Chapter 8
Water Quality

8.1 Readers' Guide

Chapter 8, *Water Quality,* describes the environmental setting and potential impacts of the BDCP on water quality in and upstream of the Sacramento-San Joaquin Delta. The chapter provides the results of the evaluation of the effects of implementing the BDCP conservation measures on water quality constituents under a no action alternative and 15 different project alternatives. This guide is intended to help the reader understand the organization of the chapter and the impact analysis of the constituent of interest.

8.1.1 Overview

Chapter 8 is organized much like the other chapters in this document, but because of the chapter's greater scope, this guide is provided to help the reader navigate through the various components of the chapter.

The chapter is divided into three main sections.

- 8.1 *Environmental Setting/Affected Environment*
- 8.2 *Regulatory Setting*
- 8.3 *Environmental Consequences*

These sections parallel the same sections in other resource chapters.

8.1.2 Environmental Setting/Affected Environment

The first part of the chapter is the Environmental Setting and Affected Environment section. This section provides a general description of the existing environment, including the following:

- Overview of the Sacramento and San Joaquin River Watersheds
- Water Management and the State Water Project and Central Valley Project Systems
- Primary Factors Affecting Water Quality
- Beneficial Uses
- Water Quality Objectives and Criteria
- Water Quality Impairments
- Water Quality Constituents of Concern
- Selection of Monitoring Stations for Characterization of Water Quality
- Existing Surface Water Quality—this characterization is meant to provide a general understanding of water quality conditions and historical monitoring data in the study area. The discussion is not meant to explicitly define the Existing Conditions for CEQA purposes. The CEQA baseline, *Existing Conditions*, is defined in Appendix 3D and for the purposes of

quantitative water quality assessments (as described in Section 8.3.4, *Effects and Mitigation Approaches*) is represented by Existing Conditions modeling runs, not historical water quality monitoring data as presented in this section.

8.1.3 Regulatory Setting

Numerous federal, state and local acts, rules, plans, policies, and programs define the framework for regulating water quality in California. The second part of the chapter, Regulatory Setting, describes water quality requirements that are applicable to the BDCP.

8.1.4 Environmental Consequences

The third part of the chapter describes the anticipated environmental consequences of the no action alternative and each of the 15 action alternatives. This part of the chapter is divided into four sections. The first two sections (Sections 8.3.1 and 8.3.2) provide an important foundation for the analysis of the environmental effects. The third section contains the analysis of each alternative's impacts as well as associated environmental commitments and mitigation measures that would be implemented to reduce those impacts. The final section discusses cumulative effects. The four sections are as follows:

- Methods of Analysis (Section 8.3.1), which presents information on models used and their linkages, methods specific to three different regions of the affected environment (Upstream of the Delta, Plan Area/Delta, and SWP/CVP Export Service Area), mercury and selenium bioaccumulation models, and constituent-specific considerations used in the assessment. The constituent-specific considerations used in the assessment section specifically identifies the water quality criteria/objectives used in the assessments and other methodological details specific to each constituent.
- Determination of Adverse Effects (Section 8.3.2), which describes results of the constituent screening analysis, a description of the comparisons made in the Effects and Mitigation Approaches section, and the criteria for determining if an impact is adverse and/or significant.
- Effects and Mitigation Approaches (Section 8.3.3), which provides a full discussion by alternative (no action alternative and 15 project alternatives) of impacts and mitigation approaches of the BDCP conservation measures on water quality constituents. ***Important information about the organization of the Effects and Mitigation Approaches section is provided below***.
- Cumulative Analysis (Section 8.3.4) addresses the potential for the BDCP alternatives to act in combination with other past, present, and probable future projects or programs to create a cumulatively significant adverse impact.

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

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

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

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

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

The BDCP conservation measures (see Table 3.3 Summary of Proposed BDCP Conservation Measures of All Action Alternatives in Chapter 3, *Description of Alternatives*) that are analyzed for each water quality constituent under each alternative are treated in two distinct categories for purposes of impact analysis. Those categories are as follows:

- Potential impacts resulting from water operations and maintenance of Conservation Measure 1 (Conservation Measure 1 provides for the development and operation of a new water conveyance infrastructure and the establishment of operational parameters associated with both existing and new facilities). For the purposes of the assessment, the study area was divided into the three regions which are discussed separately for each constituent for Conservation Measure 1:
    - Upstream of the Delta (including the Sacramento and San Joaquin River watersheds).

   - Plan Area, including the Yolo Bypass, SWP North Bay Aqueduct service area, and Suisun Marsh.
   - SWP/CVP Export Service Area (south of the Delta, areas served by the California Aqueduct, Delta Mendota Canal, and South Bay Aqueduct).
- Potential impacts resulting from other conservation measures, Conservation Measures 2-22 (these include habitat restoration measures that provide for the protection, enhancement and restoration of habitats and natural communities and measures to reduce the direct and indirect adverse effects of other stressors on covered species).

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

After the discussion for each water quality constituent, construction-related water quality effects are discussed. As opposed to discussing construction-related water quality effects for each water quality constituent within the constituent-specific assessments described above, construction-related water quality effects on all constituents are discussed in a single section for all Conservation Measures 1–22. Within each alternative discussion section, the impacts of the BDCP conservation measures are analyzed in the following order:

- Ammonia
- Boron
- Bromide
- Chloride
- Dissolved Oxygen
- Electrical Conductivity
- Mercury
- Nitrate
- Organic Carbon
- Pathogens
- Pesticides and Herbicides
- Phosphorus
- Selenium
- Trace Metals
- TSS and Turbidity

- Construction-related Activities

8.1.6 NEPA and CEQA Impact Conclusions

The analysis in Chapter 8 has been prepared in accordance with NEPA and CEQA. Each impact is presented as a NEPA analysis, using the appropriate terminology for presence or absence of adverse effects. This analysis is followed by a CEQA conclusion, which is identified as such. The CEQA conclusion uses the terminology appropriate to describing the presence or absence of significant impacts.

In some instances, the NEPA and CEQA discussions differ for a particular impact discussion because NEPA and CEQA have different points of comparison (or "baselines" in CEQA terms). The NEPA point of comparison for each alternative is based on the comparison of the action alternative (Alternatives 1A through 9) at 2060, with the no action alternative which supposes conditions at 2060 in the absence of the proposed project. The CEQA baseline is based on the comparison of the action alternative (Alternatives 1A through 9) at 2060 with existing conditions. Consistent with this, the NEPA point of comparison accounts for anticipated climate change conditions at 2060, whereas the CEQA baseline is assumed to occur during existing climate conditions. Therefore, differences in model outputs between the CEQA baseline and the action alternative (Alternatives 1A through 9) are due primarily to both the impacts of proposed alternative as well as future climate change conditions (sea level rise and altered precipitation patterns).

8.2 Environmental Setting/Affected Environment

This section defines the environmental setting/affected environment for surface water quality, reviews the environmental and regulatory setting with respect to water quality, and provides an assessment of existing water quality conditions in the study area (the area in which impacts may occur), shown in Figure 1-4, which includes the Plan Area (the area covered by the BDCP), upstream of the Delta, and the State Water Project/Central Valley Project (SWP/CVP) Export Service Areas. Water quality conditions refer to the chemical and physical properties of the surface water in the study area.

Conveying, using, and disposing of water occurs in association with domestic, industrial, and agricultural uses. Natural and anthropogenic contaminants, or *constituents of concern*, can enter Delta waters from various point and nonpoint sources. Point sources are any discernible, confined and discrete conveyance, including any pipe, ditch, channel, tunnel, conduit, or well from which pollutants (constituents of concern) are or may be discharged (Clean Water Act [CWA], Section 502[14]), and include treated water from industrial and municipal facilities, or points of agricultural discharge. The term *nonpoint source* is defined to mean any source of water pollution that does not meet the legal definition of *point source* in Section 502(14) of the CWA and includes urban and irrigation runoff. In the case of nonpoint sources, constituents of concern may enter receiving waters at multiple discrete and diffuse points throughout a watershed (i.e., not traceable to a single point). Daily tidal action has a major water quality influence from the high salinity of the Pacific Ocean and specific salinity constituents (e.g., sodium, potassium, chloride transported inland to the Delta through the San Francisco Bay.

Temperature, pH, dissolved oxygen (DO), nutrients, and concentrations of other various constituents such as methylmercury and total organic carbon (TOC) can be affected by tidal marsh and floodplain habitats, especially when marsh waters are exchanged with other Delta waters both upstream and downstream of the tidal marsh/floodplain habitats. Because the primary concern of water temperature is effects on fish and aquatic organisms, temperature is addressed in Chapter 11, *Fish and Aquatic Resources.*

8.2.1 Affected Environment

For the purposes of characterizing the existing water quality conditions and evaluating the consequences of implementing the BDCP alternatives on surface water quality, the affected environment is defined as anywhere an effect could occur, which includes but is not necessarily limited to the statutory Delta, Suisun Bay and Marsh, and areas to the north and south of the Delta, which are defined in various parts of this chapter as Upstream of the Delta and the SWP/CVP Export Service Areas, as shown in Figure 1-4. When compared to the watershed boundaries, it is noted that the affected environment falls primarily within the Sacramento and San Joaquin River watersheds.

This section identifies the watershed factors that affect water quality, the water quality standards applicable to the affected environment, and the known impairments (i.e., CWA Section 303[d], the primary constituents of concern in these areas, the regulatory framework, and the key water quality monitoring stations). Finally, water quality data from selected monitoring stations were reviewed for specific constituents in Section 8.1.3.

Because of the very distinct hydrologic and hydraulic characteristics (including the various inflow/outflow conditions) and specific operational details, the water quality in the Delta is described separately from the northern and southern parts of the study area. The Delta environment is much more complex and dynamic than the rest of the study area and requires a more detailed approach. Hence, the water quality conditions in the Delta were reviewed at a greater level of detail.

To characterize the existing water quality conditions in the Delta, it is important to evaluate the water quality of the primary inflows to and outflows from the Delta. Consequently, the water quality data compiled and described in this section include monitoring data from the three major rivers in the north (Sacramento, Feather, and American Rivers), the tributaries from the east (Cosumnes, Mokelumne, and Calaveras Rivers), the San Joaquin River from the south (including its major tributaries), San Francisco Bay water from the west, and agricultural runoff in the Delta. It also is important to characterize water quality at points where water is pumped out of the Delta (e.g., Harvey O. Banks Pumping Plant [Banks pumping plant], C. W. "Bill" Jones Pumping Plant (Jones pumping plant), Contra Costa Water District [CCWD] Pumping Plant #1 (CCWD pumping plant #1), North Bay Aqueduct Pumping Plant), and in areas south of the Delta where exported water is conveyed and stored. Examples of the latter include the Delta-Mendota Canal, the California Aqueduct, and San Luis Reservoir. Similarly, net outflow from the Delta occurs into Suisun Bay at Mallard Island, which is on the western boundary of the Delta and is the approximate boundary between limnetic (salinity of 0–0.5 parts per thousand [ppt]) and oligohaline (salinity of 0.5–5 ppt) areas during median flow conditions (Jassby 2008:4).

8.2.1.1 Organization of the Section

The following sections (Sections 8.1.1.2 through 8.1.3.17) describe the Existing Conditions in the study area with respect to surface water quality and are organized in the following sequence.

- **Overview of the Sacramento and San Joaquin River Watersheds—**Brief overview of the watersheds and the Delta environment; location, physical description, and characteristics of the watersheds; climate; and hydrology.
- **Water Management and the State Water Project and Central Valley Project Systems—**Brief overview of the SWP and CVP, their key features, and the complex hydrodynamics of the study area.
- **Primary Factors Affecting Water Quality**—Brief discussion and listing of point and nonpoint pollutant sources, including historical and recent drainage from inactive and abandoned mines, industrial and municipal water treatment plant (WTP) discharges, agricultural and urban storm water runoff, recreational uses, and wildlife.
- **Beneficial Uses**—Brief overview of the designated beneficial uses in the study area, as defined in the Regional Water Quality Control Boards' (Regional Water Boards') water quality control plans (WQCPs or Basin Plans).
- **Water Quality Objectives and Criteria**—Brief discussion of regulatory water quality standards as described in the California Toxics Rule (CTR), water quality control plans, and California drinking water standards.
- **Water Quality Impairments**—Description of Section 303(d) list of impaired water bodies in the study area, existing Total Maximum Daily Loads (TMDLs), and descriptions of major ongoing water quality monitoring programs.
- **Water Quality Constituents of Concern**—Rationale for selecting specific water quality constituents of concern that are important to maintaining the water quality in the study area, and discussion of sensitive receptors affected by water quality.
- **Selection of Monitoring Stations for Characterization of Water Quality**—Brief description of the data sources, selection of monitoring stations to be analyzed, and data availability at the selected locations.
- **Regulatory Setting—**Brief description of federal, state, and regional/local regulatory agencies and the applicable guidance related to surface water quality.

Section 8.1.2, *Selection of Monitoring Stations for Characterization of Water Quality*, includes detailed discussions of the selected water quality constituents of concern in the study area. For each constituent, the discussion is organized by: (1) background information available in the literature; (2) importance of the constituent in the study area, including its potential effects on other resources; (3) Existing Conditions, including concentrations at various monitoring locations; and (4) spatial and temporal trends.

8.2.1.2 Overview of the Sacramento River and San Joaquin River Watersheds

Geographic Location and Physical Description

The Delta watershed includes the watersheds of the Sacramento and San Joaquin Rivers, the two largest rivers in the state. Together, the watersheds make up roughly one third of the state's land area. These rivers originate in the Coast Range, Cascade Range, and Sierra Nevada and flow through the Central Valley before entering the Delta. Following is a brief overview of watershed characteristics of the study area; for additional detailed discussion, refer to Chapter 5, *Water Supply*, and Chapter 6, *Surface Water*.

The Delta is a complex system of stream channels, sloughs, marshes, canals, and islands in northern-central California at the confluence of the Sacramento and San Joaquin Rivers. The Delta covers 738,000 acres, which includes 59 islands, 1,100 linear miles of levees, hundreds of thousands of acres of farmland, and various habitat types (California Department of Water Resources 1993:91). The Delta lands and waterways support communities, agriculture, and recreation while providing essential habitat for a multitude of fish and wildlife species.

Delta inflow consists of runoff from the Sacramento River watershed, the San Joaquin River watershed, and the eastside tributaries (Cosumnes, Mokelumne, and Calaveras Rivers). Long-term average annual Delta inflow is approximately 22 million acre-feet (MAF), with a range of less than 8 MAF to more than 74 MAF (CALFED Bay-Delta Program 2000). Dry and critical year Delta inflow averages about 12 MAF annually under Existing Conditions (CALFED Bay-Delta Program 2000). As a contributor to the state's agricultural irrigation system and a major source of drinking water for two thirds of California's population, the Delta is a critical component of the state's water supply infrastructure.

Area Climate, Hydrology, and Watershed Characteristics

Sacramento River Watershed

The Sacramento River watershed drains the northern part of California's Central Valley. The Sacramento River, California's longest river, is approximately 447 miles long and drains approximately 27,000 square miles of land. Predominant land uses in the Sacramento River watershed are agriculture, natural (undeveloped), and urban areas. The major Sacramento River watershed drainages are the upper Sacramento, Feather, Yuba, and American Rivers (Figure 8-1).

The climate in the Sacramento River watershed is mediterranean in character, typified by cool, wet winters and warm, dry summers. Daily high air temperatures in the Sacramento Valley range from around 45 degrees Fahrenheit (°F) in the winter to over 100°F in the summer. Average air temperatures in the mountainous regions of the watershed are typically 5–10° less than the temperature on the valley floor. Annual precipitation in the Sacramento River watershed ranges from 80 to 90 inches of primarily snowfall in the mountainous regions, to 41 inches of rain in Redding and 19 inches in Sacramento. Average annual precipitation for the entire watershed is approximately 36 inches. Most precipitation falls between November and April, with little or no precipitation falling between May and October (CALFED Bay-Delta Program 2000).

The majority of the runoff in the Sacramento River watershed is in the upper Sacramento River watershed and in the rivers flowing out of the western slope of the Sierra Nevada. Numerous reservoirs are located in the Sacramento River watershed. The major reservoirs in the Sacramento River watershed are Shasta Lake, Lake Oroville, and Folsom Lake. Trinity Lake lies in the coastal watershed, and water is diverted from it to the Sacramento River watershed. Total reservoir capacity in the Sacramento River watershed, including Trinity Lake, is approximately 16 MAF (California Department of Water Resources 2005).

An important characteristic of the Sacramento River watershed is that precipitation patterns are highly variable from year to year and within years. Figure 8-2 illustrates the precipitation pattern in the Sacramento Valley for water years between 1977 and 2008. Surface water supply is measured by water year. A *water year* is defined as the 12-month period of October 1 through September 30 of the following year. The water year is designated by the calendar year in which it ends (e.g., the year ending September 30, 2010, is called the *2010 water year*). The Sacramento River Index is a yardstick of northern California water supply or water availability from the Sacramento River watershed. The index is used to project the current water-year type and is based partially on the previous year's index and on the sum of the unimpaired runoff (in MAF) of four rivers: Sacramento River above Bend Bridge near Red Bluff, Feather River inflow to Lake Oroville, Yuba–River at Smartville, and American River inflow to Folsom Lake. Unimpaired runoff is an estimate of the runoff that would occur in a watershed if unaltered by upstream diversions, storage, or export/import of water to/from other watersheds. Based on the unimpaired runoff, the water year–type classifications are defined as follows.

- Wet: equal to or greater than 9.2 MAF.
- Above normal: greater than 7.8 and less than 9.2 MAF.
- Below normal: greater than 6.5 and less than or equal to 7.8 MAF.
- Dry: greater than 5.4 and less than or equal to 6.5 MAF.
- Critical: equal to or less than 5.4 MAF.

Relative water availability from the watershed is greatest in wet years and lowest in critical years. In the water years between 1977 and 2008, 10 years were wet (31%), six years were above normal (19%), two years were below normal (6%), seven years were dry (22%), and seven years were critical (22%), as shown in Figure 8-2.

San Joaquin River Watershed

The San Joaquin River watershed drains the southern part of the Central Valley. The San Joaquin River, California's second longest river, is approximately 330 miles long and drains approximately 15,200 square miles of land. Similar to the Sacramento River watershed, predominant land uses in the San Joaquin River watershed consist of agriculture, natural (undeveloped), and urban areas. The main San Joaquin River watershed drainages are the upper San Joaquin, Merced, Tuolumne, and Stanislaus Rivers (Figure 8-1).

The climate in the San Joaquin River watershed is similar to the Sacramento River watershed but is generally warmer and drier. Air temperatures in the city of Fresno range from 37°F in the winter to over 100°F in the summer. Annual precipitation in the San Joaquin Valley ranges from 8 to 12 inches of rain.

The warmer and drier conditions in the San Joaquin River watershed result in considerably less runoff compared to the Sacramento River watershed. The annual unimpaired runoff of the San Joaquin River watershed is approximately 5.5 MAF, with 60% of runoff occurring on the Merced, Tuolumne, and Stanislaus Rivers. Of the 5.5 MAF total unimpaired runoff, losses account for approximately 2.5 MAF via diversions for agricultural or municipal water supply, or losses to evaporative and groundwater infiltration, and 3 MAF flows into the Delta, past Vernalis (CALFED Bay-Delta Program 2000). Major reservoirs and impoundments in the San Joaquin River watershed are New Melones Lake, Hetch Hetchy, New Don Pedro Lake, Lake McClure, and Millerton Lake. Total reservoir capacity in the San Joaquin River watershed is approximately 11 MAF (California Department of Water Resources 2005). Figure 8-3 illustrates the highly variable precipitation pattern in the San Joaquin Valley for water years between 1977 and 2008. The water year–type classification used in Figure 8-3 is determined based partially on the previous year's index and on the sum of unimpaired flow (in MAF) at Stanislaus River below Goodwin Reservoir (inflow to New Melones Lake), Tuolumne River below LaGrange (inflow to New Don Pedro Lake), Merced River below Merced Falls (inflow to Lake McClure), and San Joaquin River inflow to Millerton Lake. The water year–type classifications are defined as follows.

- Wet: equal to or greater than 3.8 MAF.
- Above normal: greater than 3.1 and less than 3.8 MAF.
- Below normal: greater than 2.5 and equal to or less than 3.1 MAF.
- Dry: greater than 2.1 and equal to or less than 2.5 MAF.
- Critical: equal to or less than 2.1 MAF.

In the water years between 1977 and 2008, 12 years were wet (37%), four years were above normal (13%), one year was below normal (3%), five years were dry (16%), and 10 years were critical (31%), as shown in Figure 8-3.

East Side Tributaries Watersheds

The east side tributaries to the Delta include the Cosumnes, Mokelumne, and Calaveras Rivers. All three rivers drain the west slope of the Sierra Nevada. The Cosumnes River is approximately 50 miles long, drains approximately 725 square miles, and is the only river draining the west slope of the Sierra Nevada without a major dam. The Cosumnes River empties into the Mokelumne River just within the Delta. The Mokelumne River is approximately 95 miles long, drains approximately 2,140 square miles, and feeds both Pardee Reservoir and Camanche Reservoir. The Calaveras River is approximately 50 miles long, drains approximately 470 square miles, and feeds New Hogan Lake. The Calaveras River empties into the San Joaquin River north of Stockton. The climate and watershed characteristics of these drainages vary, but are generally similar to those described for the Sacramento and San Joaquin River watersheds above.

8.2.1.3 Water Management and the State Water Project and Central Valley Project Systems

The management of the SWP and CVP systems to meet water supply, flood management, and environmental obligations has a substantial effect on the quantity and timing of inflows to the Delta and on water quality in the study area. This section provides a brief overview of the SWP and CVP facilities and their operations. Following is a brief overview of surface water management in the study area; for additional detailed discussion, refer to Chapter 5, *Water Supply*, and Chapter 6, *Surface Water,* which provide an overview of key facilities in the SWP and CVP systems.

State Water Project

The SWP's 33 water storage facilities, 600 miles of aqueducts, and multiple pumping plants and hydroelectric plants supply water to over 25 million Californians and to approximately 700,000 acres of farmland. Depending on the water-year type (i.e., available water supply) and demands, the SWP annually delivers up to about 3.7 MAF to meet contract demands. However, in drier water-year types when supply is limited, deliveries are considerably lower with an estimated 50% delivery reliability in any given water year of less than 2.7 MAF (California Department of Water Resources 2010). The primary objectives of the SWP are water supply; flood control; power generation; recreation, fish, and wildlife protection; and water quality improvements in the Sacramento–San Joaquin Delta.

Distribution of SWP water begins with releases from Oroville Dam into the Feather River, which flows into the Sacramento River at River Mile 80 and, ultimately, to the Delta. SWP pumps water into the North Bay Aqueduct from Barker Slough in the north Delta for use in Napa and Solano Counties. In the south Delta, water also is pumped into the South Bay Aqueduct to serve areas of Alameda County and Santa Clara County, and via the Banks pumping plant into the 444-mile-long California Aqueduct (California Department of Water Resources 2009a). The California Aqueduct conveys water south primarily to meet potable water demands of SWP contractors serving Central Valley and southern California counties, and to meet agricultural demands in the San Joaquin Valley and Tulare Basin. The California Aqueduct delivers water to O'Neill Forebay and the San Luis Reservoir, a storage reservoir jointly owned by the SWP and CVP. Water is delivered to Santa Clara County and San Benito County from San Luis Reservoir via the Santa Clara and Hollister conduits. The Coastal Branch Aqueduct diverts water from the California Aqueduct to areas west in San Luis Obispo and Santa Barbara Counties. In southern California, water is delivered to the major storage reservoirs of Lake Perris, Silverwood Lake, Castaic Lake, and Lake Pyramid.

California Department of Water Resources (DWR), in its management of the SWP to supply the 29 contracting public agencies with water supply and provide flood control, additionally provide recreation opportunities, generate hydroelectric power, and protect fish and wildlife. These benefits of the SWP operations are achieved by increasing or decreasing upstream water releases, changing Delta pumping rates, or storing river flows south of the Delta at the San Luis Reservoir (Water Education Foundation 2004). During February through June, DWR reduces the ratio of water exports to inflows to reduce potential impacts on migrating salmon and spawning delta smelt, Sacramento splittail, and striped bass (Jassby et al. 1995). SWP facilities are operated to meet numerous water quality objectives, such as the X2 location objective. *X2* refers to the horizontal distance from the Golden Gate up the axis of the Delta estuary to where tidally averaged near-bottom salinity concentration of 2 parts of salt in 1,000 parts of water occurs; the X2 standard was established to improve shallow water estuarine habitat in the months of February through June and relates to the extent of salinity movement into the Delta (Jassby et al. 1995). The location of X2 is important to both aquatic life and water supply beneficial uses. Chapter 5, *Water Supply*, describes the multiple water supply, flood control, and water quality targets that are used for SWP facilities management and operations.

Central Valley Project

The CVP annually delivers approximately 7 MAF of water for agricultural, urban, and wildlife use and is the largest water storage and delivery system in California (Bureau of Reclamation 2009a; CALFED Bay-Delta Program 2000). The CVP system consists of 20 dams and reservoirs, 11 hydropower plants, 500 miles of major canals, and additional related facilities (Bureau of Reclamation 2009a).

Transfer of water through the CVP system and the Delta begins with the release of water from reservoirs located on the Trinity, Sacramento, American, and Stanislaus Rivers (Bureau of Reclamation 2009a) Water released from Trinity and Shasta Dams flows into Keswick Reservoir and then is released into the Sacramento River from Keswick Dam at River Mile 303. A portion of the river's flow is diverted into the Tehama-Colusa and Corning Canals to irrigate the western side of the Sacramento Valley (Water Education Foundation 2002). The remainder of the Trinity and Shasta releases continue flowing south in the Sacramento River, combining with CVP releases from Folsom and Nimbus Dams at the confluence of the Sacramento and American Rivers and, ultimately, flowing to the Delta in the vicinity of Freeport. The Stanislaus River releases of water from New Melones Lake serve as a water source for CVP users in the Stanislaus River watershed and in the northern San Joaquin Valley (Bureau of Reclamation 2009a).

In the Delta, the released water is used to meet D-1641 Delta outflow and water quality objectives and to support export from the Delta at the Jones pumping plant into the Delta-Mendota Canal, which conveys water south for agricultural uses in the San Joaquin Valley. Water transported in the 117-mile Delta-Mendota Canal can be used as an irrigation supply, a source of San Luis Reservoir water, for managed wetland refuges, or as a replacement for upper San Joaquin River water used in the Friant-Kern and Madera Canal systems (Bureau of Reclamation 2009a). The San Luis Reservoir is an off stream storage reservoir that is used by both SWP and CVP to provide water to Central Valley and Bay Area users (Bureau of Reclamation 2009b). The Friant-Kern and Madera Canal systems originate at Friant Dam and transport upper San Joaquin River water approximately 152 miles south to Bakersfield and approximately 36 miles to the north, respectively (Water Education Foundation 2002). Additionally, CVP's Contra Costa Canal conveys Delta water from Rock Slough. CCWD's Los Vaqueros Pipeline diverts water from Old River to the west to meet potable demands of Bay Area users served by CCWD (Bureau of Reclamation 2009a).

Reclamation operates the CVP to meet the following objectives (Bureau of Reclamation 2009a).

- Regulate rivers and improve flood management and navigation.
- Provide water for irrigation and domestic use.
- Generate power.
- Provide recreation opportunities.
- Protect fish and wildlife.
- Improve water quality.

Reclamation's operation of the CVP facilities changes seasonally based on varying management objectives. During the winter and early spring months when flood management is a priority, CVP reservoirs are operated to store winter runoff (Water Education Foundation 2002). Releases during May through October are timed to meet a variety of water supply needs, manage water quality, and create available storage capacity for flood flows (Water Education Foundation 2002).

Hydrodynamics in the Delta

Delta hydrodynamics are a product of a complex interaction of tributary inflows, tides, in-Delta diversions, and SWP and CVP operations, including conveyance, pumping plants, and operations of channel barriers and gates designed to direct tributary inflows to certain regions of the Delta. Each region is affected differently by these variables, and the nature of the effect varies daily, seasonally, and from year to year, depending on the magnitude of inflows, the tidal cycle, and the extent of pumping at the SWP and CVP pumping plants.

For example, the SWP and CVP pumping plants can affect the direction of flow of water in the Delta channels, particularly during periods of low water flow and high export quantities. Normally, net flows in the Delta travel toward Suisun and San Francisco Bays. However, SWP and CVP pumping can cause the net flows within the interior south Delta to reverse, which causes more saline water to move farther inland (Bureau of Reclamation 2009a).

The Delta Cross Channel is a controlled diversion channel that transports Sacramento River water to Snodgrass Slough and then to the Mokelumne River, where it flows into the central and south Delta. Opening the Delta Cross Channel's gates generally can reduce salinity in some channels of the central and southern Delta, particularly during the summer months, through the transport of relatively low–salinity Sacramento River water into the Delta (Bureau of Reclamation 2009a).

Flow in the Delta channels can change direction as a result of tidal exchange, ebbing and flooding with the two tides per day, which is a major factor of Delta hydrodynamics. The daily, seasonal, and year-to-year differences in source water contributions to various locations throughout the Delta affect the water quality in the Delta, particularly with regard to salinity. Figure 8-4 and Figure 8-5 show the variations in maximum intrusion of chloride into the Delta since 1921, which demonstrate that variability and intrusion distance generally have been reduced following construction of the major storage reservoirs and implementation of Delta water management facilities and operations.

8.2.1.4 Primary Factors Affecting Water Quality

Primary factors affecting water quality in the study area include patterns of land use in the upstream watersheds and the Delta; SWP and CVP operations; and in-Delta/upstream activities and sources of pollutants. Point and nonpoint pollutant sources include historical and recent drainage from inactive and abandoned mines and related debris/sediment, industrial and municipal WTP discharges, agricultural drainage, urban storm water runoff, atmospheric deposition, recreational uses, and metabolic waste (e.g., pathogens) from wildlife.

Figure 8-6 shows land uses and major point sources (consisting primarily of municipal WTPs) and nonpoint sources (e.g., urban storm water runoff) of pollutants. Natural erosion and in stream sediments, atmospheric deposition, and geothermal inputs (CALFED Bay-Delta Program 2000) also affect Delta water quality. The magnitude of the effect of each of these sources is correlated with the relative contribution from each source and can differ, for different constituents or with conditions (e.g., hydrologic and climatic), during different times of a given year. The principal contaminants and conditions affecting water quality in the Delta are as follows (CALFED Bay-Delta Program 2000).

- Historical drainage and sediment discharged from upstream mining operations in the late 1800s and early 1900s has contributed metals, such as cadmium, copper, and mercury.
- Storm water runoff can contribute metals, sediment, pathogens, organic carbon, nutrients, pesticides, dissolved solids (salts), petroleum products, oil and grease, and other chemical residues.
- Wastewater discharges from treatment plants can contribute salts, metals, trace organics, nutrients, pathogens, pesticides, organic carbon, personal care products, pharmaceuticals, and oil and grease.
- Agricultural irrigation return flows and nonpoint discharges can contribute salts (including bromide), organic carbon, nutrients, pesticides, pathogens, and sediment.
- Large dairies and feedlots can contribute nutrients, organic carbon, pathogenic organisms, hormones, and veterinary pharmaceuticals/antibiotics.

- Water-based recreational activities (such as boating) can contribute hydrocarbon compounds, nutrients, and pathogens.
- Atmospheric deposition can contribute metals, nutrients, pesticides, and other synthetic organic chemicals and may lower pH.
- Seawater intrusion can contribute salts, including bromide, which affect total dissolved solids (TDS) concentrations and can contribute to formation of unwanted chemical disinfection by-products (DBPs) in treated drinking water. Additionally, seawater can contribute sulfate, which can influence the methylation of mercury.
- Selenium can originate from the Sacramento River and San Joaquin River. Major sources of selenium include irrigation drainage from agricultural lands of the western San Joaquin Valley. Refinery wastewater discharges in North San Francisco Bay also serve as a source of selenium in the Delta.
- Organic loading from the San Joaquin River can contribute to low DO conditions in the Delta.

Both variations in watershed hydrology and SWP and CVP operations affect the variability of water quality in the study area; also both SWP/CVP and non-SWP/CVP water diversions reduce the amount of water available for dilution and assimilation of contaminant inputs and hydrodynamic conditions associated with channel flows and tidal action in the Delta. Water quality can vary seasonally in response to winter-spring runoff and summer-fall lower-flow periods or seasonal agricultural practices and cropping; water quality also can vary from year to year as a result of precipitation and snowpack levels in the upper watersheds and the resulting releases from upstream reservoirs for water supply, flood management, and environmental obligations (e.g., fish flows, Delta water quality objective compliance), operations of the Delta Cross Channel, and seasonal and annual variations in SWP and CVP pumping rates.

8.2.1.5 Beneficial Uses

Beneficial uses are designated for specific water bodies, either as existing or potential, by each Regional Water Board in their respective WQCPs or Basin Plans. Water bodies in the study area are used for many purposes as evidenced by the number of beneficial uses shown in Table 8-1. For water bodies where beneficial uses have not been identified specifically in a Basin Plan, the *tributary rule* allows a Regional Water Board to apply the designated beneficial uses that exist in the nearest downstream tributary. Established in the 1978 WQCP for the San Francisco Bay/Sacramento–San Joaquin Delta estuary (Bay-Delta WQCP), designated beneficial uses of Delta water remain unchanged in the 1991, 1996, and 2006 WQCPs. Additionally, the individual Basin Plans for the San Francisco Bay Regional Water Quality Control Board (San Francisco Bay Water Board) and Central Valley Regional Water Quality Control Board (Central Valley Water Board) identify beneficial uses of the Delta areas within their jurisdictions.

Table 8-1. Designated Beneficial Uses for Water Bodies in the Study Area

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

Name [a]	Abbreviation [a]	Beneficial Uses [a]
Migration of Aquatic Organisms	MIGR	Uses of water that support habitats necessary for migration and other temporary activities by aquatic organisms, such as anadromous fish
Spawning, Reproduction, and/or Early Development	SPWN	Uses of water that support high quality aquatic habitats suitable for reproduction and early development of fish
Shellfish Harvesting	SHELL	Uses of water that support habitats suitable for the collection of filter feeding shellfish (e.g., clams, oysters, mussels) for human consumption, commercial, or sport purposes
Additional Beneficial Uses of the Delta		
Estuarine Habitat	EST	Uses of water that support estuarine ecosystems, including preservation or enhancement of estuarine habitats, vegetation, fish, shellfish, and wildlife (e.g., estuarine mammals, waterfowl, shorebirds)
Additional Beneficial Uses of Inland Waters (not common to all Basin Plans)		
Freshwater Replenishment[b]	FRSH	Uses of water for natural or artificial maintenance of surface water quantity or quality
Hydropower Generation[c]	POW	Uses of water for hydropower generation
Aquaculture[c]	AQUA	Uses of water for aquaculture or mariculture operations, including propagation, cultivation, maintenance, and harvesting of aquatic plants and animals for human consumption or bait purposes
Inland Saline Water Habitat[d]	SAL	Uses of water that support inland saline water ecosystems, including preservation or enhancement of aquatic saline habitats, vegetation, fish, and wildlife, including invertebrates
Limited Warm Freshwater Habitat[e]	LWRM	Waters that support warm water ecosystems that are severely limited in diversity and abundance as the result of concrete-lined watercourses and low, shallow dry weather flows, which result in extreme temperature, pH, and/or DO conditions; naturally reproducing finfish populations are not expected to occur in LWRM waters

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

[b] Potential beneficial use identified in Sacramento–San Joaquin, San Francisco Bay, Central Coast, Los Angeles, and San Diego Basin Plans.

[c] Potential beneficial use identified in Sacramento–San Joaquin, Central Coast, Los Angeles, Santa Ana, and San Diego Basin Plans.

[d] Potential beneficial use identified in Central Coast, Los Angeles, and San Diego Basin Plans.

[e] Potential beneficial use identified in Santa Ana Basin Plan only.

Sources: Central Coast Regional Water Quality Control Board 2011; Central Valley Water Board 2009a; Los Angeles Regional Water Quality Control Board 1994; Santa Ana Regional Water Quality Control Board 2008; San Diego Regional Water Quality Control Board 2007; San Francisco Bay Regional Water Quality Control Board 2007; State Water Resources Control Board 2006.

There are several additional beneficial uses in the Central Valley Water Board Basin Plan that are applicable to surface waters other than the Delta in the Sacramento River basin and south of the Delta export service area. Additionally, south-of-Delta exports are conveyed to service areas of SWP contractors that lie within the jurisdictions of the Central Coast, Los Angeles, Santa Ana, and San Diego Regional Water Boards, which address several other beneficial uses that are unique to those geographic regions.

8.2.1.6 Water Quality Objectives and Criteria

It is important to define the terms *standards*, *numerical and narrative Basin Plan water quality objectives*, *CTR criteria*, and U.S. Environmental Protection Agency (USEPA) *recommended criteria* as they relate to the assessment of water quality. As defined by USEPA, water quality standards consist of: (1) the designated beneficial uses of a water segment; (2) the water quality criteria (referred to as *objectives* by the state) necessary to support those uses; and (3) an antidegradation policy that protects existing uses and high water quality. Each Regional Water Board's Basin Plan identifies numeric and narrative water quality objectives, together with the beneficial uses assigned to water bodies and the state antidegradation policy. By definition, Basin Plan objectives have gone through the standard-setting process, which includes public participation, consideration of economics, environmental review, and state and federal agency review and approval. Consequently, Basin Plan objectives are legally applicable and enforceable. In addition, the *Water Quality Control Plan for the San Francisco Bay/Sacramento–San Joaquin Delta Estuary* (Bay-Delta WQCP) (State Water Resources Control Board 2006) identifies beneficial uses of water in the Delta to be protected, water quality objectives for the reasonable protection of beneficial uses, and an implementation program to achieve the water quality objectives. The CTR criteria were established through the USEPA-led water quality standard–setting process. Hence, the CTR criteria, together with the beneficial uses assigned to water bodies and the state antidegradation policy, constitute additional water quality standards for the regions (beyond those specified in the Basin Plans). Finally, USEPA periodically recommends ambient water quality criteria to states for their consideration in adopting state standards. As stated by USEPA, the USEPA recommended criteria (also referred to as 304[a][1] criteria) "…are not regulations, and do not impose legally binding requirements on EPA, States, tribes or the public." Therefore, USEPA-recommended criteria and other nonenforceable guidance values are referred to as *advisory* when discussed in this chapter in order to distinguish them from adopted objectives and criteria.

Applicable ambient surface water quality criteria and objectives for the study area are contained in the following sources.

- CTR (criteria applicable to all surface waters in California).
- *2006* Bay-Delta WQCP (or the 1995 Bay-Delta WQCP) (objectives applicable to the Delta only, regulated through water rights conditions by the State Water Resources Control Board [State Water Board]).
- Central Valley Water Board and San Francisco Bay Water Board Basin Plans (objectives applicable to the Delta and other surface waters in the study area, regulated through point and nonpoint source controls).
- Basin Plans for the Central Coast, Los Angeles, Santa Ana, and San Diego Regional Water Boards (applicable to surface waters in the south-of-Delta areas served by SWP exports).

State objectives can be narrative or numeric. A narrative objective establishes a *desired level of protection* or describes a *favorable condition to be achieved* rather than defining a specific numerical concentration. An example of a narrative objective is "Waters shall not contain chemical constituents in concentrations that adversely affect beneficial uses." A numeric objective defines a concentration that must not be exceeded for a parameter (e.g., 10 milligrams per liter [mg/L]). Along with the concentration value, numerical water quality objectives also typically specify an averaging period to which the concentration value applies to protect the beneficial use of interest. Averaging periods typically depend on the sensitivity of the use, such as a 1-hour averaging period for objectives designed to prevent acute toxicity in aquatic life, to longer averaging periods (e.g., 30-day, annual average) for less-sensitive effects (e.g., human health effects, industrial uses, agricultural crop production).The value of some numerical water quality objectives (primarily for aquatic life) depends on the prevailing ambient freshwater and saltwater salinity conditions. With regard to these objectives, the salinity conditions across the large majority of the Delta are sufficiently low that the Delta channels are subject to the freshwater regulatory water quality criteria/objectives. However, tidal influence and associated saltwater intrusion can result in salinity concentrations in areas of the west Delta that require regulation with saltwater criteria/objectives. Salinity standards themselves are discussed in the section below on the Bay-Delta WQCP. Appendix 8A, *Water Quality Criteria and Objectives*, summarizes the specific water quality criteria/objectives that apply to the Delta.

California Toxics Rule

CTR criteria are established only for aquatic life and human health protection. CTR criteria for aquatic life protection for some constituents (most metals, cyanide, various organic compounds) are specified for freshwater and saltwater conditions. The CTR states that the salinity characteristics (fresh water versus saltwater) of the receiving water must be considered in determining the applicable criteria. Freshwater criteria apply to waters with salinity equal to or less than 1 ppt at least 95% of the time. Saltwater criteria apply to waters with salinity equal to or greater than 10 ppt at least 95% of the time. For waters with salinity between these two categories, or tidally influenced freshwaters that support estuarine beneficial uses, the applicable criteria are the lower of the freshwater or saltwater values for each substance. CTR criteria for the protection of human health are specified that apply to any receiving water where human consumption of water and/or organisms occurs. Refer to Section 8.2, *Regulatory Setting*, for additional detail about the CTR and other applicable water quality regulations. Appendix 8A provides the applicable CTR criteria specified for aquatic life protection and human health protection.

Water Quality Control Plan for the San Francisco Bay/Sacramento–San Joaquin Delta Estuary

The Bay-Delta WQCP (State Water Resources Control Board 2006) identifies the beneficial uses of the Bay–Delta to be protected, the water quality objectives for reasonable protection of beneficial uses, and a program of implementation for achieving the water quality objectives. Unless otherwise indicated, water quality objectives cited for a general area, such as for the south Delta, are applicable for all locations in that general area, and specific compliance locations are used to determine compliance with the cited objectives within the area. Numeric objectives for chloride are included for the protection of municipal and industrial water supply beneficial uses. Objectives for electrical conductivity (EC) are included for multiple western, interior, and south Delta compliance locations for the protection of agricultural supply beneficial uses. Salinity objectives also are specified for fish and wildlife protection in the form of EC objectives for eastern and western locations in Suisun Marsh, a narrative salinity objective for brackish tidal marshes of Suisun Bay, and the X2 standard that regulates the location and number of days of allowable encroachment into the west Delta of salinity exceeding 2 ppt. In general, the chloride and EC objectives (and Delta inflow/outflow operational objectives) vary depending on the month of the year and the water-year type. EC and DO objectives are included for the protection of fish and wildlife beneficial uses. Additionally, Delta inflow and outflow operational objectives (Delta outflow, river flows, export limits, and Delta Cross Channel gate operations) are specified for the protection of fish and wildlife beneficial uses.

Compliance with salinity objectives in particular is largely dependent on Delta inflows and outflows. The current water quality objectives under this plan are included in Appendix 8A.

