nevertheless, it should be noted that projected Delta  
 33 water temperature increases are would be due entirely to climate change, and are not due to the  
 34 implementation of Alternatives 1A-9. Because climate change is assumed under the No Action  
 35 Alternative, potential water temperature-driven increases in *Microcystis* blooms in the Delta,  
 36 relative to Existing Conditions, also would occur under the No Action Alternative. Therefore, no  
 37 water temperature-driven increases in *Microcystis* blooms would occur in the Delta under  
 38 Alternatives 1A-9, relative to the No Action Alternative.

39 Water diverted from the Sacramento River in the North Delta is expected to be unaffected by  
 40 *Microcystis* and microcystins. However, the fraction of water flowing through the Delta that reaches  
 41 the existing south Delta intakes is expected to be influenced by an increase in the frequency,  
 42 magnitude, and geographic extent of *Microcystis* blooms as discussed above. Therefore, relative to  
 43 Existing Conditions and the No Action Alternative, the addition of Sacramento River water from the  
 44 North Delta under Alternatives 1A-9 serves to dilute *Microcystis* and microcystins in water diverted  
 45 from the South Delta with water that is not expected to contain them. Because the degree to which



1 Microcystis blooms, and thus microcystins concentrations, will increase in source water from the  
 2 South Delta is unknown, it cannot be determined whether Alternatives 1A-9 will result in increased  
 3 or decreased levels of microcystins in the mixture of source waters exported from Banks and Jones  
 4 pumping plants, relative to Existing Conditions and the No Action Alternative.

5 Implementation of Alternatives 1A-9 (including CM2 and CM4) would contribute substantially to the  
 6 adverse cumulative condition for Microcystis through their effects on residence time. Conversely,  
 7 because projected Delta water temperature increases are due entirely to climate change, and are not  
 8 due to the implementation of Alternatives 1A-9, implementation of Alternatives 1A-9 would not  
 9 contribute substantially to the adverse cumulative condition for Microcystis via changes to Delta  
 10 water temperature.

### 11 **Selenium**

12 The lower San Joaquin River and the western Delta are listed as impaired in accordance with section  
 13 303(d) of the Clean Water Act for exceeding selenium water quality objectives or bioaccumulation in  
 14 biota. The San Joaquin River impairment is listed as extending from the Mud Slough confluence to  
 15 the Airport Way Bridge near Vernalis, a reach distance of about 43 river miles. Selenium occurs  
 16 naturally throughout the lower San Joaquin River watershed, with elevated concentrations of  
 17 selenium occurring in the shallow groundwater within the Grassland Watershed. Subsurface  
 18 agricultural drainage discharges from this area are the major source of selenium to the San Joaquin  
 19 River and Delta. Load allocations for agricultural subsurface drainage discharges from the Grassland  
 20 Drainage Area have been developed through completion of the lower San Joaquin River selenium  
 21 TMDL and the Grassland Bypass Project. The Grassland Bypass Project prevents discharge of  
 22 subsurface agricultural drainage water into wildlife refuges and wetlands. The Grassland Area  
 23 Farmers have been successful in meeting TMDL wasteload allocations and continue to utilize and  
 24 expand the San Joaquin River Water Quality Improvement Project. Moreover, the Grassland Area  
 25 Farmers continue to work closely with the Central Valley Water Board and U.S. Bureau of  
 26 Reclamation to further develop and improve their drainage solutions for the Grassland Drainage  
 27 Area. Despite these improvements in reducing selenium loading to the San Joaquin River and Delta,  
 28 it is anticipated that the cumulative condition for selenium in the lower San Joaquin River and Delta  
 29 will remain adverse.