The State Water Board is now in the midst of a four-phased process of developing and implementing updates to the Bay-Delta WQCP and flow objectives for priority tributaries to the Delta to protect beneficial uses in the Bay-Delta watershed. Phase 1 of this work involves updating San Joaquin River flow and southern Delta water quality requirements included in the Bay-Delta WQCP. Phase 2 involves other comprehensive changes to the Bay-Delta WQCP to protect beneficial uses not addressed in Phase 1. Phase 3 involves changes to water rights and other measures to implement the changes to the Bay-Delta WQCP from Phases 1 and 2. Phase 4 involves developing and implementing flow objectives for priority Delta tributaries outside of the Bay-Delta WQCP updates (State Water Resources Control Board 2013).

Water Quality Control Plan for the Sacramento and San Joaquin River Basins

The Basin Plan for the Sacramento and San Joaquin Rivers defines the beneficial uses, water quality objectives, implementation programs, and surveillance and monitoring programs for waters of the Sacramento and San Joaquin River basins. The Basin Plan contains specific numeric water quality objectives that are applicable to certain water bodies, or portions of water bodies. Numerical objectives have been established for bacteria, DO, pH, pesticides, EC, TDS, temperature, turbidity, and trace metals. The Basin Plan also contains narrative water quality objectives for certain parameters that must be attained through pollutant control measures and watershed management. Narrative water quality objectives also serve as the basis for the development of detailed numerical objectives. The narrative water quality objectives and numeric freshwater criteria/objectives adopted for the Delta are included in Appendix 8A (Regions 2 and 5).

Water Quality Control Plan for San Francisco Bay

The Basin Plan for the San Francisco Bay basin (San Francisco Bay Water Board 2007) is similar to the Basin Plan for the Central Valley and defines numerical and narrative water quality objectives for San Francisco Bay (including San Pablo Bay) and portions of the west Delta. The designated beneficial uses for the Delta are consistent with the Central Valley Basin Plan. This Basin Plan contains both freshwater and saltwater criteria for several priority pollutant trace metals. Freshwater objectives apply to waters lying outside the zone of tidal influence and having salinities lower than 5 ppt at least 75% of the time. Saltwater objectives apply to waters with salinities greater than 5 ppt at least 75% of the time. For waters with salinities between the two categories, or tidally influenced freshwaters that support estuarine beneficial uses, the objectives are the lower of the freshwater or saltwater objectives, based on ambient hardness, for each substance. Appendix 8A provides the numeric freshwater and saltwater objectives adopted for the Delta.

Water Quality Control Plans Applicable to the State Water Project South-of-Delta Service Area

The Basin Plans for the Central Coast, Los Angeles, Santa Ana, and San Diego Regional Water Boards similarly define beneficial uses and numeric and narrative water quality objectives for inland and coastal waters and other water bodies in the service areas of SWP contractors that use water from the California Aqueduct and are located generally south of the Central Valley and in the central and southern California coastal counties. In general, the narrative and numeric water quality objectives for inland waters established in these Basin Plans are similar to the Central Valley and San Francisco

Bay Regions. However, because salinity is a primary water quality constituent of concern in the inland and coastal counties of arid southern California, the Basin Plans for these regions all contain specific numeric water quality objectives for salinity constituents (e.g., TDS, hardness, sodium, chloride, sulfate) for the protection of municipal/domestic and agricultural water supply beneficial uses. The established salinity-based objectives for specific water bodies in these Basin Plans can vary substantially based on specific base-level conditions.

Water Quality Control Plans Applicable to Suisun Marsh

Suisun Marsh is located at the northern edge of Suisun Bay, just west of the confluence of the Sacramento and San Joaquin Rivers and is not within the statutory Delta. Suisun Marsh consists of tidal wetlands, sloughs, managed diked wetlands, managed seasonal wetlands, and upland grasslands. The marsh contains approximately 59,000 acres of marsh, managed wetlands, and adjacent grasslands, plus 30,000 acres of open-water areas. Most of the managed wetlands are within levee systems with a majority owned by private duck hunting clubs. About 14,000 acres are state-owned and managed by the California Department of Fish and Wildlife (CDFW), and about 1,400 acres on channel islands are federal lands. Elevation and salinity are the principal factors controlling the distribution of tidal marsh plants in the marsh. Within the diked wetlands, water diversion and release operations are managed to maximize the production of aquatic vascular plants that traditionally have been considered important for wintering waterfowl.

The regulatory framework for managing water quality conditions in Suisun Marsh began in the 1970s with the development of the Suisun Marsh Protection Plan by the Bay Conservation and Development Commission (BCDC) and the adoption of salinity objectives for marsh channels in the 1978 Bay-Delta WQCP to protect the beneficial uses for fish and wildlife. The State Water Board water rights decision (D-1485), applicable to DWR and Reclamation for the management of SWP and CVP operations, was adopted with provisions to meet the Suisun Marsh salinity objectives. DWR's 1984 Plan of Protection for Suisun Marsh was developed to meet the D-1485 requirements and outlined a staged implementation for a combination of proposed physical salinity management initial facilities, monitoring, a wetlands management program for marsh landowners, and supplemental releases of water from SWP and CVP reservoirs. In 1987, federal and state agencies adopted the Suisun Marsh Preservation Agreement (SMPA) to mitigate impacts on marsh salinity from the SWP, CVP, and other upstream diversions. The SMPA identified the schedule for construction of large-scale facilities in Suisun Marsh that would enable the salinity objectives to be met. The 1991 Bay-Delta WQCP increased to seven the number of locations in the marsh where numerical salinity objectives were to be met. The 1994 Principles of Agreement on Bay-Delta Standards (Bay-Delta Accord that formed CALFED), the 1995 Bay-Delta WQCP, and the adoption of State Water Board water rights decision (D-1641) in 1999 all resulted in refinements to the Suisun Marsh salinity standards, added narrative salinity objectives for the tidal marshes of the surrounding Suisun Bay, and mandated the formation of a Suisun Marsh Ecological Work Group that would provide recommendations for water quality objectives to improve conditions for beneficial uses (wildlife habitat; rare, threatened and endangered species; and estuarine habitat) and recommend future research and monitoring needs for the marsh. Because evidence showed a potential for actions to meet the salinity objectives at two compliance stations within the marsh might cause harm to the beneficial uses they were intended to protect, the State Water Board in D-1641 did not require that DWR and Reclamation attain the objectives at these stations. The salinity objectives for the marsh remained unchanged in the 2006 Bay-Delta WQCP, but it notes that salinity objectives will be finalized, including adoption of numerical objectives for brackish marshes in

Suisun Bay and other locations (if necessary), by 2015 and following development and implementation of a comprehensive Suisun Marsh Plan. Federal and state agencies recently completed environmental compliance documentation for the Suisun Marsh Plan (Bureau of Reclamation et al. 2011), which assesses a comprehensive 30-year plan designed to address use of resources within about 52,000 acres of wetland and upland habitats in the marsh, restoration of tidal wetlands, and the enhancement of managed wetlands and their functions.

The Suisun Marsh Salinity Control Gates (SMSCG) were constructed on Montezuma Slough near Collinsville and began operating in late 1988. The gates are operated periodically from September to May to meet the salinity standards of the 1995 Bay-Delta WQCP and D-1641 requirements. The SMSCG operation acts to restrict the inflow of high-salinity flood-tide water from Grizzly Bay into the marsh but allow passage of freshwater ebb-tide flow from the mouth of the Delta. Operation of the gates in this fashion lowers salinity in Suisun Marsh channels and results in a net movement of water from east to west. When Delta outflow is low to moderate and the gates are not operating, net movement of water is from west to east, resulting in higher-salinity water in Montezuma Slough. Because the SMSCG operations have been more effective than anticipated, and as a result of additional freshwater Delta outflows required by the 1995 Bay-Delta WQCP, other previously proposed large physical facilities to promote further salinity controls in the marsh have not been implemented. The SMSCG are operated only as needed and generally do not operate from June through August.

Other Water Quality Plans

The State Water Board has begun development of a statewide mercury regulatory program to address reservoirs on the state's 303(d) list for mercury. The plans are at the scoping level as of first quarter 2012.

In 2005, the State Water Board directed the San Francisco and Central Valley Water Board to address the public health impacts of mercury in fish. In response, the Central Valley Basin Plan requires all entities subject to controlling methylmercury in the Delta and Yolo Bypass to participate in a program to reduce human exposure to mercury through eating fish. The Mercury Exposure Reduction Program (MERP) was developed to meet this objective. The primary goals of the Delta MERP are to increase understanding of contaminants in fish and reduce exposure to mercury among people who eat fish from the Delta.

The Delta Regional Monitoring Program (RMP) is currently under development by the Central Valley Water Board as of August 2013. The RMP was initiated by the Central Valley Water Board to establish a system for coordinating among the many agencies and groups that monitor water quality, flows, and ecological conditions in the Delta, whereby all data are synthesized and assessed on a regular basis, with the primary goal of tracking and documenting the effectiveness of beneficial use protection and restoration efforts through comprehensive monitoring of contaminants and contaminant effects in the Delta.

California Drinking Water Standards Incorporated by Reference in Basin Plans

Both the Central Valley and San Francisco Bay Basin Plans incorporate by reference the California Department of Public Health (DPH) numerical drinking water maximum contaminant levels (MCLs). The incorporation of the MCLs, which apply to treated drinking water systems regulated by DPH, makes the MCLs also applicable to ambient receiving water with respect to the regulatory programs administered by the Regional Water Boards. DPH establishes state drinking water standards, enforces both federal and state standards, administers water quality testing programs, and issues permits for public water system operations. The drinking water regulations are found in Title 22 of the California Code of Regulations (CCRs). The state drinking water standards consist of primary and secondary MCLs. Primary MCLs are established for the protection of environmental health, and secondary MCLs are established for constituents that affect the aesthetic quality of drinking water, such as taste and odor. The incorporation by reference of the MCLs in Basin Plans is meant to ensure, to the extent possible, that adequate source water quality is maintained to support the domestic and municipal water supply beneficial use, particularly from constituents that WTPs are not typically designed to remove. The state primary and secondary MCLs applicable to the Central Valley and San Francisco Bay Basin Plans are provided in Appendix 8A.

8.2.1.7 Water Quality Impairments

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

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

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

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

The State Water Board and USEPA have approved TMDLs for organic enrichment/low DO and methylmercury in the Delta, and for salt and boron in the San Joaquin River at Vernalis. TMDLs for other constituents remain under planning or development. Additionally, the San Francisco Bay Water Board is currently developing a TMDL for Suisun Marsh to address impairment by methylmercury, DO, and nutrient enrichment (San Francisco Bay Water Board 2012).

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

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

Pollutant/Stressor	Listing Region	Listed Source	Delta Location of Listing
Boron	Central Valley	Agriculture	Exp
Chlordane	Central Valley and San Francisco Bay	Agriculture, nonpoint source	N, W
Chloride	Central Valley	Source unknown	TomP
Chlorpyrifos	Central Valley	Agriculture, urban runoff/ storm sewers	N, S, E, W, NW, C, Exp, Stk, CalvR, Duck, Five, French, MokR, Morm, Mosh, OldR, Pix
Copper	Central Valley	Resource extraction	MokR
DDT	Central Valley and San Francisco Bay	Agriculture, nonpoint source	N, S, E, W, NW, C, Exp, Stk
Diazinon	Central Valley	Agriculture, urban runoff/ storm sewers	N, S, E, W, NW, C, Exp, Stk, CalvR, Five, French, Mosh, Pix
Dieldrin	San Francisco Bay	Nonpoint source	N, W
Dioxin compounds	Central Valley and San Francisco Bay	Source unknown, atmospheric deposition	W, Stk
Disulfoton	Central Valley	Agriculture	Pix
E. coli	Central Valley	Source unknown	E, French, Pix
Invasive species	Central Valley and San Francisco Bay	Source unknown, ballast water	N, S, E, W, NW, C, Exp, Stk
Furan compounds	Central Valley and San Francisco Bay	Contaminated sediments, atmospheric deposition	Stk
Group A pesticides[a]	Central Valley	Agriculture	N, S, E, W, NW, C, Exp, Stk
Mercury	Central Valley and San Francisco Bay	Resource extraction, industrial-domestic wastewater, atmospheric deposition, nonpoint source	N, S, E, W, NW, C, Exp, Stk, CalvR, MokR, Mosh
Pathogens	Central Valley	Recreational and Tourism Activities (nonboating), Urban Runoff/Storm Sewers	Stk, CalvR, Five, Morm, Mosh, Walk
PCBs	Central Valley and San Francisco Bay	Source unknown	W, N, Stk
Unknown toxicity[b]	Central Valley	Source unknown	N, S, E, W, NW, C, Exp, Stk, French, MokR, Morm, Pix
EC	Central Valley	Agriculture	S, W, NW, Exp, Stk, OldR, TomP
Organic enrichment /low DO	Central Valley	Municipal point sources, urban runoff/storm sewers	Stk, CalvR, Five, MidR, MokR, Morm, Mosh, OldR, Pix, TomP
Sediment toxicity	Central Valley	(Not specified)	French
Selenium	San Francisco Bay	Refineries, invasive species, natural sources	W
TDS	Central Valley		S, OldR
Zinc	Central Valley	Resource extraction	MokR

Source: State Water Resources Control Board 2011.

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

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

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

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

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

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

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

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

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

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

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

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

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

Source: State Water Resources Control Board 2011.

8.2.1.8 Water Quality Constituents of Concern

Constituents that are of concern in the study area are those that, at elevated concentrations, have the potential to adversely affect or impair one or more beneficial uses (Table 8-1), such as the constituents identified from the Section 303(d) listing process described above (Tables 8-1 and 8-2).

Salinity is an important parameter of concern for the Delta that reflects the total ionic content of the water, ranging from very low levels deemed fresh water to the high salinity content of seawater. Chloride, bromide, and boron are specific ions that contribute to overall salinity and are constituents of concern. Salinity can affect multiple beneficial uses, including defining the types and distribution of aquatic organisms that are adapted to fresh water versus brackish, or saline, water conditions in the Delta.

Other constituents of concern for the Delta in particular are of importance to municipal water suppliers, including organic carbon (total and dissolved) and bromide, which are precursors for the formation of DBPs such as trihalomethanes (THMs), haloacetic acids (HAAs), bromate, chlorite, and nitrosamines at treated drinking water treatment processes. The DBPs mentioned are of concern because they are known or suspected human carcinogens when consumed at elevated concentrations over many years. Pathogens are of importance to municipal water suppliers as well as recreational uses.

In addition, elevated nutrient concentrations can affect municipal water suppliers that store diverted Delta water in reservoirs. Elevated nutrient levels contribute to algae growth and affect the taste and odor of treated water, filter clogging at WTPs, and increased levels of organic carbon. Increased salinity concentrations also can alter the taste of finished drinking water.

Constituents of concern to agricultural users in the study area include boron and salinity. Many crops are sensitive to these constituents, which can affect their yield.

Numerous constituents, including temperature, turbidity and suspended sediment, DO, pesticides, herbicides, nutrients, and trace metals, can cause adverse effects on aquatic life in the study area. Trace metals, pesticides, and herbicides can be toxic to aquatic life at relatively low concentrations. Temperature and DO are of concern because the Delta serves as a migration and rearing corridor for anadromous salmonids, which are sensitive to these parameters. Because the primary concern of water temperature is effects on fish and aquatic organisms, temperature is addressed in Chapter 11, *Fish and Aquatic Resources.* Excess nutrients can cause blooms of nuisance algae and aquatic vegetation, and their decay can result in depleted DO.

Finally, an emerging class of constituents of concern is endocrine-disrupting compounds (EDCs), pharmaceutical and personal care products (PPCPs), and nitrosamines. EDCs and PPCPs are thought to have potential to cause adverse effects on aquatic resources, and their potential presence in drinking water supplies has received significant attention (World Health Organization 2002; U.S. Geological Survey 2002). Nitrosamines have long been suspected carcinogens, but their more recent discovery as a DBP, along with lower detection limits for the analytical methods used to measure them, has spurred more attention in recent years.

As noted in Table 8-2, the entire Delta is identified on the Section 303(d) list as impaired by unknown toxicity. Aquatic toxicity refers to the mortality of aquatic organisms or sublethal (e.g., growth, reproductive success) effects. Aquatic toxicity can be caused by any number of individual constituents of concern, or through additive and synergistic effects attributable to the presence of multiple toxicants. No TMDLs have been developed for the Delta to address the sources of toxicity, identify alternatives to reduce toxicity, or identify the allocation of the allowable loading of constituents that would result in achieving the Basin Plan narrative toxicity objective that forms the basis for the Section 303(d) listing. Because unknown toxicity is a primary concern for fish and other aquatic organisms, Chapter 11, *Fish and Aquatic Resources*, addresses the subject in detail.

In light of these issues, the constituents of concern identified in Table 8-5 are addressed in detail for the purposes of characterizing existing water quality in the study area (Section 8.1.3, *Existing Water Quality*) and to support the water quality impact assessments. Table 8-5 also relates the constituents of concern to the various receptors in the study area that could be adversely affected by their concentrations. For purposes of this characterization, the receptors are categorized by the designated beneficial uses specified in the Bay-Delta WQCP. The constituent-specific sections described subsequently (Section 8.1.3) characterize the potential effects on beneficial uses and various receptors, including known information regarding specific locations in the Delta most affected by the constituents.

8.2.2 Selection of Monitoring Locations for Characterization of Water Quality

8.2.2.1 Water Quality Monitoring Programs and Sources of Data

In compiling water quality data for the constituents of concern (Table 8-5), data sets from the following monitoring programs/entities were obtained through the Bay-Delta and Tributaries Project (BDAT) database for the period from 1990 through 2009 (Bay Delta and Tributaries Project 2009). This effort began in early 2010, when data more recent than 2009 were not available. Revision of the data summarized below to account for more recent monitoring data was not considered necessary because there was no reason to expect that water quality conditions as represented by these monitoring databases would be substantially changed relative to the data already collected. Also, any differences would not be of a magnitude that would alter the nature of the characterization or the assessment in any substantial way.

- California National Water Information System Water Quality Data (U.S. Geological Survey [USGS]).
- Environmental Monitoring Program (DWR) (continuous and discrete data).
- Municipal Water Quality Investigations Program data (DWR).
- Surface Water Ambient Monitoring Program (State Water Resources Control Board and Regional Water Boards).

BDAT contains environmental data concerning the Bay-Delta and provides public access to those data. More than 50 organizations voluntarily contribute biological, water quality, meteorological, and other data to this database. In the event the monitoring programs listed above, as accessed through BDAT, did not provide data for all the constituents of interest, additional data were obtained from one or more of the following monitoring programs/databases to provide a more comprehensive characterization of Delta water quality.

- California Data Exchange Center (DWR).
- Interagency Ecological Program (multiagency).
- National Water Information System (USGS).
- San Francisco Estuary Institute ([SFEI] multi-agency in Bay Area).
- Sacramento River Coordinated Monitoring Program (Sacramento Stormwater Quality Partnership and the Sacramento Regional County Sanitation District (SRCSD)).
- Sacramento River Watershed Program (nonprofit 501[c][3] organization).
- Water Data Library (DWR).

8.2.2.2 Surface Water Quality Monitoring Locations

Based on data availability, data continuity, and geographic location, a total of 20 water quality monitoring stations were selected to characterize the water quality conditions in the study area (Figure 8-7). Because of the complexity of the Delta environment, a detailed characterization of water quality was necessary for the statutory Delta to represent the effects of water quality on the broad beneficial use categories (e.g., agriculture, aquatic life, recreation) and more specific issues such as major water diversion locations. For example, major water diversions include CCWD's three intakes at Rock Slough, Old River, and Victoria Canal; the North Bay Aqueduct; Jones and Banks pumping plants; seasonal Antioch and Mallard Slough diversions; and the City of Stockton's new diversion from the central Delta. The following section provides a brief illustration of how the data from these stations were used to represent various parts of the study area. Table 8-6 presents the specific reasons for selecting these locations and describes the spatial area of the study area for which specific stations provide adequate representation.

Table 8-5. Receptors Affected by Water Quality—Characterized by the Designated Beneficial Uses of the Study Area

Constituent	Freshwater Replenishment	Municipal and Domestic Supply and Groundwater Recharge	Agricultural Supply	Industrial Process Supply	Recreation		Shellfish Harvesting and Aquaculture	Commercial/ Sport Fishing	Freshwater Habitat		Migration/ Spawning	Estuarine Habitat	Wildlife Habitat	Endangered Species and Areas of Biological Significance
					Contact	Non-Contact			Warm	Cold				
Physical Parameters														
Temperature							X	X	X	X	X	X		X
Turbidity/suspended solids	X	X		X	X	X			X	X	X	X		X
Inorganic parameters														
Salinity (EC/TDS)	X	X	X	X			X	X	X	X	X	X	X	X
Bromide	X	X												
Chloride	X	X	X	X			X	X	X	X	X	X	X	X
Boron	X		X											
Organic carbon	X	X												
Ammonia (nitrogen)		X					X	X	X	X	X	X		X
Other nutrients (nitrogen, phosphorus)	X	X					X	X	X	X	X	X	X	X
DO							X	X	X	X	X	X		X
Trace Metals														
Mercury	X	X					X	X	X	X	X	X	X	X
Selenium	X		X						X	X	X	X	X	X
Others (e.g., copper, lead, zinc,)	X	X					X	X	X	X	X	X		X
Other														
Pathogens	X	X			X		X	X						
Pesticides and herbicides	X	X					X	X	X	X	X	X	X	X
Dioxins/furans and PCBs	X	X					X	X	X	X	X	X	X	X
Polycyclic aromatic hydrocarbons	X	X					X	X	X	X	X	X	X	X
Emerging pollutants (EDCs/PPCPs)	X	X					X	X	X	X	X	X	X	X
Applicable Basin Plan	N, S, Ext	D, N, S, Ext	D, N, S, Ext	D, N, S, Ext	D, N, S, Ext		D, N, S, Ext	D, N, S, Ext	D, N, S, Ext		D, N, S, Ext	D	D, N, S, Ext	D, N, S, Ext

Notes:

D = Delta.
EDC = endocrine-disrupting compound.
Ext = export area.
N = north.
PCB = polychlorinated biphenyl.
PPCP = pharmaceutical and personal care product.
S = south.

Applicable Basin Plans

Delta: Central Valley and San Francisco Bay Water Boards
Export Area: Central Valley, San Francisco Bay, Central Coast, Santa Ana, and Los Angeles Water Boards
North: Central Valley Water Board
South: Central Valley Water Board

1 **Table 8-6. Locations Selected to Represent Existing Water Quality in the Delta**

Location	Data Sources	Justification for Selecting Location
North of Delta Locations		
Sacramento River at Keswick	DWR	Characterizes water quality in the area north of the Delta
Feather River at Oroville	DWR	Characterizes water quality in the area north of the Delta
American River at the E.A. Fairbairn Water Treatment Plant	DWR	Characterizes water quality in the area north of the Delta
Sacramento River at Verona	DWR	Characterizes water quality in the area north of the Delta
Delta Source Water Locations		
Sacramento River at Hood	BDAT, CDEC, MWQI	Characterizes water quality at the northern boundary of the Delta
San Joaquin River near Vernalis	BDAT, CDEC, MWQI	Characterizes water quality at the southern boundary of the Delta
Mokelumne River (South Fork) at Staten Island	BDAT, WDL	Characterizes EC from a major eastern Delta boundary river
Suisun Bay at Bulls Head Point near Martinez	BDAT	Characterizes water quality at the western export area of the Delta; represents saltwater intrusion into the Delta
Delta Interior		
San Joaquin River at Buckley Cove	BDAT	Represents effects of Stockton Deep Water Ship Channel in the eastern Delta near the city of Stockton
Franks Tract at Russo's Landing	BDAT	Characterizes water quality in a reclaimed area in the central portion of the Delta
Old River at Rancho del Rio	BDAT	Characterizes water quality in the central portion of the Delta
Major Outflows		
Sacramento River above Point Sacramento	BDAT, SFEI	Characterizes Sacramento River water quality prior to its confluence with the San Joaquin River; essentially the same location as the SFEI's BG20 station
San Joaquin River at Antioch Ship Channel	BDAT, SFEI	Characterizes San Joaquin River water quality prior to its confluence with the Sacramento River; essentially the same location as the SFEI's BG30 station
Sacramento River at Mallard Island	DWR, MWQI	Characterizes water quality at the western boundary of the Delta; essentially the same location as Sacramento River at Chipps Island
Major Diversions		
North Bay Aqueduct at Barker Slough Pumping Plant	CDEC, MWQI	Major municipal water supply intake in northwestern portion of the Delta
Contra Costa Pumping Plant No. 1	MWQI	Major municipal water supply intake in western portion of the Delta
Harvey O. Banks Pumping Plant	CDEC, MWQI	Major water supply intake; pumps SWP water into the California Aqueduct
C. W. "Bill" Jones Pumping Plant	BDAT, CDEC, MWQI	Major water supply intake; pumps CVP water into the Delta-Mendota Canal
South-of-Delta Locations		
California Aqueduct at Check 13	DWR	Characterizes water quality in the area south of the Delta
California Aqueduct at Check 29	DWR	Characterizes water quality in the area south of the Delta

Notes: BDAT = Bay Delta and Tributaries Project; CDEC = California Data Exchange Center; DWR = California Department of Water Resources; EC = electrical conductivity; MWQI = Municipal Water Quality Investigations; SFEI = San Francisco Estuary Institute; WDL = Water Data Library; WTP = water treatment plant.

North of Delta

The hydrology north of the Delta is dominated by three major rivers—the Sacramento, Feather, and American. To characterize the water quality for the area north of the Delta, it is important to review the water quality entering these three rivers from their major reservoirs (Shasta Lake, Lake Oroville, and Folsom Lake, respectively). For the purpose of this assessment, the water quality of the area north of the Delta is represented by locations downstream of these three lakes, as well as a monitoring location at the Sacramento River at Verona (immediately downstream of the confluence of the Feather and Sacramento Rivers, representing the water quality of the combined flow after mixing) Figure 8-7 shows the selected locations.

- Sacramento River at Keswick.
- Feather River at Oroville.
- American River at the E. A. Fairbairn Water Treatment Plant.
- Sacramento River at Verona.

Because organic carbon data were not monitored at the Verona location, data from a monitoring location approximately 9 miles downstream of the Verona location (Sacramento River at Vietnam Veterans Memorial Bridge [Interstate 5] [Veterans Bridge]) were reviewed and analyzed for organic carbon. Water quality downstream of the confluence of American and Sacramento Rivers is represented by the monitoring station at Hood, which is addressed in the following section, *Delta Source Waters*.

8.2.2.3 Delta Source Waters

Water quality in the Delta at any given location and time is primarily the result of the sources of water to that location (i.e., the percentage of the water at the site comprising water from the Sacramento River, the San Joaquin River, eastside tributaries, Bay water, in-Delta runoff, and agricultural return flows). Consequently, it is important to characterize the quality of the major sources of water entering the Delta to determine how Delta water quality may change, as the source fractions of water to various locations change with implementation of alternative activities. For the purpose of this section, the water quality of the major Delta source waters will be represented by the following locations.

- Sacramento River at Hood.
- San Joaquin River at Vernalis.
- Mokelumne River at Staten Island.
- Bay water intrusion to Suisun Bay at Martinez.

Figure 8-7 shows the selected locations. It should be noted that the selected Sacramento, San Joaquin, and Mokelumne Rivers monitoring stations are within the statutory Delta and can be affected by tidal action, depending on the stream flow rates. Additionally, the Mokelumne River is directly affected by the flow of Sacramento River water when the Delta Cross Channel is open. However, these locations generally represent the water quality occurring at these perimeter locations in the Delta.

Interior Delta and Outflow Locations

In addition to characterizing the quality of the major source water inputs to the Delta, a number of interior Delta locations were identified for characterizing existing interior Delta water quality. The locations chosen for this purpose were selected based on the following criteria.

- Availability of water quality data (locations used by the various water quality monitoring programs).
- Geographic location in the Delta, in an effort to have one or more stations in the northern, central, eastern, western, and southern portions of the Delta.
- Locations of the primary water supply intakes.
- Bay-Delta WQCP EC compliance locations.
- Other related considerations (e.g., locations of output nodes for Delta Simulation Model 2 [DSM2], reasonable number of locations to support the water quality impact assessments).

Based on the selection criteria listed above, 10 interior and outflow Delta locations were chosen (Figure 8-7) to characterize existing water quality in the Delta and to support the water quality impact assessments.

South of the Delta

The system south of the Delta is influenced primarily by the numerous dams and reservoirs and hundreds of miles of canal that constitute the SWP and CVP (described previously). The SWP and CVP serve as a major source of municipal water supply for Central Coast, San Joaquin Valley, and southern California water contractors and also as one of the major sources of agricultural water supply for the San Joaquin Valley. For the purpose of this assessment, the water quality of the area south of the Delta is represented by two locations along the California Aqueduct.

- California Aqueduct at Check 13.
- California Aqueduct at Check 29.

Figure 8-7 shows the selected locations for the area south of the Delta.

The San Luis Reservoir is a major storage reservoir 50 miles south of the Delta that is used for various control purposes within the system (e.g., storing water from the San Joaquin River and Sacramento River to re-release into the aqueducts). Hence, the water quality downstream of this reservoir is of great importance in characterizing the water quality in the service area. Water exiting the San Luis Reservoir passes through the O'Neill Forebay, which also is fed by water from the California Aqueduct and the Delta-Mendota Canal. The water quality monitoring location at the exit point of the O'Neill Forebay is called the California Aqueduct at Check 13.

South of O'Neill Forebay, there are inflows to the aqueduct, including storm water and flood flows at crossings of several streams and groundwater inflows, prior to water being pumped over the Tehachapi Mountains and into watersheds of water supply reservoirs in the Los Angeles region and areas to the south. DWR accepts the introduction of local groundwater into the aqueduct ("Pump-In" Projects) in accordance with California Water Code provisions that state that nonproject water may be conveyed, wheeled, or transferred in the SWP provided that water quality is protected.

8.2.3 Existing Surface Water Quality

In the following subsections, each constituent of concern (or category of similar constituents) is reviewed in detail to characterize the general patterns of concentrations that exist in the study area at present. The review process followed the steps outlined below.

- Literature review—A wide range of scientific articles, agency reports, and site-specific studies was reviewed to collect the following information:
  - The various structural and nonstructural features and operations in the study area that affect water quality.
  - The importance and relevance of each of the constituents of concern in the study area.
  - The interaction of various constituents and the combined effect on water quality.
  - The historical and current patterns in concentrations of the constituents at selected locations.
  - The variation in concentrations in wet and dry years.
  - Applicable standards and regulatory criteria, and known impairments.
- Some of the key documents reviewed include:
  - Basin Plan for the Sacramento and San Joaquin River Basins.
  - Bay-Delta WQCP.
  - CALFED Bay-Delta Program 2000 Water Quality Program Plan.
  - CALFED 2008 State of Bay-Delta Science.

Water quality data for the identified constituents were collected from various monitoring programs and databases. Data were downloaded for selected locations (described in previous section) for each constituent for the period between 1990 and 2009 and stored in a database. In the discussions below, various periods of record are discussed for different constituents and different purposes. The time period of data used to characterize present conditions varied by constituent according to what was available in the database, but in general, data from 2001–2006 are presented as a representative time period that contained both wet and dry years and for which data were available for the entirety of all water years. It must be noted that the characterization provided below is meant to provide a general understanding of water quality conditions and historical monitoring data in the study area. The discussion below is not meant to explicitly define the Existing Conditions for CEQA purposes. The CEQA baseline, *Existing Conditions*, is defined in Appendix 3D and for the purposes of quantitative water quality assessments (as described in Section 8.3.4, *Effects and Mitigation Approaches*) is represented by Existing Conditions modeling runs, not historical water quality monitoring data as presented below. For more information on the comparisons made to the Existing Conditions modeling run for assessment purposes, see Section 8.3.3.2, *Comparisons*. For these reasons, the time period 2001–2006 was generally considered sufficient for characterization purposes because inclusion of more recent data that have been made available since the start of the environmental review process would not alter the nature of the characterization or the assessment in any substantial way. For instances in which it would be expected that water quality conditions would have changed since this time period, for example, if major sources of a constituent of concern to the Delta were created or eliminated, more recent data was examined and characterized. Appendix 8B summarizes the data availability for each of the constituents of concern and locations where substantial information exists for characterizing the Existing Conditions. Depending on the availability of data, the information was presented in various forms.

- Spatial distribution—data presented in a map for individual constituents identifying the location of the sampling station; the date range; and the maximum, minimum, average, and median values.
- Seasonal patterns—plots showing the change in concentrations over time.
- Tabular—tables showing concentrations of constituents where data are discrete or discontinuous.

8.2.3.1 Ammonia

Background and Importance in Study Area

Ammonia, a form of nitrogen, exists primarily in two forms: un-ionized ammonia (NH_3) and an ionized form—ammonium (NH_4^+). In general terms, ammonia and ammonia-N refer to total ammonia (i.e., un-ionized ammonia plus ammonium) in this chapter. The relative levels of un-ionized ammonia and ammonium in a water body depend primarily on pH, and to a lesser extent on temperature and salinity (U.S. Environmental Protection Agency 2009a). Un-ionized ammonia is a gas that is toxic to animals, while ammonium is a solid dissolved in water and an important nutrient for plants and algae. Both ammonium and ammonia are present in effluent from WTPs that employ only secondary treatment methods, in some types of agricultural runoff (e.g., fertilizers, animal wastes), fish and other wildlife wastes, urban runoff, and atmospheric depositions (Ballard et al. 2009:2). Concern about total ammonia effects in the Delta have led to focused efforts to define and assess the issue (e.g., March 2009 CALFED Science Program Workshop, August 2009 Ammonia Summit). The Sacramento Regional Wastewater Treatment Plant (SRWTP) discharge into the Sacramento River at Freeport is a large point source of ammonia in the Delta. The SRWTP's output has increased with human population growth, and it has contributed to an increase in ammonium concentrations in the Delta downstream of the discharge (Ballard et al. 2009:3). The primary source of total ammonia-N at Hood location is the SRWTP (Central Valley Water Board 2010a). The discharge from the SRWTP accounts for 90% of the ammonium load in the Sacramento River at Hood (Jassby 2008).

In the aquatic environment ammonia-N may rapidly cycle among the water, organisms, and sediments. The presence of high concentrations of ammonia-N usually is associated with reducing conditions and/or proximity to locally high concentrations of ammonia-N discharge such as WTP discharges. Ammonia-N is rapidly oxidized in the flowing river environment to nitrate-N (NO_3^-). More than three quarters of the ammonia present in the Sacramento River downstream of Freeport is converted to nitrate by the time the water reaches Chipps Island (Central Valley Water Board 2010a Update memo:4).

Concerns regarding ammonia in the Delta include potential toxicity to fish and other organisms, shifts in algal community structure (e.g., dominant species), and inhibition of nitrate uptake by diatoms. Ammonia can be toxic to aquatic organisms at very low concentrations. The results of a 2008 pilot study to assess the potential acute toxicity of ammonia in treated wastewater effluent from the SRWTP to larval delta smelt suggest that ammonia concentrations present in the Sacramento River below the SRWTP were not acutely toxic to 55-day-old delta smelt. In general, un-ionized ammonia concentrations in the Delta appear to be too low to cause acute mortality of even the most sensitive species. It is unclear whether lower concentrations of ammonia may have chronic effects on species survival, growth, or reproduction (Ballard et al. 2009:7).

There may be a potential for toxic ammonia concentrations in very productive areas in the southern Delta, or smaller productive sloughs or shallow areas throughout the Delta, when high concentrations of un-ionized ammonia coincide with warm temperatures and elevated pH (phytoplankton productivity increases pH, which influences how much un-ionized ammonia is present). In addition, the potential for combined effects of un-ionized ammonia with other toxicants and stressors, and differences in fish sensitivity depending on health status, age, and physiological state, add uncertainty to data analyses (Ballard et al. 2009:7).

Human-induced excesses in nitrogen concentrations, which includes ammonia, can cause eutrophication, or increased biological production. Eutrophic conditions result in enhanced death and decay of biomass and create an oxygen demand in sediments that lowers DO concentrations in the water column (Wetzel 2001). Eutrophic conditions also can affect turbidity and, therefore, the light regime, which can cause changes in the balance of benthic and planktonic productivity. Increases in algal and macrophyte growth can add to the concentrations of dissolved organic carbon (DOC) and TOC in water. Organic carbon in source waters is a constituent of drinking water concern because of DBP formation during water treatment. See the organic carbon section for more on water quality concerns associated with organic carbon and DBPs. Additionally, NH_3 can form nitrogenous DBPs when combined with chlorine.

Nutrient concentrations currently in the Delta are high enough that they are probably not a true limiting factor for overall algal growth, and therefore increases in ammonia generally will not lead to an increase in algal growth (Jassby et al. 2002:1). However, it is unclear whether nutrient levels are adversely affecting algal composition and thus primary productivity. For example, recent work has suggested that elevated blue-green algal concentrations in the Delta interior were associated with nitrogen (including ammonia) and phosphorus concentrations (Lehman et al. 2010). The composition of the phytoplankton community has generally shifted from diatoms toward green algae, cyanobacteria, and miscellaneous flagellate species (Lehman 2000). The changes in phytoplankton composition, and especially the now regularly occurring *Microcystis* blooms, have been implicated as possible factors in the decline of important Delta pelagic fish species, but the connection with ammonia is not clear (Ballard et al. 2009:5).

In addition, Glibert (2010) analyzed more than 30 years of Delta water quality data, concluding that aquatic organism population shifts were associated with changes in the quality and quantity of nutrients discharged from the SRWTP. Subsequently, others have criticized this work by demonstrating that the statistical techniques used were not appropriate and, therefore, that the conclusions were flawed (Cloern et al. 2012:1). Glibert and others agreed that the statistical conclusions of the 2010 review paper should be disregarded (Lancelot et al. 2012). However, a subsequent paper emphasized that changes in nutrient concentrations and nutrient ratios (primarily nitrogen to phosphorus) over time fundamentally affect biogeochemical nutrient dynamics that can lead to conditions conducive to invasions of rooted macrophytes, benthic grazing bivalve mollusks, and blooms of potentially harmful cyanobacteria (Glibert et al. 2011).

Research also has indicated that ammonia, while stimulating diatom growth at very low concentrations, also can inhibit uptake of nitrate in diatoms as concentrations increase above about 4 micromoles per liter (μmol/L) (0.056 mg/L-N) (Dugdale et al. 2007:23). This may be of concern in Suisun Bay, where algal blooms may be prevented when conditions otherwise would be favorable

(Wilkerson et al. 2006:1). A recent study showed that indeed, ammonia concentrations downstream of the SRWTP appeared to inhibit phytoplankton nitrate uptake, and that chlorophyll a and primary productivity were also concurrently reduced for many miles downstream (Parker et al. 2012). The authors attribute the reduced chlorophyll a and primary productivity to the nitrate uptake inhibition, though primary productivity decreases in the reach of the Sacramento River upstream of the SRWTP. Therefore, there is some uncertainty as to the cause of the declines, as the Central Valley Water Board discussed in its findings of the SRWTP NPDES permit issued in 2010: "the SRWTP discharge cannot be cause of pigment decline upstream of the discharge point, and may not be contributing to the decline downstream of the discharge point" (Central Valley Water Board 2010b).

Elevated concentrations of ammonium-N and other nutrients also may benefit invasive aquatic plants in the Delta, which are controlled in Delta channels through chemical herbicides and mechanical removal (Ballard et al. 2009:6). However, it is not clear how often ammonia concentrations rise above those concentrations (Engle and Suverkropp 2010).

Research assessing the effects of nitrogen and phosphorus on phytoplankton in the Delta is far from complete due in part to the large number of physical, chemical, and biological interactions occurring in the Delta, e.g., Glibert et al. (2011). In addition to nutrients, Delta phytoplankton can be affected by light conditions, filtration feeders (e.g., *Corbula amurensis*, *Corbicula fluminea*), and microbial processing of organic carbon, to name a few factors (Sacramento Regional County Sanitation District 2009). Manipulation of all these factors to determine their relative contribution to Delta phytoplankton quantity/quality is a significant task that likely will require a broad array of experiments (both laboratory and field) and modeling studies to tease apart causal relationships.

The beneficial uses that could be affected most by ammonia concentrations include aquatic organisms (cold freshwater habitat, warm freshwater habitat, and estuarine habitat) or activities that depend on aquatic life (shellfish harvesting, commercial and sport fishing). Drinking water supplies (municipal and domestic supply) and recreational activities (water contact recreation, noncontact water recreation) are indirectly affected by nuisance eutrophication effects of ammonia (Table 8-1).

As mentioned above, the SRWTP discharge to the Sacramento River at Freeport is a large point source of ammonia in the Delta. In 2010, the Central Valley Water Board issued an updated NPDES permit for the SRWTP requiring nitrification (i.e., conversion of ammonia to nitrate) and partial denitrification (i.e., removal of nitrate). In its findings, the permit states: "However, as described above, the ammonia discharged by the Discharger is impacting beneficial uses of the Sacramento River, Delta and the Suisun Bay. Therefore, Best Practical Treatment and Control (BPTC) technologies in the form of nitrification and denitrification is required to assure that a pollution or nuisance will not occur and the highest water quality consistent with maximum benefit to the people of the State will be maintained" (Central Valley Water Board 2010b). The term BPTC appears in the state antidegradation policy, however BPTC is not defined specifically. BPTC is generally recognized to refer to best available and cost-effective methods that meet performance requirements, such as federal CWA requirements in the case of wastewater treatment plants, and maintain water quality standards. In the discussion leading up to this statement, many concerns regarding ammonia in the discharge are discussed, including potential toxicity concerns, inhibition of diatom primary production, algal community shifts, effects on dissolved oxygen, and nitrosamine formation during disinfection. Subsequently, the permit was appealed to the State Water Board, and the State Water Board upheld requirements related to ammonia removal (State Water Board 2012). Further lawsuits were also settled, and therefore the SRWTP will begin ammonia removal in 2021.

Existing Conditions in the Study Area

Most examined locations in the Delta have had low concentrations of ammonia-N in recent years (water years 2001–2006), with mean values typically ranging from 0.03 to 0.11 mg/L (Figure 8-8). The two exceptions are the Sacramento River at Hood and the San Joaquin River at Buckley Cove. The Hood station had a mean value of 0.27 mg/L, a median value of 0.23 mg/L, and a maximum value of 0.84 mg/L. The source of the majority of the ammonia-N at Hood is the SRWTP. The Buckley Cove station had instances of elevated ammonia prior to 2007, due to ammonia-N discharged from the City of Stockton Regional Wastewater Control Facility (RWCF). However, the City of Stockton has since installed a nitrifying biotower system that converts nearly all ammonia in the wastewater to nitrate in the final effluent that is discharged to the San Joaquin River. Therefore, data summarized for this monitoring location in Figure 8-8 is from water years 2008-2012, to reflect current conditions.

Mean values for the north-of-Delta area ranged from 0.01 mg/L at the Feather River at Oroville to 0.07 mg/L at the Sacramento River at Keswick (Table 8-7). South-of-Delta mean values ranged from 0.02 to 0.03 mg/L.

Table 8-7. Ammonia Concentrations at Selected North- and South-of-Delta Stations, Water Years 2001–2006[a]

	Ammonia (mg/L as N)				
Location	Samples	Min	Max	Mean	Median
Sacramento River at Keswick	25	0.03	0.24	0.07	0.03
Sacramento River at Verona	9	0.01	0.10	0.04	0.03
Feather River at Oroville	8	0.01	0.03	0.01	0.01
American River at WTP	14	0.01	0.06	0.02	0.02
California Aqueduct at Check 13	26	0.01	0.12	0.03	0.02
California Aqueduct at Check 29	20	0.01	0.04	0.02	0.01

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

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

Source: California Department of Water Resources 2009b

Time series data indicate that ammonia-N concentrations at the examined stations generally fluctuate on an annual basis (Figure 8-9 and Figure 8-10). Higher values have tended to occur during the months of November through March.

Regulatory criteria with respect to ammonia are as follows. Regarding narrative objectives, as stated in the San Francisco Bay Water Board Basin Plan and Central Valley Water Board Basin Plan, ammonia might be considered a biostimulatory substance because it is the preferred form of nitrogen for plant nutrient uptake, and a toxic compound under certain circumstances (e.g., high un-ionized ammonia concentrations). There are no numerical water quality criteria for the CTR or the Central Valley Water Board Basin Plan, and there is no California drinking water MCL associated with ammonia. The San Francisco Bay Water Board Basin Plan water quality objective of 0.025 mg/L ammonia-N 4-day average for fresh water refers to un-ionized ammonia, which is a function of ionized ammonia, pH, temperature, and salinity. Available data are inadequate to assess whether the sites examined herein exceeded this standard. Because the Central Valley Water Board Basin Plan and CTR lack objectives/criteria for ammonia, the Regional Water Board regulates ammonia through its narrative toxicity objective. Water Board staff rely on the USEPA National Recommended Water Quality Criteria for ammonia (U.S. Environmental Protection Agency 1999a, 2009a) to numerically interpret the narrative standard with regard to ammonia. The USEPA has established criteria for ammonia-N with respect to the toxicity of un-ionized ammonia-N, which is dependent on water temperature and pH (U.S. Environmental Protection Agency 1999a, 2009a). The 2009 document represents draft criteria. A final relevant threshold includes a recommended goal for sensitive crops of 1.5 mg/L-N (Ayers and Westcot 1994).

8.2.3.2 Boron

Background and Importance in Study Area

Boron is a naturally occurring compound found in sediments and sedimentary rocks in the form of borates (e.g., boron oxide, boric acid, borax). Natural weathering of rocks is thought to be the primary source of boron compounds in water and soil (Agency for Toxic Substances and Disease Registry 2007). The richest deposits in the United States are located in California (sediments and brines). Natural sources include releases to air from oceans, volcanoes, and geothermal steam. Total natural global releases of boron from weathering, volcanoes, and geothermal steam are approximately 360,000 metric tons per year (U.S. Environmental Protection Agency 2008a), while releases from seawater range from 800,000 to 4,000,000 metric tons per year (U.S. Environmental Protection Agency 2008b).

Human uses of boron compounds include production of glass, ceramics, soaps, fire retardants, pesticides, cosmetics, photographic materials, and high-energy fuels (U.S. Environmental Protection Agency 2008a). Anthropogenic releases of boron compounds occur through such pathways as air emissions (power plants, chemical plants, manufacturing facilities), soils (fertilizers, herbicide, and industrial wastes), and water (industrial wastewaters, municipal sewage) (Agency for Toxic Substances and Disease Registry 2007). Approximately 180,000 to 650,000 metric tons of boron are released annually into the atmosphere from the industries that use boron and boron-containing products (U.S. Environmental Protection Agency 2008b).

Even though it is found naturally in many fruits and vegetables, boron does not accumulate in human tissues (Waggot 1969; Butterwick et al. 1989). While boron may serve as a trace mineral nutrient for humans, it has potential detrimental health effects such as nausea, vomiting, swallowing difficulties, diarrhea, and rashes due to acute overdoses (U.S. Environmental Protection Agency 2008b). Related effects have occurred in animals. Aquatic plants and animals accumulate boron, but residues do not increase through the food chain (U.S. Environmental Protection Agency 2008a).

USEPA recently evaluated boron and its potential for contamination of drinking water supplies (73 Federal Register [FR] 44251–44261) and made a determination not to regulate boron with a National Primary Drinking Water Regulation. Because boron is not likely to occur at concentrations of concern when considering both surface and groundwater systems, USEPA believes that a National Primary Drinking Water Regulation does not present a meaningful opportunity for health risk reduction.

Agricultural supply uses, specifically crop irrigation, are the most sensitive receptor to boron because of issues related to boron deficiency (Nable et al. 1997) and boron toxicity (Chauhan and Powar 1978; Nable et al. 1997) in crops. Ayers and Westcot (1994) provide a discussion of boron toxicity to plants. Very sensitive plants, which include lemons and blackberries, may show signs of toxicity at concentrations less than 500 micrograms per liter (µg/L) but are not widely grown in the

Delta and areas upstream (refer to Chapter 14, *Agricultural Resources*, Table 14-2). Sensitive crops begin to show signs of toxicity between 500 and 750 μg/L and include a variety of fruit and nut trees that are commonly grown in the Delta.

In a study of groundwater from the Sacramento Valley aquifer, boron was detected in all 31 samples, in concentrations ranging from 12 μg/L to 1,100 μg/L (Dawson 2001). The median concentration was 42 μg/L. Two of the 31 samples had concentrations in excess of the then-current Health Advisory Level of 600 μg/L.

Assessment of how human atmospheric emission sources of boron in the Delta directly affect the Delta would be difficult, given the complexity of area meteorology. Such sources would need to be identified and undergo air transport modeling to determine deposition rates onto land and water in the study area. Human activities related to boron land and water emissions may be more easily quantified. Land applications of boron in the Delta may include fertilizer, herbicide, and industrial waste; water sources may include industrial wastewaters, municipal sewage, and agricultural return drains.

Approximately 85% of the boron load to the Delta originates from the western side of the lower San Joaquin River, represented by the Grasslands and Northwest Side Subareas. Agricultural drainage, discharge from managed wetlands, and groundwater accretions are the principal sources of boron loading to the river. Additionally, large-scale, out-of-basin water transfers have reduced the assimilative capacity of the river, thereby exacerbating the water quality issues associated with boron.

The source analysis contained in the Central Valley Water Board's TMDL describes the magnitude and location of the sources of boron loading to the lower San Joaquin River. The watershed is divided into seven component subareas to elucidate differences in boron loading between different geographic areas (Figure 8-11).

Contributions of boron to the Delta also originate from other sources, including the Sacramento River, the eastside tributaries, Delta agricultural return drains, and San Francisco Bay. The next section describes how these sources, in addition to the San Joaquin River, contribute to boron concentrations in the Delta.

Existing Conditions in the Study Area

Most examined locations in the Delta have had low concentrations of boron in recent years (water years 2001–2006), with mean values ranging from 0.1 to 0.5 mg/L (Figure 8-12). The Sacramento River at Mallard Island location had a mean value of 0.5 mg/L. Maximum boron values were in the 0.1 to 1.5 mg/L range, with higher values at the San Joaquin River near Vernalis (0.8 mg/L) and the Sacramento River at Mallard Island (1.5 mg/L).

Minimal data were available for the north-of-Delta area, while the mean value for the south-of-Delta stations was 0.2 mg/L (Table 8-8).

Time series data indicate that boron concentrations at the examined stations generally fluctuate on an annual basis (Figure 8-13 and Figure 8-14). Higher values have tended to occur during the months of November through March.

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

	Boron (dissolved, mg/L)				
Location	Samples [a]	Minimum	Maximum	Mean	Median
Sacramento River at Keswick	1	—	—	0.1	—
Sacramento River at Verona	n/a	—	—	—	—
Feather River at Oroville	n/a	—	—	—	—
American River at WTP	n/a	—	—	—	—
California Aqueduct at Check 13	64	0.1	0.4	0.2	0.2
California Aqueduct at Check 29	74	0.1	0.3	0.2	0.2

Notes:
mg/L = milligrams per liter
n/a = not available
WTP = water treatment plant
[a] Sample size represents water quality samples having values at or greater than the reporting limit.
Source: California Department of Water Resources 2009b.

Regulatory criteria with respect to boron are as follows. Because boron is not a priority pollutant, there are no criteria established for boron in the National Toxics Rule (NTR) or CTR. The Bay-Delta WQCP also does not contain objectives for boron, and there are no California drinking water MCLs. The lower San Joaquin River is listed on the Section 303(d) list as impaired for boron. The impairment extends from downstream of the Mendota Pool to the Airport Way Bridge near Vernalis. As an outcome of the Section 303(d) listing for the lower San Joaquin River and associated TMDL development process, the Central Valley Basin Plan contains a monthly average boron objective for the lower San Joaquin River to Vernalis of 800 μg/L for the irrigation season (March 15 through September 15), and 1,000 μg/L for the non-irrigation season (Central Valley Water Board 2009a). Additionally, the San Francisco Bay Basin Plan contains agricultural objectives, with a lower value of 500 μg/L for irrigation and a value of 5,000 μg/L for stock watering.

8.2.3.3 Bromide

Background and Importance in the Study Area

Bromide is an inorganic anion that is generally present at low concentrations in freshwater bodies. Bromide has the potential to most directly affect municipal and domestic supply, agricultural supply, and industrial service supply beneficial uses (Table 8-1). Typical drinking water source concentrations of bromide in the United States average 0.062 mg/L (Amy et al. 1998); typical seawater concentrations of bromide are 65–67 mg/L (Morris and Riley 1966: 699; Hem 1985).

In addition to its contribution to salinity, bromide is of concern in water as a precursor to the formation of bromate, bromoform and other brominated THMs, and HAAs, which are potentially harmful DBPs in municipal water supplies (CALFED Bay-Delta Program 2003). These compounds have been shown to cause carcinogenic, negative developmental, and negative reproductive effects in laboratory animals (U.S. Environmental Protection Agency 2010). DBP formation is increased when the source water contains both dissolved organic compounds and halides (CALFED Bay-Delta Program 2007a). Bromate forms when water that contains bromide is disinfected with ozone, a technique employed by many drinking water treatment plants as an alternative to chlorination to reduce DBP formation (in compliance with THM Rule, DBP Stage 1 and Stage 2 Rules).

The primary source of bromide in the Delta is seawater intrusion from the west (CALFED Bay-Delta Program 2000). As discussed in the salinity subsection with respect to salinity, bromide in the Delta is the result of a complex interplay between hydrology (dilution), water operations, bromide sources, and hydrodynamics. Because there are several major water diversions in the Delta for municipal water supplies, bromide in the source water is of concern because of the potential for DBP formation. Bromide concentrations also can be generally higher in the lower San Joaquin River and Delta island agricultural drainage as a result of agricultural irrigation practices and evaporative concentration that occurs in water diverted from the Delta for irrigated agriculture. Recirculation, or the process of agricultural drainage entering the San Joaquin River and its subsequent and repetitive diversion for agricultural practices, has also contributed to elevated bromide concentrations in the San Joaquin River.

Median concentrations at the southern Delta export pumps are about 16 times higher than in the Sacramento River at Hood, and other tributaries upstream of any seawater influence (CALFED Bay-Delta Program 2007b). Based on historical data and current conditions, bromide concentration in water diverted from the southern Delta can be estimated from EC or chloride data, with chloride being the most reliable indicator (Public Policy Institute of California 2008).

Existing Conditions in the Study Area

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

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

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

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

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

8.2.3.4 Chloride

Background and Importance in the Study Area

Chloride is an inorganic anion generally found at low concentrations in freshwater bodies; however, chloride is the dominant anion in seawater at about 19,000 mg/L (Hem 1985). Chloride commonly occurs in nature as salts of sodium, potassium, and calcium. Tidal seawater intrusion is the primary source of chloride in the Delta. Delta tidal water containing elevated levels of chloride, which is subsequently diverted for agricultural irrigation uses on Delta islands or exported from the Delta via the Banks and Jones pumping plants to the San Joaquin valley, returns to the Delta as agricultural drainage (CALFED Bay-Delta Program 2007a). Chloride concentrations in these return flows to the Delta can contain additional chloride as a result of evaporative concentration of salts that occurs in water diverted for agricultural irrigation. Chloride is a potential concern for crop yields in agricultural irrigation water, and excess chloride can impart an unpalatable, “salty” taste in drinking water supplies. Taste thresholds for chloride range from 200 to 300 mg/L, depending on the associated cation (World Health Organization 2003).

Existing Conditions in the Study Area

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

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

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

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

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

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

The Bay-Delta WQCP contains chloride objectives for municipal and industrial water supply beneficial uses protection, including a maximum mean daily concentration of 250 mg/L year-round at the five major municipal water supply diversion locations—Contra Costa Canal at pumping plant #1, West Canal at mouth of Clifton Court Forebay, Jones pumping plant, Barker Slough at North Bay Aqueduct, and Cache Slough at the City of Vallejo intake (abandoned). This standard has been exceeded at the CCWD pumping plant #1 on several occasions and, on rare occasions, at the Delta-Mendota Canal headworks. Additionally, the Bay-Delta WQCP contains a chloride objective for Contra Costa Canal at pumping plant #1 or the San Joaquin River at Antioch Water Works intake that specifies the number of days each calendar year that the maximum mean daily chloride concentration must be less than 150 mg/L (must be provided in intervals of not less than 2 weeks' duration). The days per year depend on water-year type, ranging from 155 days for critical water-year types to 240 days in wet water-year types. The industrial uses for which this objective was established (cardboard manufacturing in Antioch) no longer exist; however, the objective has been retained for general municipal use protection (CALFED Bay-Delta Program 2007a). The secondary MCL for chloride is specified as a range: 250 mg/L (recommended), 500 mg/L (upper), and 600 mg/L (short-term) and is applicable to all surface waters in the affected environment, other than the Delta, that have the municipal and domestic supply beneficial use designation. The USEPA's recommended chloride ambient water quality criteria for the protection of freshwater aquatic life are 230 mg/L (chronic 4-day average) and 860 mg/L (acute 1-hour average). The San Francisco Bay Water Board Basin Plan has a 355 mg/L chloride objective for agricultural supply. CCWD has a goal of delivering treated water that has less than 65 mg/L chloride.

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

8.2.3.5 Dioxins, Furans, and Polychlorinated Biphenyls

Background

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

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

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

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

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

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

Importance in the Study Area

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

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

Existing Conditions in the Study Area

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

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

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

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

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

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

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

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

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

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

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

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

Sampling at south-of-Delta locations at California Aqueduct Check 13 and Check 29 for the same constituents also resulted in no detections during the same time period. Sampling at the north-of-Delta locations (approximately 35 to 60 visits per site) resulted in multiple detections at the Sacramento River at Keswick, the Feather River at Oroville, and the Sacramento River at Verona; however, the sampling and analytical protocol for these data were not available, and the validity of the data could not be confirmed.

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

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

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

8.2.3.6 Dissolved Oxygen

Background and Importance in the Study Area

DO is a measure of the concentration of oxygen carried in a water body. Water gains oxygen from the atmosphere and from aquatic plant photosynthesis. DO in water is consumed through respiration by aquatic animals, decomposition of plant and animal material (microbial respiration), sediment oxygen demand, and various chemical processes. DO depletion affects primarily aquatic life beneficial uses, which include warm freshwater habitat; cold freshwater habitat; migration of aquatic organisms and spawning, reproduction, and/or early development; estuarine habitat; and rare, threatened, or endangered species (Table 8-1). The most sensitive receptors are cold freshwater habitat and migration of aquatic organisms and spawning, reproduction, and/or early development because of the relatively high DO requirements of coldwater fish, such as Chinook salmon and steelhead. Low DO concentrations in water bodies can have adverse effects on aquatic life, including fish kills, fish egg mortality, and growth rate reductions, and can serve as a barrier to migration of anadromous fish such as Chinook salmon (Central Valley Water Board 2005; Schmieder et al. 2008).

Seasonal declines in DO are typical in many estuaries, and DO concentrations are negatively affected by increases in water temperature (Schmieder et al. 2008). Nutrient loading from point and nonpoint sources can result in increased algal growth, thereby causing higher DO levels when blooms are photosynthesizing and lowering DO levels during night time hours and when the blooms die and decompose (Schmieder et al. 2008) Activities that disturb sediments and aquatic plants such as dredging and clearing of aquatic plants from ship channels can cause increased decomposition of organic material, resulting in decreases in DO concentrations (Greenfield et al. 2007; Schmieder et al. 2008). However, removal of aquatic plants, especially invasive surface-covering plant species, may allow light to better penetrate the water column, increasing photosynthesis and thereby increasing DO concentrations (Greenfield et al. 2007). On the other hand, submerged macrophytes tend to cause suspended sediment to settle and increase water clarity (Madsen et al. 2001)

Although localized incidents of depressed DO concentrations may occur in the study area, notable low DO concentrations occur in the Stockton Deep Water Ship Channel, and to a lesser extent in Middle River and Old River. Additionally, low DO conditions occur in areas of the Suisun Marsh channels, particularly in small, isolated, backwater slough areas that receive little exchange of water (San Francisco Bay Water Board 2012). The San Joaquin River experiences regular periods of low DO concentrations in the Stockton Deep Water Ship Channel from the city of Stockton downstream to Disappointment Slough. These conditions often violate the Basin Plan water quality objective for DO in the Stockton Deep Water Ship Channel; they occur most often during the months of June through October, although severe conditions have occurred in the winter months as well (Central Valley Water Board 2005; Schmieder et al. 2008). Data also show that the frequency and severity of low DO concentrations are generally worse during dryer water years (Table 8-11) (Central Valley Water Board 2005). Jassby and Van Nieuwenhuyse (2005) found that low DO was due to a combination of low flow and high nutrient loads. The 2012 draft *Pulse of the Delta* reports that DO in the lower San Joaquin River has increased since the early 2000s, primarily due to the implementation of algae removal ponds and nitrification treatment by the Stockton RWCF. However, monthly minimum values continue to fall frequently below the statutory limits of 5 mg/L (December 1 to August 31) and 6 mg/L (September 1 to November 30) (Aquatic Science Center 2012:56).

1 **Table 8-11. Temporal Distribution of Low Dissolved Oxygen Impairment**

Year		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1983	Excursion rate (%)[a]	n/a	n/a	n/a	n/a								
	Minimum (DO)[b]												
1984	Excursion rate (%)[a]				1	7	84	91	62	2			
	Minimum (DO)[b]				*4.4*	*3.9*	*3.0*	*2.8*	*4.0*	*4.7*			
1985	Excursion rate (%)[a]				6		48	78	15				
	Minimum (DO)[b]				*4.4*		*3.3*	*3.5*	*4.2*				
1986	Excursion rate (%)[a]	29				5		21	9				
	Minimum (DO)[b]	*4.4*				*3.1*		*4.5*	*4.8*				
1987	Excursion rate (%)[a]					44	43	3		29		<1	
	Minimum (DO)[b]					*3.5*	*3.6*	*4.6*		*3.9*		*4.9*	
1988	Excursion rate (%)[a]	51	52	52			3		10	62			
	Minimum (DO)[b]	*3.5*	*3.3*	*3.8*			*4.8*		*4.4*	*2.3*			
1989	Excursion rate (%)[a]			65	<1		37	2		38	14		
	Minimum (DO)[b]			*3.7*	*4.9*		*4.1*	*4.8*		*2.4*	*4.2*		
1990	Excursion rate (%)[a]			1	5	3	11	<1	<1				
	Minimum (DO)[b]			*4.8*	*4.6*	*4.7*	*4.5*	*4.8*	*4.9*				
1991	Excursion rate (%)[a]		<1	8	37	34	1	5	14	55	99		
	Minimum (DO)[b]		*4.7*	*4.3*	*4.4*	*4.2*	*4.9*	*4.7*	*4.4*	*1.8*	*0.4*		
1992	Excursion rate (%)[a]		21	100	60	29	43	39	97	100	77	6	
	Minimum (DO)[b]		*3.1*	*2.1*	*1.9*	*3.6*	*3.7*	*3.7*	*2.8*	*0.5*	*1.3*	*4.7*	
1993	Excursion rate (%)[a]			25	8	2	29	54	87	81	23		1
	Minimum (DO)[b]			*3.7*	*4.7*	*4.8*	*3.6*	*3.7*	*2.6*	*2.6*	*1.6*		*4.8*
1994	Excursion rate (%)[a]		2		<1		61	80	63	16	46		
	Minimum (DO)[b]		*4.8*		*4.9*		*4.0*	*3.7*	*3.4*	*4.3*	*3.2*		
1995	Excursion rate (%)[a]							2	61	6			
	Minimum (DO)[b]							*4.8*	*3.0*	*4.6*			
1996	Excursion rate (%)[a]	15	n/a				8	63	94	89	15	18	
	Minimum (DO)[b]	*4.1*					*4.8*	*3.4*	*2.0*	*2.5*	*3.7*	*4.3*	
1997	Excursion rate (%)[a]						14	74	88	83	44	2	11
	Minimum (DO)[b]						*3.6*	*3.1*	*3.3*	*2.4*	*2.2*	*4.7*	*4.5*
1998	Excursion rate (%)[a]												
	Minimum (DO)[b]												
1999	Excursion rate (%)[a]					n/a	<1	48	20	43	100	93	39
	Minimum (DO)[b]						*4.9*	*3.0*	*3.1*	*1.8*	*1.7*	*3.8*	*3.8*
2000	Excursion rate (%)[a]	4	11				11	61	28	1			12
	Minimum (DO)[b]	*4.7*	*3.9*				*2.9*	*2.9*	*2.7*	*4.8*			*4.7*
2001	Excursion rate (%)[a]	5					69	75	73	61			n/a
	Minimum (DO)[b]	*4.7*					*2.5*	*2.3*	*3.0*	*2.9*			
Avg[c]		5	6	14	6	6	27	34	37	36	23	3	4

Notes:

DO = dissolved oxygen.

For each month of the year in the table, the upper number presented is the percentage of hourly DO measurements below 5.0 mg/L recorded that month. If a cell is blank, there were no DO measurements below 5.0 mg/L that month. If a cell contains "n/a," no data were recorded at all for that month. The lower italicized number presented for each month is the minimum DO concentration measured that month. The average rate (weighted to account for months with partial data sets) for the 19-year period is shown in the bottom row.

[a] Excursion rate is the number of hourly average DO measurements from the California Department of Water Resources monitoring station below 5.0 mg/L divided by the total number of such measurements recorded that month, shown as a percentage.

[b] The minimum hourly average DO measurement for the month in mg/L.

[c] Average excursion rate is not the simple average of all monthly data—it is weighted to account for months that had only partial data sets.

Source: Central Valley Water Board 2005.

The Stockton Deep Water Ship Channel is a portion of the San Joaquin River that has been dredged by the U.S. Army Corps of Engineers (USACE) to a depth of 35 feet to allow the navigation of cargo vessels between San Francisco Bay and the Port of Stockton (Central Valley Water Board 2005). Upstream of the channel, the San Joaquin River is otherwise about 10 feet deep. The entire length of the channel is within the tidal prism and experiences regular flow reversals (Central Valley Water Board 2005). Increased water depth increases the time required to aerate the water column and the residence time of water in the channel and promotes stronger thermal stratification during summer months, which lessens the amount of mixing; these conditions negatively affect DO concentrations in the channel (Schmieder et al. 2008).

The occurrence of low DO concentrations also coincides with periods of low-flow conditions, indicating that flow and channel morphology in the San Joaquin River are important factors influencing DO conditions in the Stockton Deep Water Ship Channel. Table 8-11 demonstrates that the frequency of violations of the 5.0 mg/L objective since 1983 is highest, on the average, during the months of June through October (Central Valley Water Board 2005; California Department of Water Resources 2009b). Oxygen concentrations less than 5.0 mg/L, however, have occurred during all months of the year. The frequency of violations is worse in dry years (1991 through 1993 and less frequent during wet years (1998) (Central Valley Water Board 2005). An analysis of more than 20 years of time series data suggests that the low DO problem is attributable to a combination of river discharge, river phytoplankton, and formerly discharges of elevated ammonia levels from the Stockton RWCF, (which releases approximately 53 mgd of effluent), including large seasonal wastewater loading from food canneries (Jassby and Van Nieuwenhuyse 2005).

Existing Conditions in the Study Area

All examined locations in the Delta had mean DO concentrations above 8.4 mg/L in recent years (water years 2001–2006) except the San Joaquin River at Buckley Cove (6.8 mg/L, Figure 8-21). DO minima were below 7.0 mg/L at approximately 40% of examined stations including the Sacramento River at Hood (4.8 mg/L), which was the only value at that location below 6.0 mg/L during that time period, the San Joaquin River at Vernalis (4.3 mg/L), the Sacramento River at Mallard Island (6.5 mg/L), and the San Joaquin River at Buckley Cove (3.3 mg/L), which falls under the Stockton Deep Water Ship Channel water quality criteria. Mean values for the north-of-Delta area ranged from 9.6 mg/L at the American River at WTP to 11.0 mg/L at the Sacramento River at Keswick (Table 8-12). South-of-Delta mean values were lower than north-of-Delta stations examined (8.2 to 8.9 mg/L).

Time series data indicate that DO concentrations at the examined stations generally fluctuate on an annual basis (Figure 8-22 and Figure 8-23). Higher values have tended to occur during the months of November through March, with lower values occurring during June through September. The San Joaquin River at Buckley Cove site has continued to experience low DO concentrations, primarily in the late summer to late fall period.

Table 8-12. Dissolved Oxygen Concentrations at Selected North- and South--of-Delta Stations, Water Years 2001–2006[a]

	Dissolved Oxygen (mg/L)				
Location	Samples	Minimum	Maximum	Mean	Median
Sacramento River at Keswick	32	7.3	15.6	11.0	11.1
Sacramento River at Verona	15	5.4	13.0	10.0	10.0
Feather River at Oroville	29	7.4	12.5	10.1	10.2
American River at WTP	120	6.5	13.0	9.6	9.5
California Aqueduct at Check 13	68	5.7	10.9	8.9	9.0
California Aqueduct at Check 29	49	0.0	12.6	8.2	9.5

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

The 2006 Bay-Delta WQCP, Region 2 Basin Plan, and Region 5 Basin Plan all contained DO objectives applicable to water bodies in the affected environment. A DO objective for protection of fish and wildlife beneficial uses exists in the 2006 Bay-Delta WQCP for the San Joaquin River between Turner Cut and Stockton: 6.0 mg/L from September through November (State Water Resources Control Board 2006). The Region 5 Basin Plan has the same objective for the San Joaquin River, and the Region 2 Basin Plan incorporates by reference the DO objectives in the 2006 Bay-Delta WQCP (Central Valley Water Board 2009a; San Francisco Bay Water Board 2007). The Region 5 Basin Plan contains the following additional numerical DO objectives for the Delta (Central Valley Water Board 2009a).

- At least 7.0 mg/L in the Sacramento River below the I Street bridge and west of the Antioch Bridge.
- At least 5.0 mg/L at all other locations and times, unless the water body has been constructed for special purposes and fish are excluded or not important as a beneficial use.

In addition, the Region 5 Basin Plan requires that water bodies outside the legal boundary of the Delta meet certain saturation levels and not be reduced below the following levels at any time.

- Waters designated WARM, 5.0 mg/L.
- Waters designated COLD, 7.0 mg/L.
- Waters designated SPWN, 7.0 mg/L.

The Region 2 Basin Plan also has minimum DO objectives for warm and coldwater habitat of 5.0 mg/L and 7.0 mg/L, respectively (San Francisco Bay Water Board 2007). Lastly, the Region 5 Basin Plan contains a DO objective for the Sacramento River from Keswick Dam to Hamilton City of 9.0 mg/L (or 95% saturation) from June 1 to August 31, and an objective of 8.0 mg/L for the Feather River from Fish Barrier Dam at Oroville to Honcut Creek from September 1 to May 31 (Central Valley Water Board 2009a). There are no DO criteria in the CTR (as it is not a priority pollutant), nor is there a California drinking water MCL for DO.

Water bodies in the affected environment listed on the state's CWA Section 303(d) list as impaired because of low DO levels include Middle River, Old River, the Stockton Deep Water Ship Channel and portions of other sloughs and rivers in the southern, eastern, and western Delta (State Water

Resources Control Board 2011). A TMDL for the Stockton Deep Water Ship Channel was approved by USEPA on February 27, 2007, and includes a Region 5 Basin Plan Amendment that contains a Control Program to reduce the amount of oxygen-demanding substances and their precursors in the San Joaquin River. The TMDL takes a phased approach to allow more time to gather additional informational on source and linkages to the DO impairment, while at the same time moving forward on improving DO conditions. TMDLs for listed water bodies are proposed for completion in 2012 through 2021 (State Water Resources Control Board 2011).

Actions that are being taken to address DO conditions in the Stockton Deep Water Ship Channel, or have assisted in improving DO conditions, include the construction of water aeration devices by the Port of Stockton at the confluence of the San Joaquin River and Stockton Deep Water Ship Channel and by DWR with a new aeration facility at the west end of the Port of Stockton docks in the Deep Water Ship Channel. DWR's aeration facility is much larger than the Port of Stockton system and injects pure oxygen into the Deep Water Ship Channel through a 200-foot-long diffuser during periods when DO conditions approach, or drop below, 5 mg/L. Testing of the facility during 2008–2010 indicates that the aeration facility can help prevent exceedances of the DO objectives but is not sufficient to prevent low DO under all possible upstream oxygen loading conditions (ICF International 2010). Additionally, the Stockton RWCF constructed nitrifying bio-towers that became operational in 2006, which, by converting ammonia to nitrate, reduce the historical ammonia loading rate and its associated oxygen demand to the San Joaquin River by about 90%.

8.2.3.7 Salinity and Electrical Conductivity

Background and Importance in the Study Area

Salinity is the concentration of dissolved salts in water. Typical salts found include the major cations (calcium, magnesium, sodium, and potassium) and anions (sulfate, chloride, fluoride, bromide, bicarbonate, and carbonate). The relative proportion of the anions and cations are different in typical fresh water and seawater, with sodium and chloride dominating seawater salinity. The composition of dominant cations and anions in fresh water can vary to a much greater degree. Salinity can be measured in a variety of ways, including chloride concentration, TDS concentrations, and EC. While a recognized international measurement scale of salinity exists (Practical Salinity Units), the term is not commonly used, and the measured parameters EC and TDS are more often used interchangeably to refer to generalized effects of salinity. The beneficial uses most affected by salinity concentrations are municipal, agricultural, and industrial water supply.

Additionally, changes in salinity, including tidally influenced interfaces between fresh water and saltwater in the Delta, directly affect aquatic organisms and indirectly affect aquatic and wildlife habitats (warm freshwater habitat, cold freshwater habitat, estuarine habitat). Related beneficial uses such as commercial and sport fishing and shellfish harvesting also are affected.

EC and TDS values tend to be highly correlated because the majority of chemicals that contribute to TDS are charged particles that impart conductance of water. EC often is used to measure salinity because a simple electronic probe can measure salinity directly in the field and be recorded at frequent intervals (e.g., every 15 minutes), making it a cost-effective measurement. Other measures require field collection of water samples and laboratory analysis, which can be expensive. EC units commonly used are micromhos per centimeter (µmhos/cm) and milliSiemens per centimeter (mS/cm), and both are measures of the conductivity of the water.

Salinity can originate from natural sources such as seawater and rainfall-induced leaching of salts from soils. Anthropogenic sources of salinity include drainage from irrigated agricultural lands and managed wetlands, agricultural chemical soil additives, municipal and industrial wastewater discharges, and urban stormwater. Salinity also increases through evaporative concentration, which occurs during the dry, warm months of the year in ditches, canals, and reservoirs. Also, when excess water is applied to land for crop irrigation, the excess runs off to drainage ditches where it can be subject to evaporative concentration. Concern about salinity involves three main issues: drinking water, crop irrigation, and biota/habitat. Elevated concentrations of salinity result in poor-tasting water and also limit the ability to recycle wastewater for nonpotable uses (e.g., landscape irrigation). The TDS concentration of water from Sierra Nevada streams is typically less than 100 mg/L, while drinking water from the Delta typically has TDS concentrations from 150 to 300 mg/L, with concentrations occasionally exceeding 500 mg/L (CALFED Bay-Delta Program 2007a). Bromide, a constituent most commonly found in seawater and marine sediments, is a precursor to the formation of DBPs in drinking water facilities, which can be harmful to humans and animals (see Section 8.1.3.3 for a detailed discussion of bromide). In addition, industrial processes that require low-salinity water can be negatively affected. Salt removal during the water purification process (for either drinking or process water) is presently very expensive.

When salinity concentrations in irrigation water are too high, yields for salt-sensitive crops may be reduced. Salinity can decrease water available to the plant and cause plant stress (CALFED Bay-Delta Program 2007a). There are also fish, wildlife, and aquatic plant species that have adapted to naturally occurring salinity ranges in the Bay-Delta system, with specific salinity requirements at certain life stages in order to survive. There is evidence to suggest that the artificial stabilization of salinity, which has been undertaken in the Delta to maximize drinking and agricultural water quality, may create habitat more suitable for invasive species than for native species (Lund et al. 2007).

The primary source of salinity in the Delta is seawater intrusion from the west (CALFED Bay-Delta Program 2000), which occurs at greater magnitudes when Delta outflow to San Francisco Bay is low. Salinity also is elevated in the San Joaquin River inflows as a result of irrigated agricultural drainage on southern San Joaquin Valley soils of marine origin that are naturally high in salts, and from salt in Delta waters that are used for irrigation and returned back to the Delta. From a broad viewpoint, salinity is determined as interplay between the amount of fresh water entering the Delta from the major tributaries (e.g., Sacramento and San Joaquin Rivers) and seawater from San Francisco Bay. During the late winter and spring months of seasonally elevated runoff and flows, and in particular during wet years with high levels of runoff from interior California, the elevated freshwater flows limit the extent of seawater intrusion into the Delta from the Bay. During low-flow summer and fall months, and dry water-year types with low levels of runoff, the lower freshwater flows result in greater amounts of seawater intrusion (Figures 8-6 and 8-7). Maximum salinity intrusions into the Study area from the Bay are greatest during low-precipitation years.

The volume of Delta channels subject to daily tidal action is an important factor affecting the extent of high-salinity seawater intrusion and also influences the behavior of saline water once in the Delta. As described above, salinity in the Suisun Marsh channels are similarly affected by tidal seawater intrusion, and the SMSCG facilities and operations were developed in the late 1980’s in response to the need to better manage changing salinity conditions. Increases in channel volume associated with levee failures on Delta islands (Mierzwa and Suits 2005) can result in daily tidal exchange moving considerably farther inland compared to conditions with the island levees intact. The June 2004 failure of a levee at Jones Tract, which flooded both upper and lower Jones Tract, resulted in substantial increased salinity conditions in the southern and central Delta (Mierzwa and Suits 2005).

The description of salinity in the Delta provided above is intended as an overview; salinity in the Delta can vary greatly in time and space (CALFED Bay-Delta Program 2007a) with many contributing factors, including those following.

- Hydrology (precipitation and runoff).
- Water operations (reservoir releases, channel barrier operations, diversion pumping rates).
- Watershed sources (agriculture, managed wetlands, natural leaching, municipal and industrial discharges).
- Hydrodynamics (geometry of water bodies, meteorology, salinity gradients, freshwater inputs, tidal action).

Existing Conditions in the Study Area

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

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

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

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

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

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

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

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

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

Background

Emerging water quality contaminants represent a broad range of chemicals that have not traditionally been part of monitoring programs because they were not deemed important until recently or the ability to quantify them had not been possible until recent laboratory advances allowed their detection. As such, data for these parameters in the study area are relatively sparse. The beneficial uses most directly affected by emerging pollutant concentrations are aquatic organisms (cold freshwater habitat, warm freshwater habitat, and estuarine habitat) and drinking water supplies (municipal and domestic supply) (Table 8-1). The focus of the following section is on three classes of emerging contaminants: EDCs, PPCPs, and nitrosamines (e.g., NDMA).

Endocrine-Disrupting Chemicals

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

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

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

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

WTPs are just beginning to examine their ability to treat for EDCs, with an encouraging degree of success (e.g., Snyder 2008; Benotti et al. 2009; Contra Costa Water District 2009). Related research suggests that estrogen compounds can be biodegraded in the stream sediments below plant outfalls (Bradley et al. 2009).

Pharmaceuticals and Personal Care Products

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

PPCPs in the environment have not yet been shown to adversely affect human health, but some studies suggest that they contribute to ecological harm (U.S. Environmental Protection Agency 2009c). PPCPs have been found in most places sampled but typically at very low concentrations. Research to study the long-term exposure to very low PPCP concentrations is in its infancy. Concern exists because so much is unknown about the effects of PPCPs and because the number of PPCPs is growing.

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

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

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

Nitrosamines

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

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

Importance in the Study Area

Studies of EDCs and PPCPs in California waters are, like the national studies, typically less than 10 years old. A few of these studies are highlighted in the following sections.

In 2001 and 2002, a survey of raw and treated drinking water from four water filtration plants in San Diego County showed the occurrence of several PPCPs including phthalate esters, sunscreens, clofibrate, clofibric acid, ibuprofen, triclosan, and DEET (Loraine and Pettigrove 2006). This is important because on average, roughly a third of the water in San Diego County originates from the Delta via conveyances of the SWP. According to the study, occurrence and concentrations of these compounds were highly seasonally dependent, and reached maximums when the flow of the San Joaquin River was low and the quantity of imported water was high. The maximum concentrations of the PPCPs measured in the raw water were correlated with low-flow conditions in the Delta that feed the SWP.

Sampling in the Bay-Delta system in 2002 and 2003 resulted in detection of several EDCs and PPCPs (Hoenicke et al. 2007). In this study, the authors reported flame-retardant compounds, pesticides and insecticide synergists, insect repellents, PPCPs, plasticizers, non-ionic surfactants, and other manufacturing ingredients in water, sediment, and biological tissue samples. Several of these compounds, especially polybrominated diphenyl ether flame retardants, exhibited concentrations of environmental concern. The highest tissue concentrations of total polybrominated diphenyl ethers in bivalves (oysters, mussels, and clams) were detected in samples near the outlets of the Sacramento and San Joaquin Rivers. Another study evaluated the occurrence and fate and transport of 33 target analytes representing EDCs, PPCPs, and other organic chemicals in wastewater from quarterly samples (April 2008–2009) collected at 11 locations in the Sacramento River, Delta, and California Aqueduct, along with similar watershed sample locations from the Santa Ana River and imported Colorado River water distribution systems in southern California (Guo et al. 2010). With the exception of the American River sample, all of the Sacramento River/Delta/Aqueduct sample locations had one or more target analytes detected. The median concentration of individual analytes was <30 ng/L, except for diuron (81 ng/L), an agricultural pre-emergent herbicide that is used extensively in the region. Maximum concentrations for some analytes exceeded 100 ng/L. The study determined that analyte concentrations were generally lower in locations upstream of domestic WTPs, indicating that wastewater effluent discharges are the likely dominant sources of most PPCPs detected.

A preliminary screening study of surface waters along the northern California coast and the Central Valley took place between 2003 and 2005 to determine whether chemicals associated with agricultural and urban land uses could be potential sources of EDCs (de Vlaming et al. 2006). The authors concluded that there was no strong estrogenic activity equivalent to assay positive control.

In 2006, CCWD participated in a study to examine the toxicological relevance of EDCs and PPCPs in both raw source and treated water (Contra Costa Water District 2009). Of the 62 compounds analyzed, only five were detected in the treated water: sulfamethoxazole (pharmaceutical), meprobamate (pharmaceutical), atrazine (herbicide—endocrine disruptor), triclosan (pharmaceutical), and dioctyl phthalate (used to make plastics—endocrine disruptor). The study concluded that detection occurred at low concentrations and should not pose any health threats.

Regarding nitrosamines, while several studies have examined NDMA and other nitrosamine formation in water and WTPs, few studies have examined NDMA or other nitrosamines in the study area. A study conducted in the Delta concluded that locations downstream of WTPs had the highest levels of NDMA precursors, as measured by NDMA formation potential, although actual NDMA concentrations were low. Formation potential as a result of diuron in the samples was low (DiGiorgio 2009).

Existing Conditions in the Study Area

Data for most EDCs, PPCPs, and nitrosamines in the Delta and the north- and south-of-Delta locations are very sparse because most compounds are not typically part of water quality sampling programs. The aforementioned studies represent the most current information on the monitoring of these compounds in the Delta. This reality lead EPA to recently conclude in its Advanced Notice of Proposed Rule Making regarding water quality challenges in the Delta, “Although there is not sufficient data in the published literature to adequately assess the ecological implications of these compounds in the Bay Delta Estuary, there is ample evidence to warrant additional attention” (U.S. Environmental Protection Agency 2011:48). As such, EPA included emerging contaminants on its list of likely stressors affecting aquatic resources in the Delta (U.S. Environmental Protection Agency 2011:20, 48; 2012a:3).

Regulatory criteria with respect to emerging pollutants are as follows. Numerical water quality objectives for the CTR, Central Valley Water Board Basin Plan, San Francisco Bay Water Board Basin Plan, or California drinking water MCLs for pollutants that act as EDCs are discussed in previous constituent subsections: mercury, other trace metals, dioxins, PAHs, PCBs, and pesticides. Listings for emerging pollutants on the Section 303(d) list are limited to these aforementioned subsections as well. With regard to Basin Plan narrative objectives, emerging pollutants might fall under the *population and community ecology* or *toxic* categories. Finally, in addition to the aforementioned DPH public health goal (3 ng/L for NDMA) and notification levels for some nitrosamines, three nitrosamines (NDMA, NDPA, and N-Nitrosodiphenylamine) are listed in the CTR (0.00069, 0.005, 5.0 µg/L, respectively, for consumption of water and organisms).

8.2.3.9 Mercury

Background

Mercury and its more biologically available methylated form is an element of statewide concern. Mercury present in the Delta, its tributaries, Suisun Marsh, and San Francisco Bay today is derived both from current processes and as a result of historical deposition. The majority of the mercury present (and hence the impacts on beneficial uses) is the result of historical mining of mercury ore in the Coast Ranges (via Putah and Cache Creeks to the Yolo Bypass) and the extensive use of elemental mercury to aid gold extraction processes in the Sierra Nevada (via Sacramento, San Joaquin, Cosumnes, and Mokelumne Rivers) (Alpers et al. 2008:6; Wiener et al. 2003). Residual mercury in soils affected by historical mining continues to contribute to mercury concentrations in water and sediments of the Delta and its tributaries. The mercury supplied from historical gold mining processes appears to be the most bioavailable of the two primary sources because that mercury was purified prior to use rather than left as more refractory ore and tailings (Central Valley Water Board 2008a).

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 or wetlands. These environments tend to be more stagnant, with reduced oxygen concentrations, and promote chemical reduction processes that make methylation possible.

Areas of enhanced bioavailability and toxicity of mercury (created through the mercury methylation process) exist in the Delta, and elevated methylmercury concentrations in fish tissue produce subsequent exposure and risk to humans and wildlife. Consequently, the beneficial uses most directly affected by mercury are shellfish harvesting and commercial and sport fishing activities that pose a human health concern, and wildlife habitat and rare, threatened, and endangered species resources that can be exposed to bioaccumulation of mercury (Table 8-1). Because of these concerns, mercury was the first TMDL approved for San Francisco Bay in 2007 (San Francisco Bay Water Board 2006). The Delta methylmercury TMDL was approved by the Central Valley Water Board in 2010 and was approved as final on October 20, 2011 (Central Valley Water Board 2011b). The Delta, several direct tributaries to the Delta (i.e., Sacramento River, San Joaquin River, Mokelumne River, Putah Creek, and Calaveras River), and areas downstream (i.e., Suisun Bay and Suisun Marsh) also are listed as impaired water bodies on the Section 303(d) lists for mercury in fish tissue (State Water Resources Control Board 2011).