30 Facilities operations and maintenance (CM1) of Alternatives 1A-5 would not be expected to  
 31 substantially alter the cumulative condition for selenium and selenium impairment in the Delta.  
 32 Modeled selenium concentrations in sturgeon in the western Delta, in the San Joaquin River at  
 33 Antioch and the Sacramento River at Mallard Island, would increase ~~and~~ under Alternatives 6A-9 by  
 34 1720-2342%, which may represent a measurable increase in the environment. These increases  
 35 would contribute to low toxicity benchmarks being exceeded on average, in all years, and to high  
 36 toxicity benchmarks being approached or exceeded during drought years. Because both low and  
 37 high toxicity benchmarks are already exceeded under the No Action Alternative, these increases  
 38 would further degrade water quality by measurable levels, on a long-term basis, for selenium and,  
 39 thus, cause the CWA Section 303(d)-listed impairment of beneficial uses to be made discernibly  
 40 worse. These potentially measurable increases would contribute substantially to the adverse  
 41 cumulative condition for selenium in the Delta. Under Alternative 9, modeled selenium  
 42 concentrations in water would increase at Rock Slough, Franks Tract, and Contra Costa PP,  
 43 decreasing the available assimilative capacity by more than 10 percent at each of those locations;  
 44 consequently, selenium concentrations in whole-body fish and in bird eggs (invertebrate and fish  
 45 diets) at those locations would increase so that Level of Concern benchmarks for biota would be

1 ~~exceeded at Rock Slough and Contra Costa PP (and approach exceedance at Franks Tract). The~~  
 2 ~~greater level of selenium bioaccumulation in the vicinities of Rock Slough and Contra Costa PP~~  
 3 ~~would further degrade water quality by measurable levels, on a long term basis, for selenium and,~~  
 4 ~~thus, cause the 303(d) listed impairment of beneficial use to be made discernibly worse.~~ However,  
 5 the greater Sacramento River flow fraction at the south Delta pumps under all alternatives would be  
 6 expected to result in reduced selenium concentrations in the SWP/CVP Export Service Areas and  
 7 thus would not contribute to the adverse cumulative condition. Implementation of CM4 (tidal  
 8 wetland habitat), CM5 (floodplain habitat), and CM10 (freshwater marsh habitat) could create  
 9 conditions resulting in increased flow residence time at the restored Delta locations, which could  
 10 increase biotic exposure to and uptake of selenium, potentially resulting in increased selenium  
 11 bioaccumulation in fish tissues. The potential for increased biotic exposure in and near these  
 12 restored wetland habitats would contribute substantially to the adverse cumulative condition for  
 13 selenium in the Delta. However, Environmental Commitment: Selenium Management (AMM27),  
 14 which affords for site-specific measures to reduce effects, would be available to reduce BDCP-  
 15 related effects associated with selenium.

16 **NEPA Effects:** The cumulative water quality conditions are considered to be adverse for bromide,  
 17 chloride, electrical conductivity, mercury, *Microcystis blooms*, organic carbon, pesticides and  
 18 herbicides, and selenium in areas of the Delta, and thus may adversely affect beneficial uses of the  
 19 Delta such as domestic, agricultural, municipal and industrial water supply and recreation, aesthetic,  
 20 and fish and wildlife resources. The implementation of BDCP Alternatives 1A–9 would contribute  
 21 substantially to these adverse cumulative water quality conditions. With respect to bromide,  
 22 chloride, and electrical conductivity, implementation of Alternatives 1A–9 would improve water  
 23 quality conditions for these constituents at the Banks and Jones pumping plants in the south Delta  
 24 and thus in the SWP/CVP Export Service Areas. Mitigation measures (described below) and  
 25 environmental commitments have been developed to mitigate the alternatives' contributions to the  
 26 adverse cumulative water quality conditions elsewhere in the Delta for bromide (WQ-5), chloride  
 27 (WQ-7), electrical conductivity (WQ-11), mercury (see mitigation measure below), *Microcystis*  
 28 *blooms (WQ-32a and WQ-32b )*, organic carbon (WQ-17 and WQ-18), pesticides and herbicides  
 29 (WQ-21 and WQ-22) and selenium (Environmental Commitment: Selenium Management (AMM27)).

30 **CEQA Conclusion:** The cumulative Delta water quality conditions are anticipated to be significant for  
 31 bromide, chloride, electrical conductivity, mercury, *Microcystis blooms*, organic carbon, pesticides  
 32 and herbicides, and selenium.