Importance in the Study Area

Limiting characterization to the routine monitoring of total mercury waterborne concentrations is inadequate to determine mercury bioavailability. A conceptual model is needed to determine the importance of sediment, fish tissue, and methylated mercury as measures of exposure and risk in the system. A description of this model follows, and then concentrations in sediment and fish tissues are detailed.

Conceptual Model of Mercury and Methylmercury Transport and Fate in the Delta

Several conceptual models have been created for the Delta to describe important linkages among waterborne loading, waterborne concentrations, and water, sediment, and biotic processing of mercury and methylmercury (Ecosystem Restoration Program Delta Regional Ecosystem Restoration Implementation Plan [ERP DRERIP]). Figure 8-27 shows the important linkages, pathways, and relative importance of each in determining bioavailability; the important links between sediment processes and biotic uptake are emphasized. Mercury is strongly particle-associated and tends to settle and accumulate in sediment deposition areas, where, if conditions are favorable, can facilitate mercury methylation by sulfur-reducing bacteria. From that point in the cycle, diet (rather than waterborne concentration) is the primary route for methylmercury exposure to fish, wildlife, and humans. Refer also to Chapter 25 (Public Health) for discussion of the effects of mercury to human health.

The goal of mercury conceptual models (such as Alpers et al. 2008:ii) and plans created for integrated mercury investigations as part of Delta restoration efforts (such as Wiener et al. 2003) has been to identify linkages that can be used to guide restoration efforts toward the least harmful alternatives (the alternative with the least potential to exacerbate mercury-related effects). Aside from controlling upstream sources of mercury and methylmercury loading to the Delta, it may be important to limit the conversion of mercury to the more bioaccumulative and toxic methylmercury in Delta environments. For that reason, the Central Valley Water Board has focused on controlling methylmercury to protect beneficial uses in the Delta (Central Valley Water Board 2008b). As shown in Figure 8-27, a series of drivers related to water quality and sediment determines methylmercury production and uptake in biota and subsequent health effects on humans or wildlife. At every step of the process, opportunities exist to modify final outcomes and minimize impacts from mercury toxicity.

As suggested in Figure 8-27 and summarized from the local and general literature (as discussed and cited in Alpers et al. 2008), the following environmental characteristics are most important for determining risks to fish, wildlife, and humans from waterborne mercury contamination in the Delta.

- Source of mercury (atmospheric and gold mining operations are most bioavailable).
- Nutrient enrichment (high nutrient supply, algal growth, and eutrophication favor mercury uptake, bioaccumulation, and methylation).
- Water column DO (oxygen depletion in water or surface sediments favors methylation).
- Sediment organic content and grain size (small size fractions and more organic characteristics favor methylation).
- Water residence time and sediment accumulation (high residence time and sediment deposition areas favor methylation).

- Periodic drying and wetting (seasonal or annual flooding enhances methylmercury production and food chain bioaccumulation in certain areas of the Delta) (Slotton et al. 2007).
- Fish species and age structure (top predators and older, larger fish accumulate higher tissue concentrations of methylmercury).

Although sulfate could affect rates of mercury methylation (due to the dependence on sulfate-reducing bacteria for methylation), such a relationship is highly variable and site-specific and not a good predictor of methylation potential. The environmental factors governing rates of methylation are complicated and site-specific modeling is required (Moore et al. 2003). Although sulfate can be important to the rate of mercury methylation (Gilmour et al. 1992), intermediate levels may be more stimulatory than low or high concentrations (Shao et al. 2012). Furthermore, experiments have revealed that sulfate supply does not always directly relate to rates of methylation (Johnson and Beck 2012). In contrast, the importance of low DO and availability of organic carbon is well known (Alpers et al. 2008; Gorski et al. 2007), as well as the necessary supply of inorganic mercury (Shao et al. 2012). In addition, the availability of dissolved mercury may be determined by the availability of solid FeS (Han et al. 2007). For these reasons, waterborne sulfate, by itself, is not considered a reliable predictor of mercury methylation potential or correlated to methylmercury concentrations.

Existing Conditions in the Study Area

Water Concentrations

Water quality data from the Delta and Suisun Marsh include records of mercury and methylmercury waterborne concentrations as total or filtered water fractions. Water quality summary information since 1999 is shown in Table 8-14. The general pattern of mercury waterborne loading to the Delta shows the dominance of mercury mining sources via Cache Creek and the Yolo Bypass (Central Valley Water Board 2008b); however, the waterborne average concentrations do not reflect the same pattern as loads (Table 8-15). Instead, the eastside tributaries and San Joaquin River show higher mercury and methylmercury concentrations than the Sacramento River inputs. In general, waterborne concentrations of total mercury fall below regulatory guidelines while most of the mean methylmercury concentrations throughout the Delta exceed the Regional Board TMDL concentration guidelines of 0.06 ng/L (Table 8-14).

Sediment Concentrations

It has been estimated that the flux of methylmercury from Delta sediments contributes up to 36% of the waterborne methylmercury load in the Delta (Central Valley Water Board 2008a). Therefore, the spatial variability of mercury and methylmercury in sediments is an important characteristic of the Delta's current condition for mercury exposure and could be important for determining future mercury risk. Table 8-15 shows the pattern of surface sediment mercury throughout the Delta and Suisun Bay. The data is presented to show the pattern of mercury deposition and to aid future planning, but sediment data (in contrast to water and fish) is not modeled as part of this evaluation of future conditions for BDCP Alternatives.

The CALFED sediment mercury study reported that total mercury in sediments varied spatially but not seasonally (Heim et al. 2007). Total mercury concentrations (the sum of elemental and methylmercury) in sediment were most elevated in the influent tributary streams and Suisun Bay compared to the central and southern Delta.

In contrast, methylmercury showed both spatial and seasonal variations in concentration. The biologically mediated nature of mercury methylation was apparently important in creating a seasonal summer maximum in sediment methylmercury concentrations. Methylmercury concentrations were highest in the mid-Delta interior marshes (compared to peripheral rivers) and varied on a small scale, with the highest concentrations in mid-marsh.

The pattern of mercury transport and fate in the Delta is one of waterborne loading from historical source waters (and runoff from historically affected soils) to the interior Delta, followed by the accumulation of fine sediments in the marsh and subsequent methylation of elemental mercury in those locations (Heim et al. 2007).

Fish Tissue Concentrations

Resident Delta fish accumulate mercury primarily through dietary exposure; larger, piscivorous (fish-eating) fish show the greatest levels of tissue mercury. In contrast to anadromous fish (migratory species), the resident fish experience constant exposure to local mercury sources. Resident species include larger fish with human health exposure (such as largemouth bass) and smaller, forage fish (such as inland silversides). Fish tissues are the ultimate route of exposure to mercury for aquatic-dependent birds and mammals, and for humans who consume locally caught fish.

The mercury conceptual model illustrates these principles. Human health and wildlife health effects resulting from mercury exposure and uptake are the final outcomes of the mercury conceptual model (Figure 8-27). Available data show substantial levels of mercury contamination in fish throughout the Delta. For example, the tissue concentrations of mercury in largemouth bass are shown as a spatial distribution throughout the Delta in Figure 8-28 (1999–2000 data). Note that the Mokelumne River, Cosumnes River, Sacramento River, and San Joaquin River inflows exhibit the highest fish tissue bioaccumulation, whereas these larger sport fish had uniformly lower tissue concentrations in the central Delta.

Larger, piscivorous resident fish, in general, provide a good record of fish tissue mercury as a baseline condition for the Delta. Largemouth bass were chosen because they are popular sport fish, top predators, live for several years, and tend to stay in the same area (exhibit high site fidelity). Consequently, they are excellent indicators of long-term average mercury exposure, risk, and spatial pattern for ecological and human health. Results from a study of mercury in sport fish from the Delta region found the median largemouth bass tissue mercury concentration to be 0.53 mg mercury per kilogram (Hg/kg) wet weight (Davis et al. 2008). Recent summaries from tributary inputs to the Delta reveal average bass concentrations similar to or higher than this Delta-wide average (Table 8-16).

Current fish tissue concentrations thus exceed both adopted regulatory standards and guidance from the USEPA. In the draft Delta TMDL for methylmercury, the Central Valley Water Board has recommended fish tissue goals (fillet concentrations, wet weight mercury) of 0.24 mg Hg/kg wet weight in trophic level 4 fish (adult, top predatory sport fish, such as largemouth bass) (Central Valley Water Board 2008b). These values are slightly lower than USEPA's national recommended water quality criterion for fish tissue of 0.3 mg Hg/kg wet weight for protection of human health and wildlife (U.S. Environmental Protection Agency 2001). Therefore, the Delta average for largemouth bass fillet concentrations in the study by Davis et al. exceeds both recommended safe consumption guidelines.

1 **Table 8-14. Mercury and Methylmercury Surface Water Concentrations at Tributary Inputs and the Delta's Major Outputs**

	Mercury Concentration (ng/L)						Methylmercury Concentration (ng/L)					
Site	No. of Samples	Min.	Max.	Mean	Year Collected	Source	No. of Samples	Min.	Max.	Mean	Year Collected	Source
Mercury Concentrations for Tributary Inputs												
Sacramento River at Keswick	26	0.2	2.7	0.5	2006–2007	DWR 2010	—	—	—	—	—	—
Sacramento River at Keswick[a]	—	—	—	—	—	—	—	—	—	—	—	—
Feather River at Oroville	5	0.2	0.7	0.4	2006–2007	DWR 2010	—	—	—	—	—	—
Feather River at Oroville[a]	—	—	—	—	—	—	—	—	—	—	—	—
Sacramento River at Verona	5	0.8	2.6	1.6	2006–2007	DWR 2010	—	—	—	—	—	—
Sacramento River at Verona[a]	—	—	—	—	—	—	—	—	—	—	—	—
Sacramento River at Freeport	45	1.2	30.6	4.1	1999–2002	Central Valley Water Board 2008a	36	0.05	0.24	0.10	2000–2003	Central Valley Water Board 2008a
Sacramento River at Freeport[a]	0	—	—	—	—	—	1	0.03	0.03	0.03	2000	Central Valley Water Board 2008a
San Joaquin River at Vernalis	49	3.1	21.7	7.6	2000–2004	BDAT 2010; Central Valley Water Board 2008a	49	0.09	0.26	0.15	2000–2001, 2003–2004	BDAT 2010; Central Valley Water Board 2008a
San Joaquin River at Vernalis[a]	19	0.3	3.0	0.8	2000–2002	BDAT 2010; USGS 2010	25	0.01	0.08	0.03	2000–2002	BDAT 2010; Central Valley Water Board 2008a; USGS 2010
Mokelumne River at I-5	21	0.3	12.0	4.5	2000, 2001, 2003	Central Valley Water Board 2008a	23	0.02	0.32	0.12	2000, 2001, 2003	Central Valley Water Board 2008a
Mokelumne River at I-5[a]	0	—	—	—	—	—	8	0.02	0.17	0.06	2000	Central Valley Water Board 2008a
Cosumnes River at Michigan Bar[a]	1	1.4	1.4	1.4	2002	USGS 2010	1	0.41	0.41	0.41	2002	USGS 2010

Site	Mercury Concentration (ng/L)						Methylmercury Concentration (ng/L)					
	No. of Samples	Min.	Max.	Mean	Year Collected	Source	No. of Samples	Min.	Max.	Mean	Year Collected	Source
Calaveras River at Rail Road upstream of West Lane	4	13	26	20	2003–2004	Central Valley Water Board 2008a	4	0.11	1.9	0.14	2003–2004	Central Valley Water Board 2008a
Mercury Concentrations for Delta's Major Outputs												
Delta-Mendota Canal at Byron Highway	23	1.9	6	3.3	2000, 2001, 2003	Central Valley Water Board 2008a	21	0.01	0.17	0.05	2000, 2001, 2003	Central Valley Water Board 2008a
Delta-Mendota Canal at Byron Highway[a]	0	—	—	—	—	—	8	0.02	0.09	0.03	2000	Central Valley Water Board 2008a
SWP	20	1.2	7.2	2.5	2000, 2001, 2003	Central Valley Water Board 2008a	20	0.01	0.14	0.04	2000, 2001, 2003	Central Valley Water Board 2008a
SWP[a]	0	—	—	—	—	—	8	0.02	0.08	0.03	2000	Central Valley Water Board 2008a
X2	20	4	49	15	2000, 2001, 2003	Central Valley Water Board 2008a	22	0.007	0.24	0.05	2000, 2001, 2003	Central Valley Water Board 2008a
X2[a]	0	—	—	—	—	—	8	0.02	0.06	0.03	2000	Central Valley Water Board 2008a
Suisun Bay	34	2.52	35.24	9.43	2000–2008	SFEI 2010	36	8E-05	0.18	0.03	2000–2008	SFEI 2010
Suisun Bay[a]	35	0.16	4.80	0.84	2000–2008	SFEI 2010	32	8E-05	0.10	0.01	2000, 2002–2008	SFEI 2010
California Aqueduct Check 13	—	—	—	—	—	—	—	—	—	—	—	—
California Aqueduct Check 13[a]	36	0.2[b]	0.2[b]	0.2[b]	2000–2005	DWR 2010	—	—	—	—	—	—
California Aqueduct Check 29	—	—	—	—	—	—	—	—	—	—	—	—
California Aqueduct Check 29[a]	152	0.2[b]	0.2[b]	0.2[b]	2000–2010	DWR 2010	—	—	—	—	—	—

Notes: Max. = maximum, Min. = minimum, ng/L = nanograms per liter.

[a] Dissolved concentration of analyte.

[b] It is assumed that the units were reported incorrectly for the site.

Sources: Bay Delta and Tributaries Project (BDAT) 2010; Central Valley Water Board 2008a; California Department of Water Resources 2010; San Francisco Estuary Institute 2010; U.S. Geological Survey 2010.

Table 8-15. Mercury and Methylmercury Sediment Concentrations for Tributary Inputs, the Delta, and Suisun Bay

Site	Sample Type	Total Mercury (ng/g Dry Weight) Samples	Min.	Max.	Mean	Year	Methylmercury (ng/g Dry Weight) Samples	Min.	Max.	Mean	Year
Concentrations at Tributary Inputs											
Sacramento River, Freeport[a]	Colloid	4	140	290	208	1996–1997	—	—	—	—	—
Sacramento River, Freeport[a]	Bed Sediment	1	267	267	267	1996–1997	—	—	—	—	—
Concentrations in Delta and Suisun Bay											
North Delta[b]	Surficial Sediment	11	104	320	170	1999	11	0.12	0.64	0.35	1999
East Delta[b]	Surficial Sediment	12	10.5	340	110	1999	9	0.02	0.68	0.3	1999
Central and West Delta[b]	Surficial Sediment	15	10.5	370	77	1999	12	0.019	1.1	0.36	1999
Central and West Delta[c]	Surficial Sediment	18	16.5	417	106	2000–2008	18	0.02	0.7	0.11	2000–2008
Suisun Bay[b]	Surficial Sediment	21	66	580	270	1999	20	0.019	9.3	0.45	1999
Suisun Bay[c]	Surficial Sediment	69	0.03	413	114	2002–2007	69	0.004	0.82	0.13	2000–2008

Notes:
Max. = maximum.
Min. = minimum.
ng/g = nanograms per gram
[a] Source: U.S. Geological Survey 2009.
[b] Source: Heim et al. 2007.
[c] Source: San Francisco Estuary Institute 2010.
Sources: Heim et al. 2007; San Francisco Estuary Institute 2010; U.S. Geological Survey 2009.

Table 8-16. Mercury Concentrations in Largemouth Bass Fillets for Tributary Inputs

		Length (mm)			Concentration (mg Hg/kg Wet Weight)			
Site	Fish	Min.	Max.	Mean	Min.	Max.	Mean	Year
San Joaquin River at and downstream of Vernalis	40	226	530	325	0.21	1.4	0.56	1998–2000
Mokelumne River downstream of Cosumnes River	22	210	425	331	0.31	1.6	0.83	1999–2000
Cosumnes River	19	201	485	329	0.34	2.1	0.87	1999–2000

Notes:
Max = maximum.
mg Hg/kg = milligrams mercury per kilogram.
Min = minimum.
mm = millimeters.
Source: Central Valley Water Board 2008a.

Surprisingly, spatial patterns of mercury bioaccumulation in larger piscivorous sport fish do not show a clear link to zones of active sediment methylation in the Delta. In the study by Davis et al., the highest levels of fish tissue concentrations were found in the north Delta, Cosumnes River, and San Joaquin River, and lower fish tissue concentrations were found in the central, marsh-like Delta locations (Davis et al. 2008). The pattern reflects the dominance of source waters carrying methylmercury as a driver of increased fish tissue concentrations relative to the contribution from areas of secondary methylation in marshy locations or wetlands. In fact, in a related comprehensive study of Delta sport fish (including largemouth bass), mercury concentrations in fish tissues were found not to directly relate to the presence of wetlands. The authors found that the data "contradicted the prevailing notion that wetlands generally increase methylmercury accumulation in the food web" (Melwani et al. 2007). Nevertheless, the authors acknowledged the complexity of developing such relationships on a watershed scale; small-scale local factors may be the most important determinants of mercury bioaccumulation. In a subsequent study, the same authors suggest that in the case of the Delta, waterborne methylmercury may be a more important determinant of fish bioaccumulation than sediment mercury and the associated sites where methylation occurs (Melwani et al. 2009). Furthermore, laboratory studies of mercury uptake in Delta species indicate that much higher assimilation and uptake were observed in waters of lower DOC (as might be expected from the tributaries versus the interior Delta) (Pickhardt et al. 2006). This finding may help explain the dissimilar spatial pattern between sediment and fish methylmercury concentrations in the areas studied; waterborne methylmercury loading may be more important than sediment methylation in explaining the patterns of fish mercury bioaccumulation in the Delta.

In addition to human exposure as estimated from large-fish monitoring, the monitoring of whole-body fish tissues from various smaller species provides slightly different information. Monitoring of these so-called *biosentinel species*, such as inland silversides, prickly sculpin, and juvenile largemouth bass, demonstrates the variation in mercury bioaccumulation over small spatial scales and seasonal time frames (Slotton et al. 2007). The fish were juveniles of predatory fish or were various short-lived, smaller species and exhibited high site fidelity; thus, they were good monitors of spatial patterns and short time exposure. These fish were also good indicators of short-term seasonal or interannual exposure patterns. Biosentinel monitoring has been implemented at various locations within the watershed, a subset of which was incorporated into a Fish Mercury Project Ecosystem Restoration Program grant. However, funding to support such a program over the long term is not currently in place. To date, the ongoing biosentinel monitoring program (Slotton et al. 2007) has made these key findings.

- Episodic, aperiodic, and nonroutine flooding (such as seasonal high flows, extremely high tides, and managed marsh flooding) of formerly dry sediments leads to enhanced methylmercury exposure in some areas.
- The general pattern of bioaccumulation was higher fish tissue mercury concentrations in Suisun Marsh, Cosumnes River, and Yolo Bypass but lower tissue concentrations in the central Delta (similar to sport fish results).
- Large differences occurred in fish tissue concentrations from year to year in Suisun Marsh, associated with large variations in the extent of annual flooding.

The current pattern of mercury bioaccumulation in fish in the Delta and Suisun Marsh demonstrates the response to enhanced sources of mercury and methylmercury from water, sediment, and dietary pathways. Larger, piscivorous fish almost uniformly exhibit greater tissue mercury concentrations than human diet consumption guidelines and are linked to sources of influent loading (Central Valley Water Board 2008b). Smaller, short-lived fish demonstrate clear spatial patterns of bioaccumulation and the effects of enhanced mercury exposure following the flooding of usually dry areas (Slotton et al. 2007).

Regulatory criteria with respect to mercury are as follows. Applicable water quality criteria for judging the degree of contamination and effects of future changes in concentrations include those following.

- The CTR contains criteria for human health protection of 50 ng/L for fresh water and 51 ng/L for saltwater, which are expressed in the total recoverable form of the metal.
- The national recommended water quality criterion for total mercury is 770 ng/L to protect freshwater aquatic life from chronic exposure and 940 ng/L to protect marine life (U.S. Environmental Protection Agency 2012b).
- The Delta methylmercury TMDL limit of methylmercury in water, protective of fish bioaccumulation, is 0.06 ng/L (Central Valley Water Board 2008b).
- The San Francisco Bay mercury TMDL limit of total mercury in water is 25 ng/L (4-day average).

A comparison to Table 8-15 shows that the total mercury criterion (25 ng/L) is exceeded in the Sacramento River at Freeport, the Calaveras River, Suisun Bay, and Delta exports. In contrast, many of the mean and maximum methylmercury concentrations in water exceed the suggested guidelines for aquatic life (0.06 ng/L) and human health (through fish consumption).

Sediment concentrations can be judged against the Section 303(d) list screening as used by the Central Valley Water Board, based on the consensus screening value of 1.06 mg Hg/kg dry weight (1,060 ng/g) (MacDonald et al. 2000). Note that all total mercury values in Table 8-16 are below this screening value. However, this does not account for the complicated exposure pathways and methylation, which drive uptake and bioaccumulation into the food chain (Figure 8-27) more than does the total mercury concentrations in bulk sediment. Instead, sediment concentrations of mercury and methylmercury can serve as weights of evidence for differences among areas in mercury exposure potential from in-place or resuspended sediments.

The Delta TMDL limit for small, whole-fish mercury content for protection of fish and wildlife is 0.03 mg Hg/kg wet weight (Central Valley Water Board 2008b). This is in comparison to 2005–2006 Mississippi silversides whole-body mercury concentrations of 0.03 to 0.06 mg Hg/kg wet weight in the central Delta, 0.17 mg Hg/kg wet weight in the Yolo Bypass, and up to 0.20 mg Hg/kg wet weight at the Cosumnes River site (Slotton et al. 2007). Most of these small fish from the Delta and Suisun Marsh exceeded the recommended Delta TMDL small-fish guideline concentrations for mercury.

USEPA (2012a) has initiated a series of special, focused studies concerned with the control of mercury methylation in marsh and wetland habitats of the Delta, with special emphasis on the mitigation for enhanced methylation as may occur in new restoration wetland environments. As part of their list of water quality challenges and action plan for the Delta, USEPA (2012a) lists the need to "Restore aquatic habitats while managing methylmercury". The plan cites specific ongoing studies by USGS, the Central Valley Water Board, and the California Coastal Conservancy, in conjunction with USEPA, to study treatment technologies that may be used to sequester methylmercury.

Additionally, the Central Valley basin Plan requires all entities subject to controlling methylmercury in the Delta and Yolo Bypass, including DWR and USBR, to participate in a program to reduce human exposure to mercury through eating fish. Individually or collectively, these entities will submit a mercury exposure reduction program strategy in 2013.

8.2.3.10 Nitrate/Nitrite and Phosphorus

Background and Importance in the Study Area

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

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

There are presently no applicable water quality standards for P. Drinking water standards have been set for nitrate (10 mg/L) and nitrite (1 mg/L) because nitrate and nitrite can compete with oxygen for receptor sites on hemoglobin in the bloodstream, thereby interfering with normal respiration and causing effects in humans such as blue-baby syndrome.

Nutrients in the Delta are derived from a variety of point sources, including municipal discharges, and nonpoint sources, including agricultural and urban runoff. As discussed previously (see the *Ammonia* section), nutrient concentrations in the Delta are high enough that they are probably not a true limiting factor for algal growth. However, excessively high nutrient concentrations also can be associated with algal blooms and decreased water quality, and it is unclear whether nutrient concentrations are adversely affecting primary productivity, which may be a contributing factor to pelagic organism decline (POD) (see the *Ammonia* section for more information on POD).

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

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

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

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

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

This relationship between nutrient ratios and organism population shifts is not unique to the Delta. Studies in Hong Kong, Tunisia, Germany, Florida, Spain, Korea, Japan and Washington D.C. (Chesapeake Bay), to name a few, have all concluded that nutrient stoichiometry influences phytoplankton community composition (Ruhl and Rybicki 2010; Ibanez et al. 2008; Hodgkiss and

Ho 1997; and Glibert et al. 2004). Furthermore, studies by Glibert et al. (2004; 2006), Lomas and Glibert (1999, and Dortch (1990) concluded that diatoms have a preference for nitrate while dinoflagellates and cyanobacteria generally prefer more reduced forms of nitrogen. Hessen (1997) found that a shift from calanoid copepods to *Daphnia* tracked N:P changes in Norwegian lakes. Sterner and Elser (2002) found that zooplankton size, composition and growth rates changed as the N:P ratio changed. Similar changes have been observed in the Delta, though these researchers did not differentiate the form of N between nitrate and ammonium. Glibert et al. (2011) found significant correlations between nutrient ratios and the dominant zooplankton in the Delta over the last 30 years.

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

Existing Conditions in the Study Area

A conceptual model developed for the Central Valley Drinking Water Policy Workgroup (Tetra Tech 2006a) estimated nutrient concentrations across the Central Valley by averaging time series data at many sampling locations. Results indicate that total nitrogen (TN) and total phosphorus (TP) concentrations were typically higher in the San Joaquin River (approximately 1.6 mg/L and 0.16 mg/L, respectively) compared to the Sacramento River (approximately 0.4 mg/L and 0.08 mg/L, respectively). TN was typically in the form of nitrate-N. TP composition varied from high to low concentrations of particulate-phosphorus. TP concentrations showed little inter-seasonal variation for these two rivers, but higher TN concentrations were seen in the Sacramento River during wet months and in the San Joaquin River during dry months (Tetra Tech 2006a).

Overall, TN and TP concentrations in the San Joaquin River and the Delta are relatively high and are at concentrations that would be classified as eutrophic waters. Given the abundance of nutrients, primary productivity in the Delta is fairly low (Jassby et al. 2002), suggesting that factors other than nutrients are limiting, specifically light limitation caused by turbidity levels. The San Joaquin River exhibits symptoms of eutrophic conditions, notably low DO concentrations that impair migration of cold and warm freshwater species (Jassby 2005). However, when waters from the Delta are pumped out in aqueducts for transport, or stored in reservoirs along the way, other limiting factors may disappear and high levels of algal growth may result (Tetra Tech 2006a).

Although effects on water quality usually are related to concentrations of constituents, load estimates may facilitate identification of important sources. Tributary loads were found to vary substantially between wet and dry years, with loads from the Sacramento River exceeding the San Joaquin River loads by nearly a factor of two or greater, especially in dry years (Tetra Tech 2006a). Forest/rangeland loads may dominate the overall nitrogen loads for the Sacramento Basin, and agricultural loads may dominate in the overall nitrogen loads to the San Joaquin Basin, particularly for wet years. Point source loads from wastewater discharges may contribute nearly half or more of the overall nitrogen and phosphorus loads during dry years in both basins, and possibly during wet years for phosphorus in the San Joaquin Basin. Current estimates for in-Delta contribution of nutrients from agriculture on the Delta islands are small compared to tributary sources (Tetra Tech 2006a).

TN and TP are often subdivided into different chemical species. Filtered water samples consist of dissolved organic nitrogen, nitrate-N (NO_3-N), nitrite-N (NO_2-N), ammonia (NH_3-N), dissolved organic phosphorus, and ortho-phosphorus (ortho-P). Due in part to their immediate biological availability to algae, chemical species typically analyzed by water quality monitoring programs include NH_3-N (see previous section), the combined NO_3/NO_2-N fraction (because of ease of analysis; in oxygenated waters the sample typically is dominated by NO_3-N), and ortho-P.

In the aquatic environment, nitrogen and phosphorus compounds may rapidly cycle between water, organisms, and sediments. Nitrate also is formed in the process of nitrification from ammonia. It is estimated that 75% of the ammonia present in the Sacramento River at Hood is converted to nitrate by the time the water reaches Chipps Island (Central Valley Water Board 2010a:4).

Dissolved ortho-phosphate is the form of phosphorus that generally is considered to be available for algal and plant uptake. Total phosphorus may be a better determinant of lake and reservoir productivity because most phosphorus is tied up in plankton and organic particles during periods of high productivity. Therefore, dissolved ortho-phosphate concentrations may be very low in highly productive lakes and reservoirs (Tetra Tech 2006a:2-4). The dynamics and speciation of phosphorus in flowing water bodies such as the Sacramento and San Joaquin Rivers is not as straightforward because they continually receive phosphorus from upstream, groundwater, and runoff. Because of this, the form in which phosphorus is delivered plays a role in determining which form of phosphorus is a better predictor of productivity downstream (Tetra Tech 2006a:2-5). An analysis of source waters to the Delta found that ortho-phosphate may make up from very little to almost all of the TP at a location at any given time (Tetra Tech 2006a:3-25 to 3-26).

Nitrate/Nitrite

Most examined locations in the northern half of the Plan Area, as well as the export area of the Delta, have had low concentrations of NO_3/NO_2-N in recent years (water years 2001–2006), with mean values typically ranging from 0.28 to 0.40 mg/L (Figure 8-29). Concentrations in the southern half of the Delta, however, were typically higher. For example, the CCWD pumping plant #1 had a mean value of 0.46 mg/L, and the Banks pumping plant had a mean value of 0.56 mg/L. The highest mean values were seen at the San Joaquin River near Vernalis (1.34 mg/L) and San Joaquin River at Buckley Cove (1.63 mg/L).

Mean values for the north-of-Delta area ranged from 0.6 mg/L at the Feather River at Oroville to 0.12 mg/L at the Sacramento River at Verona (Table 8-17). South-of-Delta mean values were higher than north-of-Delta stations examined (0.62 to 0.64 mg/L), comparable to the mean at the Banks headworks (0.56 mg/L) (Figure 8-29).

Time series data indicate that NO_3/NO_2-N concentrations at the examined stations generally fluctuate on an annual basis (Figure 8-30 and Figure 8-31). Higher values have tended to occur during the months of November through March.

Table 8-17. Nitrate/Nitrite Concentrations at Selected North- and South-of-Delta Stations, Water Years 2001–2006[a]

	Nitrate/Nitrite (mg/L as N)				
Location	Samples	Minimum	Maximum	Mean	Median
Sacramento River at Keswick	44	0.03	0.99	0.10	0.08
Sacramento River at Verona	19	0.02	0.34	0.12	0.09
Feather River at Oroville	40	0.01	0.20	0.06	0.04
American River at WTP	39	0.01	0.36	0.07	0.05
California Aqueduct at Check 13	27	0.18	1.50	0.62	0.59
California Aqueduct at Check 29	29	0.19	1.70	0.64	0.50

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

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

Source: California Department of Water Resources 2009b.

Ortho-Phosphorus

Most examined locations have had low concentrations of ortho-P in recent years (water years 2001–2006), with mean values typically ranging from 0.04 to 0.08 mg/L (Figure 8-32). Exceptions include the Barker Slough pumps (mean 0.10 mg/L), the San Joaquin River near Vernalis (mean 0.11 mg/L), and San Joaquin River at Buckley Cove (0.16 mg/L).

Mean values for the north-of-Delta area were all 0.02 mg/L (Table 8-18). South-of-Delta mean values were higher than north-of-Delta and Plan Area stations examined, with mean values of 0.08 to 0.10 mg/L (Banks headworks: 0.07 mg/L) (Figure 8-32).

Table 8-18. Ortho-Phosphorus Concentrations at Selected North- and South-of-Delta Stations, Water Years 2001–2006[a]

	Ortho-Phosphorus (mg/L)				
Location	Samples	Minimum	Maximum	Mean	Median
Sacramento River at Keswick	41	0.01	0.03	0.02	0.02
Sacramento River at Verona	18	0.01	0.05	0.02	0.02
Feather River at Oroville	7	0.01	0.05	0.02	0.01
American River at WTP	8	0.01	0.05	0.02	0.01
California Aqueduct at Check 13	27	0.05	0.15	0.08	0.07
California Aqueduct at Check 29	2	0.04	0.15	0.10	0.10

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

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

Source: California Department of Water Resources 2009b.

Time series data indicate that ortho-P concentrations at the examined stations generally fluctuate on an annual basis (Figure 8-33 and Figure 8-34). However, some stations have seen higher values during the summer and fall months, while other stations have seen higher values during the winter and spring months.

Total Phosphorus

Most examined Delta locations have had low concentrations of TP in recent years (water years 2001–2006), with mean values typically ranging from 0.08 to 0.11 mg/L (Figure 8-35). As seen with ortho-P, exceptions include the Barker Slough pumps (mean 0.20 mg/L), the San Joaquin River near Vernalis (mean 0.19 mg/L), and San Joaquin River at Buckley Cove (0.25 mg/L).

Mean values for the north-of-Delta area were between 0.06 and 0.08 mg/L, with the exception of a lower value of 0.02 mg/L at the American River at WTP (Table 8-19). South-of-Delta mean values were higher than north-of-Delta and Plan Area stations examined, with mean values (0.10 mg/L) near those seen in the Plan Area.

Table 8-19. Total Phosphorus Concentrations at Selected North- and South-of-Delta Stations, Water Years 2001–2006[a]

	Total Phosphorus (mg/L)				
Location	Samples	Minimum	Maximum	Mean	Median
Sacramento River at Keswick	44	0.01	0.89	0.06	0.02
Sacramento River at Verona	19	0.02	0.20	0.06	0.04
Feather River at Oroville	36	0.01	1.80	0.08	0.02
American River at WTP	37	0.01	0.10	0.02	0.02
California Aqueduct at Check 13	27	0.06	0.21	0.10	0.10
California Aqueduct at Check 29	29	0.06	0.22	0.10	0.09

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

Time series data indicate that TP concentrations at the examined stations generally did not fluctuate in a consistent manner on an annual basis (Figures 8-36 and 8-37).

Regulatory criteria with respect to nitrogen and phosphorus are as follows. Regarding Basin Plan narrative objectives, nitrogen and/or phosphorus could be considered biostimulatory substances because they are plant nutrients. There are no numerical water quality criteria for nutrients in the CTR or the Central Valley Water Board Basin Plan. The San Francisco Bay Water Board Basin Plan has objectives of 30 mg/L NO_3 plus NH_4 as nitrogen for agricultural supply—irrigation, and 100 mg/L NO_3/NO_2-N for agricultural supply—livestock watering. The California drinking water MCL is 1 mg/L for NO_2-N and 10 mg/L for NO_3-N because it can compete with oxygen for receptor sites on hemoglobin in the bloodstream, thereby interfering with normal oxygen transport by the blood and causing effects in humans, particularly infants. Another threshold for nitrate-N is for irrigation water as recommended by Ayers and Westcot (1994), who recommend a value of 5 mg/L NO_3-N for sensitive crops (e.g., sugar beets, grapes, apricot, citrus, avocado, grains).

8.2.3.11 Organic Carbon

Background and Importance in the Study Area

In an aquatic system, organic carbon encompasses a broad range of compounds, all of which fundamentally contain carbon in their structure. Organic carbon may be contributed to the aquatic environment by degraded plant and animal materials, and from anthropogenic sources such as domestic wastewater, urban runoff, and agricultural discharge. TOC represents the summation of both particulate organic carbon (POC) and DOC.

Organic carbon is a critical part of the foodweb and sustains aquatic life in the Delta and Bay. However, organic carbon and bromide, a naturally occurring salt found throughout the Delta, are precursors that contribute to DBP formation risk at drinking water treatment plants that use disinfection processes to treat Delta surface water sources. DBPs in municipal water supplies can be harmful to humans when consumed at low levels over a lifetime, and thus organic carbon concentrations are of primary concern for the municipal water supply beneficial use (Table 8-1). Environmental concerns regarding DBPs are related primarily to the consumers (humans, animals) of drinking water containing the DBPs HAAs (monochloroacetic acid, dichloroacetic acid, trichloroacetic acid, monobromoacetic acid, and dibromoacetic acid) and THMs (chloroform, bromodichloromethane, dibromochloromethane, and bromoform). THMs and HAAs are known to cause liver, kidney, and central nervous system problems and an increased risk of cancer (U.S. Environmental Protection Agency 2008c). The risk of DBP formation at drinking water treatment plants that use Delta surface water sources has been, and will continue to be, a central focus of water quality regulations for the Delta and the SWP/CVP Export Service Areas.

DBP-Formation Potential

The primary disinfectants currently used at municipal drinking water treatment plants to remove microbial contaminants consist of chlorine, chloramines, ozone, and ultraviolet (UV) light. Numerous DBPs can be formed by disinfectants reacting with various constituents in the source water, particularly DOC, bromide, and nitrogenous compounds. Chlorine-based disinfectants are a cause in the formation of many DBPs, including the THMs and HAAs. Modern disinfection methods used instead of chlorine to reduce DBP formation include chloramines and chlorine dioxide, ozone, and UV light. Ozone can substantially reduce THM formation, and UV light does not form DBPs; however, ozone can cause formation of bromate if bromide is present in the water (see the *Bromide* section for a detailed discussion of its effects on water quality). UV light disinfection system design must account for potential reduced efficiency associated with elevated turbidity and suspended solids (which can shield bacteria/viruses from radiation) and biological fouling of lamps. Ozone and UV light disinfection processes leave no residual disinfectant in the treated water, so a chlorine disinfectant generally must be added to finished water to provide a residual level of disinfection effect from the drinking water treatment plant through the distribution system to a user's tap. The potential for DBPs to form during drinking water disinfection is a function of source water quality, influenced primarily by DOC concentration and bromide, and a function of treatment operational factors such as disinfectant dose and reaction time, pH, and temperature (Sadiq and Rodriquez 2004). The potential formation of THMs, HAAs, and bromate has been extensively studied, and models are able to predict their formation with reasonable accuracy (Sohn et al. 2004).

Methods to Reduce DBP Formation Risk

Identifying and developing dynamic strategies and options to reduce DBP formation requires analysis of technical feasibility and economic considerations and is one element of the Equivalent Level of Public Health Protection (ELPH) concept of a multibarrier approach to providing drinking water and public health protection. Because organic/inorganic substances act as precursors for DBPs, their removal prior to disinfection is effective in reducing DBP formation potential. Organic matter can be partially removed using conventional coagulation, flocculation, sedimentation, and filtration methods or with more advanced methods (e.g., enhanced coagulation, granular activated carbon [GAC] filtration, and membrane filtration). The control of water treatment operational factors such as pH or disinfection contact time may reduce the formation of DBPs. Ozonation and UV light are the primary existing and alternative disinfection processes to reduce DBP formation that have been considered or implemented by water purveyors that use Delta source waters (Chen et al. 2010). pH reduction can control bromate formation during ozonation; however, the process requires increased ozone dosage and large amounts of acid to lower the pH and base addition to raise pH after ozonation to prevent corrosion in the distribution system (TetraTech 2006a).

Our understanding of organic carbon dynamics in the Delta has advanced greatly in recent years, due in part to intensive sampling efforts and research conducted by various institutions (e.g., Chow et al. 2007; Deverel et al. 2007; Drexler et al. 2009a, 2009b; Eckard et al. 2007; Kratzer et al. 2004; Kraus et al. 2008; Municipal Water Quality Investigations 2009; Saleh et al. 2007; Sickman et al. 2007; Spencer et al. 2007; Stepanauskas et al. 2005; U.S. Geological Survey 2003). Sources of organic carbon in the study area include peat soils, upland, agricultural and urban runoff, wetlands, algae production, and municipal wastewater discharges. DOC is present in all the streams and rivers flowing into the Delta, and it is these upstream sources that supply the majority of the organic carbon load to the Delta. It has been estimated that between 50 and 90% of the DOC load entering the Delta arrives from upstream sources (CALFED Bay-Delta Program 2008a:6). There are also sources internal to the Delta, such as agricultural drains and wetlands that, on an annual average basis, provide nearly 25% of the DOC load. These upstream and internal loads, and their related sources, vary by season. Related to particular in-Delta sources, loading of DOC from agricultural drains is typically greatest in the winter, while loading from wetlands is greatest in the spring and summer (Fleck et al. 2007:1,21; Deverel et al. 2007:18).

In the Delta, THM formation has been found to be strongly correlated to TOC concentrations, but relationships to DOC depend on specific structural characteristics of the organic matter, and research has focused on the sources of DOC as being a critical factor for THM formation potential (TetraTech 2006a). A study assessing organic carbon, bromide, and THM formation potential in the California Aqueduct found that TOC concentration was a good predictor of THM formation potential at the Banks pumping plant, the Delta-Mendota Canal (which feeds the Jones pumping plant), and several locations along the California Aqueduct (California Department of Water Resources 2005). The study did not measure DOC. Data collected from August 1998 at various Delta locations (Municipal Water Quality Investigations 2003a:62, Table 4-3) indicated a strong positive relationship between DOC and HAA formation potential ($r^2 = 0.996$). In Delta waters, DOC typically represents 85–90% of TOC (CALFED Bay-Delta Program 2007b:5–22).

The measurement of specific UV light absorbance at a wavelength of 254 nanometers (nm) (SUVA) is a commonly used measure of the potential conversion of DOC compounds into compounds such as THMs; however, SUVA has been found to be a generally poor predictor of THM formation potential in Delta waters (TetraTech 2006a). THMs generally are anticipated to be the most abundant DBP formed in treated Delta source water, with HAA formation generally expected to be less than 50% of the DBP production.

Table 8-20 provides a summary of TOC concentrations at several Delta intakes and major tributaries. In general, the highest average concentrations of organic carbon occur in the San Joaquin River and in the Delta, while the lowest average concentrations occur in the Sacramento River.

Table 8-20. Total Organic Carbon Concentrations at Delta Intakes and Major Tributaries

Intake	Form	Period	Number of Samples (n)	Median TOC (mg/L)	Maximum TOC (mg/L)
Harvey O. Banks	TOC	1986–2006	252	3.20	16.3
C. W. Jones (Tracy)	TOC	1986–1999	29	3.30	5.0
CCWD Old River	TOC	1994–2006	176	3.00	14.0
CCC (Rock Slough)	TOC	1991–2006	169	3.60	40.0
North Bay Aqueduct (Barker Slough)	TOC	1988–2006	289	4.70	38.0
Sacramento River	TOC	1998–2006	595	1.75	8.6 (19.9)[a]
San Joaquin River at Vernalis	TOC	1986–2006	418	3.30	10.5

Notes:
CCC = Contra Costa Canal.
CCWD = Contra Costa Water District.
NBA = North Bay Aqueduct.
mg/L = milligrams per liter.
TOC = total organic carbon.
[a] Maximum reported value is 19.9 mg/L, second highest is 8.6 mg/L; site: Hood/Greene's Landing.
Source: CALFED Bay-Delta Program 2007b.

Peak concentrations are important to municipal drinking water purveyors because of regulations that require advanced treatment depending on TOC concentrations. Drinking water treatment plants using North Bay Aqueduct water repeatedly have shut down, switched to blending operations with better quality water, or alternative water sources to avoid seasonal precipitation-induced spikes in DOC (Municipal Water Quality Investigations 2003b). DOC in the Delta typically peaks in the winter months, when seasonal river and Delta agricultural drain DOC loading are their greatest (Fleck et al. 2007:1,21; Deverel et al. 2007:18).

Existing Conditions in the Study Area

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Organic carbon is not a priority pollutant; thus, the CTR has no criteria. There are no state or federal regulatory water quality objectives/criteria for organic carbon or any USEPA-recommended criteria. As a consequence, none of the water bodies in the affected environment are listed as impaired on the state's CWA Section 303(d) list because of elevated organic carbon. However, under USEPA's Disinfectants and Disinfection Byproducts Rule (63 FR 69390), municipal drinking water treatment facilities are required to remove specific percentages of TOC in their source water through enhanced treatment methods, unless the drinking water treatment system can meet alternative criteria. USEPA's action thresholds begin at 2–4 mg/L TOC and, depending on source water alkalinity, may require a drinking water utility to employ treatment to achieve as much as a 35% reduction in TOC. Where source water TOC is between 4 and 8 mg/L TOC, drinking water utilities may be required to achieve a 45% reduction in TOC. Existing Delta water quality regularly exceeds 2 mg/L TOC, and existing treatment plants already are obligated to remove some amount of TOC. Nevertheless, changes in source water quality at municipal intakes may trigger additional enhanced TOC removal, and associated increased treatment costs.

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

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

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

8.2.3.12 Pathogens

Background and Importance in the Study Area

The term *pathogens* refers to viruses, bacteria, and protozoa that pose human health risks. Pathogens of concern include bacteria, such as *Escherichia coli* and *Campylobacter*; viruses such as hepatitis and rotavirus; and protozoans such as *Giardia* and *Cryptosporidium*. Most data that exist regarding pathogens are for coliform bacteria, which are indicators of potential fecal contamination by humans or other warm-blooded animals because of their relative abundance and ease of measuring in water samples.

Sources of pathogens include wild and domestic animals, aquatic species, urban stormwater runoff, discharge from WTPs, and agricultural point and nonpoint sources such as confined feeding lots and runoff. Pathogens that have animal hosts can be transported from the watershed to source waters from natural lands or grazed lands and cattle operations; aquatic species such as waterfowl also contribute pathogens directly to water bodies. Stormwater runoff from urban or rural areas can contain pathogens carried in waste from domestic pets, birds, or rodents as well as sewage spills. Once in the ambient environment, pathogens often die, although in some instances they can survive and even reproduce in sediments.

The beneficial uses of surface waters in the affected environment that are affected by pathogens are municipal and domestic supply, water contact recreation, shellfish harvesting, and commercial and sport fishing. Of these beneficial uses, municipal and domestic supply and water contact recreation are the receptors most affected by pathogens because direct contact or ingestion affects human health, as shown in Table 8-1. Infections in humans may arise from pathogens that break through into treated drinking water or from external sources such as food ingestion and ingestion of untreated water during recreation.

Water treatment processes that are focused on the removal of particulates, such as filtration and membranes, are generally effective at removing pathogens. Disinfection of bacteria pathogens can be achieved effectively either through chemical oxidation using chlorine or ozone, or through exposure to UV light. Viruses also can be removed effectively through chlorine or ozone oxidation. The treatment of protozoans is more challenging, as cysts and oocysts of protozoans cannot be fully removed by sand filtration and are resistant to chemical disinfection; however, disinfection using UV light has been found to be effective (Tetra Tech 2007).

Escherichia Coli

Escherichia coli is an anaerobic bacterium that lives in the gastrointestinal tract of warm-blooded animals. The presence of *E. coli* normally is beneficial to the host through the synthesis of vitamins and the suppression of harmful bacteria. However, some strains of *E. coli* are pathogenic. Pathogenic *E. coli* affect humans by generating toxins that can result in diarrhea, inflammation, fever, and bacillary dysentery (U.S. Environmental Protection Agency 2009d). Certain strains of *E. coli* can be severely toxic to some patients, particularly children, causing hemolytic uremic syndrome and leading to destruction of red blood cells and occasional kidney failure (Tetra Tech 2007). The presence of *E. coli* is an indicator of fecal contamination, either by human waste, wastewater, or animal wastes.

Campylobacter

Campylobacter is a bacterium that can be found in natural waters throughout the year. *Campylobacter jejuni* is commonly present in the gastrointestinal tract of cattle, pigs, and poultry and is a leading cause of bacterial gastroenteritis in the United States. *Campylobacter* infection in some rare cases may be followed by Guillain-Barré syndrome, a form of neuromuscular paralysis. Strains of *Campylobacter* have developed resistance to antibiotics, resulting in the difficulties with clinical treatment.

Hepatitis

Hepatitis is a virus that causes liver inflammation and sometimes leads to jaundice. Hepatitis Types A and E are infectious and are transmitted through the fecal-oral route. Hepatitis A is a well-documented waterborne disease and is widespread throughout the world.

Rotavirus

Rotaviruses are the most prevalent viruses that cause diarrhea worldwide. Rotavirus was estimated to contribute to 30 to 50% of severe diarrhea disease in humans (Tetra Tech 2007). The virus can be transmitted through fecal-oral route and through contaminated food and water.

Giardia

Giardia is a parasite found in the intestinal linings of a wide range of animals and their feces, and in contaminated water. *Giardia* can survive a wide range of temperature—from ambient temperature of fresh water to internal temperatures of animals. Among the many species of *Giardia*, *Giardia lamblia* infects humans and causes diarrhea and abdominal pain. *Giardia lamblia* has been found in wastewater and has been related to several outbreaks of waterborne disease around the world (Tetra Tech 2007).

Cryptosporidium

Cryptosporidia are single-celled, intestinal parasites that infect humans and a variety of animals. These parasites can infect epithelial cells of the intestinal wall and are excreted in feces as oocysts. *Cryptosporidium* has a wide range of hosts, including domestic and wild animals. Symptoms of cryptosporidiosis, a disease caused by ingestion of *Cryptosporidium*, include diarrhea, stomach cramps, upset stomach, and slight fever; more serious symptoms can result in weakened immune systems (U.S. Environmental Protection Agency 1999b). Cryptosporidiosis is a major cause of gastrointestinal illness around the world, especially to individuals with compromised immune systems. For these people, the symptoms can be more severe or life-threatening.

Existing Conditions in the Study Area

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

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

Regulatory criteria with respect to pathogens are as follows. The Central Valley Water Board Basin Plan specifies water contact recreation criteria for fecal coliform bacteria not to exceed a geometric mean of 200 organisms/100 ml in any 30-day period (based on a minimum of five samples), nor more than 10% of the total number of samples taken during any 30-day period to exceed 400 organisms/100 ml. The Central Valley Water Board Basin Plan water quality objectives for pathogens are detailed in Appendix 8A. The Stockton Deep Water Ship Channel and various sloughs and creeks in the western and eastern Delta are on the state's CWA Section 303(d) list as impaired because of pathogens, with sources identified as recreational and tourism activities [nonboating] and urban runoff/storm sewers (State Water Resources Control Board 2011). A TMDL for the Stockton Urban Waterbodies was approved by EPA on 13 May 2008. TMDLs for other listed water bodies in the affected environment are proposed for completion in 2021 (State Water Resources Control Board 2011).

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

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

- Viruses: 99.99% removal/inactivation.
- *Giardia lamblia*: 99.9% removal/inactivation.
- *Cryptosporidium*: 99% removal.

8.2.3.13 Pesticides and Herbicides

Background and Importance in the Study Area

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

Current use pesticides include carbamates (e.g., carbofuran), organophosphates (e.g., chlorpyrifos, diazinon, methyl parathion, malathion), thiocarbamates (e.g., molinate, thiobencarb), and more recently pyrethroids (e.g., permethrin, cypermethrin), a class of synthetic insecticides applied in urban and agricultural areas. USEPA has begun to phase out certain uses of organophosphates because of their potential toxicity in humans, which has led to the gradual replacement of organophosphates by pyrethroids (Werner et al. 2008).

Legacy pesticides include primarily organochlorine pesticides like dichlorodiphenyltrichloroethane (DDT) and Group A Pesticides (aldrin, dieldrin, chlordane, endrin, heptachlor, heptachlor epoxide, hexachlorocyclohexane [including lindane], endosulfan, and toxaphene). These chemicals are highly persistent in the environment and were banned in the 1970s because of their health and environmental effects. Organochlorines are prone to accumulation in sediments.

Pesticides, including pyrethroids, organophosphates, carbamate insecticides, herbicides, and fungicides are used extensively throughout the Central Valley. The critical pathways for pesticides entering the rivers, streams, and the Delta include agricultural and urban stormwater runoff, irrigation return water, drift from aerial or ground-based spraying, and periodic release of agricultural return flows from rice production (Werner and Oram 2008). Agricultural inputs are dominant, but urban inputs are also substantial in areas of high population density (CALFED Bay-Delta Program 2008a) and appear to be a primary source of pyrethroid insecticides entering urban creeks. For example, Weston and Lydy (2010) demonstrated that urban runoff produced pyrethroid concentrations exceeding acutely toxic thresholds. The authors also found that the pyrethroids passed through secondary treatment systems at wastewater treatment facilities, suggesting possible sewer disposal of pyrethroids (e.g., household pesticides).

The timing of pesticide input to Delta waters is related to application rates, when pesticides are applied to farmed land, runoff events, and other transport processes (Kuivila and Jennings 2007). In agricultural applications, for example, diazinon and chlorpyrifos are applied during the dormant season (December through February) and the irrigation season (March through November). Dormant orchards (nuts and fruits) are sprayed to limit pest damage. Application totals for diazinon (1999–2003 average) were 52% dormant season and 48% irrigation season (47,652 pounds total);

application totals for chlorpyrifos (1999–2003 average) were 3% dormant season and 97% irrigation season (114,101 pounds total).

Concern about pesticides is primarily associated with nontarget-organism toxic effects; because many pesticides have been developed to target insect pests (e.g., neurotoxins), these pesticides also have the potential to harm other organisms. Pesticides have toxic effects on the nervous systems of terrestrial and aquatic life, and some are toxic to the human nervous system U.S. Environmental Protection Agency 2008d). Consequently, the beneficial uses most directly affected by pesticide concentrations are aquatic organisms (cold freshwater habitat, warm freshwater habitat, and estuarine habitat); rare, threatened, and endangered species; harvesting activities (shellfish harvesting and commercial and sport fishing); and drinking water supplies (municipal and domestic supply) (Table 8-1).

Toxicity of pesticides, like all toxins, is related to the dose an organism receives. For example, a pesticide applied to a rice field in the Sacramento Valley may be diluted many times before it reaches irrigation return canals and the Sacramento River. Aquatic herbicides are applied to control invasive aquatic plants in irrigation canals and in the Delta (CALFED Bay-Delta Program 2008b). A recent assessment of heavily used aquatic herbicides suggests that there is limited short-term and no long-term toxicity directly attributable to their use (Siemering et al. 2008). However, acute toxicity to algae (*Selenastrum capricornutum*) has been found in numerous studies and attributed to the widely used agricultural herbicide diuron (de Vlaming et al. 2005). Ecological effects of pesticide contamination (e.g., fish toxicity) reflect the cumulative influence of pesticides currently in use, those used historically, and the constantly changing new pesticides introduced for agricultural practices (CALFED Bay-Delta Program 2008b).

The Department of Pesticide Regulation, an agency within the California Environmental Protection Agency (Cal/EPA), is charged with administering California's statewide pesticide regulatory program, the largest of its kind in the nation. It administers the CCR Title 6 (Food and Agriculture), which restricts the use of pesticides near water bodies and establishes Pesticide Management Zones and reporting requirements for pesticide use. The Department of Pesticide Regulation also conducts pesticide-monitoring activities. It and other agencies responsible for water quality, such as the State Water Board, promote use of Best Management Practices (BMPs) and other preventive measures to reduce pesticide contamination of water bodies. For example, rice growers are required to hold water on their fields following application of rice pesticides to allow pesticides to degrade, reducing concentrations contained in rice field runoff that enters waterways adjacent to treated fields (Newhart 2002).

The fate and effects of pesticide mixtures in the Delta and the implications of pesticide mixtures for populations of native species are not well understood (Werner and Oram 2008). Monitoring data for pyrethroids in water and sediment are scarce or do not exist, confounding attempts to estimate loads of pyrethroids transported to the Delta from the Central Valley (Werner and Oram 2008; TDC Environmental 2010). Implementation of TMDLs has reduced concentrations of some pesticides in the Delta (e.g., chlorpyrifos, diazinon); incidences of toxicity attributable to organophosphate pesticides have declined substantially compared to observations in the early 1990s (CALFED Bay-Delta Program 2008b). Organophosphates have been shown to be present at elevated concentrations in tributaries and the Delta, and pyrethroids at toxic concentrations have been detected in water bodies draining agricultural areas in the Central Valley, as well as urban creeks in the Delta region (Werner et al. 2008; Weston and Lydy 2010).

Existing Conditions in the Study Area

Limited data and studies are available for characterizing the existing conditions of pesticide concentrations in the study area. These are summarized below.

Monitoring efforts at the north-of-Delta stations since 2001 have resulted in no pesticide detections, while monitoring at the south-of-Delta stations resulted in various detections. The California Aqueduct at Check 13 had detections of chlorpyrifos (3/15/05, 0.02 μg/L), diazinon (3/20/01, 0.01 μg/L), and metolachlor (6/14/05, 0.1 μg/L) and of diuron (eight detections between 3/15/00 and 9/15/09, ranging from 0.27 to 3.2 μg/L) and simazine (13 detections between 3/15/00 and 9/15/09, ranging from 0.02 to 0.14 μg/L). The California Aqueduct at Check 29 had detections of chlorpyrifos (9/20/05, 0.01 μg/L) and dacthal (9/19/07, 0.12 μg/L) and numerous detections of diazinon (four detections between 3/20/01 and 6/22/06, ranging from 0.01 to 0.03 μg/L), diuron (seven detections between 3/14/00 and 9/15/09, ranging from 0.29 to 1.2 μg/L) and metolachlor (detections on 6/15/04 and 6/21/05, 0.01 and 0.01 μg/L).

Monitoring for diazinon suggests that higher concentrations occur in Delta back sloughs and small upland drainages, with lower concentrations occurring in Delta island drains, main rivers, and tributaries (Table 8-23). Monitoring for chlorpyrifos suggests that higher concentrations occur in Delta back sloughs, Delta island drains, and small upland drainages, with lower concentrations occurring in main rivers and tributaries (Table 8-24).

Table 8-23. Diazinon Concentrations, by Water Body Category

Water Body Type	Number of Samples	Median Concentration (ng/L)	90th Percentile Concentration (ng/L)	Maximum Concentration (ng/L)	Samples >160 ng/L[a]
Delta Back Sloughs	352	13	300	1,400	56 (16%)
Delta Island Drains	57	0	17	82	0 (0%)
Delta Rivers and Main Delta Waterways	774	0	97	797	31 (4%)
Major Delta Tributaries	2,056	0	80	1,700	106 (5%)
Small Upland Drainages	146	16	150	2,790	13 (9%)

Note: ng/L = nanograms per liter.
[a] Acute toxicity water quality objective for diazinon to protect invertebrates.
Source: Central Valley Water Board 2006.

Table 8-24. Chlorpyrifos Concentrations, by Water Body Category

Water Body Type	Number of Samples	Median Concentration (ng/L)	90th Percentile Concentration (ng/L)	Maximum Concentration (ng/L)	Samples >25 ng/L[a]
Delta Back Sloughs	373	0	68	677	62 (17%)
Delta Island Drains	57	5	46	360	11 (19%)
Delta Rivers and Main Delta Waterways	722	0	0	76	7 (1%)
Major Delta Tributaries	1,887	0	7	700	32 (2%)
Small Upland Drainages	148	0	87	180	35 (24%)

Note: ng/L = nanograms per liter.
[a] Acute toxicity water quality objective for chlorpyrifos to protect invertebrates.
Source: Central Valley Water Board 2006.

Pesticide data available for the Banks and Barker Slough pumping plants include the Group A Pesticides (aldrin, dieldrin, chlordane, endrin, heptachlor, heptachlor epoxide, lindane, endosulfan, and toxaphene), DDT products (p,p'-DDD, p,p'-DDE, and p,p'-DDT), atrazine, chlorpyrifos, diazinon, glyphosate, malathion, molinate, methyl parathion, permethrin, simazine, and thiobencarb. The monitoring program sampled for these analytes approximately 16 times during the water years 2001–2006 for each location. Detections were limited to those presented in Table 8-25. These detections generally occurred during the wet season during wet years. The exception is for molinate, which was detected during the early summer of a dry year (2004).

Table 8-25. Pesticide Concentrations at the Banks and Barker Slough Pumping Plants, Water Years 2001–2006

Pesticide	Harvey O. Banks	Barker Slough
Chlorpyrifos	0.03 μg/L (3/16/05)	—
Diazinon	0.01 μg/L (3/21/01)	0.01 μg/L (3/21/01)
Molinate	0.04 μg/L (6/16/04)	0.04 μg/L (6/15/04)
Simazine	0.12 μg/L (3/21/01)	0.02 μg/L (3/21/01)
	0.02 μg/L (3/20/02)	0.24 μg/L (3/16/05)
	0.11 μg/L (3/16/05)	0.02 μg/L (6/15/05)
	0.05 μg/L (3/15/06)	0.46 μg/L (3/15/06)

Notes: Data represent water quality samples having values at or greater than the reporting limit.
μg/L = micrograms per liter.
Source: Bay Delta and Tributaries Project 2009.

SFEI data for the Sacramento River above Point Sacramento and the San Joaquin River at Antioch, which has very low detection limits, have enabled the detection of many pesticides (Table 8-26). The samples were taken annually between late July and late August, which does not allow examination of wet versus dry season effects. The results suggest that many of the legacy pesticides are still present in the Sacramento River and San Joaquin River outflows during summer conditions, albeit at low concentrations. Chlorpyrifos, diazinon, and DDT median concentrations were higher than the other pesticides; median concentrations for nearly all pesticides were higher in the Sacramento River than in the San Joaquin River.

The Central Valley Water Board and San Francisco Bay Water Board Basin Plans contain narrative objectives for pesticides and toxicity. There are several pesticides with water quality criteria listed under the CTR, the Central Valley Water Board Basin Plan, the San Francisco Bay Water Board Basin Plan, and the California drinking water MCLs (Appendix 8A).

1 **Table 8-26. Pesticide Concentrations at the Mouths of the Sacramento and San Joaquin Rivers, Water Years 2001–2006**

		Sacramento River above Point Sacramento (pg/L)					San Joaquin River at Antioch Ship Channel (pg/L)				
Pesticide	Fraction	Samples	Min.	Max.	Mean	Median	Samples	Min.	Max.	Mean	Median
Aldrin	Dissolved	4	1	3	2	2	2	<1	2	1	1
Aldrin	Total	1	4	4	4	4	1	3	3	3	3
Chlorpyrifos	Dissolved	4	300	1,070	719	753	4	76	789	486	541
Chlorpyrifos	Total	4	332	1,070	727	753	4	90	789	490	541
Diazinon	Dissolved	3	511	765	599	520	4	229	1079	515	375
Diazinon	Total	3	511	765	599	520	4	229	1079	605	557
Dieldrin	Dissolved	7	56	110	85	82	5	49	81	68	73
Dieldrin	Total	7	60	117	89	84	6	52	87	74	77
Endosulfan I	Dissolved	5	11	57	32	31	2	13	13	13	13
Endosulfan I	Total	2	31	43	37	37	3	13	35	20	13
Endosulfan II	Dissolved	1	34	34	34	34	1	3	3	3	3
Endosulfan II	Total	0					1	3	3	3	3
Endrin	Dissolved	4	2	2	2	2	3	2	2	2	2
Endrin	Total	2	2	2	2	2	2	2	2	2	2
Heptachlor	Dissolved	4	<1	2	1	1	1	1	1	1	1
Heptachlor	Total	2	2	3	2	2	1	1	1	1	1
Heptachlor Epoxide	Dissolved	7	2	24	7	4	5	4	15	6	4
Heptachlor Epoxide	Total	6	2	24	7	4	4	3	15	6	4
Sum of Chlordanes	Dissolved	6	25	106	48	40	5	20	55	37	30
Sum of Chlordanes	Total	5	20	143	66	51	4	27	68	46	45
Sum of DDTs	Dissolved	7	153	227	188	194	5	93	144	124	131
Sum of DDTs	Total	7	266	546	368	366	6	175	257	214	210

Notes: Sample size represents water quality samples having values at or greater than the reporting limit. Values for "dissolved" may exceed "total" because of rejected laboratory samples.

DDT = dichlorodiphenyltrichloroethane; Max. = maximum; Min. = minimum.

Source: San Francisco Estuary Institute 2010.

2

Regions on the CWA Section 303(d) list for pesticides include the Central Valley Region (chlordane, chlorpyrifos, DDT, diazinon, dieldrin, and Group A pesticides) and the San Francisco Bay Region (chlordane, DDT, dieldrin). The Section 303(d) list of impaired water bodies identifies the entire Delta as impaired by one or more legacy pesticides (State Water Resources Control Board 2011). Chlorpyrifos and diazinon TMDL studies have been completed for Sacramento County urban creeks, the Feather River, the Sacramento River, the San Joaquin River, and the Delta; ongoing TMDL studies are occurring for organochlorine and other pesticides. There are many water bodies served by SWP South-of-Delta exports listed for pesticide impairment (State Water Resources Control Board 2011) including those listed by the Central Coast Water Board, the Los Angeles Water Board, the Santa Ana Water Board, and the San Diego Water Board.

A target list of pesticides has been developed by the Central Valley Water Board (2009d) to assess risk in the study area. The list was based on work by Urban Pollution Prevention Projects for the San Francisco Estuary Project (TDC Environmental 2008). Eight of the 38 pesticides considered highly toxic to aquatic organisms are pyrethroids, and the process has begun to establish water quality criteria for bifenthrin, lambda-cyhalothrin, and cyfluthrin (Central Valley Water Board 2010c).

8.2.3.14 Polycyclic Aromatic Hydrocarbons

Background

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

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

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

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

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

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

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

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

Importance in the Study Area

Assessment of how human atmospheric emission sources of PAHs in the study area directly affect the area would be difficult, given the complexity of area meteorology. Such sources would need to be identified and undergo air transport modeling to determine deposition rates onto land and water in the study area. Human activities related to PAH land and water emissions may be more easily quantified. Land applications of PAHs in the study area may include unintended releases from hazardous waste containers, while water sources may include industrial wastewaters, municipal sewage, and stormwater runoff.

The Regional Monitoring Program for Water Quality in the San Francisco Estuary has monitored PAHs and other pollutants in San Francisco Bay water, sediments, and bivalves since 1993 at several locations, including the mouths of the Sacramento and San Joaquin Rivers near Antioch.

In an analysis of 1993–2001 data, Ross and Oros (2004) found the distribution of median total PAH concentration by estuary segment was as follows.

- Extreme South Bay (120 ng/L).
- South Bay (49 ng/L).
- North Estuary (29 ng/L).
- Central Bay (12 ng/L).
- Delta (7 ng/L).

These results suggest that the Delta is not a major contributor of PAHs to San Francisco Bay. Using PAH isomer pair ratio analysis, Ross and Oros (2004) showed that PAHs in estuary waters were derived primarily from combustion of fossil fuels/petroleum (possible PAH source contributors include coal, gasoline, kerosene, diesel, No. 2 fuel oil, and crude oil) and biomass (possible contributors include wood and grasses), with lesser amounts of PAH contributed from direct petroleum input.

A modeling exercise of PAHs in San Francisco Bay ranked PAH loading pathways as stormwater runoff (51%), tributary inflow (28%), WTP effluent (10%), atmospheric deposition (8%), and dredged material disposal (2%) (Greenfield and Davis 2005; Oros et al. 2007). A study of PAH inputs and sources along an urban tributary to the Sacramento River took place in 2004 and 2005 (Kim and Young 2009).

Surface water concentrations varied from 192 to 3,784 ng/L for total PAHs and 18 to 48 ng/L for dissolved PAHs. Precipitation concentrations varied from 77 to 236 ng/L for total PAHs and 15 to 66 ng/L for dissolved PAHs. The authors suggest that indirect deposition (i.e., washoff of atmospheric particles previously deposited to land) of PAHs into surface water is a more likely substantial input pathway for total PAHs than direct dry or wet deposition during the wet season. They also assert that particulate matter carried by stormwater runoff was the major source of PAHs in surface water in the early rainy season.

Existing Conditions in the Study Area

Recent monitoring efforts to assess PAHs are very limited with respect to locations selected. For example, naphthalene had been sampled at three pumping plants (Banks, Barker Slough, CCWD #1) and the San Joaquin River at Vernalis since the late 1990s with no laboratory detections.

The Sacramento River above Point Sacramento and the San Joaquin River at Antioch Ship Channel were sampled for 24 different PAH compounds on an annual basis by SFEI as part of its monitoring program (denoted as stations BG20 and BG30, respectively). The SFEI laboratory reporting limits are on the order of pg/L, which are orders of magnitude more sensitive than the laboratory reporting limits for the Banks and Barker Slough pumping plants. These very low detection limits have enabled the detection of many PAHs examined in the current study, which are presented as the sum of all PAHs in Table 8-27.

Table 8-27. Sum of All Polycyclic Aromatic Hydrocarbons at the Mouths of the Sacramento and San Joaquin Rivers, Water Years 2001–2006

Sum of all PAHs	Samples	Minimum (pg/L)	Maximum (pg/L)	Mean (pg/L)	Median (pg/L)
Sacramento River above Point Sacramento					
Dissolved	7	2,240	17,444	8,962	9,359
Total	6	9,090	29,205	16,510	15,415
San Joaquin River at Antioch Ship Channel					
Dissolved	5	1,380	16,637	9,881	9,331
Total	6	6,472	21,972	14,117	15,017

Notes: All concentrations in picograms per liter (pg/L). Sample size represents water quality samples having values at or greater than the reporting limit.

PAH = polycyclic aromatic hydrocarbon.

Source: San Francisco Estuary Institute 2010.

The samples were taken between late July and late August, which does not allow examination of wet versus dry season effects. The results indicate that PAHs are present in the Sacramento and San Joaquin River outflows during summer conditions, albeit at low concentrations. Values for PAHs were comparable between the two locations. No detections were reported in the data examined for the north- and south-of-Delta sampling locations.

Regulatory criteria with respect to PAHs are as follows. There are no listings for PAHs on the Section 303(d) list in the Delta. With regard to Basin Plan narrative objectives, PAHs might be considered toxic at high concentrations. There are no numerical water quality objectives for the Central Valley Water Board or San Francisco Bay Water Board Basin Plans. The CTR criteria for benzo[a]pyrene is 0.0044 μg/L (Human Health: Water and Organisms) and 0.049 μg/L (Human Health: Organisms Only). The California drinking water standard MCL for benzo[a]pyrene is 0.0002 mg/L. Data are inadequate to assess whether the sites examined in this study exceeded the CTR or drinking water standard MCL.

8.2.3.15 Selenium

Background

Selenium is a constituent of concern in the Delta, the lower San Joaquin River, and San Francisco Bay for potential effects on water quality, aquatic and terrestrial resources, and (indirectly) human health. Because of the known effects of selenium bioaccumulation from aquatic organisms to higher trophic levels in the foodchain, the wildlife habitat and rare, threatened, or endangered species beneficial uses are the most sensitive receptors to selenium exposure. Examples of those effects include reduced hatchability of fertile eggs and the development of severe, often lethal, embryo deformities in fish and birds (Department of the Interior 1998; Ohlendorf 2003). Selenium also affects other aquatic life beneficial uses, including warm freshwater habitat; cold freshwater habitat; migration of aquatic organisms; spawning, reproduction, and/or early development; and estuarine habitat. Additional nonhabitat beneficial uses that may be affected include freshwater replenishment, municipal and domestic supply, and agricultural supply.

The State Water Board lists the western Delta as having impaired water quality for selenium (under Section 303[d]) (State Water Resources Control Board 2011). The Central Valley Water Board completed a TMDL for selenium in the lower San Joaquin River (downstream of the Merced River) in 2001 and Salt Slough in 1997/1999, and USEPA approved this in 2002 (Central Valley Water Board 2001, 2009c).

The Central Valley Water Board adopted amendments to the Basin Plan for the Sacramento River and San Joaquin River basins to address selenium control in the San Joaquin River basin in May 2010 (Central Valley Water Board 2010d), and the State Water Board approved the amendments in October (State Water Resources Control Board 2010b, 2010c). The intent is to modify the compliance time schedule for discharges regulated under waste discharge requirements to meet the selenium objective or comply with a prohibition of discharge of agricultural subsurface drainage to Mud Slough (north), a tributary to the San Joaquin River, in Merced County. The proposed amendments and supporting staff report include environmental documentation required under California Public Resources Code 21080.5 and 23 CCR 3775–3782. The environmental documentation is informed by the environmental analysis conducted by Reclamation and the San Luis and Delta Mendota Water Authority, dated December 21, 2009 (Bureau of Reclamation 2009c), which was prepared in compliance with the same legal provisions with regard to the use of the federally owned San Luis Drain. The environmental analysis concluded that, with the agreed-upon mitigation measures, the amendments would have no significant effects on the environment. The proposed Basin Plan amendments are administrative in nature and will not alter any water quality objective, program goal, policy, or other scientific underpinning of the selenium control program for the San Joaquin River.

The San Francisco Bay Water Board is conducting a new TMDL project to address selenium toxicity in the North San Francisco Bay (North Bay), defined to include a portion of the Delta, Suisun Bay, Carquinez Strait, San Pablo Bay, and the Central Bay (State Water Resources Control Board 2011).The North Bay selenium TMDL will identify and characterize selenium sources to the North Bay and the processes that control the uptake of selenium by wildlife. The TMDL will quantify selenium loads, develop and assign waste load and load allocations among sources, and include an implementation plan designed to achieve the TMDL and protect beneficial uses.

Importance in the Study Area

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

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

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

Existing Conditions in the Study Area

Water Concentrations

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

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

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

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

Much less sampling has been conducted for selenium analysis in the Sacramento River. The most recent available data for locations in or near the Delta are from Freeport (Table 8-28). A mean concentration of 0.072 µg/L was reported for Freeport in 1984 to 1988 and 1997 to 2000 (years combined, with no apparent difference between the two periods) (Cutter and Cutter 2004), but the detailed data (e.g., min-max values and sample numbers) are not available for comparison to the USGS data shown in the table. Because of the limited data from Freeport, additional values are provided from the Sacramento River at Verona and Knights Landing (upstream from Sacramento but reflecting quality of water that may enter the Yolo Bypass during flooding). The maximum selenium concentration at those locations was 1.0 µg/L, and the mean concentrations were all less than 0.5 µg/L. Only limited selenium data are available for other major tributaries to the eastern Delta.

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

	No. of	Selenium Concentration (μg/L)				
Site	Samples	Min.	Max.	Mean	Years	Source
Selenium Concentrations North of the Delta						
Sacramento River at Keswick	86	0.061	0.40	0.21	2003–2008	DWR 2010
Sacramento River at Keswick[a]	80	0.090	0.40	0.19	2004–2008	DWR 2010
Feather River at Oroville	31	0.033	0.37	0.19	2003–2008	DWR 2010
Feather River at Oroville[a]	30	0.052	0.28	0.16	2003–2008	DWR 2010
Selenium Concentrations for Inflows to the Delta						
Sacramento River at Verona	24	0.061	0.39	0.21	2003–2009	DWR 2010
Sacramento River at Verona[a]	21	0.15	0.29	0.20	2004–2009	DWR 2010
Sacramento River at Knights Landing	13	0.19	1.0	0.45	2003, 2004, 2007, 2008	DWR 2009
Sacramento River at Freeport[a]	62	0.044	1.0	0.32	1996–2001, 2007–2010	USGS 2010
San Joaquin River at Vernalis (Airport Way)[c]	105d	0.20	2.3	0.83	1999–2007	Bureau of Reclamation 2009d
San Joaquin River at Vernalis (Airport Way)	201	0.40	2.8	0.98	1999–2002	BDAT 2009
San Joaquin River at Vernalis (Airport Way)[c]	453	0.40	2.8	0.84	1999–2007	SWAMP 2009
Selenium Concentrations within/near the Delta						
North: Cache Slough near Ryer Island Ferry	7	0.05	0.24	0.12	1999–2000	BDAT 2009
South: Old River at Tracy Boulevard	1	0.61	0.61	0.61	2002	BDAT 2009
South: Old/Middle River	6	1.0	1.0	1.0	1999	DWR 2009
South: Old/Middle River[a]	6	1.0	2.0	1.6	1999	DWR 2009
Central-West: Sacramento River near Mallard Island (BG20)	11	0.06	0.45	0.11	2000–2008	SFEI 2010
Central-West: Sacramento River near Mallard Island (BG20)[a]	12	0.03	0.44	0.09	2000–2008	SFEI 2010
Central-West: San Joaquin River near Mallard Island (BG30)	11	0.03	0.40	0.11	2000–2008	SFEI 2010
Central-West: San Joaquin River near Mallard Island (BG30)[a]	11	0.03	0.45	0.09	2000–2008	SFEI 2010
Suisun Bay	38	0.02	0.21	0.12	2000–2008	SFEI 2010
Suisun Bay[a]	38	0.02	0.44	0.10	2000–2008	SFEI 2010
Selenium Concentrations for the Delta's Major Outputs						
Banks Pumping Plant[a]	71	1.0	2.0	1.0	2001–2007	MWQI 2003, 2005, 2006, 2008

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

[a] Dissolved selenium concentration.

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

[c] Not specified whether total or dissolved selenium.

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

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

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

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

Notes: Data collected within 1 mile of sample stations were compiled in the same data location. Means are geometric means.
Max. = maximum, µg/L = micrograms per liter, Min. = minimum.
[a] One sample each station was collected during July 2000; all other data are from January 2003 to January 2004.
Source: Lucas and Stewart 2007.

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

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

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

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

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

Sediment and Fish Tissue Concentrations

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

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

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

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

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

Source: San Francisco Estuary Institute (SFEI) 2010.

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

Site	Number of Samples	Selenium Concentration (mg/kg)			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
Chipps Island[a]	41	0.70	2.3	1.5	Delta Smelt	1993, 1994	Bennett et al. 2001
San Joaquin River, Dos Reis State Park and Mossdale Sites[b]	13	1.6	3.4	2.6	Silversides	May–July 1995	Bennett et al. 2001

Notes: Means are geometric means.

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

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

[b] Near Manteca.

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

Table 8-32. Selenium Concentrations in Largemouth Bass

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

Notes: Means are geometric means.

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

[a] Near Clarksburg.

Source: Foe 2010.

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

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

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

Selenium concentrations in the bass were compared to criteria recommended for the protection of human health (based on fillets; 2 mg/kg, wet weight) and wildlife health (based on whole-body fish; concern threshold of 4–9 mg/kg, dry weight) (Foe 2010). Average and maximum concentrations were always less than the criteria.

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

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

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

Recent preliminary information concerning USEPA's pending revision of the draft chronic ambient water quality criterion suggests that the agency will propose a two-part criterion: selenium concentration in fish egg/ovary coupled with a water screening value (Delos pers. comm.). If the latter is exceeded, the former either must be measured or may be estimated using whole-body concentrations. It is expected the water screening value will be conservative (so that if the value is not exceeded, there will be no problem), and that it will be lower than the current 5 μg/L USEPA water criterion. The number for egg/ovary selenium will be driven by the available trout, bluegill, and largemouth bass studies. EC_{10} values (concentration at which 10% of offspring are affected) for those species range from about 18 to 23 mg/kg dry weight based on egg/ovary data. Consistent with USEPA's criterion calculation methods, the egg/ovary criterion is likely to be extrapolated downward from the lowest observed value and is, thus, expected to be in the range of 15 to 18 mg/kg.

USEPA's Action Plan for Water Quality Challenges in the San Francisco Bay/Sacramento-San Joaquin Estuary (U.S. Environmental Protection 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 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.

8.2.3.16 Other Trace Metals

Background and Importance in the Study Area

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

Many trace metals are necessary for healthy biological function, where deficiencies in certain trace metals can result in disease and ailment. At elevated levels, trace metals can be toxic to humans and aquatic life, where the concentration of concern in surface waters is specific to each metal and each receptor (human or aquatic life). Thus, the beneficial uses of Delta waters most affected by trace metal concentrations are aquatic life uses (cold freshwater habitat, warm freshwater habitat, and estuarine habitat), harvesting activities that depend on aquatic life (shellfish harvesting, commercial and sport fishing), and drinking water supplies (municipal and domestic supply) (Table 8-1).

Trace metal contamination demonstrates the magnitude of effect that human activities have had on the Delta. Sediment transport to the Bay increased by nearly an order of magnitude during the mid-1800s to early 1900s as a result of hydraulic gold mining operations; these sediments carried high concentrations of metal contaminants, which persist today (Van Geen and Luoma 1999b). The effect of these residual metals in the water column is exacerbated by the decreased river inflows into the Delta in recent years, as well as the continued discharge of contaminants from stormwater runoff and other urban activities.

Hayward et al. (1996), in an evaluation of metals concentrations in the San Joaquin River, found that concentrations of trace metals were uniformly low, with a few isolated exceptions related to specific point sources (e.g., elevated zinc near boat docks in the Stockton Harbor). However, relatively low concentrations in water can have effects on aquatic life. A 2006 study of sediment toxicity in the San Francisco estuary identified toxic hotspots where metals were found to cause sediment toxicity in bivalve embryos (Anderson et al. 2007).

Alpers et al. (2000:2) evaluated metals concentrations in the Sacramento River (Shasta Dam to Delta region) from July 1996 to June 1997, encompassing both low-flow and flood conditions. Their study showed that cadmium, copper, and zinc were transported primarily in dissolved form upstream of major agricultural activities but primarily in colloidal form downstream. Iron and lead were transported primarily in colloidal form at all mainstem Sacramento River sites.

Additional background for arsenic, cadmium, chromium, copper, iron, lead, manganese, nickel, silver, and zinc is provided below.

Arsenic

Arsenic is a semi-metal element that is tasteless and odorless and highly toxic to humans. Long-term, chronic exposure to arsenic has been linked to cancer of the bladder, lungs, skin, kidneys, nasal passages, liver, and prostate (U.S. Environmental Protection Agency 2009h). Short-term exposure to high doses of arsenic can cause acute symptoms such as skin damage, circulatory system dysfunction, stomach pain, nausea and vomiting, diarrhea, numbness in hands and feet, partial paralysis, and blindness (U.S. Environmental Protection Agency 2009h).

Sources of arsenic contamination in water supplies include erosion of natural deposits, agricultural runoff, and runoff or wastewater from industrial point sources. Arsenic commonly is found in volcanic rocks and metal oxides, and is commonly associated with sulfide minerals and organic carbon (Saracino-Kirby 2000). Arsenic also is found in certain pesticides, fertilizers, and feed additives used in commercial agricultural operations (Saracino-Kirby 2000; U.S. Environmental Protection Agency 2009h). Approximately 90% of the industrial arsenic used in the United States is used as wood preservative; industry practices such as copper smelting, mining, and coal burning also contribute arsenic to the environment (U.S. Environmental Protection Agency 2009h).

Cadmium

Cadmium can be toxic to humans. Long-term, chronic exposure to cadmium has been linked to blood damage and several forms of cancers; short-term exposure to high concentrations of cadmium may cause nausea, vomiting, diarrhea, muscle cramps, salivation, sensory disturbances, liver injury, convulsions, shock, and renal failure (U.S. Environmental Protection Agency 2009i). Some aquatic species (e.g., Chinook salmon, Sacramento sucker, threespine stickleback) tend to bioaccumulate cadmium, while others do not (U.S. Environmental Protection Agency 2009i; Saiki et al. 1995). The toxicity of cadmium to aquatic life varies with the total hardness of the water, exhibiting generally lower toxicity as hardness increases.

Cadmium occurs naturally in zinc, lead, copper, and other ores, which may erode and release cadmium into water bodies, especially in soft, acidic waters (U.S. Environmental Protection Agency 2009i). Cadmium is used in a variety of industrial activities and applications, including metal plating and coating operations, machinery and baking enamels, photography, and nickel-cadmium and solar batteries (U.S. Environmental Protection Agency 2009i). Cadmium can enter water bodies through urban or industrial wastewater, leaching from landfills, and from corrosion of some galvanized plumbing and water mains (Van Geen and Luoma 1999a; U.S. Environmental Protection Agency 2009i).

Regulation of industrial and urban wastewater has led to a steady reduction in metal discharges to water bodies over the past two decades; however, these contaminants persist in sediments. A study of cadmium concentrations in San Francisco Bay revealed that coastal upwelling of cadmium-rich sediment contributes to seasonal peaks in those levels in the Bay. Surface samples collected throughout the Bay confirmed an internal cadmium source unrelated to river discharge. The results of the study suggested that concentrations of cadmium and other metals in the Delta and Bay water column are sensitive to river inflow and may have increased in response to reduced inflows in recent years. (Van Geen and Luoma 1999a.)

Copper

Copper is found primarily in the form of ores with other elements. Copper occurs in both organic and inorganic forms; organic copper is an essential micronutrient for animals, while exposure to high concentrations of inorganic copper can be toxic (Buck et al. 2006; U.S. Environmental Protection Agency 2009j). In humans, short-term exposure to copper can cause nausea and vomiting; long-term exposure can cause liver or kidney damage (U.S. Environmental Protection Agency 2009j).

Sources of copper contamination include natural deposits, industrial and urban wastewater, and urban stormwater runoff (Buck et al. 2006; U.S. Environmental Protection Agency 2009j). Historical copper contamination from industrial development and mining operations persists in sediments in the Delta and Bay (Buck et al. 2006). Dissolved copper tends to bind with organic matter, resulting in a strong correlation between concentrations of dissolved copper and organic carbon (Buck et al. 2006). This binding of copper with organic carbon has reduced concentrations of the toxic form of copper in San Francisco Bay to concentrations that do not pose a threat to aquatic life; without the copper-binding organic matter, it is likely that copper concentrations in the Bay would be toxic to most aquatic microorganisms (Buck et al. 2006).

The most common source of copper contamination in drinking water is corrosion of household copper plumbing materials. This contamination cannot be directly detected or removed with conventional drinking water treatment methods; thus, USEPA requires drinking water suppliers to control the corrosiveness of their water to minimize copper contamination at the tap. (U.S. Environmental Protection Agency 2009j.)

Lead

Lead is a metal found in natural deposits as ores with other elements. Short-term exposure to lead can cause a variety of health effects, including problems with blood chemistry, mental and physical development in babies and young children, and increases in blood pressure in some adults. Long-term exposure to lead has the potential to cause stroke, kidney disease, and cancer. (U.S. Environmental Protection Agency 2009k.)

Sources of lead contamination include natural deposits, mining, and smelting operations (U.S. Environmental Protection Agency 2009k). Lead is sometimes used in household plumbing materials or in water distribution systems. Lead is regulated in drinking water systems via the USEPA's Lead and Copper rule.

Nickel

Recent work has shown that the most substantial sources of nickel are in the South Bay; the next largest source is in the Delta (Yee et al. 2007). Nickel sources in the region originate from natural and human sources such as natural rock erosion, urban runoff, and WTPs (Yee at al. 2007). Total nickel concentrations from samples in the Delta averaged 3.5 μg/L in the dry season, and 5.1 μg/L in the wet season. Davis et al. (2000) estimated nickel loads were 975,000 kg/yr from San Francisco Bay bottom sediments, 410,000 kg/yr from the Delta, 49,000 kg/yr from Bay tributaries, 4,800 kg/yr from effluent, and 580 kg/yr from atmospheric deposition.

Silver

Silver is present in San Francisco Bay sediments, which can have toxic effects on biota (Flegal et al. 2007). Most fluxes of silver in the Bay are from past industrial activities and wastewater treatment sources. Delta waters entering the Bay have some of the lowest river silver concentrations reported.