33 The incremental effects of Alternatives 1A–9 would be cumulatively considerable with respect to  
 34 significant cumulative bromide, chloride, *Microcystis*, and electrical conductivity conditions at  
 35 various western and interior Delta locations. However, implementation of Alternatives 1A-9 would  
 36 not contribute considerably, and would, in fact, improve conditions for these constituents (except  
 37 *Microcystis*) at the Banks and Jones pumping plants in the south Delta and thus in the SWP/CVP  
 38 Export Service Areas. It cannot be determined whether Alternatives 1A--9 will result in increased or  
 39 decreased levels of microcystins in the mixture of source waters exported from Banks and Jones  
 40 pumping plants, relative to Existing Conditions.

41 Implementation of WQ-5 may reduce impacts on bromide relative to municipal and industrial  
 42 beneficial uses in Barker Slough, but it is not known whether actions to reduce this impact under the  
 43 mitigation measures are feasible. Implementation of Mitigation Measures WQ-7a, WQ-7b, WQ-11a,  
 44 and WQ-11b may reduce impacts on chloride relative to municipal and industrial beneficial uses and  
 45 EC relative to agricultural beneficial uses in the western Delta, but it is not known whether actions

1 to reduce this impact under the mitigation measures are feasible. Implementation of Mitigation  
 2 measure WQ-11c may reduce potential impacts of EC on fish and wildlife beneficial uses in the  
 3 interior Delta, but it is not known whether actions to reduce this impact under the mitigation  
 4 measure are feasible. Thus, for these impacts, the contribution to the adverse cumulative condition  
 5 is expected to remain significant. Implementation of Mitigation Measure WQ-7d and WQ-11d is  
 6 expected to reduce the contribution of impacts on chloride and EC water quality degradation in  
 7 Suisun Marsh to a less than significant level. Implementation of WQ-32 may reduce potential  
 8 impacts on Microcystis in the Delta, but it is not known whether actions to reduce this impact under  
 9 the mitigation measure are feasible; thus, the contribution to the adverse cumulative condition is  
 10 expected to remain significant.

11 Regarding mercury and selenium, facilities operations and maintenance (CM1) would not be  
 12 expected to contribute considerably to the significant cumulative mercury and selenium conditions  
 13 in the Delta for Alternatives 1A--5, but would be expected to contribute to these conditions for  
 14 Alternatives 6--9. (with the exception of Alternative 8 for mercury and Alternative 9 for selenium),  
 15 but iImplementation of CM4, CM5, and CM10 would be expected to contribute considerably to  
 16 certain localized areas (i.e., near where the wetland restoration areas are planned) within the Delta  
 17 through the potential for increased mercury methylation and selenium bioaccumulation in these  
 18 restored wetland habitats. Although CM12 is designed to reduce these effects for mercury, it is not  
 19 known if these actions would be feasible and could effectively reduce the incremental contribution  
 20 to the adverse cumulative condition to a less than significant level. However, with implementation  
 21 of Environmental Commitment: Selenium Management (AMM27), which affords for site-specific  
 22 measures to reduce effects, the incremental effects of ~~BDCP of these CMs on selenium~~ would not be  
 23 expected to be cumulatively considerable. Likewise, CM2 would create greater localized source  
 24 loading of methylmercury to Delta waters, to the degree that the Yolo Bypass is inundated more  
 25 frequently and/or to a greater geographic extent under the alternatives, relative to the existing  
 26 condition. Conversely, CM2 is not expected to contribute considerably to future Delta selenium  
 27 levels and thus would not be expected to affect future bioaccumulation of selenium in Delta fish  
 28 tissues.

29 For organic carbon, implementation of facilities operations and maintenance (CM1) for Alternatives  
 30 6A-9 would contribute considerably to the significant cumulative organic carbon condition in the  
 31 Delta, but Alternatives 1A-C, 2A-C, and 3-5 would not contribute considerably to this cumulative  
 32 condition. Conservation Measures 4, 5, and 10, through the ability of these new wetlands to load  
 33 additional organic carbon to Delta waters, would contribute considerably to the significant adverse  
 34 cumulative organic carbon condition in the Delta. In addition, CM2 would create greater localized  
 35 source loading of DOC to Delta waters for all alternatives, to the degree that the Yolo Bypass is  
 36 inundated more frequently and/or to a greater geographic extent under the alternatives, relative to  
 37 the existing condition. Implementation of Mitigation Measure WQ-17 and WQ-18 may reduce these  
 38 contributions, but it is unknown whether these actions would be feasible and would effectively  
 39 reduce the incremental contribution to the adverse cumulative condition to a less than significant  
 40 level. These cumulative effects are not expected to extend to the south Delta pumps or the SWP/CVP  
 41 Export Service Areas, ~~but to the extent that they do, the mitigation measure proposed also would~~  
 42 ~~address such effects.~~