Zinc

Zinc potentially can have toxic effects on biota, although it is an essential element in the diet of these plants and animals. Zinc is used to make tires, so it is generally found at higher concentrations near highways. It is also used in manufacturing processes.

Existing Conditions in the Study Area

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

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

Results from recent monitoring efforts for trace metals at the Banks pumping plant and Barker Slough pumping plant are shown in Table 8-34. Analytes examined in the present effort for the Banks and Barker Slough pumping plants include arsenic, cadmium, copper, lead, nickel, silver, and zinc. The monitoring program sampled for each of these analytes approximately 72 times during the water years 2001 to 2006 at each location. Arsenic, copper, and nickel were detected in almost all sampling events for each location. Median values for these metals were similar at the two locations. Elevated values for these metals occurred primarily between January and March, although the copper maxima occurred during May. There were one detection of lead and three detections of zinc at the Banks pumping plant. There were no detections of cadmium or silver at either station, and no detections of lead or zinc at the Barker Slough pumping plant. Cadmium values matched the MCL of 0.005 mg/L at several locations during the 1988–1993 study, but there were no detections at either the Banks or Barker Slough pumping plants during water years 2001–2006.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

8.2.3.17 Turbidity and Total Suspended Solids

Background and Importance in the Study Area

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

Sensitive receptors that have the potential to be affected by elevated concentrations of turbidity and TSS (Table 8-1) are municipal and industrial water supply uses (municipal and domestic supply/industrial service supply), aquatic life beneficial uses (warm freshwater habitat, cold freshwater habitat, migration of aquatic organisms and spawning, reproduction, and/or early development), and estuarine habitat because of habitat and other physiological effects. In the Delta, a declining turbidity trend, which has been attributed to a declining sediment supply and invasive submerged aquatic vegetation, is believed to have caused, at least in part, changes in Delta ecology and the decline of delta smelt (Hestir et al. 2013). The filtering of phytoplankton by invasive clams may also be contributing to reduced turbidity in the Delta (Appendix 11A, section 11A.1.6 Threats and Stressors).

Turbidity is a critical measurement for drinking water treatment plants because the constituents suspended in the water affect the filtration systems used to remove disease-causing microorganisms such as viruses, parasites, and some bacteria (e.g., fecal coliforms). Turbidity also can reduce the efficiency of disinfection techniques; disinfectants do not selectively target microbes, but rather react with many constituents within the water matrix (CALFED Bay-Delta Program 2008b).

Monitoring in the San Francisco estuary has used turbidity as a proxy for TSS, which in turn has been correlated to contaminant concentrations such as metals, PAHs, and organochlorine pesticides (Schoellhamer et al. 2007a). One study by Anderson et al. (2007) collected sediment samples between 1994 and 2001 from the mouths of the Sacramento and San Joaquin Rivers; all the samples collected were found to be toxic to mussels. These results suggest that the greatest concern for human health is not TSS itself but rather the contaminants associated with the solids and sediment, which can bioaccumulate up the aquatic food chain and be consumed by humans (e.g., fish, shellfish).

Elevated levels of turbidity and TSS limit light penetration into the water column, altering photosynthesis, primary production, and fish behavior (Schoellhamer et al. 2007b). After runoff events, TSS can settle to cover streambed spawning sites for fish and also alter macroinvertebrate habitat.

A major historical source of TSS in central California was hydraulic mining for precious metals in the late 1800s and early 1900s. The majority of this mining sediment has passed through the Delta system, although mine tailings remain in many watersheds. The construction and operation of dams in the Sacramento and San Joaquin River system have the effect of reducing TSS concentrations downstream because sediments become trapped in the reservoirs. Floodplain management in the form of levees can contribute to instream erosion by confining the flow to the channel and increasing streambed shear stress, but channels for flood management are often lined to protect the channel and minimize erosion (Schoellhamer et al. 2007b).

Given that the dam and levee systems in place are unlikely to be removed, the human activity that most likely affects sediment delivery to the Delta is soil erosion associated with agricultural and urban land uses. These activities are pertinent because they occur downstream from the major dams on the system (Schoellhamer et al. 2007b). Examples include crop production, livestock production, and construction activities. Stormwater runoff and overland flow are the likely mechanisms delivering sediment to streams and larger rivers, although erosion control practices may be implemented to minimize this contribution (Schoellhamer et al. 2007b).

Maintenance of the islands and wetlands in the Delta depends on replenishment of their sediments from upstream sources. At the same time, erosion in Delta channels may expose previously contaminated sediments that can negatively affect biota and drinking water supplies. The Delta also has been identified as a source of toxic sediments to the San Francisco estuary (Anderson et al. 2007).

Some aquatic species, such as the delta smelt, tend to prefer turbid waters (CALFED Bay-Delta Program 2008b). Moreover, relatively turbid Delta waters limit light penetration, thereby limiting the frequency and magnitude of nuisance algal blooms.

TSS concentrations in the Delta range from 10 to 50 mg/L but can exceed 200 mg/L during flood events (Schoellhamer et al. 2007b). The size of suspended particles in Delta waters is typically less than 63 microns. These are silts and clays that tend to remain suspended in the water column (Schoellhamer et al. 2007b). Particulates in the water column play an important role in chemical adsorption and the transport of pollutants. The most sediment is supplied to the Delta during high flows (Wright and Schoellhamer 2005; McKee et al. 2006).

The average annual Delta sediment budget for 1999–2002 as presented by Schoellhamer et al. (2007b) is shown in Figure 8-46. The Sacramento River supplies the greatest input of sediment (66%), followed by the Yolo Bypass (19%), the San Joaquin River (13%), and the eastside tributaries (2%). The largest contributor of sediment to San Francisco Bay from the Delta is the Sacramento River–Yolo Bypass system.

Existing Conditions in the Study Area

The cost-effectiveness and simplicity of sampling for turbidity rather than TSS have resulted in fewer TSS data in recent years. Hence, turbidity data are examined here.

Most examined locations in the Delta have had low mean values of turbidity in recent years (water years 2001–2006), with mean values typically ranging from 8 to 13 nephelometric turbidity units (NTU) (Figure 8-47). The exceptions include the major system inputs (Sacramento River at Hood [18 NTU]) and the San Joaquin River near Vernalis (23 NTU), natural outflows (Sacramento River above Point Sacramento [19 NTU] and San Joaquin River at Antioch Ship Channel [18 NTU]), and the Barker Slough pumps (40 NTU).

Mean values for the north-of-Delta area were typically 5 NTU, with the exception of 19 NTU at the Sacramento River at Verona (Table 8-37). South-of-Delta mean values were typically 6 NTU.

Time series data indicate that turbidity values at the examined stations generally fluctuate on an annual basis (Figure 8-48 and Figure 8-49), with higher values during the months of December through March.

Table 8-37. Turbidity Concentrations at Selected North- and South-of-Delta Stations, Water Years 2001–2006[a]

	Turbidity (NTU)				
Location	Samples	Minimum	Maximum	Mean	Median
Sacramento River at Keswick	17	9	33	5	3
Sacramento River at Verona	18	4	68	19	12
Feather River at Oroville	5	2	10	5	4
American River at WTP	119	1	146	5	2
California Aqueduct at Check 13	69	1	23	6	6
California Aqueduct at Check 29	74	2	21	6	5

Notes:
NTU = nephelometric turbidity unit.
WTP = water treatment plant.
[a] Sample size represents water quality samples having values at or greater than the reporting limit.
Source: California Department of Water Resources 2009b.

There are no numeric criteria for TSS. Because TSS and turbidity are not priority pollutants, there are no criteria established for these parameters in the NTR or CTR. The San Francisco Bay Water Board Basin Plan objectives for turbidity are associated with waste dischargers such that turbidity relatable to such discharge shall not increase receiving water by more than 10% in areas where natural turbidity is greater than 50 NTUs. Central Valley Water Board Basin Plan objectives are more restrictive. Applicable objectives are detailed in Appendix 8A. None of the water bodies in the affected environment have been listed as impaired on the state's CWA Section 303(d) list due to elevated TSS or turbidity (State Water Resources Control Board 2011).

The current CALFED turbidity goal is 50 NTU for the purposes of reducing turbidity variability (CALFED Bay-Delta Program 2007b).

USEPA's Surface Water Treatment Rules require systems using surface water or groundwater under the direct influence of surface water to implement the appropriate disinfection and/or filtration techniques to minimize turbidity in treated drinking water (U.S. Environmental Protection Agency 2006a). At no time can turbidity go above 5 NTU; systems that use filtration must ensure that the turbidity go no higher than 1 NTU (0.5 NTU for conventional or direct filtration) in at least 95% of the daily samples in any month. As of January 1, 2002, turbidity may never exceed 1 NTU, and must not exceed 0.3 NTU in 95% of daily samples in any month.

8.3 Regulatory Setting

Numerous federal, state and local acts, rules, plans, policies, and programs define the framework for regulating water quality in California. The following discussion focuses on water quality requirements that are applicable to the BDCP. The federal and state agencies responsible for regulating water quality in the study area are:

- USEPA.
- State Water Board.
- San Francisco Bay Water Board.
- Central Valley Water Board.

USEPA provides guidance and oversight to California in regulating water quality, as it does for other states and for tribes. As in other states across the country, USEPA delegates various authorities for establishing water standards and regulating controllable factors affecting water quality to the state. In California, this authority is delegated to the State Water Board. The State Water Board, in turn, delegates authority to its nine regional water boards to implement the state's water quality management responsibilities in the nine geographic regions. Although the state generally takes the lead on developing and adopting water quality standards for California, USEPA must approve new or modified standards. Thus, USEPA, the State Water Board, and the two Regional Water Boards cited above have worked together to establish existing water quality standards for the study area. Water quality standards have three components: (1) the beneficial uses of the water to be protected; (2) the water quality criteria (referred to as *objectives* in California) that must be met to protect the beneficial uses; and (3) an antidegradation policy to protect and maintain water quality when it is better than the criteria/objectives. Additionally, CDFW, USFWS, NMFS and the Federal Energy Regulatory Commission impose water quality standards such as DO and temperature in the study area.

8.3.1 Federal Plans, Policies, and Regulations

8.3.1.1 Clean Water Act

The federal CWA (33 U.S.C. § 1251 et seq.) places primary reliance for developing water quality standards on the states (e.g., water quality objectives). The CWA established the basic structure for regulating point and nonpoint discharges of pollutants into the waters of the United States and gave USEPA the authority to implement pollution control programs, such as setting wastewater standards for industry. The statute employs a variety of regulatory and nonregulatory tools to sharply reduce direct pollutant discharges into waterways, finance municipal wastewater treatment facilities, and manage polluted runoff. The CWA authorizes USEPA to delegate many permitting, administrative, and enforcement aspects of the law to state governments. However, USEPA still retains oversight responsibilities. In California, such responsibility has been delegated to the state, which administers the CWA through the Porter-Cologne Water Quality Control Act (Porter-Cologne Act) (Wat. Code, § 13000 et seq.). Under the Porter-Cologne Act, the State Water Board oversees nine Regional Water Boards that regulate the quality of waters within their regions.

Section 303(d)

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

Section 401

Under CWA Section 401, applicants for a federal permit or license to conduct activities that may result in the discharge of a pollutant into waters of the United States must obtain certification from the state in which the discharge would originate or, if appropriate, from the interstate water pollution control agency with jurisdiction over affected waters at the point where the discharge would originate. Therefore, all projects that have a federal component and may affect state water quality (including projects that require federal agency approval [such as issuance of a CWA Section 404 permit] must comply with CWA Section 401. In California, the authority to grant water quality certification has been delegated to the State Water Board, and applications for water quality certification are typically processed by the Regional Water Board with local jurisdiction. Water quality certification requires evaluation of potential effects in light of water quality standards and CWA Section 404 criteria governing discharge of dredged and fill materials into waters of the United States. For the BDCP, water quality certifications may be obtained from either the State Water Board (e.g., for large scale authorizations for BDCP actions such as a Section 404 Regional General Permit), or the Central Valley Water Board or San Francisco Bay Water Board for individual facility construction elements of BDCP in each agency's jurisdictional area.

Section 402

Under CWA Section 402, point- and nonpoint-source discharges to surface waters are regulated through the NPDES program. In California, the State Water Board oversees the NPDES program, which is administered by the Regional Water Boards. The NPDES program provides both general permits (those that cover a number of similar or related activities) and individual permits.

The NPDES Wastewater Program has responsibility for regulating wastewater discharges to surface waters. Primary program activities include: (1) issuing NPDES permits (new and renewals); (2) monitoring discharger compliance with permit requirements (review of discharger self-monitoring reports and compliance inspections); (3) taking enforcement action as appropriate; (4) investigating spills and illegal discharges; and (5) handling petitions and litigation.

The NPDES Stormwater Program regulates municipal (Municipal Separate Storm Sewer Systems), construction, industrial, and California Department of Transportation stormwater discharges. BMPs to control sediment erosion typically are used as part of this program. In general, the stormwater program differs from many other programs in that it uses general permits adopted by the State Water Board. Dischargers that desire coverage under these permits must submit a Notice of Intent to the State Water Board indicating the intent to be covered under the general permit and comply with its requirements. Exceptions to this process include Phase I Municipalities and the California Department of Transportation. Beginning in March 2003, all construction activities with 1 acre of soil disturbance or greater are required to obtain coverage under the General Construction Permit.

Section 404

Under CWA Section 404, a program was established to regulate the discharge of dredged and fill material into waters of the United States, including some wetlands, via the issuance of NPDES permits. USACE is authorized to issue Section 404 permits. Activities in waters of the United States that are regulated under this program include fills for development, water resource projects (e.g., dams and levees), infrastructure development (e.g., highways and airports), and conversion of wetlands to uplands for farming and forestry. Under Section 404(b)(1) of the CWA, the Least Environmentally Damaging Practicable Alternative (LEDPA) must be identified from among those alternatives considered in detail in the Environmental Impact Statement (EIS)/Environmental Impact Report (EIR). If a federal agency is a partner in the implementation of a project, the proposed action/project must be recognized as the LEDPA. A Section 404(b)(1) evaluation will be included with the project's Final EIS/EIR pursuant to the CWA, to provide required information on the potential effects of project activities regarding water quality and to provide rationale in support of identifying the LEDPA. The Draft EIR/EIS will be reviewed by concerned members of the public and stakeholders while given the opportunity to provide comments on project alternatives and documentation.

Construction for the water conveyance facilities and several other conservation measures associated with the BDCP would be subject to regulation under Sections 401, 402, and 404 of the CWA.

8.3.1.2 Rivers and Harbors Act Section 10

Section 10 of the Rivers and Harbors Act of 1899 requires authorization from the USACE for the construction of any structure in or over navigable waters of the United States, the excavation/dredging or deposition of material in these waters, or any obstruction or alteration in navigable water.

Construction for the water conveyance facilities and several other conservation measures associated with the BDCP would be subject to regulation under Section 10 of the Rivers and Harbors Act.

8.3.1.3 Federal Antidegradation Policy

The federal antidegradation policy is designed to provide the level of water quality necessary to protect existing uses and provide protection for higher quality and national water resources. The federal policy directs states to adopt a statewide policy that includes the following primary provisions (40 CFR 131.12).

Existing instream water uses and the level of water quality necessary to protect the existing uses shall be maintained and protected.

1. Where the quality of waters exceed levels necessary to support propagation of fish, shellfish, and wildlife and recreation in and on the water, that quality shall be maintained and protected unless the state finds, after full satisfaction of the intergovernmental coordination and public participation provisions of the state's continuing planning process, that allowing lower water quality is necessary to accommodate important economic or social development in the area in which the waters are located.

2. Where high quality waters constitute an outstanding national resource, such as waters of national and state parks and wildlife refuges and waters of exceptional recreational or ecological significance, that water quality shall be maintained and protected.

8.3.1.4 National Toxics Rule

In 1992, pursuant to the CWA, USEPA promulgated the NTR to establish water quality criteria for 12 states and two territories, including California, that had not complied fully with Section 303(c)(2)(B) of the CWA (57 FR 60848). As described in the preamble to the final NTR, when a state adopts and USEPA approves water quality criteria that meet the requirements of Section 303(c)(2)(B) of the CWA, USEPA will issue a rule amending the NTR to withdraw the federal criteria for that state. If the state's criteria are no less stringent than the promulgated federal criteria, USEPA will withdraw its criteria without notice and comment rules because additional comment on the criteria is unnecessary (65 FR 19659). However, if a state adopts criteria that are less stringent than the federally promulgated criteria, but in USEPA's judgment fully meet the requirements of the CWA, USEPA will provide an opportunity for public comment before withdrawing the federally promulgated criteria (57 FR 60860, December 22, 1992). Amendments to the NTR occurred in May 1995 and November 1999. The CTR (described in a subsequent section) subsequently was promulgated in 2000 and carried forward the established criteria of the NTR, thereby providing a single regulation containing California's adopted and applicable water quality criteria for priority pollutants.

8.3.1.5 Safe Drinking Water Act

The SDWA was established to protect the public health and quality of drinking water in the United States, whether from aboveground or underground sources. The SDWA directed USEPA to set national standards for drinking water quality. It required USEPA to set MCLs for a wide variety of potential drinking water pollutants (Appendix 8A). The owners and operators of public water systems are required to comply with primary (health-related) MCLs and encouraged to comply with secondary (nuisance- or aesthetics-related) MCLs.

SDWA drinking water standards apply to treated water as it is served to consumers. All surface waters require some form of treatment in order to meet drinking water standards. The degree of treatment needed depends on the quality of the raw water. The highest quality raw surface waters need only to be disinfected before being served to consumers. More typically, raw water is treated in a conventional WTP that includes sedimentation, filtration, and disinfection processes. Municipal water suppliers prefer raw water sources of high quality because their use minimizes risk to public health and because their use minimizes the cost and complexity of treatment to meet SDWA drinking water standards.

Some constituents of Delta water are of particular concern to municipal contractors because they are either not removed, only partially removed, or are transformed by the treatment process into hazardous substances by community-used water treatment processes. Constituents of concern include TDS, chlorides, bromides, and organic compounds. These substances can be removed from raw water by advanced water treatment processes, but to do so substantially increases the cost borne by municipalities.

8.3.1.6 Surface Water Treatment Rule

The Federal Surface Water Treatment Rule is implemented by the California Surface Water Treatment Rule, which satisfies three specific requirements of the SDWA by: (1) establishing criteria for determining when filtration is required for surface waters; (2) defining minimum levels of disinfection for surface waters; and (3) addressing *Cryptosporidium* spp., *Giardia lamblia*, *Legionella* spp., *E. coli*, viruses, turbidity, and heterotrophic plate count by setting a treatment technique. A treatment technique is set in lieu of an MCL for a contaminant when it is not technologically or economically feasible to measure that contaminant. The Surface Water Treatment Rule applies to all drinking water supply activities in California; its implementation is overseen by DPH.

8.3.1.7 Stage 1 and Stage 2 Disinfectants and Disinfection Byproducts Rule and Long-Term 1 and Long-Term 2 Enhanced Surface Water Treatment Rule

The Stage 1 D/DBP Rule established maximum residual disinfectant level goals and maximum residual disinfectant levels for chlorine, chloramines, and chlorine dioxide. It also set MCLGs and MCLs for THMs, five HAAs, chlorite, and bromate. The primary purpose of the Long-Term 1 Enhanced Surface Water Treatment Rule is to improve microbial control, especially of *Cryptosporidium*.

Water systems that use surface water and conventional filtration treatment are required to remove specified percentages of organic materials, measured as TOC, which may react with disinfectants to form DBPs. Removal is to be achieved through a treatment technique (e.g., enhanced coagulation or enhanced softening), unless the system meets alternative criteria.

USEPA adopted the Stage 2 Microbial and Disinfection Byproducts Rules in January 2006. The Rules include both the Stage 2 D/DBP Rule and Long-Term 1, and Long-Term 2 Enhanced Surface Water Treatment Rule. These rules include revised and new requirements, such as water systems having to meet DBP MCLs at each monitoring site in the distribution system, rather than averaging multiple sites. The rules also contain a risk-targeting approach to better identify monitoring sites where customers are exposed to high levels of DBPs. The rules include new requirements for treatment efficacy and *Cryptosporidium* inactivation/removal, as well as new standards for DBPs, disinfectants, and potential contaminants.

The overall goal of this group of regulations is to balance the risks from microbial pathogens with those from carcinogenic DBPs. All domestic water suppliers must follow the requirements of these rules, which are overseen by DPH.

8.3.2 State Plans, Policies, and Regulations

8.3.2.1 Porter-Cologne Water Quality Control Act of 1969

Under the Porter-Cologne Act, water quality objectives are limits or levels of water quality constituents or characteristics established for the purpose of protecting beneficial uses. The act requires the Regional Water Boards to formulate and adopt WQCPs, commonly called *Basin Plans*, that designate the beneficial uses of the water to be protected, and establish water quality objectives and a program to meet the objectives. Water quality objectives means the limits or levels of water quality constituents or characteristics that are established for the reasonable protection of beneficial uses of water or the prevention of nuisance in a specific area. Therefore, the water quality objectives form the regulatory references for meeting state and federal requirements for water quality control.

A change in water quality is allowed only if the change is consistent with the maximum beneficial use of the waters of the state, would not unreasonably affect the present or anticipated beneficial uses, and would not result in water quality lower than that specified in applicable Basin Plans (Central Valley Water Board 2009a). The BDCP is subject to the Porter-Cologne Act.

8.3.2.2 State Water Resources Control Board Water Rights Decisions, Water Quality Control Plans, and Water Quality Objectives

The preparation and adoption of Basin Plans is required by the California Water Code (Section 13240) and supported by the CWA. Section 303 of the CWA requires states to adopt water quality standards that "consist of the designated uses of the navigable waters involved and the water quality criteria for such waters based upon such uses." According to Section 13050 of the California Water Code, Basin Plans consist of a designation or establishment for the waters within a specified area of beneficial uses to be protected, water quality objectives to protect those uses, and a program of implementation needed for achieving the objectives. Beneficial uses are defined in Water Code Section 13050(f) as including domestic, municipal, agricultural, and industrial supply; power generation; recreation; aesthetic enjoyment; navigation; and the preservation and enhancement of fish, wildlife, and other aquatic resources or preserves. Because beneficial uses, together with their corresponding water quality objectives, can be defined per federal regulations as water quality standards, the Basin Plans are regulatory references for meeting the state and federal requirements for water quality control. One substantial difference between the state and federal programs is that California's Basin Plans establish standards for groundwater in addition to surface water. Adoption or revision of surface water standards is subject to the approval of USEPA.

The State Water Board is responsible for protecting, where feasible, the state's public trust resources, including fisheries, and has the authority under Article X, Section 2, of the California Constitution and Water Code Section 100 to prevent the waste or unreasonable use, unreasonable method of use, or the unreasonable method of diversion of all waters of the state.

The State Water Board Water Rights Division has primary regulatory authority over water supplies and issues permits for water rights—specifying amounts, conditions, and construction timetables—for diversion and storage facilities. Water rights decisions implement the objectives adopted in the Delta WQCP and reflect water availability, recognize prior water rights and flows needed to preserve instream uses (such as water quality and fish habitat), and whether the diversion of water is in the public interest.

Basin Plans adopted by Regional Water Boards are implemented primarily through the NPDES permitting system and issuance of waste discharge requirements to regulate waste discharges so water quality objectives are met. Basin plans provide the technical basis for determining waste discharge requirements and authorize the Regional Water Boards to take regulatory enforcement actions if deemed necessary.

8.3.2.3 Water Quality Control Plan for the San Francisco Bay/Sacramento–San Joaquin Delta Estuary

The current WQCP in effect in the Delta is the *2006 Water Quality Control Plan for the San Francisco Bay/Sacramento–San Joaquin Delta Estuary* (Bay-Delta WQCP) (State Water Resources Control Board 2006). The Bay-Delta WQCP identifies beneficial uses of water in the Delta to be protected, water quality objectives for the reasonable protection of beneficial uses, and an implementation program to achieve the water quality objectives.

The 2006 Bay-Delta WQCP adoption did not involve substantial changes to the prior 1995 Bay-Delta WQCP. The 1995 Bay-Delta WQCP was developed as a result of the December 15, 1994, Bay Delta Accord, which committed SWP and CVP to new Delta habitat objectives. In 1999, the State Water Board, through a water rights decision (D-1641), assigned responsibilities to entities holding certain water rights to help meet the objectives of the WQCP. One key feature of the 1995 Bay-Delta WQCP is the estuarine habitat objectives (X2) for Suisun Bay and the western Delta. The X2 standard refers to the position at which 2 ppt salinity occurs in the Delta estuary and is designed to improve shallow-water fish habitat in the spring of each year. The X2 standard requires specific daily or 14-day salinity, or 3-day averaged outflow requirements, to be met for a certain number of days each month from February through June. D-1641 also implemented the Vernalis salinity objective and directed the Regional Board to adopt salinity objectives and an implementation program for the lower San Joaquin River. (See 8.2.2.12 below.)

Other elements of the Bay-Delta WQCP include export-to-inflow ratios intended to reduce entrainment of fish at the export pumps, Delta Cross Channel gate closures, minimum Delta outflow requirements, and San Joaquin River salinity and flow standards.

8.3.2.4 Water Quality Control Plan (Basin Plan) for the Sacramento and San Joaquin River Basins

The Basin Plan for the Central Valley Water Board covers an area including the entire Sacramento and San Joaquin River basins, involving an area bound by the crests of the Sierra Nevada on the east and the Coast Range and Klamath Mountains on the west. The area covered in this Basin Plan extends some 400 miles, from the California-Oregon border southward to the headwaters of the San Joaquin River. The BDCP will be required to meet the water quality objectives in the Basin Plan for the Sacramento and San Joaquin River basins, which was designed to protect the beneficial uses of the Sacramento and San Joaquin Rivers and their tributaries and was last amended in 2009 (Central Valley Water Board 2009a).

8.3.2.5 San Francisco Bay Basin Water Quality Control Plan (Basin Plan)

This Basin Plan covers 1,100 square miles of the 1,600–square mile San Francisco Bay estuary and includes coastal portions of Marin and San Mateo Counties, from Tomales Bay in the north to Pescadero and Butano Creeks in the south. The Bay system functions as the only drainage outlet for waters of the Central Valley. It also marks natural topographic separation between the northern and southern coastal mountain ranges. The region's waterways, wetlands, and bays form the centerpiece of the fourth-largest metropolitan region in the United States, and the region includes all or major portions of Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo, Santa Clara, Solano, and Sonoma Counties.

8.3.2.6 State Water Board Resolution No. 68-16—Statement of Policy with Respect to Maintaining High Quality Waters in California (State Antidegradation Policy)

The goal of State Water Board Resolution No. 68-16 (Statement of Policy with Respect to Maintaining High Quality Waters in California) is to maintain high quality waters where they exist in the state. State Board Resolution No. 68-16 states, in part:

1. Whenever the existing quality of water is better than the quality established in policies as of the date on which such policies become effective, such existing high quality will be maintained until it has been demonstrated to the state that any change will be consistent with maximum benefit to the people of the state, will not unreasonably affect present and anticipated beneficial use of such water, and will not result in water quality less than that prescribed in the policies.

2. Any activity that produces or may produce a waste or increased volume or concentration of waste and that discharges or proposes to discharge to existing high quality waters will be required to meet waste discharge requirements that will result in the best practicable treatment or control of the discharge necessary to ensure that (a) a pollution or nuisance will not occur and (b) the highest water quality consistent with maximum benefit to the people of the state will be maintained.

The State Water Board has interpreted Resolution No. 68-16 to incorporate the federal antidegradation policy, which is applicable if a discharge that began after November 28, 1975, will lower existing surface water quality.

8.3.2.7 State Water Resources Control Board Sources of Drinking Water Policy (Resolution No. 88-63)

The Sources of Drinking Water Policy established state policy that all waters, with certain exceptions, should be considered suitable or potentially suitable for municipal or domestic supply. Under the policy, unless otherwise designated, Regional Water Boards must consider all surface water and groundwater as suitable, or potentially suitable, for municipal or domestic water supply. The policy defines the following three categories of waters potentially eligible for an exception from the designation and protection of a water source for municipal/domestic supply.

- Water bodies with high salinity (defined as TDS >3,000 mg/L), that either have naturally high contaminant levels that cannot reasonably be treated using either BMPs or best economically achievable treatment practices, or produce too low yield (<200 gallons per day).

- Waters designed or modified to treat wastewaters (domestic or industrial wastewater, process water, stormwater, mining discharges, or agricultural drainage), provided that such systems are monitored to ensure compliance with all relevant water quality objectives.

- Groundwater aquifers regulated as geothermal energy–producing sources or aquifers that have been exempted administratively by federal regulations for the purpose of underground injection of fluids associated with the production of hydrocarbon or geothermal energy.

8.3.2.8 Policy for Implementation and Enforcement of the Nonpoint-Source Pollution Control Program (Water Code Section 13369[a][2][B])

Agricultural return flows include flows from tile drains and irrigation and stormwater runoff. These discharges can affect water quality by transporting pollutants, including pesticides, sediments, and nutrients, from cultivated fields into surface water. Many surface water bodies are impaired because of pollutants from agricultural sources. Groundwater bodies in California's agricultural areas also have suffered pesticide, nitrate, and salt contamination.

Historically, most Regional Water Boards regulated these discharges under waivers, as authorized by Water Code Section 13269, and other administrative tools were seldom used. Section 13269 allows the Regional Water Boards to waive the requirement for waste discharge requirements if it is in the public interest. Although waivers were always conditional, the historical waivers had few conditions. In general, they required that discharges not cause violations of water quality objectives but did not require water quality monitoring.

In May 2004, the State Water Board adopted a new policy regulating nonpoint-source pollution, known as the Policy for Implementation and Enforcement of the Nonpoint Source Pollution Control Program, fulfilling the requirements of Water Code Section 13369(a)(2)(B). This policy affects landowners and operators throughout the state engaged in agricultural production, timber harvest operations, and other potential sources of nonpoint source pollution.

The 2004 policy generally expects nonpoint-source dischargers to use management practices that do not impair surface water quality and charges each landowner a fee to cover increased regulatory oversight. Consequently, implementation programs for nonpoint-source pollution control have expanded beyond waivers and now may be developed by a Regional Water Board, the State Water Board, individual dischargers, or by a coalition of dischargers in cooperation with a third-party representative, organization, or government agency. The latter programs are collectively known as *third-party programs*, and the third-party role is restricted to entities that are not actual dischargers under Regional Water Board/State Water Board point-discharge permitting and enforcement jurisdiction.

8.3.2.9 California Toxics Rule

As a result of a court-ordered revocation of California's statewide objectives for priority pollutants in September 1994, USEPA initiated efforts to promulgate additional numeric water quality criteria for California. In May 2000, USEPA issued the CTR that promulgated numeric criteria for priority pollutants not included in the NTR. The CTR documentation (65 FR 31682, May 18, 2000) carried forward the previously promulgated standards of the NTR, thereby providing a single document listing California's adopted and applicable water quality criteria for priority pollutants.

8.3.2.10 Policy for the Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California

In March 2000, the State Water Board adopted the Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California (SIP), which implemented criteria for priority toxic pollutants contained in the CTR as well as other priority toxic pollutant criteria and objectives. The SIP applies to discharges of toxic pollutants into inland surface waters, enclosed bays, and estuaries of California subject to regulation under the state's Porter-Cologne Act (Division 7 of the Water Code) and the federal CWA. Such regulation may occur through the issuance of NPDES permits or other relevant regulatory approaches. The goal of this policy is to establish a standardized approach for permitting discharges of toxic pollutants to nonocean surface waters in a manner that promotes statewide consistency. As such, SIP is a tool to be used in conjunction with watershed management approaches and, where appropriate, the development of TMDLs to ensure achievement of water quality standards (water quality criteria or objectives and the beneficial uses they are intended to protect, as well as the state and federal antidegradation policies).

SIP established: (1) implementation provisions for priority pollutant criteria promulgated by USEPA through the NTR and CTR and for priority pollutant objectives established by Regional Water Boards in their WQCPs; (2) monitoring requirements for 2,3,7,8-TCDD equivalents; and (3) chronic toxicity control provisions. In addition, the SIP includes special provisions for certain types of discharges and factors that could affect the application of other provisions in the policy.

8.3.2.11 Department of Public Health Safe Drinking Water Act Implementation

DPH is designated by USEPA as the primary agency to administer and enforce requirements of the federal SDWA in California. Public water systems are required to monitor for regulated contaminants in their drinking water supply. California's drinking water standards (e.g., MCLs) are the same or more stringent than the federal standards and include additional contaminants not regulated by USEPA. Like the federal MCLs, California's primary MCLs address health concerns, while secondary MCLs address aesthetics, such as taste and odor. The California SDWA is administered by DPH primarily through a permit system.

8.3.2.12 State Water Resources Control Board Decision 1641

The Bay-Delta WQCP (discussed previously) outlines current water quality objectives for the Delta. State Water Resources Control Board D-1641 contains the current water right requirements, applicable to DWR and Reclamation's operations of the SWP and CVP facilities, respectively, to implement the Bay-Delta water quality objectives. Objectives included in D-1641 include those related to salinity and dissolved oxygen, spring outflow (i.e., X2) objectives, export pumping, Delta cross-channel operations, and flow objectives in the Sacramento and San Joaquin Rivers.

Regarding X2, D-1641 specifies that, from February through June, the location of X2 must be west of Collinsville and additionally must be west of Chipps Island or Port Chicago for a certain number of days each month, depending on the previous month's Eight River Index. D-1641 specifies that compliance with the X2 standard may occur in one of three ways: (1) the daily average EC at the compliance point is less than or equal to 2.64 millimhos/cm; (2) the 14-day average EC is less than or equal to 2.64 millimhos/cm; or (3) the 3-day average Delta outflow is greater than or equal to the corresponding minimum outflow.

In D-1641, the State Water Board assigned responsibilities to Reclamation and DWR for meeting these requirements on an interim basis. These responsibilities required that SWP and CVP be operated to meet water quality objectives in the Delta, pending a water rights hearing to allocate the obligation to meet the water quality and flow-dependent objectives among all users of the Sacramento and San Joaquin River basins with appropriative water rights with post-1914 priority dates. However, in lieu of this hearing, the San Joaquin River Agreement and Sacramento Valley Water Management Agreement are settlements between Reclamation and DWR with water users upstream of the Delta, in which SWP and CVP committed to continue to meet the D-1641 water quality requirements in return for other commitments by major upstream water-rights holders. After these agreements were executed, the State Water Board cancelled the water rights hearing to allocate that responsibility.

In February 2006, the State Water Board issued a Cease and Desist Order (CDO, Water Rights Order No. 2006-0006) to DWR and Reclamation that established actions and a compliance schedule for implementation of the requirements contained in D-1641, in particular to ensure compliance with the salinity objectives for the interior southern Delta. The CDO also revised the previously issued (July 1, 2005) Water Quality Response Plan approval governing Reclamation's and DWR's Joint Point of Diversion (JPOD) operations (i.e., use of the other agency's respective point of diversion in the southern Delta). The CDO specified that the agencies may conduct JPOD operations provided that both agencies are in compliance with all of the conditions of their respective water right permits and licenses at the time that the JPOD operations would occur. The CDO was amended in January 2010 (Water Rights Order No. 2010-0002) to modify the time schedule of actions to follow the State Water Board's next review of the 2006 Bay-Delta WQCP and separate hearings completed in 2010 for the consideration of changes to the interior southern Delta salinity objectives.

D-1641 also established the Vernalis Adaptive Management Plan, (VAMP), a 12-year experimental/adaptive management program to assess effects of changes in flows and aquatic habitat resources on juvenile Chinook salmon migrating from the San Joaquin River through the Delta. This 12-year experimental/adaptive management program concluded in 2011. No formal plans for its continuation have been adopted.

SWP and CVP Coordinated Operations Agreement

SWP and CVP are relatively independent projects that use a common water supply. However, the SWP and CVP operations are linked by the requirement that they meet Delta flow and water quality standards and are linked by joint operations south of the Delta at the San Luis complex and the joint-use San Luis Canal. In 1986, Public Law 99-546 authorized the Coordinated Operations Agreement (COA) between Reclamation and DWR, intended to define the rights and responsibilities of SWP and CVP with respect to use of that common water supply and provide an infrastructure to monitor those rights and responsibilities. Specifically, the COA defines the project facilities and their water supplies, sets forth procedures for coordination of operations, identifies formulas for sharing joint responsibilities for meeting Delta flow and water quality standards and other legal uses of water, identifies how unstored flow will be shared, sets up a framework for exchange of water and services between the projects, and provides for periodic review every 5 years (Bureau of Reclamation 2004).

SWP and CVP Project Water Acceptance Criteria

In consultation with SWP contractors and DHS, DWR developed acceptance criteria to govern the water quality of nonproject water conveyed through the California Aqueduct. Non-project water with chemical concentrations less than the acceptable criteria is routinely accepted by DWR. Non-project water with chemical concentrations greater than the criteria is managed on a case-by-case basis.

8.3.2.13 Central Valley Water Board Drinking Water Policy

A commitment of the CALFED Bay-Delta Program process and Record of Decision was the development of a new drinking water policy for Delta waters. Currently, both the Bay-Delta WQCP and the Sacramento–San Joaquin Basin Plan lack numeric water quality objectives for several known drinking water constituents of concern, such as organic carbon and pathogens (CALFED Bay-Delta Program 2008b). In response to the CALFED commitment, the Central Valley Water Board is in the process of a multiyear effort to develop a drinking water policy for surface waters in the Central Valley (Central Valley Water Board 2011a). Existing policies and plans lack water quality objectives for several known drinking water constituents of concern, including DBP precursors and pathogens, and also lack implementation strategies to provide effective source water protection. The new policy will culminate in the incorporation of new requirements into a Basin Plan amendment, anticipated to be completed in 2013. The Central Valley Water Board Drinking Water Policy will apply to Delta waters and any activities, such as discharges, that affect Delta water quality.

8.3.3 Nonregional and Local Plans, Policies, and Regulations

The boundaries of Contra Costa, Sacramento, San Joaquin, Solano, and Yolo Counties include water bodies that would be most directly affected by implementation of BDCP alternatives. The respective general plans for these counties include goals and policies regarding water resources and stormwater management, and overall water quality management, designed for protection of beneficial uses of importance within the Delta and elsewhere. Cities and counties also have developed numerous ordinances, policies, and other regulatory mechanisms for controlling stormwater drainage and related contaminant discharges to surface water bodies. General plan policies and local regulations, and potential consistency of BDCP alternatives with such policies and regulations, are described below.

8.3.3.1 General Plan Goals and Policies

Contra Costa County General Plan

A comprehensive update to the Contra Costa County General Plan was adopted on January 18, 2005, to guide future growth, development, and resource conservation through 2020. Goal 8-T reflects the principal relevant water quality goal of the Contra Costa County General Plan, which states: “To conserve, enhance and manage water resources. Protect their water quality, and assure an adequate long-term supply of water for domestic, fishing, industrial and agricultural use.” Accompanying policy 8-75 states, “Preserve and enhance the quality of surface and groundwater quality.”

Sacramento County General Plan

The Sacramento County General Plan, amended on November 9, 2011, provides for growth and development in the unincorporated area through 2050. The principal goal of the Sacramento County General Plan pertaining to water resources states: “Ensure that a safe, reliable water supply is available for existing and planned urban development and agriculture while protecting beneficial uses of Waters of the state of California, including important associated environmental resources." Supporting policies include those following.

- **CO-21.** Support protection and restoration of the Sacramento River Delta.
- **CO-24.** Comply with the Sacramento Areawide National Pollutant Discharge Elimination System Municipal Stormwater Permit (NPDES Municipal Permit) or subsequent permits, issued by the Central Valley Water Board to the County, and the Cities of Sacramento, Elk Grove, Citrus Heights, Folsom, Rancho Cordova, and Galt (collectively known as the Sacramento Stormwater Quality Partnership [SSQP]).
- **CO-27.** Support surface water quality monitoring programs that identify and address causes of water quality degradation.
- **CO-28.** Comply with other water quality regulations and NPDES permits as they apply to County projects or activities, such as the State's Construction General Permit and Aquatic Pesticides Permit.
- **CO-29.** Continue to support the County's participation in regional NPDES Municipal Permit compliance activities through collaborative efforts such as the Sacramento Stormwater Quality Partnership.
- **CO-30.** Require development projects to comply with the County's stormwater development/design standards, including hydromodification management and low impact development standards, established pursuant to the NPDES Municipal Permit.

San Joaquin County General Plan

The "Resources" section of the San Joaquin County General Plan that addresses objectives and policies for water resources management was last updated in 1992 (San Joaquin County 1992). The General Plan contains the following four objectives that are directly or indirectly address protection of water quality conditions for the county:

- **Objective 1.** To ensure adequate quantity and quality of water resources for municipal and industrial uses, agriculture, recreation, and fish and wildlife.
- **Objective 2.** To obtain sufficient water supplies to meet all municipal and agricultural water needs.
- **Objective 4.** To prevent and eliminate contamination of surface and groundwater resources.
- **Objective 5.** To recognize the surface water resources of San Joaquin County as resources of the State and national significance for which environmental and scenic values must be protected

The General Plan further contains the following three specific water quality policies:

- **Policy 1.** Water quality shall meet the standards necessary for the uses to which the water resources are put.
- **Policy 2.** Surface water and groundwater quality shall be protected and improved when necessary.
- **Policy 3.** The use and disposal of toxic chemicals, the extraction of resources, and the disposal of wastes into injection wells shall be carefully controlled and monitored to protect water quality.

Solano County General Plan

The Solano County General Plan was adopted on August 5, 2008. The general plan is the guide for both land development and conservation in the unincorporated portions of the county and contains the policy framework necessary to fulfill the community's vision for Solano County in 2030. Relevant policies of the Solano County General Plan pertaining to water resources are described below.

The primary water resources goal (Goal RS.G-9) states: "Protect, monitor, restore and enhance the quality of surface and groundwater resources to meet the needs of all beneficial uses." Supporting polices include those following.

- **RS.P-64:** Identify, promote, and seek funding for the evaluation and remediation of water resource or water quality problems through a watershed management approach. Work with the regional water quality control board, watershed-focused groups, and stakeholders in the collection, evaluation and use of watershed-specific water resource information.
- **RS.P-73:** Use watershed planning approaches to resolve water quality problems. Use a comprehensive stormwater management program to limit the quantity and increase the water quality of runoff flowing to the county's streams and rivers.

Yolo County General Plan

The Yolo County 2030 Countywide General Plan was adopted on November 10, 2009, and provides for growth and development in the unincorporated area through 2030. Among all the county general plans in the Primary Zone of the Delta, Yolo County contains the most specific policies relating to protection of water resources. Relevant water resource policies and actions of the Yolo County general plan are listed below.

- **Policy CO-5.1:** Coordinate with water purveyors and water users to manage supplies to avoid long-term overdraft, water quality degradation, land subsidence and other potential problems.
- **Policy CO-5.6:** Improve and protect water quality for municipal, agricultural, and environmental uses.
- **Policy CO-5.7:** Support mercury regulations that are based on good science and reflect an appropriate balancing of sometimes competing public values including health, food chain, reclamation and restoration of Cache Creek, sustainable and economically viable Delta agriculture, necessary mineral extraction, flood control, erosion control, water quality, and habitat restoration.
- **Policy CO-5.21:** Encourage the use of water management strategies, biological remediation, and technology to address naturally occurring water quality problems such as boron, mercury, and arsenic.
- **Policy CO-5.23:** Support efforts to meet applicable water quality standards for all surface and groundwater resources.

8.3.3.2 Local Regulations

The principal regulatory requirements for surface water quality protection at the local governmental agency level consist primarily of stormwater management programs to implement responsibilities under the statewide NPDES stormwater permits for Municipal Separate (MS) Storm Sewer Systems adopted by the State Water Board. Larger entities such as the core municipal areas of

Sacramento and Stockton are regulated under individual permits (MS1 permits), whereas smaller cities and unincorporated county areas typically are regulated by the State Water Board's MS4 permit. Entities must prepare Storm Water Management Plans (SWMPs) for the stormwater NPDES permits that outline the agency actions that will be conducted to reduce the discharge of pollutants from storm drainage systems. The SWMPs must address urban runoff and construction site runoff. Additional city and county code and regulations for water quality protection typically may include grading permits, erosion and sediment control ordinances, and stormwater drainage facility design and management requirements.

8.3.3.3 Policy Consistency

The implementation of the selected alternative by the project proponent will comply with applicable stormwater management programs. In particular, as part of the Environmental Commitments (Appendix 3B) for each alternative, project construction activities will be conducted in compliance with the State Water Board's *NPDES Stormwater General Permit for Stormwater Discharges Associated with Construction and Land Disturbance Activities* (Order No. 2009-0009-DWQ/NPDES Permit No. CAS000002). This General Construction NPDES Permit requires the preparation and implementation of Stormwater Pollution Prevention Plans (SWPPPs) that outline the temporary construction-related BMPs to prevent and minimize erosion, sedimentation, and discharge of other construction-related contaminants, as well as permanent post-construction BMPs to minimize adverse long-term stormwater related–runoff water quality effects. Therefore, implementation of the alternatives would be anticipated to be consistent with local plans and regulations for stormwater management.

Although the state and federal project proponents and decision-makers are not required to comply with county general plans and policies, it is important for CEQA and NEPA compliance purposes to identify any relevant local land use plans, policies, and regulations that are adopted for the purpose of avoiding or mitigating an environmental effect. Potential inconsistencies with such enactments do not *per se* translate into adverse environmental effects under either CEQA or NEPA. Even where a lead agency is subject to an environmentally protective policy, the mere fact of inconsistency (a "paper" phenomenon) is not by itself an adverse effect on the environment. Such paper inconsistencies sometimes indicate, however, that a proposed physical activity might harm the environmental resource intended to be protected by the plans, policies, or regulations at issue. Potential adverse effects on such resources (e.g., water quality) are addressed in the *Environmental Consequences* section of this chapter, where the extent and significance of such effects are addressed.

8.4 Environmental Consequences

This section describes potential direct (both temporary construction-related and permanent operations-related) and indirect effects on water quality within the affected environment that would result from implementation of each alternative. For the purposes of this chapter, temporary impacts refer to those effects that are caused directly or indirectly through implementation of some temporary or intermittent activity associated with the proposed project, and thus ultimately the effect ceases to exist. Given the large scale of the potential temporary activities associated with the project, such as construction activities, it should be noted that temporary impacts may still occur over a relatively extended time period of many months or years at some project locations. An analysis of the consistency of the alternatives with applicable state water quality standards, plans, and policies, including the federally promulgated NTR and CTR, is provided for the Upstream of the Delta Region, Delta Region, and the SWP and CVP Export Service Areas Region of the affected environment. The impact analysis separates temporary construction-related impacts from those associated with long-term facilities operations for the alternatives. Each of the alternatives' proposed features are divided into two categories: physical/structural components associated with the new conveyance facilities (CM1) and their operations and maintenance, which are project-level features, and restoration actions or Conservation Measures 2–22 (CM2–CM22), which are programmatic features.

8.4.1 Methods for Analysis

Each Alternative would consist of two broad categories of actions, which are: (1) temporary construction activities associated with construction of the various conservation measures (CM1–CM22), and (2) non-construction-related actions associated with the numerous conservation measures. The non-construction-related actions associated with the conservation measures are further characterized by the following four major components.

1. New north Delta diversion and conveyance facilities to be operated in conjunction with SWP and CVP existing facilities (collectively called *conveyance*).
2. Detailed criteria that will govern the operations of the new SWP conveyance facilities and other in-Delta facilities across a range of hydrological conditions (collectively called operations). Number 1 and 2 together are referred to as conservation measure (CM) 1.
3. Habitat Restoration: each action alternative would include a range of tidal marsh, floodplain, riparian, and upland transition habitat activities within the Plan Area. (CM2–CM11).
4. Actions to address and control contaminants, nonnative invasive species, and predation, and to address other potentially important non-conveyance and non-habitat-related stressors on covered species (collectively called *other stressors*) (CM12–CM22).

Implementation of the alternatives would result in changes to SWP and CVP operations, Delta habitats, channel flows, and Delta hydrodynamics (i.e., how water moves through the Delta). Implementation of conservation measures also could directly affect water quality positively or negatively at certain locations. Thus, the components of the Alternatives could collectively result in complex water quality changes within the affected environment (see Section 8.1). For the purposes of this assessment, the study area is divided into the three regions (Figure 1-4).

- Plan Area, including the Yolo Bypass, SWP North Bay Aqueduct service area, and Suisun Marsh.
- Upstream of the Delta (including the Sacramento and San Joaquin River watersheds).
- SWP/CVP Export Service Area (south of the Delta, areas served by the California Aqueduct, Delta Mendota Canal, and South Bay Aqueduct [SBA]).

The two key questions to be addressed by this surface water quality impact assessment are as follows.

1. Would implementation of the Alternatives result in water quality changes to the Plan Area, Upstream of the Delta, or SWP/CVP Export Service Areas that would result in exceedances of water quality criteria/objectives, or substantially degrade water quality, of/by sufficient frequency, magnitude, and geographic extent as to cause or substantially contribute to

significant adverse effects on the beneficial uses of water in these areas of the affected environment?

2. Would implementation of the Alternatives result in beneficial effects on water quality in these areas?

Appropriately addressing these questions is a complex task because:

- The full effects of the Alternatives would occur in the future, and "project effects" on water quality involve numerous constituents of interest (many having adopted water quality objectives/criteria and some without adopted objectives/criteria).
- Multiple beneficial uses could be affected by changes in water quality.
- Numerous locations of interest are found throughout the large affected environment.

Moreover, models available for use in addressing such questions have been previously developed for the effects of operations of the SWP-CVP facilities for only a few water quality parameters (e.g., EC, DOC, and temperature) in defined portions of the affected environment (i.e., the Delta), and are poorly developed or not developed at all for nearly all other water quality parameters and locations, nor for most of the conservation measures proposed for implementation. Consequently, the methodology developed for assessing water quality impacts differed for each of the three areas of the affected environment because:

- The beneficial uses of water in each area are affected differently by the Alternatives.
- Each area has different constituents of concern and different historical data availability for those constituents.
- The availability of models that can be used to support quantitative assessments differs in each area.

Hence, a combination of both quantitative and qualitative analyses (as appropriate) was performed to estimate the changes in water quality attributable to implementation of the Alternatives within the three areas of the affected environment. Depending on the constituent and location, these changes could be significant/adverse (e.g., increase in concentration or mass loading of harmful constituents), insignificant, or beneficial.

In general, the fewest water quality changes of importance are expected to occur Upstream of the Delta, followed by the SWP/CVP Export Service Areas, with the greatest number and magnitude of water quality changes expected for the Plan Area. The Plan Area was analyzed in the greatest detail for the following reasons.

- Its water quality would be most affected by the BDCP action alternatives.
- It has complex hydrodynamic characteristics.
- Models are available to simulate hydrodynamic and water quality changes within the Delta region.
- Delta water quality is critically important to the water supplies of California residents that use water within the Delta and in the SWP/CVP Export Service Areas.

All constituents for which data were compiled were run through an initial screening analysis that determined the appropriate levels of analysis needed for each constituent, and whether further analysis beyond that provided by the screening analysis itself, if needed, would be qualitative or quantitative. The details of the screening analysis are discussed later in this section.

The constituents of concern in the affected environment included both physically and chemically conservative and non-conservative parameters. The concentrations of conservative constituents tend to not be affected substantially by physical, chemical, or biological mechanisms that would result in a loss of the constituent from the system. Thus, the concentrations of conservative constituents can be reasonably estimated and changes assessed with mass-balance accounting of the mixing of known volumes and concentrations of different water sources. Non-conservative constituents can be affected by mechanisms that result in loss from the water such as physical (e.g., settling, volatilization), chemical (e.g., adsorption, oxidation-reduction, complexation), or biological (e.g., uptake, decay) mechanisms such that mass-balance accounting becomes much more complex. Historical monitoring data for the majority of these constituents were collected and reviewed from various locations of interest within the affected environment.

Conservative parameters were evaluated using available models used for SWP-CVP planning and operations (i.e., California Water Resources Simulation Model [CALSIM II, Delta Simulation Model 2 [DSM2], and Reclamation's Temperature Model) wherever applicable, as well as constituents directly addressed by these models, and included EC, DOC, and temperature. It should be noted that because aquatic life beneficial uses are the only uses expected to be affected by temperature changes under the various Alternatives, the water quality chapter cross-references to Chapter 11, *Fish and Aquatic Resources*, for all impact assessments for temperature.

These models produce detailed estimates of existing and future flow and water quality conditions for the major reservoir, river, Delta, and constructed features such as agricultural diversions, municipal diversions, and associated conveyance facilities within the study area. As such, the CALSIM and DSM2 model outputs also were used to support quantitative mass-balance assessments for several other constituents that exhibit generally conservative characteristics. Non-conservative parameters were evaluated qualitatively. Detailed discussion on when and where qualitative or quantitative analyses were performed is included later in this section.

Mercury and selenium were analyzed in detail because of their bioaccumulative properties. Bioaccumulation refers to the uptake of a constituent by a biological organism which exceeds the excretion or loss from the organism, such that concentrations within the organism are increased over time. The specific methodologies used to evaluate these two parameters are discussed separately in this section. Various models used in analyzing these constituents of interest and their interrelationship have also been discussed in detail.

Based on the components of the Alternatives (described previously in this section), three categories of potential changes in water quality conditions are described, as follows.

- Changes attributable to construction-related conservation measure activities (CM1–CM22).
- Changes attributable to operations and maintenance of new conveyance facilities and new SWP and CVP operational criteria (CM1).
- Changes attributable to non-construction related actions associated with implementation of other defined conservation measures (CM2–CM22).

It was determined that the action alternatives would result in all three categories of potential water quality effects within the Plan Area. However, based on the description of BDCP alternatives (see Chapter 3, *Description of Alternatives*) for construction activities or other conservation measures in the Upstream of the Delta and the SWP/CVP Export Service Area, water quality changes were expected to be minimal and, hence, are not addressed in as much detail. For those Alternatives that include specific CM1 measures in the Plan Area, however, a project specific level of analysis is included.

The frequency, magnitude, and geographic extent of any change in specific water quality constituents, or change in mass loading, is of primary importance in determining effects on beneficial uses (aquatic biology, municipal and domestic supply, agricultural uses, recreation, etc.). Consequently, findings regarding estimated concentrations at each assessment location for individual constituents of concern under the alternatives were compared to thresholds of significance (Section 8.3.2) for the purposes of making California Environmental Quality Act (CEQA) and National Environmental Policy Act (NEPA) impact determinations. Thresholds of significance define the criteria used to define the level at which an impact would be considered significant in accordance with CEQA and NEPA. Thresholds were based on the checklist in Appendix G of the CEQA Guidelines (CCR, Title 14, Division 6, Chapter 3), scientific information and data, and regulatory standards. These thresholds take into account the factors under NEPA to determine the significance of an action in terms of the context and intensity of its effects (40 CFR 1508.27).

If the estimated water quality conditions for a constituent under an Alternative triggers one or more of the five water quality conditions defined as effects assessment criteria (NEPA) and thresholds of significance (CEQA) (see Section 8.3.2.3) at one or more of the assessment locations, then that Alternative was determined to have an adverse water quality effect (under NEPA) and a significant impact on water quality (under CEQA) for that water quality constituent or parameter. Improvements to water quality conditions, where modeled or estimated to occur, also were generally identified as beneficial if considered to reflect a substantial change.

In summary, the impact assessment methodology includes the following:

1. Addresses all constituents of concern based on available information and the current science regarding concentrations/levels that would affect beneficial uses of waters within the affected environment.

2. Quantitatively evaluates constituents of primary concern where modeling tools were developed and were available for doing so, and qualitatively assesses effects where appropriate modeling tools were unavailable.

3. Evaluates the overall effect of the Alternatives on beneficial uses in a comparative manner throughout the affected environment, during three distinct time frames (see Section 8.3.1), which address climate change considerations.

The details of this methodological approach are discussed below. In the following sections, the specific methodologies used to assess water quality impacts within the three distinct areas of the affected environment (i.e., Upstream of the Delta, Plan Area, and SWP/CVP Export Service Areas) are discussed.

8.4.1.1 Models Used and Their Linkages

The models used in support of the quantitative water quality analyses were: (1) Reclamation's and DWRs' CALSIM II hydrologic model; and (2) DWR's DSM2. A brief description of each model is provided below, followed by a discussion of how the results from these models were used to quantify changes in water quality constituent concentrations/parameter levels. More information on these models and the assumptions included in their application is described in Appendix 5A.

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

Among other output, CALSIM II provides mean monthly output for reservoir storage levels, reservoir releases, flows at various locations along the major rivers, X2 location, Delta inflow, and Delta outflow for an 82-year hydrologic period of record. The primary linkage of these models is for CALSIM II output to serve as input to the DSM2 model and the Reclamation temperature models, as shown in Figure 8-50. Input assumption details for each scenario modeled using CALSIM II are provided in Appendix 5A.

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.

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.

8.4.1.2 Upstream of the Delta Region

Water quality changes in the affected environment upstream from the north-Delta boundary, which includes the Sacramento River to Shasta Lake, the Feather River to Lake Oroville, and the American River to Folsom Lake, were primarily assessed qualitatively. Assessment of water quality changes was limited to operations-related water quality changes and the implementation of CM2–CM22. Conveyance facility construction-related effects are not anticipated upstream of the Delta.

The assessment of water quality changes in water bodies upstream of the Delta relied, in part, on making determinations as to how reservoir storage and releases would be changed. Specific changes in reservoir storage and releases were determined from CALSIM II modeling of the SWP and CVP system (Appendix 5A describe the CALSIM II modeling performed in support of this assessment). Reservoir storage and river flow changes were then evaluated to make determinations regarding the capacity for the affected water bodies to provide dilution of watershed contaminant inputs. Also, if a particular parameter was found to be correlated to seasonal reservoir levels or river flows, how the parameter would be altered seasonally by operational changes in reservoir levels or river flows was assessed.

8.4.1.3 Plan Area

Water quality changes in the Delta were assessed quantitatively to the extent that data and models were available to do so; otherwise, water quality changes were assessed qualitatively. Using the methodology described below, changes in boron, bromide, chloride, mercury, methylmercury, nitrate, organic carbon, and selenium, within the Delta were determined quantitatively at 11 assessment locations (Figure 8-7), while electrical conductivity and chloride were assessed at D-1641 compliance locations.

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

Methodologies to determine the effects attributable to construction activities and actions to address the other stressors are discussed later in this section.

Constituent Screening Analysis

Constituents assessed in the water quality chapter were identified based on the following considerations.

- Availability of historical monitoring data.
- Constituents having adopted federal water quality criteria or state water quality objectives.
- Constituents on the state's CWA Section 303(d) list in the Delta.
- Constituents identified in public scoping comments.
- Constituents deserving assessment based on professional judgment.

A constituent *screening analysis* was conducted on 182 water quality constituents/parameters. The screening analysis determined which constituents had no potential to exceed the thresholds of significance by implementation of the Alternatives and, thus, did not warrant further assessment. This analysis identified a list of "constituents of concern" that were further analyzed as part of assessing their potential water quality related impacts under the Alternatives. For a detailed description of the approach employed in the constituent screening analysis, see Appendix 8C.

Determining Whether Assessment is Qualitative or Quantitative

For many constituents, lack of adequate representative data precluded a quantitative assessment. Tables SA-8 and SA-9 of Appendix 8C identify the types of constituents that were carried forward for detailed analysis and were automatically determined to be assessed qualitatively. For constituents for which at least one data point in the representative data set was a detected value (see Table SA-7, Appendix 8C), the assessment was either quantitative or qualitative, depending on three factors: (1) adequacy of data to perform a quantitative assessment, (2) adequacy of modeling tools, relative to the physical/chemical properties of the constituent, to perform a quantitative assessment, and availability of these tools, and (3) whether a quantitative analysis was necessary to perform the assessment.

Available tools were considered appropriate for modeling only those constituents that could be assumed to be conservative. Other gain/loss mechanisms were accounted for and addressed qualitatively within the quantitative modeling-based assessment. Constituents of concern that could not be analyzed through quantitative modeling were carried forward for qualitative analysis. Appendix 8C, Table SA-11 contains a list of water quality constituents for which individual assessments were performed and denotes the constituents that were assessed quantitatively through modeling and those that were assessed qualitatively.

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 Sacramento-San Joaquin Delta WQCP (Bay-Delta WQCP) and are described in further detail below. Chloride was also assessed at D-1641 compliance locations, in addition to the 11 other assessment locations.

Calculation of Changes in Constituent Levels

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

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

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

In the above equation, $f_{X,i}$ is the mean monthly flow fraction from source X at assessment location i, C_X is the constituent concentration from source X, and C_i is the constituent concentration at assessment location i. Contribution from the Yolo Bypass was added to contribution from the Sacramento River to constitute a single source, except in the case of selenium. Source water concentrations in the above equation are described for each of the constituents assessed via this method in Section 8.3.1.7, Constituent-Specific Considerations Used in the Assessment. Source water concentrations may vary seasonally, and this was examined. In some cases, source water concentrations were varied seasonally based on historical trends. It is recognized that C_{BAY} is dependent on flows in the Sacramento and San Joaquin Rivers as well as Delta exports (i.e., net Delta outflow), which may change due to climate change/sea level rise, and altered operations of the SWP/CVP system. It is also dependent on the tidal exchange volume, which may change as a result of restoration associated with CM4. However, beyond accounting for seasonal trends in the historical data, neither of these were taken into account in determining a value for C_{BAY}. Therefore, for cases in which net delta outflow increases or decreases relative to what has historically occurred, the value used for C_{BAY} may overestimate or underestimate the concentrations associated with San Francisco Bay water (as measured at Martinez). Additionally, if restoration component CM4 increases tidal exchange volume, the value used for C_{BAY} would underestimate concentrations associated with San Francisco Bay water (as measured at Martinez). For constituents associated with seawater intrusion that were not modeled directly in DSM2 (bromide, chloride), these considerations were addressed qualitatively. Additionally, due to the uncertainty inherent in using a constant historical monthly average concentration as the value of C_{BAY}, a second modeling approach was used for chloride and bromide for west Delta locations that were influenced by seawater intrusion. Results from this alternative modeling approach were used to supplement the results using the approach described above as a means of providing best available information related to chloride and bromide in the Delta.

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

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

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

For bromide, the same EC to chloride relationship was used, followed by a relationship between chloride and bromide, to estimate bromide concentrations. The chloride to bromide relationship is approximately the same in multiple areas in the west delta, including Old River at Rock Slough

(Contra Costa Water District 1997), the intakes at Banks Pumping Plant (CALFED 2007a), and Mallard Island (Appendix 8E Figure 1). The relationship used was:

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

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

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

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

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

Calculation of Use of Assimilative Capacity

The concept of assimilative capacity was used as a measure of the extent of water quality degradation that could occur under the alternatives, relative to water quality conditions under the baselines. Water quality degradation was assessed in order to address the Federal and State Antidegradation Policies, which state that existing instream water uses and the level of water quality necessary to protect the existing uses shall be maintained and protected (see Section 8.2.1.3 for a full discussion). Assimilative capacity is the capacity of a water body to experience increased levels of a water quality constituent without exceeding the adopted water quality criterion/objective. In practical terms, when levels or concentrations of a water quality constituent are below water quality criteria/objectives, use of available assimilative capacity by an action is the relative amount of water quality degradation that the action causes (i.e., causing an existing constituent concentration to increase such that its resulting concentration is now closer to, but still below the applicable criterion/objective). If the action causes sufficient degradation of water quality such that the resulting constituent level or concentration is now greater than the criterion/objective, then 100% of the available assimilative capacity would be "used" by the action, and thus no assimilative capacity would remain for that constituent.

In this assessment, assimilative capacity available under a baseline was calculated according to equation 2:

$$A_{avail} = C_{WQO} - C_{base} \quad \textbf{(2)}$$

In the equation above, A_{avail} is the available assimilative capacity, C_{WQO} is the concentration of the water quality objective, and C_{base} is the concentration in the modeled baseline.

The amount of assimilative capacity used by an alternative was calculated according to equation 3:

$$A_{used} = C_{ALT} - C_{base} \quad \textbf{(3)}$$

In the equation above, A_{used} is the assimilative capacity that was used under the alternative, relative to the baseline, and C_{ALT} is the concentration in the modeled alternative.

The determination of the percent use of available assimilative capacity under an alternative was dependent on the relative values of A_{used} and A_{avail}, and thus was calculated according to equation 4:

$$-\frac{A_{used}}{A_{avail}} \times 100 \quad \text{for} \quad A_{used} \le A_{avail} > 0$$

$$\text{No Calculation} \quad \text{for} \quad A_{avail} \le 0 \qquad \textbf{(4)}$$

$$-100 \quad \text{for} \quad A_{used} \ge A_{avail}$$

In the above equation, the second case in which no calculation was performed occurs when there is no assimilative capacity under the baseline (i.e., concentrations are above water quality objectives), in which case the concept of assimilative capacity is not a useful tool for assessing water quality changes. In the third case, all of the available assimilative capacity is used by the alternative, but the percent use of assimilative capacity is limited to what was initially available (i.e., cannot have greater than 100% use of available assimilative capacity).

Qualitative Assessments

Some constituents were assessed strictly qualitatively (Appendix 8C, Table SA-11) because: (1) insufficient historical monitoring data were available to adequately characterize the concentrations of the five source waters to the Delta (i.e., to accurately define the distribution of concentrations observed in the SAC, SJR, BAY, eastside tributaries, AGR), which are necessary to implement the quantitative mass-balance assessment approach described above; (2) the locations for which the constituent was assessed (within the affected environment) was outside of any available modeling domain, or available modeling tools were not appropriate for predicting constituent concentrations based on the physical, chemical, and/or biological properties and environmental fate and transport of the constituent. Nevertheless, the same conceptual framework was used for qualitatively assessing constituents of concern. Best available information regarding concentrations/levels in the

Delta source waters was evaluated relative to how flow-fractions at various Delta locations would change under the Alternatives, as defined by DSM2 model flow-fraction output (Appendix 8D), to estimate the relative frequency and magnitude of change expected for a given constituent at a specified location.

Additionally, assessments of the effects of implementing CM2–CM22 were qualitative, at a programmatic level, for all constituents. Construction-related water quality changes also were assessed qualitatively. Potential water quality effects of these generally specific and/or geographically localized actions were assessed by evaluating the anticipated type, duration, and geographic extent of construction activities to take place, and location and type of water bodies potentially affected. The potential for soil, sediment, and contaminants to be discharged to water bodies was determined by identifying construction practices and equipment that could be used, common materials or contaminants that may be present or be used for construction or construction equipment, and pathways by which contaminants may enter receiving waters, and measures to minimize or eliminate adverse construction-related effects on water quality.

8.4.1.4 SWP/CVP Export Service Areas

Assessment of water quality changes in the SWP/CVP Export Service Areas, which begin at the export pumps (i.e., Banks and Jones pumping plants) and extend to facilities receiving exported Delta water, was conducted for construction-related, operations-related, and restoration-related (CM2–CM22) effects.

Water quality changes in the SWP/CVP Export Service Areas were assessed both quantitatively and qualitatively. Water quality changes at the export pumps (i.e., Banks and Jones pumping plants) were quantified using DSM2 for EC and DOC and from mass-balance calculations based on DSM2 flow-fraction output data and Delta source water quality data. Because DSM2 does not account for water sourced from the new north Delta intakes (that are part of all Alternatives except Alternative 9), modeled water quality at Banks and Jones pumping plants under the various alternatives was accounted for in post-processing the DSM2 data. For the Existing Conditions, No Action Alternative, and Alternative 9, no post-processing was necessary, since all of the exported water was from the existing south Delta intakes (i.e., "Through-Delta" conveyance). For all "Dual-Conveyance" alternatives (i.e., Alternatives 1–5, and 7–8), EC, DOC, and fingerprinting data at the export pumps were blended according to equation 5:

$$\frac{Q_N C_N + Q_S C_S}{Q_N + Q_S} = C_{EXP} \quad \textbf{(5)}$$

In the equation above, Q_N is the flow diverted from the north Delta intakes to either Banks or Jones pumping plants, C_N is the value of the water quality parameter (EC, DOC, or fingerprinting for the 5 source waters) in the Sacramento River at Green's Landing (used as representative of intake water quality), Q_S is the flow exported from the south Delta in either Banks or Jones pumping plants, C_S is the value of the water quality parameter at the existing south Delta intakes for the pumping plants, and C_{EXP} is the value of the water quality parameter in the exported water. For the "Isolated-Conveyance" alternative, Alternative 6, all water quality parameters for the exports at both pumping plants were set equal to the values in the Sacramento River at Green's Landing.

Water quality changes at the export pumps served as the basis for making determinations of water quality changes within the associated primary conveyance facilities, Delta Mendota Canal and

California Aqueduct, as well as the other locations within the service area outside of the Delta, such as San Luis Reservoir and reservoirs operated by southern California water purveyors. Water quality changes in the conveyance and terminus facilities were assessed qualitatively, with consideration of dilution, transformation, uptake, and loss to the extent such factors were applicable to the constituents evaluated.

8.4.1.5 Mercury and Selenium Bioaccumulation Assessment

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

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

- **Literature-based regression models or bioaccumulation factors**. These resources provide a basis for estimating tissue concentrations for mercury and selenium from concentrations in surface water or sediment.
- **Site-specific linkages**. Methods were developed to describe existing relationships between waterborne concentrations of mercury and selenium at the nearest modeling nodes, existing sediment (for mercury), and fish tissue concentrations in an attempt to create predictive relationships for impact analysis and alternatives comparisons.
- **Delta methylmercury**. The TMDL translation equation for mercury (Central Valley Water Quality Board 2011b) was used to estimate fish tissue concentrations from waterborne concentrations. In addition, DSM2 water quality model predictions were investigated separately for their ability to predict measured fish tissue concentrations at discrete locations. The two translation models were compared for their predictive ability.
- **U.S. Geological Survey Bioaccumulation and Trophic Transfer Factors for selenium**. Values for uptake of selenium from water to the lowest trophic levels (e.g., algae) and transfer factors from invertebrates to fish and bird eggs developed by Presser and Luoma (2009, 2010) were used to estimate uptake from water to fish and to bird eggs. Initial modeling for fish was based on a model calibrated for largemouth bass as the representative species because of the available data for bass across the Delta (Appendix 8M). However, because there would be more bioaccumulation of selenium by species such as sturgeon that feed in part on clams that are known to bioaccumulate selenium readily in Suisun Bay, additional modeling was conducted for sturgeon in the western Delta (Addendum M.A for Appendix 8M).

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

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

- Literature-derived effect levels for mercury, methylmercury, and selenium in fish fillets for species most representative of the Delta.
- Literature-derived effect levels for selenium in whole-body fish for species most representative of the Delta.
- Literature-derived effect levels for selenium in eggs of bird species most representative of the Delta.
- State of California Office of Environmental Health Hazard Assessment's fish contaminant goals and advisory tissue levels for mercury, methylmercury, and selenium.

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

8.4.1.6 Summary of Methods Used to Assess Water Quality Changes Related to Construction Activities (CM1–CM22), Conveyance Operations and Maintenance (CM1), and Habitat Restoration and Other Stressor Related Conservation Measures (CM2–CM22)

The construction-related water quality changes associated with all conservation measures (CM1–CM22) were assessed qualitatively by evaluating the anticipated type, duration, and geographic extent of construction activities to take place, and location and type of water bodies potentially affected. The potential for soil, sediment, and contaminants to be discharged to water bodies was determined by identifying best management/construction practices and equipment that could be used, common materials or contaminants that may be present or be used for construction or construction equipment, and pathways by which contaminants may enter receiving waters.

Actions associated with new conveyance facilities and operations criteria that resulted in water quality changes associated with altered hydrodynamics, which were captured in the DSM2 modeling, were assessed quantitatively and discussed in Section 8.3.4.

Restoration actions that would result in water quality changes associated with altered hydrodynamics, which were captured in the DSM2 modeling, are discussed in Section 8.3.4 as operations-related water quality changes (CM1). Restoration actions that could result in a potential increase in constituent loading (e.g., increased nutrient, organic carbon, or suspended solids) to the Delta region were assessed qualitatively.

Several conservation measures (i.e., CM12–CM22) address other stressors that may affect water quality through reducing contaminants and reducing predators and other sources of direct mortality to listed species. Changes in water quality associated with conservation measures implemented to address other stressors were assessed qualitatively under a separate numbered impact for CM2–CM22.

Table 8-38 provides a summary of the methodologies used to assess water quality impacts that could result from implementing the alternatives.

Table 8-38. Summary of Methodologies Used for Water Quality Impact Analyses

Project/ Alternative Component	Available Models/ Techniques	Affected Environment		
		Upstream of the Delta	Plan Area	SWP/CVP Export Service Areas
Conveyance and Operations-related Effects on Water Quality (CM1)	CALSIM II	Hydrologic changes (e.g., seasonal changes in reservoir storage and river flows) used to evaluate dilution effects on constituent levels in reservoirs and rivers.	CALSIM II hydrologic output served as input to the DSM2 model.	Operations of San Luis Reservoir.
	DSM2	N/A	EC, DOC concentrations and flow fractions.	EC, DOC concentrations directly modeled at the south Delta export pumps
	Mass Balance Using Flow Fraction and Constituent Concentrations	N/A	Estimated concentrations of constituents addressed quantitatively, other than EC, and DOC, which are directly modeled by DSM2.	Estimated concentrations of constituents addressed quantitatively, other than EC, and DOC, at the south Delta export pumps.
	Qualitative Analysis	All parameters. Qualitative approach determined whether constituent concentrations were correlated to reservoir storage or river flow levels.	For all parameters not addressed quantitatively (see Appendix 8C, Table SA-11). Qualitative approach varied based on constituent of concern and location, but attempted to estimate concentration changes attributable to the Alternatives.	For all parameters addressed. Qualitative approach varied based on constituent of concern, but attempted to estimate concentration changes attributable to the Alternatives.
Habitat Restoration-related Effects on Water Quality (CM2–11)	DSM2	N/A	To degree possible, the DSM2 model simulated altered Delta hydrodynamics attributable to restoration tidal and riparian habitats (CM2-CM4).	N/A

Project/ Alternative Component	Available Models/ Techniques	Affected Environment		
		Upstream of the Delta	Plan Area	SWP/CVP Export Service Areas
	Qualitative Analysis	N/A	Additional qualitative impact analysis of how restoration wetlands may affect specific constituent concentrations (e.g., DOC) in specific areas was provided.	Additional qualitative impact analysis of how restoration wetlands may affect specific constituent concentrations (e.g., DOC) at the south Delta pumps was provided.
	Qualitative Analysis	N/A	Qualitative analysis of how temporary conveyance construction activities would affect water quality (e.g., turbidity, sedimentation) was provided.	Qualitative impact analysis of how conveyance construction activities may affect specific constituent concentrations (e.g., turbidity, nutrients) at the south Delta pumps was provided.
Construction-related Effects on Water Quality	Qualitative Analysis	N/A	Qualitative analysis of how actions would affect water quality was provided.	Qualitative impact analysis of how the actions may affect specific constituent concentrations at specified locations was provided.
Other Stressor-related Effects on Water Quality (CM12–CM22)	Qualitative Analysis	N/A	Qualitative analysis of how actions would affect water quality was provided.	Qualitative impact analysis of how the actions may affect specific constituent concentrations at specified locations was provided.

8.4.1.7 Constituent-Specific Considerations Used in the Assessment

Constituent-specific considerations that are common to the assessment of all project alternatives are discussed below. Water quality constituents are also discussed in section 8.1. Data in section 8.1 is meant to characterize general conditions in the affected environment, and water quality criteria and objectives presented in section 8.1 are a comprehensive set of all applicable criteria and objectives. In the sections below, the methodology for each constituent assessment is presented, and only historical data and water quality criteria and objectives that are applicable to the assessment are presented. A summary of methods used in the assessments, including the specific methodologies for the quantitative assessments, is shown in Table 8-61.

Construction-Related Water Quality Effects

Water quality effects associated with construction activities for all conservation measures (CM1–CM22) were assessed in a qualitative manner. The potential construction-related water quality effects were assessed considering many aspects of the work involved and potential environmental exposure to contaminants, including, but not limited to the following factors:

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

The assessment of potential water quality effects considered all of the beneficial uses. However, given the generally temporary and intermittent characteristics of construction and maintenance discharges, a focus of the assessment is on effects to aquatic life as the likely most sensitive beneficial uses in the receiving water (also refer to Chapter 11, *Fish and Aquatic Resources*, for additional discussion of the effects of construction). In particular, large or sudden increases in sediment, or contaminant concentrations in sediment from construction or operations/maintenance activities are most likely to affect short-term, sensitive water quality characteristics such as acute health responses of aquatic organisms and their habitats. Other beneficial uses, such as municipal/industrial water supplies, recreational activities, or livestock/agricultural irrigation, are generally anticipated to be less sensitive to short-term water quality disturbances.

Ammonia

For the purposes of this analysis, the U.S. EPA's 1999 National Recommended Water Quality Criteria for ammonia and the 2009 draft criteria were used. U.S. EPA's 2009 draft recommended criteria are more restrictive than its 1999 recommended criteria. Values derived for water at 25 °C and pH 8 are shown in Table 8-39, and were used as the reasonable worst case (i.e., most sensitive) criteria in the affected environment. The chronic criteria derived according to the 2009 draft documentation (0.26 mg/L-N) is also lower than the LOEL of 0.36 mg/L-N for chronic effects recently derived to *P. forbesi*, a copepod within the affected environment (Teh et al. 2011:2).

A final relevant threshold includes a recommended goal for sensitive crops of 1.5 mg/L-N (Ayers and Westcot 1994). It is assumed that ammonia is beneficial for crops at levels below this threshold, and thus that any increases in ammonia-N concentrations that are below the 1.5 mg/L-N threshold are generally not of concern for agriculture.

Table 8-39. Applicable Federal Criteria, State Objectives, and Other Relevant Effects Thresholds for Ammonia (mg N/L)

	Region 5 Basin Plan	Region 2 Basin Plan[a]	CTR	Drinking Water MCL	U.S. EPA Recommended Criteria	Other Relevant Thresholds
Ammonia-N	--	25	--	--	5.6/1.2 (1999)[b] 2.9/0.26 (2009)[c]	1.5[d], 0.36[e]

Notes:

[a] San Francisco Bay Regional Water Quality Control Board 2007. 25 mg/L 4-day average for ammonia-N.

[b] First value represents acute, salmon present, second value represents chronic, fish early life stage s present, for water temperature 25 °C and pH 8.

[c] First value represents acute, freshwater mussels present, second value represents chronic, freshwater mussels present, for water temperature 25 °C and pH 8.

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

[e] Lowest Observed Effect Level (LOEL) determined in Teh et al. 2011, for chronic effects on *P. forbesi*.

Figure 8-52 shows the seasonal levels of ammonia in the three major source waters to the Delta—the Sacramento River (SAC), the San Joaquin River (SJR), and San Francisco Bay (BAY). The data indicate that SJR and BAY concentrations are similar during all months of the year. SAC concentrations are greater than BAY or SJR virtually all of the time, being more similar in January through March and much greater during the rest of the year. The high concentrations of ammonia in SAC are a result of the SRWTP, which discharges into the Sacramento River at Freeport. Ammonia concentrations upstream of the SRWTP are similar to those in BAY and SJR (Central Valley Water Board 2010a, p.5). Thus, the primary way in which BDCP alternatives could affect ammonia concentrations is by altering flows in the Sacramento River at Freeport, which would alter available dilution for ammonia from the SRWTP. Consequently, the assessment of ammonia in the Plan Area focused on the changes in flows in the Sacramento River at Freeport and the subsequent effects on dilution and ammonia concentrations downstream.

The SRWTP NPDES permit was renewed by the Central Valley Water Board on December 20, 2010. The permit contains seasonal effluent limitations for ammonia-N of 1.5 mg/L on an average monthly basis and 2.0 mg/L on a maximum daily basis for the months April through October, and of 2.4 mg/L on an average monthly basis and 3.3 mg/L on a maximum daily basis for the months November through March(Central Valley Water Board 2010b:14), that must be achieved by May of 2021. In order to meet these limits, the SRWTP must be upgraded to include nitrification. For the purposes of this assessment, assumptions were made regarding the status of the upgrades under the various baselines, alternatives, and time-steps, and these are summarized in Table 8-40.

Table 8-40. Assumptions on Status of Sacramento Regional Wastewater Treatment Plant Nitrification Upgrades Under Assessment Scenarios

Scenario	Status of Upgrades	Average Monthly Effluent Limit for Ammonia, mg/L as N
Existing Conditions	No Upgrades	33
No Action Alternative (2060)	Upgrades Complete	1.5 (Apr-Oct) 2.4 (Nov-Mar)
Alternatives 1–9 (2060)	Upgrades Complete	1.5 (Apr-Oct)

			2.4 (Nov-Mar)

Boron

Applicable boron objectives for the affected environment utilized in this assessment are summarized in (Table 8-41).

Table 8-41. Applicable Federal Criteria, State Objectives, and other Relevant Effects Thresholds for Boron

	Region 5 Basin Plan[a]	Region 2 Basin Plan	USEPA Recommended Criteria
Boron (µg/L)	800 / 2000 [b]	500 / 2,000 [e]	2,000 / 5,000 [g]
	1,000 / 2,600 [c]	5,000 [f]	
	1,300 [d]		

Notes:

[a] Basin Plan objectives apply to the lower San Joaquin River from the mouth of the Merced River to Vernalis (Central Valley Water Board 2009a).

[b] Agricultural objective for March 15 through September 15 specified as (monthly average) / (maximum) concentration (except critical water years).

[c] Agricultural objective for September 16 through March 14 specified as (monthly average) / (maximum) concentration (except critical water years).

[d] Agricultural objective applicable year-round as a monthly average for critical water years.

[e] Basin Plan agricultural objectives specified for irrigation as (threshold concentration) / (limit concentration) (San Francisco Bay Water Board 2007).

[f] Basin Plan agricultural objective specified for stock watering (San Francisco Bay Water Board 2007).

[g] Recommended human health advisory levels for long-term exposure through drinking water supplies specified in the form of (children)/(adults) (U.S. Environmental Protection Agency 2008b).

Sources of boron to Delta waters include the Sacramento River, the San Joaquin River, the Eastside tributaries, Delta agricultural return drains, and the San Francisco Bay. Among these sources, San Francisco Bay water contains the highest boron concentrations, followed by Delta agricultural returns, the San Joaquin River, the Sacramento River, and the Eastside tributaries (Table 8-42). Point source discharges containing boron contribute a small fraction of the boron burden to the lower San Joaquin River (Central Valley Water Board 2009a).

The lower San Joaquin River is listed on the State's CWA section 303(d) list of impaired water bodies for salt and boron (State Water Resources Control Board 2011). Boron is paired with salt in this listing due to its regular association with saline waters. The Central Valley Water Board has prepared a TMDL with implementation program where it is assumed that actions taken to control salts also will control for boron as well (Central Valley Water Board 2004).

1 **Table 8-42. Historical Boron Concentrations in the Five Delta Source Waters**

	Source Water				
Data Parameters	Sacramento River	San Joaquin River	San Francisco Bay[a]	East Side Tributaries	Delta Agriculture Return Waters[b]
Mean (µg/L)	100	349	880	68	492
Minimum (µg/L)	100	100	-	10	103
Maximum (µg/L)	200	1,100	-	250	1,192
75th Percentile (µg/L)	100	400	-	100	584
99th Percentile (µg/L)	100	918	-	244	1,159
Data source	DWR	DWR	Paulsen and List (1997) and DWR	USGS	DWR
Station(s)	Sacramento River at Greene's Landing, Sac River at Hood	San Joaquin River at Vernalis	Martinez and Sacramento River at Mallard Island	Cosumnes River	-- [b]
Date range	1986–2009	1986–2009	1986–2009	1953–1977	1987–2001
ND replaced with RL[c]	Yes	No	No	Yes	Yes
Data omitted	Two data points assumed to be in error (1,900 µg/L, 1,000 µg/L)	None	None	None	None
No. of Data Points	468	483	265	60	339

Notes:

[a] No data available for boron at Martinez in any of the available data sets. Paulsen and List (1997) measured boron daily at Martinez from 4/13/96–8/29/96. Paulsen and List (1997) lists only the mean, minimum, and maximum concentrations found. However, extensive boron data was available for the Sacramento River at Mallard Island (i.e., DWR MWQI program data for 1986–2009) which indicated a strong seasonal concentration pattern in the western Delta. Consequently, to estimate the seasonal monthly average boron concentrations at Martinez, the monthly average mean values for Mallard Island were multiplied by the ratio of the average Martinez (Paulsen and List 1997) to long term average Mallard Island mean concentrations. Refer to Appendix 8F, Table Bo-1 for additional information and tabulation of the calculated monthly average boron concentrations for the Bay source water.

[b] Agricultural return drains are distributed unevenly throughout the Delta. Water quality associated with these drains varies depending on the specific location of the drain within the Delta, and largely coincides with the water quality of the water that is withdrawn from the Delta for application onto agricultural lands. In order to characterize boron concentrations in agricultural drain water as a whole, the following process was followed:

All boron data from those agricultural drains from the DWR Water Data Library, which had historical boron data, were placed into a database.

The drains were assigned a region in the Delta according to their location (Central, North, East, South, and West)

Three drains from each region were chosen at random, and the data from each of these drains was downloaded.

The stations selected included: Ag Drain on Jersey Island, Ag Drain on King Island, PP. No. 1, Ag Drain on King Island, PP. No. 2, Ag Drain on Orwood Tract, Ag Drain on Palm Tract, Ag Drain on Pescadero Tr., PP. No. 3, Ag Drain on Pescadero Tract, PP. No. 4, Ag Drain on Rindge Tract, PP. No. 1, Ag Drain on Twitchell Isl., PP. No. 1, Ag Drain on Pescadero Tr., PP. No. 1

To derive an overall mean, minimum, maximum, 75th, and 95th percentile, the mean, minimum, maximum, 75th and 95th percentiles of the individual drain averages was calculated.

The process was an attempt to derive values that were representative of the Delta as a whole, regardless of how many drains in each region had data, and how many data points existed at each drain.

[c] In some cases, data were reported as non-detects, and the entry contained an accompanying reporting limit. "Yes" indicates that at least one non-detect was replaced with the reporting limit in order to calculate summary statistics, while "No" indicates that this was not done, generally because no data were reported as non-detect.