43 Implementation of facilities operations and maintenance (CM1) for Alternatives ~~2A-C and 4~~6-9  
 44 would contribute considerably to the adverse cumulative pesticide and herbicide condition in the  
 45 Delta, but Alternatives ~~1A-C and 3-1-5~~would not contribute considerably to this significant  
 46 cumulative condition. Also, implementation of CM13 (nonnative aquatic vegetation control) is the

1 only conservation measure identified that would contribute considerably to the cumulative  
 2 pesticide and herbicide condition in the Delta. However, with implementation of Mitigation Measure  
 3 WQ-22, the contribution to the cumulative condition of CM13 is expected to be less than significant.  
 4 The cumulative effects for pesticides and herbicides are not expected to extend to the SWP/CVP  
 5 Export Service Areas due to the increases in Sacramento River source fraction at Banks and Jones  
 6 pumping plants under all alternatives and its generally lower levels of pesticides relative to the San  
 7 Joaquin River source water.

## 8 **Mitigation Measures:**

9 The following conservation measures, mitigation measures, and environmental commitments have  
 10 been developed to mitigate the alternatives' contributions to the adverse cumulative water quality  
 11 conditions described above: for bromide (WQ-5), chloride (WQ-7), electrical conductivity (WQ-11),  
 12 mercury (~~see mitigation measure below~~ Conservation Measure 12), organic carbon (WQ-17 and WQ-  
 13 18), pesticides and herbicides (~~WQ-21 and~~ WQ-22) and selenium (Environmental Commitment:  
 14 Selenium Management (AMM27)).

15 ~~To mitigate the alternatives' contribution to adverse mercury effects, implementation of~~  
 16 ~~conservation measures (CM 2CM2, CM4, CM5, and CM10) associated with wetland/floodplain~~  
 17 ~~habitat shall conform to the relevant requirements of the Delta Mercury Control Strategy of the~~  
 18 ~~Central Valley Water Board Basin Plan. Requirements of the Delta Mercury Control Strategy include~~  
 19 ~~the following:~~

- 20 ~~● Required participation in efforts to evaluate and minimize health risk associated with eating~~  
 21 ~~mercury contaminated fish.~~
- 22 ~~● Required participation in monitoring methylmercury loading from wetlands.~~
- 23 ~~● Implementation of appropriate and site-specific methylmercury control measures.~~

24 ~~It is anticipated that these same, or similar, measures can be utilized to address and mitigate~~  
 25 ~~wetland-related bioaccumulation issues for selenium, as well.~~

26 ~~Appropriate mercury and methylmercury selenium control measures shall be developed at the time~~  
 27 ~~of formal restoration planning and design. All practicable measures (i.e., those that are both feasible~~  
 28 ~~and reasonable from a cost-benefit perspective) to reduce methylmercury formation shall be~~  
 29 ~~considered for implementation. Appropriate strategies and control measures may include the~~  
 30 ~~following:~~

- 31 ~~● Conservation measure design features, such as use of seasonal inundation periods, hydraulic~~  
 32 ~~residence time, sediment basins and vegetation traps to control mercury inputs and exports,~~  
 33 ~~inundation depths and related vegetation type and density selection so as to control oxidation-~~  
 34 ~~reduction conditions.~~
- 35 ~~● Appropriate consideration of conservation measure location, preferably not in the direct path of~~  
 36 ~~large mercury loading sources such as the Sacramento River, Yolo Bypass, Cosumnes River, or~~  
 37 ~~San Joaquin River.~~
- 38 ~~● Prioritization of conservation measures that minimize trophic level transfer of mercury through~~  
 39 ~~active or passive operation and maintenance controls, such as targeted control and/or removal~~  
 40 ~~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

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## 11 **8.4.2 Personal Communications**

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