2

Because of boron's elemental nature, it is considered a conservative constituent, not subject to degradation through volatilization, breakdown, or uptake as it moves through the system. Boron, however, does adsorb to mineral soils and organic matter, which allows for its accumulation in soils irrigated with water containing boron. Because of its ability to leach through soils, this partitioning can be considered temporary; therefore, the assessment of potential impacts from boron assumes that mass is generally conserved. Consequently, boron concentrations at any location in the Delta primarily reflect the mass balance of the flow and concentrations of the major water sources. Therefore, a quantitative mass-balance approach using the source water flow fractions from the DSM2 model output and source water concentrations was used to estimate boron concentration changes that would occur with the alternatives. The long-term average source water concentrations were used for most locations in the mass-balance assessment; however, due to the presence of a distinct seasonal pattern in the boron concentrations of the San Francisco Bay source water at the interface with the Delta in relation to seasonal Delta outflow pattern, monthly average concentrations were used for this location. Additionally, sample data for boron at the Martinez location were limited to literature values for the annual average concentration, whereas substantial monthly data were available for the Sacramento River at Mallard Island. Consequently, monthly average Martinez concentrations were estimated by simple linear extrapolation of the monthly average Mallard Island concentrations by the ratio of the annual average Mallard Island to Martinez concentration.

The mass-balance modeling results were used to compare predicted changes in assessment variables (e.g., exceedances of objectives/criteria, amount of water quality degradation relative to boron, and contribution to 303(d) impairment effects). The assessment of effects relative to applicable objectives/criteria for the protection of agricultural beneficial uses was based on changes in monthly average concentrations modeled for all water year types for the 16-year (1976–1991) hydrologic period of record and for the drought years only (i.e., 1987–1991), and the effects relative to municipal and industrial water supply was based on changes in annual average concentrations for the modeled 16-year and drought periods.

The implementation of CM4 would restore substantial areas of tidal habitat that is expected to increase the magnitude of daily tidal water exchange at the restoration areas, and could alter other hydrodynamic conditions in adjacent Delta channels. San Francisco Bay water is a substantial source of boron, thus, the increased tidal exchange resulting from tidal habitat restoration may increase boron concentrations in the portion of the Bay water that enters the western Delta. The DSM2 modeling included assumptions regarding possible locations of tidal habitat restoration areas, and how restoration would affect Delta hydrodynamic conditions and source water flow fractions. However, the magnitude of increased boron concentrations in Bay source water in the western Delta as a result of increased tidal exchange is uncertain. Consequently, the potential effects of tidal restoration on boron concentrations in the Bay source water was assessed qualitatively based on predicted changes in the Bay source water fraction. The effects of other conservation measures (i.e., CM2, CM3, and CM5–CM22) which do not substantially affect flows or Delta hydrodynamic conditions, also were assessed qualitatively.

Bromide

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

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

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

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

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

Notes:

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

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

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

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

Chloride

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

In addition, the implementation CM4 would restore substantial areas of tidal habitat that would increase the magnitude of daily tidal water exchange at the restoration areas, and could alter other hydrodynamic conditions in adjacent Delta channels. San Francisco Bay water is a major source of chloride, thus, the increased tidal exchange resulting from tidal habitat restoration may increase chloride concentrations in the portion of the Bay water that enters the western Delta. The DSM2 modeling included assumptions regarding possible locations of tidal habitat restoration areas, and how restoration would affect Delta hydrodynamic conditions and source water flow fractions. However, the magnitude of increased chloride concentrations in Bay source water in the western Delta as a result of increased tidal exchange is uncertain. Consequently, the potential effects of tidal restoration on chloride concentrations in the Bay source water was assessed qualitatively based on predicted changes in the Bay source water fraction. The effects of other conservation measures (i.e., CM2, CM3, and CM5–CM22) which do not substantially affect flows or Delta hydrodynamic conditions also were assessed qualitatively.

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

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

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

Notes: A = Annual, etc.

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

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

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

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

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

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

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

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

Need to define Water Year Types

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

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

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

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

Notes:

[a] Values reported as range of monthly values (minimum monthly–maximum monthly). Review of available sample data for the Martinez location suggests that there is a generally seasonal trend in monthly average chloride concentration.
Chloride concentrations used to represent San Francisco Bay water in the mass-balance assessment were determined on a monthly average basis. Refer to Appendix 8G, Table Cl-61 for additional information and tabulation of the calculated monthly average chloride concentrations for the Bay source water.

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

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

Dissolved Oxygen

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

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

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

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

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

Electrical Conductivity

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

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

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

The assessment of hydrodynamic effects of the BDCP alternatives' CM1, CM2, and CM4 on EC in the Plan Area relied on DSM2 output. Because implementation CM4 would restore substantial areas of tidal habitat that would increase the magnitude of daily tidal water exchange at the restoration areas, and could alter other hydrodynamic conditions in adjacent Delta channels, the DSM2 modeling included assumptions regarding possible locations of tidal habitat restoration areas, and how restoration would affect Delta hydrodynamic conditions and source water flow fractions. The effects of other conservation measures (i.e., CM3 and CM5–CM22) which do not substantially affect Delta hydrodynamic conditions were assessed qualitatively.

- DSM2 directly models Delta EC levels on a 15-minute interval. DSM2 output for EC was post-processed to compare results to the Bay-Delta WQCP objectives at the following locations.
- Western Delta: Sacramento River at Emmaton and San Joaquin River at Jersey Point
- Interior Delta: South Fork Mokelumne River at Terminous, San Joaquin River at San Andreas Landing, and San Joaquin River at Prisoners Point
- Southern Delta: San Joaquin River at Vernalis, San Joaquin River at Brandt Bridge, Old River near Middle River, and Old River at Tracy Road Bridge

For the assessment of Alternatives 1–9, the Sacramento River at Emmaton compliance location is relocated to Three Mile Slough near the Sacramento River. For comparing effects of the alternatives on EC in this portion of the Delta, two comparisons were made:

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

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

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

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

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

Notes for Table 8-46

Notes:

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

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

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

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

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

[f] Objective for municipal supply.

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

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

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

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

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

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

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

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

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

Understanding some basic input assumptions for DSM2 is important for interpreting the results and effects analysis, including assessment of compliance with water quality objectives. While DSM2 simulates EC on a 15-minute time-step, the Delta inflow and agricultural return flow inputs, and Delta operations (e.g., Delta Cross Channel gate operations) inputs to DSM2 are on a monthly time-step. Because the DSM2 inputs are on a monthly time-step, the assessment of compliance with sub-monthly objectives (e.g., 14-day running averages) is conducted in terms of assessing the overall direction and degree to which Delta EC would be affected relative to a baseline, and discussion of compliance does not imply that the alternative would literally cause Delta EC to be out of compliance a certain period of time. In other words, the model results are used in a comparative mode, not a predictive mode.

Mercury and Methylmercury

Mercury is an element of concern for the Delta, its tributaries, Suisun Marsh, and San Francisco Bay because of contamination from historical upstream sources originating from mercury mines in the Coast Ranges (via Putah and Cache creeks to the Yolo Bypass) and gold extraction processes in the Sierra Nevada (via Sacramento, San Joaquin, Cosumnes, and Mokelumne river sources) (Alpers et al. 2008; Wiener et al. 2003). Examples of primary mercury sources include mercury ore tailings (e.g., Cache Creek) or elemental mercury from gold field use (e.g., Eastside tributaries). The mercury supplied from historical gold mining processes appears to be the most bioavailable of the two primary sources (Central Valley Water Board 2008a). Although atmospheric deposition is a source of mercury, none of the proposed actions affect that source and in the case of the California Central Valley, mining sources completely dominate loading (Central Valley Water Board 2011b).

The bioavailability and toxicity of mercury (from whatever primary source) is greatly enhanced through the natural, bacterial conversion of mercury to methylmercury in marshlands or wetlands. These stagnant locations with reduced oxygen concentrations promote chemical reduction processes that make methylation possible.

Areas of enhanced bioavailability and toxicity of mercury (created through the mercury methylation process) exist in the Delta, and elevated mercury concentrations in fish tissue produce subsequent exposure and risk to humans and wildlife. Consequently, the beneficial uses most directly affected by mercury include shellfish harvesting and commercial and sport fishing activities that pose a human health concern, and wildlife habitat and Rare, Threatened, and Endangered species resources that can be exposed to bioaccumulation of mercury (Table 8-1). Because of these concerns, mercury was the first TMDL approved for San Francisco Bay in 2007 (San Francisco Bay Water Board 2006), and a methylmercury TMDL was promulgated for the Delta (Central Valley Water Board 2011b). The Delta, many direct tributaries to the Delta (i.e., Sacramento River, San Joaquin River, Mokelumne River, Putah Creek, and Calaveras River), and downstream areas (e.g., Suisun Bay and Suisun Marsh) are listed as impaired water bodies on the Clean Water Act Section 303(d) lists for mercury in fish tissue (State Water Resources Control Board 2011).

This section summarizes the potential impacts from project-related changes to concentrations of mercury and methylmercury in water and estimated changes to fish tissue concentrations of mercury. A model was developed linking methylmercury concentrations in water to concentrations in Largemouth Bass muscle tissue. Bass tissue mercury concentrations were estimated for each location and time step based on the co-located waterborne methylmercury concentration estimates from DSM2. Details are provided in Appendix 8I. Refer also to Chapter 25 (Public Health) for discussion of the effects of mercury to human health.

Applicable mercury objectives for the affected environment for waterborne concentrations are summarized in Table 8-47. In evaluating the potential effects of waterborne mercury as measured by percentage change in assimilative capacity, only total mercury concentrations are judged against the lowest mercury objective of 25 ng/L; all estimates of methylmercury concentrations in water already exceed recommended objectives of 0.06 ng/L and, therefore, no assimilative capacity exists for that compound and no comparable percentage changes in assimilative capacity were used in the evaluation of differences among alternatives.

Table 8-47. Applicable Federal Criteria, State Objectives, and Other Relevant Effects Thresholds for Mercury and Methylmercury in Water

Analyte	CTR[a]	USEPA Recommended Criteria[b]	Delta Methylmercury TMDL[c]	San Francisco Bay Mercury TMDL[d]
Mercury (ng/L)	50	770	—	25
Methylmercury (ng/L)	—	—	0.06	—

Notes:

[a] Criterion for the protection of human health from total recoverable mercury in freshwater (U.S. Environmental Protection Agency 2012b).

[b] Criterion for the protection of chronic exposure from total mercury to freshwater aquatic life (U.S. Environmental Protection Agency 2012b).

[c] The recommended water column TMDL concentration of methylmercury for the protection of fish bioaccumulation (Central Valley Water Board 2008a).

[d] The recommended water column 4-day average TMDL concentration for total mercury (U.S. Environmental Protection Agency 2012b).

Fish tissue concentrations were evaluated in relation to the Delta methylmercury TMDL tissue targets of 0.24 mg mercury/kg wet-weight of Largemouth Bass fillets (muscle tissue) for fish normalized to a standard 350 mm total length (Central Valley Water Board 2011b). The normalization is necessary because of the strong dependence of tissue mercury concentrations on fish size and age; all fish tissue mercury results presented in this document are length-normalized. It is assumed that impact evaluations relative to this established locally derived toxicity limit will provide an appropriate surrogate for effects of bioaccumulated mercury exposure to humans and wildlife from fish consumption and relative impacts on the fish. Most measured and modeled (current and future) fish tissue concentrations of mercury exceed the TMDL tissue target levels. Formulation of the fish tissue mercury model and comparisons between measured and modeled fish tissue results are provided in Appendix 8I. The Central Valley Water Board TMDL water/tissue translation model as well as a model specifically developed using DSM2 water outputs to predict fish tissue concentrations are compared in Appendix 8I.

Water quality data from the Delta and Suisun Marsh include records of mercury and methylmercury waterborne concentrations as total or filtered water fractions. Water quality summary information since 1999 is shown in Table 8-48 and Table 8-49. The general pattern of mercury waterborne loading to the Delta shows the dominance of mercury mining sources via Cache Creek and Yolo Bypass (Central Valley Water Board 2011c); however, the waterborne average concentrations do not reflect the same pattern as loads (Table 8-48). Instead, the Eastside tributary streams and San Joaquin River show higher mercury and methylmercury concentrations than the Sacramento River inputs.

Table 8-48. Historical Mercury Concentrations in the Five Delta Source Waters for the Period 1999–2008

Data Parameters	Source Water: Sacramento River[a]		San Joaquin River[a]		San Francisco Bay[a]		East Side Tributaries[a]		Agriculture within the Delta[b]	
Mean (ng/L)	4.1	—	7.6	0.8	7.8	—	8.6	1.4	6.5	—
Minimum (ng/L)	1.2	—	3.1	0.3		—	0.3	1.4	—	—
Maximum (ng/L)	30.6	—	21.7	3.0		—	26.2	1.4	—	—
75th Percentile (ng/L)	5.5	—	8.6	1.2		—	7.5	1.4	—	—
99th Percentile (ng/L)	24.2	—	17.4	2.8		—	25.2	1.4	—	—
Data Source	CVRWQCB 2008[a]	—	BDAT 2010; CVRWQCB 2008[a]	BDAT 2010; USGS 2010	SFEI 2010	—	CVRWQCB 2008[a]	USGS 2010	CVRWQCB 2008[a]	—
Station(s)	Sacramento River at Freeport		San Joaquin River at Vernalis		Martinez		Mokelumne and Calaveras Rivers[b,c]	Cosumnes River[d]	Mid-Delta locations, median	
Date Range	1999–2002	—	2000–2004	2000–2002	2007	—	2000–2001; 2003–2004	2002	2008	
ND Replaced with RL	Not Applicable		Not Applicable		—		Not Applicable		Not Applicable	
Data Omitted	None		None		—		None		None	
No. of Data Points	45	—	49	19	—	—	25	1	—	—

Notes: Means are geometric means. ng/L: nanograms per liter.

[a] The total recoverable concentration of the analyte is presented in first cell and the dissolved concentration of the analyte is presented in the second cell.

[b] Mokelumne River at I-5.

[c] Calaveras River at rail road upstream of West Lane.

[d] Cosumnes River at Michigan Bar.

Sources: Bay Delta and Tributaries Project 2010; Central Valley Water Board (CVRWQCB) 2008a; San Francisco Estuary Institute 2010; U.S. Geological Survey 2010

Table 8-49. Historical Methylmercury Concentrations in the Five Delta Source Waters for the Period 2000–2008

Source Water	Sacramento River[a]		San Joaquin River[a]		San Francisco Bay[a]		East Side Tributaries[a]		Agriculture within the Delta[a]	
Mean (ng/L)	0.10	0.03	0.15	0.03	0.032	—	0.22	0.08	0.25	
Minimum (ng/L)	0.05	0.03	0.09	0.01		—	0.02	0.02	—	—
Maximum (ng/L)	0.24	0.03	0.26	0.08		—	0.32	0.41	—	—
75th Percentile (ng/L)	0.12	0.03	0.18	0.06		—	0.20	0.15	—	—
99th Percentile (ng/L)	0.23	0.03	0.26	0.08		—	0.31	0.39	—	—
Data Source	CVRWQCB 2008a		BDAT 2010; CVRWQCB 2008a	BDAT 2010; CVRWQCB 2008a; USGS 2010	SFEI 2010	—	CVRWQCB 2008a	CVRWQCB 2008a; USGS 2010	CVRWQCB 2008a	—
Station(s)	Sacramento River at Freeport		San Joaquin River at Vernalis		Martinez		Mokelumne and Calaveras Rivers	Mokelumne and Cosumnes Rivers	Mid-Delta locations, median	
Date Range	2000–2003	2000	2000–2001; 2003–2004	2000–2002	2007	—	2000–2001; 2003–2004	2000; 2002	2008	—
ND Replaced with RL	Not Applicable		Not Applicable	Yes	—		Yes	Yes	Not Applicable	
Data Omitted	None		None		—		None		None	
No. of Data Points	36	1	49	25	—	—	27	9	—	—

[a] The total recoverable concentration of the analyte is presented in first cell and the dissolved concentration of the analyte is presented in the second column.

Notes: Means are geometric means. ng/L: nanograms per liter.

Sources: Bay Delta and Tributaries Project (BDAT) 2010; Central Valley Water Board (CVRWQCB) 2008a; San Francisco Estuary Institute (SFEI) 2010; U.S. Geological Survey 2010

Nitrate

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

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

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

[a] San Francisco Bay Water Board (2007). 30 mg/L nitrate-N criterion for irrigation water; 100 mg/L nitrate-N criterion for livestock watering.
[b] Ayers and Westcot (1994). Recommended goals for sensitive crops.
[c] For the consumption of water and organisms.

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

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

Source Water	Sacramento River [a]	San Joaquin River [a]	San Francisco Bay	East Side Tributaries	Agriculture within the Delta [a, b]
Mean (mg/L as N)	0.068–0.209	0.791–1.839	0.07	0.17	0.059–3.833
Minimum (mg/L as N)	0.023–0.113	0.068–1.175	0.026	0.010	0.002–0.339
Maximum (mg/L as N)	0.136–0.553	2.123–3.614	0.12	1.70	0.135–54.644
75th Percentile (mg/L as N)	0.09–0.248	1.017–2.169	0.09	0.16	0.068–4.516
99th Percentile (mg/L as N)	0.122–0.545	1.992–3.479	0.12	0.99	0.133–34.182
Data Source	DWR	DWR	SFEI	USGS	DWR
Station(s)	Sac River at Greene's Landing, Sac River at Hood	SJR at Vernalis	BD40 (Just W. of Carquinez Straight)	Mokelumne River, Cosumnes River	See footnote [b]
Date Range	1997–2008	1990–2009	1993–2001	1961–1993	1990–2001
ND Replaced with RL	No	No	No	No	Yes
Data Omitted	Data prior to 1992 (EPA Method 353.2; poor detection limit)	Two values > 9 mg/L as N	None	Values reported as "0"	None
No. of Data Points	25–33	29–35	25	45	5–81

[a] Values reported as range of monthly values (minimum monthly–maximum monthly). Trends in monthly average nitrate at these locations suggested a seasonality to concentration. Due to the appearance of seasonality in monthly average concentration at these locations, average monthly concentration was used. Tables of these parameters by month are show in the Nitrate Appendix, Appendix 8J.
[b] Values calculated from all agriculture drain data pooled together. All nitrate data from agricultural drains contained in the DWR Water Data Library were placed into a single database. Due to the uneven distribution of agricultural drains in the Delta, geographical trends in agricultural drain water quality were evaluated by categorizing the data based on their associated location in the Delta. Categories included western, southern, northern, eastern, and central Delta, following the geographical delineations of the State Water Resources Control Board. With data pooled and categorized by region, average concentration by region were compared. Average nitrate did not vary greatly between regions. Due to the apparent low regional variability, values were obtained by pooling all data together and obtaining summary statistics from this pooled database.

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

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

Organic Carbon

While existing goals and action threshold for organic carbon as a DBP precursor are expressed as TOC, it is the dissolved fraction, expressed as DOC, which is the focus of the organic carbon assessment. As previously stated, 85–90% of Delta TOC is in the DOC or "dissolved" form. Further, while the relative potency of organic carbon as a DBP precursor can vary considerably across samples (CALFED Bay-Delta Program 2008a:5), in the Delta it is generally believed that the dissolved fraction (i.e., DOC) most frequently influences DBP formation potential (CALFED Bay-Delta Program 2007b:5–22). Even within the DOC fraction, DBP formation can vary considerably, indicating that the nature of the organic matter that comprises DOC in a sample is important. Nevertheless, DOC is considered a more accurate surrogate for DBP formation relative to TOC or POC.

Given the strong link between THM and HAA formation potential and organic carbon, THM and HAA formation potential will not be assessed separately, but rather the assessment of organic carbon addresses concerns regarding THM and HAA formation potential.

Table 8-52 provides a summary of DOC concentrations for the Sacramento and San Joaquin Rivers as utilized for DSM2 boundary conditions. As discussed in the Methods For Analysis section (Section 8.3.1 above), DSM2 was utilized directly to model and predict DOC at 11 locations across the Delta, and the degree DOC changed under the various project alternatives. Because DOC is a precursor to the formation of DBPs which represent a long-term risk to human health, and because the existing source water quality goal is based on a running annual average, the quantitative assessment focuses on the degree to which an alternative may result in change in long-term average DOC concentrations at select locations upstream of the Delta, within the Delta, and in the SWP/CVP Export Service Areas. For municipal intakes located in the Delta interior, assessment locations at Contra Costa Pumping Plant No. 1 and Rock Slough are taken as representative of Contra Costa's intakes at Rock Slough, Old River and Victoria Canal, and the assessment location at Buckley Cove is taken as representative of the City of Stockton's intake on the San Joaquin River. Municipal intakes at Mallard Slough, City of Antioch, and the North Bay Aqueduct are represented by their respective assessment locations. For the purposes of this assessment, effects within the SWP/CVP Export Service Areas are assessed based on DOC concentrations at the primary SWP and CVP Delta export locations (i.e., Banks and Jones pumping plants). DOC in the Delta is generally considered to act conservatively; thus, the mass-balance modeling approach employed. Moreover, the POC fraction would be largely removed through conventional drinking water treatment (State Water Project Contractors Authority 2007:3–19).

Table 8-52. Monthly Average Dissolved Organic Carbon Utilized in DSM2 Modeling for Sacramento and San Joaquin River Source Waters (mg/L)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Sacramento at Hood	1.8	2.3	2.9	3.0	2.9	2.7	2.4	2.0	1.8	1.8	1.8	1.8
San Joaquin at Vernalis	3.4	3.5	3.6	4.7	4.8	4.7	3.9	3.4	3.4	3.4	3.4	3.4

In establishing its source water goal for organic carbon, CALFED assumed more stringent DBP criteria for treated drinking water than are currently in place. Source water with TOC between 4 and 7 mg/L is believed sufficient to meet currently established drinking water criteria for DPBs, depending on the amount of *Giardia* inactivation required (California Urban Water Agencies 1998, ES2). In light of these source water goals and EPA's TOC removal action thresholds, the assessment of alternatives evaluates how each alternative would affect the frequency with which predicted future DOC concentrations would exceed 2, 3, and 4 mg/L on a long-term average basis at the assessment locations. Because, in many cases, the existing condition is one already exceeding 2 and 3 mg/L, the frequency with which DOC exceeds 4 mg/L becomes a key focus of the assessment, as well as the change in long-term average DOC concentration.

An important Delta assessment location is DWR's North Bay Aqueduct intake at Barker Slough. While source-water fingerprinting identifies the Sacramento River as comprising the majority of flow at the Barker Slough location, the quality of water is substantially influenced by local sources in the Barker Slough catchment. These local sources contribute a significant organic carbon load to the Barker Slough location, where average TOC between 2001 and 2005 was 5.8 mg/L and as high as 20 mg/L in winter months (State Water Project Contractors Authority 2007: 3-19, 3-26). The DSM2 model does not account for these local sources and, therefore, concentrations presented in this assessment generally underestimate baseline DOC conditions. Nevertheless, operations and maintenance activities will not substantially affect these local sources to Barker Slough and thus their contribution to annual average DOC would continue to occur regardless of project alternative implementation. The modeling presented in this assessment for the Barker Slough location accounts for expected changes in DOC relative to changes in Delta hydrodynamics, excluding local watershed sources to Barker Slough.

Pathogens

The assessments of pathogens were conducted in a qualitative manner with consideration to sources of pathogens and factors that contribute to elevated levels in surface waters, including flow rate and distance from pathogen sources.

Pesticides

Assessing pesticide-related effects is substantially challenged by: 1) limited available monitoring data in the Delta and other water bodies of the affected environment, and 2) a continually changing pesticide use market. Due to a number of factors, including historic pesticide use patterns and analytical capabilities, there is more data available for certain classes of pesticides, such as OP insecticides, than that for other classes of pesticides, including herbicides, fungicides, and insecticides such as pyrethroids and carbamates.

Likely the single most recent and comprehensive compilation of pesticide data for the Delta and upstream water bodies (within 30 miles of the Delta) was compiled by Johnson et al. (2010). The result of this compilation and review was the conclusion that there were few chemicals for which data were of sufficient number and quality to allow a definitive conclusion regarding contaminants and toxicological issues in the Delta such as the POD. The stated exception was that of the OP insecticides chlorpyrifos and diazinon, where frequent toxicity to bioassay indicator organisms has been associated with measurable concentrations of chlorpyrifos and diazinon (Kuivila and Foe 1995; Werner et al. 2000). In fact, in the comprehensive review of Johnson et al. (2010), only the analysis of diazinon, chlorpyrfos, several pyrethroid insecticides and the herbicide diuron were carried forward, primarily due to data quantity and quality limitation. In this compilation, cumulative frequency distributions were prepared, suggesting that less than 10% of all samples for chlorpyrifos, diazinon, and diuron would be expected to exceed benchmark toxicity thresholds. Data for the pyrethroid insecticides were too limited, primarily due to data quality issues (i.e., insufficiently low detection limits). However, pyrethroid-related research and regulatory interest has intensified with the fairly recent observation of substantial pyrethroid-associated toxicity in sediments and the water column of numerous urban streams, agricultural drainage canals, and municipal wastewater effluent (Weston and Lydy 2010). These pyrethroid observations are largely believed to be related to their recent increased use as a suitable substitute for diazinon and chlorpyrifos.

Perhaps more challenging than a limited monitoring effort is the dynamic state of the pesticide market. Regulatory and pest resistance pressures have left the pesticide market, namely the insecticide market, in a state of flux. Pesticide use varies from year to year depending on numerous external factors such as climate and associated pest outbreaks, cropping patterns, and economic trends in housing construction and urban development. Layered upon this year-to-year variation is an overall trend of decreased OP insecticides use and increased pyrethroid use, primarily due to the early regulatory phase-out of many OP insecticide uses initiated in early 2000. The market has yet to balance and reach equilibrium, and what limited and relatively short-term monitoring data that is available ultimately only represents a snapshot of a trend in the gradual replacement of many OP uses with that of pyrethroids. Until markets stabilize, trends will inevitably continue to develop.

For rivers, a number of factors are necessary for pesticide-related impacts on beneficial uses to be a possibility. Although a number of relevant beneficial uses exist, for the majority of pesticides aquatic life beneficial uses are the greatest concern. For concentrations of pesticides in surface water to reach thresholds of aquatic life concern, a number of controlling factors are typically at play. First and foremost, pesticides must be used, and used in a location with hydrologic connectivity to surface water, and used in amounts that are not easily diluted in the environment. Secondly, the pesticide must be transportable. The ultimate transportability of a pesticide is largely determined by its individual chemistry, where its chemistry determines important properties such as water solubility, vaporization, and soil sorption. Factors unrelated to the pesticide are also important, such as substrate erosivity, precipitation or irrigation amounts, and time elapsed from application to runoff. Thirdly, the pesticide must be stable in the environment, such that residues of the applied pesticide are present during runoff events. And finally, if transported to surface waters, sufficient amounts of pesticide must be present that once diluted by surface water flows, the resulting concentration is of a magnitude capable of eliciting a measurable effect in aquatic life. All of these factors contribute in the end to the potential for adverse beneficial use effects, but of the many factors involved, CVP/SWP operations only affect river flows and, thus available dilution. In an estuary environment, where substantial dilution capacity typically occurs, duration of aquatic life exposure in addition to pesticide concentration is important. While the capacity of the Delta to dilute pesticide inputs is largely unaffected by CVP/SWP operations, the duration of exposure, or residence time, can be affected by operations. Therefore, in the Delta, changes in source water fractions represent long-term changes in exposure potential.

Similar to the assessment of Johnson et al. (2010), there is insufficient data to perform an assessment of BDCP alternatives' effects on all pesticides. Within available data, however, there is sufficient evidence that the OP insecticides diazinon and chlorpyrifos, and the herbicide diuron may be found in the affected environment at concentrations frequently toxic to aquatic life, and to such a degree that changes in CVP/SWP operations could possibly have an effect. Furthermore, although pyrethroid insecticides have not been demonstrated to have the same magnitude of concern throughout the affected environment, trends in OP replacement, increased pyrethroid use, and increased pyrethroid incidence in urban streams and agricultural drains suggest that pyrethroids may become a broader concern in the future. Therefore, the pesticide assessment focuses on potential effects of CVP/SWP operations into the future, under the various considered alternatives, on diazinon, chlorpyrifos, pyrethroids, and diuron, and the possibility that the frequency or magnitude of existing pesticide-related risk to beneficial uses might change.

The pesticide assessment utilizes recent research and monitoring related to OP, diuron and pyrethroid incidence in ambient waters to qualitatively assess the effects of the alternatives on those pesticides and their possible related aquatic harm. Effects of alternatives on pesticides are primarily incidental and indirect, as existing and future sources of pesticide loading are largely unrelated. Further, effects on pesticides would be related to the change in river flow rates and Delta source water volumes. Because these changes would not directly affect pesticide source loading, but could affect in-stream pesticide concentrations through dilution as well as in-water pesticide dispersion and geographic distribution, changes in CVP/SWP operations could alter the long-term risk of pesticide-related effects on aquatic life beneficial uses. This change in risk can be qualitatively assessed through change in river flows and associated dilution, as well as change in source water fraction and associated opportunity for exposure. Pesticide effect assessments based on dilution flows and source water fraction is heavily burdened by assumptions regarding pesticide use into the future. As well, pesticide effects assessments based on changes in potential risk are heavily burdened by presumptions of real hazard relative to actual in-stream concentrations and actual effect thresholds which cannot be determined. It is assumed that sources of pesticides to water bodies would be similar for all alternatives.

In addition to the present-use pesticides described above, "legacy" pesticides, which have been banned for decades and include numerous organochlorine insecticides including DDT, can still be found in terrestrial soils and riverine sediments throughout the Central Valley. These were assessed based on the understanding that residues of these pesticides enter rivers primarily through surface runoff and erosion of terrestrial soils during storm events, and through resuspension of riverine bottom sediments, the combination of which to this day may contribute to excursions above water quality objectives (Central Valley Water Board 2010c). These low level sources are widespread and dispersed throughout the Central Valley.

Phosphorus

An analysis of nutrient loads to the Delta found that phosphorus concentrations showed little inter-seasonal variability between the Sacramento and San Joaquin Rivers (Tetra Tech 2006a). Data gathered for this assessment confirm this finding, and also show that little variability exists between these two rivers and between San Francisco Bay water at Martinez. Current estimates for in-Delta contribution of nutrients from agriculture on the Delta islands are small compared to tributary sources (Tetra Tech 2006a). Table 8-53 summarizes dissolved ortho-phosphate data for source waters to the Delta, and Figure 8-56 shows the seasonal variation in dissolved ortho-phosphate concentrations among the three major source waters. During April through December, ortho-phosphate concentrations from the three major source waters are very similar. During January through March, concentrations in the San Joaquin River at Vernalis are noticeably greater than from the Sacramento River at Hood/Greene's Landing or San Francisco Bay at Martinez.

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

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

Phosphorus does not behave conservatively in the environment. It can be taken up and metabolized by organisms or lost to or supplied by sediment. Because phosphorus concentrations do not vary considerably between the major source waters (as discussed above), phosphorus was assessed qualitatively. The primary way in which the BDCP alternatives could affect phosphorus levels is by increasing the fraction of San Joaquin River water at point in the Plan Area during January through March. Thus, source water fractions for the San Joaquin River were analyzed for that period to determine if the changes would be expected to substantially affect phosphorus concentrations.

Selenium

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

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

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

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

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

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

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

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

[e] 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.

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

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

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

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

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

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

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

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

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

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

Table 8-56. Historical Selenium Concentrations in the Six Delta Source Waters for the Period 1996–2010

Source Water	Sacramento River[a]	San Joaquin River[b]	San Francisco Bay[a]	East Side Tributaries[c]	Agriculture within the Delta[a]	Yolo Bypass[d]
Mean (μg/L)[e]	0.32	0.84	0.09	0.1	0.11	0.45
Minimum (μg/L)	0.04	0.40	0.03	0.1	0.11	0.19
Maximum (μg/L)	1.00	2.80	0.45	0.1	0.11	1.05
75th percentile (μg/L)	1.00	1.20	0.11	0.1	0.11	0.65
99th percentile (μg/L)	1.00	2.60	0.41	0.1	0.11	1.04
Data Source	USGS 2010	SWAMP 2009	SFEI 2010	None	Lucas and Stewart 2007	DWR 2009b
Station(s)	Sacramento River at Freeport	San Joaquin River at Vernalis (Airport Way)	Central-West; San Joaquin River near Mallard Is. (BG30)	None	Mildred Island, Center	Sacramento River at Knights Landing
Date Range	1996–2001, 2007–2010	1999–2007	2000–2008	None	2000	2003, 2004, 2007, 2008
ND Replaced with RL	Yes	Yes	Yes	Not applicable	No	Yes
Data Omitted	None	Pending Data	None	Not applicable	None	None
No. of Data Points	62	452	11	None	1	13

[a] Dissolved selenium concentration.
[b] Not specified whether total or dissolved selenium.
[c] Dissolved selenium concentration in Mokelumne, Calaveras, and Cosumnes rivers are assumed to be 0.1 μg/L due to lack of available data and lack of sources that would be expected to result in concentrations greater than 0.1 μg/L.
[d] Total selenium concentration.
[e] Means are geometric means.
SFEI = San Francisco Estuary Institute
SWAMP = Surface Water Ambient Monitoring Program

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

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

	Sacramento River[a]		San Joaquin River[b]		Suisun Bay[c]	
Year	Measured	Modeled	Measured	Modeled	Measured	Modeled
2000	2.6	1.4[d]	1.7	1.8[e]	No Data	0.9[d]
2005	1.5	1.4[d]	1.9	1.8[e]	No Data	1.0[d]
2007[g]	1.8	2.3[f]	2.4	2.4[g]	No Data	1.2[f]

[a] Sacramento River Mile (RM) 44.

[b] Vernalis.

[c] Montezuma Slough near Grizzly Bay; bass not sampled near here.

[d] Concentration of selenium estimated from Model 8: Trophic level 4 (TL-4) fish eating TL-3 fish, using K_d = 1760, $TTF_{invertebrate}$ = 2.1, and TTF_{fish} = 1.1.

[e] Concentration of selenium estimated from Model 8a: Trophic level 4 (TL-4) fish eating TL-3 fish, using K_d = 850, $TTF_{invertebrate}$ = 2.1, and TTF_{fish} = 1.1.

[f] Concentration of selenium estimated from Model 9: Trophic level 4 (TL-4) fish eating TL-3 fish, using K_d = 2840, $TTF_{invertebrate}$ = 2.1, and TTF_{fish} = 1.1.

[g] Concentration of selenium estimated from Model 9a: Trophic level 4 (TL-4) fish eating TL-3 fish, using K_d = 1130, $TTF_{invertebrate}$ = 2.1, and TTF_{fish} = 1.1.

K_d = particulate/water ratio.

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

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

Trace Metals

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

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

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

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

All values in micrograms per liter (µg/L) and expressed as dissolved metal, unless otherwise noted.

n/a = non-applicable.

[a] Values represent both CTR/NTR criteria and criteria contained within the Region 2 Basin Plan. Acute values are applicable to short periods of time, generally defined as 1-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 $CaCO_3$).

[b] Applies at the following locations: Sacramento River from Keswick Dam to the I Street Bridge at City of Sacramento; American River from Folsom Dam to the Sacramento River; Folsom Lake; and the Sacramento-San Joaquin Delta.

[c] First value is the CTR cadmium criterion, second value is Region 2 Basin Plan criterion.

[d] Applies to the Sacramento River and its tributaries above State Hwy 32 bridge at Hamilton City.

[e] Expressed as total recoverable metal.

[f] EPA 304(a) national recommended criteria.

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

Table 8-59. Hardness-based dissolved freshwater aquatic life criteria by primary source water (µg/L)

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

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

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

Table 8-60. BLM-based criteria for dissolved copper (µg/L)

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

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

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

Total Suspended Solids and Turbidity

TSS concentrations and turbidity levels in rivers upstream of the Delta are affected primarily by: 1) TSS concentrations and turbidity levels of the water released from the upstream reservoirs, 2) erosion occurring within the river channel beds, which is affected by river flow velocity and bank protection, 3) TSS concentrations and turbidity levels of tributary inflows, point-source inputs, and nonpoint runoff as influenced by surrounding land uses; and 4) phytoplankton, zooplankton and other biological material in the water.

TSS and turbidity in Delta waters is affected by TSS concentrations and turbidity levels of the Delta inflows (and associated sediment load). TSS and turbidity within Delta waters also is affected by fluctuation in flows within the channels due to the tides, with sediments depositing as flow velocities and turbulence are low at periods of slack tide, and sediments becoming suspended when flow velocities and turbulence increase when tides are the near the maximum. TSS and turbidity variations can also be attributed to phytoplankton, zooplankton and other biological material in the water.

The TSS and turbidity assessments were conducted in a qualitative manner based on anticipated changes in these factors.

8.4.2 Determination of Effects

The water quality effects of the action alternatives and the No Project Alternative, relative to Existing Conditions for CEQA, and of the action alternatives relative to the No Action Alternative for NEPA were determined consistent with the Methods for Analysis presented in the previous section, and are presented below. Additional discussion beyond that presented herein pertaining to the potential for water quality-related effects on fish and aquatic resources, human health, and agriculture are addressed in Chapter 11, *Fish and Aquatic Resources*; Chapter 25, *Public Health*; and Chapter 14, *Agricultural Resources*, respectively.

As discussed in greater detail in Chapter 5, *Water Supply*, Section 5.3.2, the NEPA No Action Alternative, which reflects an anticipated future condition in 2060, includes both sea level rise and climate change (changed precipitation patterns), and also assumes, among many other programs, projects, and policies, implementation of most of the required actions under both the December 2008 USFWS BiOp and the June 2009 NMFS BiOp. The NEPA effects analyses in this chapter reflect these No Action assumptions.

8.4.2.1 Screening Analysis and Results

This water quality analysis assessed the potential effects of implementing the various alternatives on 182 constituents (or classes of constituents). The initial analysis of water quality effects, referred to as the "screening analysis" in the Methods of Analysis section (above) resulted in the following findings. Of the 182 constituents, 110 were determined to have no potential to be adversely affected by the alternatives to an extent to which adverse environmental effects would be expected. Historical data for these constituents showed no exceedances of water quality objectives/criteria in the major Delta source waters, were not on the State's 303(d) list in the affected environment, were not of concern based on professional judgment or scoping comments, and had no potential for substantial long-term water quality degradation. Consequently, no further analyses were performed for these 110 constituents. Conversely, further analysis was determined to be necessary for 72 constituents. Of these, 15 are addressed further in the Screening Analysis itself in Appendix 8C because they did not warrant alternative-specific analyses, and 1—temperature—is addressed in Chapter 11, *Fish and Aquatic Resources.* The remaining 56 constituents are addressed in the Environmental Consequences section, and are contained in the sections noted in Table 8-61.

As discussed in the Methods for Analysis section, constituents that require analysis beyond that of the initial screening analysis, and that do not behave conservatively (e.g., degrade or are consumed in biochemical processes) within the system were further assessed qualitatively. Conversely, constituents that are primarily conserved (i.e., do not change) as they move through the system (e.g., dissolved salts) were candidates for further quantitative assessments, via comparisons of modeled scenarios that depict the Existing Conditions, No Action Alternative, and the action alternatives (Table 8-61).

Table 8-61. Water Quality Constituents for which Detailed Assessments are Performed

Constituents Carried Forward for Further Analysis	Quantitative [a]	Qualitative	Section of Environmental Consequences
Ammonia		X	Ammonia
Boron	DSM2+MB		Boron
Bromide	DSM2+MB/ EC Ratios		Bromide
Chloride	DSM2+MB/ EC Ratios		Chloride
Oxygen		X	Dissolved Oxygen
Conductance (EC)	DSM2-QUAL		Electrical Conductivity (EC)/TDS
Total Dissolved Solids		X	Electrical Conductivity (EC)/TDS
Mercury	DSM2+MB		Mercury
Nitrate	DSM2+MB	X	Nitrate
Nitrite		X	Nitrate
Nitrite + Nitrate		X	Nitrate
Organic Carbon	DSM2-QUAL		Organic Carbon (DOC/TOC)
Haloacetic acids [b]		X	Organic Carbon (DOC/TOC)
Trihalomethanes [c]		X	Organic Carbon (DOC/TOC)
Cryptosporidium		X	Pathogens
Escherichia™coli		X	Pathogens
Organochlorine, Organophosphate, and Pyrethroid Pesticides [d]		X	Pesticides and Herbicides
Phosphorus		X	Phosphorus
Selenium	DSM2+MB		Selenium
Other Trace Metals [e]		X	Trace Metals
Total Suspended Solids		X	Turbidity and TSS
Volatile Suspended Solids		X	Turbidity and TSS
Turbidity		X	Turbidity and TSS

[a] DSM2+MB = Constituent was modeled via mass balance approach described in section 8.3.1.3 (i.e., DSM2 fingerprinting results coupled with historical source water quality data); EC Ratios = Constituent was modeled via EC to chloride and/or chloride to bromide ratios described in section 8.3.1.3; DSM2-QUAL = Constituent was modeled directly using DSM2-QUAL.

[b] Dibromoacetic Acid (DBAA), dichloroacetic Acid (DCAA), trichloroacetic Acid (TCAA), total haloacetic acids

[c] Bromodichloromethane, bromoform, dibromochloromethane, total THMs

[d] Aldrin, BHC, BHC-alpha, BHC-beta, BHC-delta, BHC-gamma (lindane), chlordane, chlorpyrifos, diazinon, dieldrin, endosulfan (mixed isomers), endosulfan-I, endosulfan-II, endrin, heptachlor, p,p'-DDD, p,p'-DDE, p,p'-DDT, toxaphene, pyrethroids

[e] Arsenic, cadmium, copper, lead, manganese, nickel, zinc, aluminum, silver

8.4.2.2 Comparisons

For hydrologic (i.e., CALSIM) modeling purposes, which depicts CVP and SWP system-wide operations and thus how water would be routed through the Delta, Existing Conditions, the No Action Alternative and the action alternatives were partly defined according to the key inputs shown in Table 8-62. For the quantitative and qualitative assessments performed, comparisons of the assessment scenarios were made consistent with Table 8-63 and are presented in the Effects and Mitigation Approaches section, below. The CEQA baseline, "Existing Conditions", is defined in Appendix 3D, and for the purposes of the quantitative water quality assessments, is represented by

Existing Conditions modeling runs, not historical water quality monitoring data as presented in Section 8.1.3. The No Action Alternative is defined by the future surface water demands at the 2025 level of development, specific future planned and approved facilities and operations described in Appendix 3D, and projected climate change and sea level rise estimated to occur by 2060. The longer planning horizon assumed for climate change compared to system water supply and demands is included to be commensurate with the 50-year implementation timeframe for BDCP actions.

Table 8-62. Water Quality Assessment Scenarios

Input Parameters	Existing Conditions	No Action Alternative	Project Alternatives
Surface Water Demands [a]	2005 / Recent Historical	2025 / Full Water Rights	2025 / Full Water Rights
Conveyance	Through Delta	Through Delta	Various
CVP/SWP Operational Criteria	Per USFWS and NMFS BiOps RPAs [b]	Per USFWS and NMFS BiOps RPAs [b]	Various
Fall X2	No	Yes	Some Yes, Some No
Climate Change / Sea Level Rise	None	Year 2060	Year 2060

Notes:

[a] This is a simplified characterization of the water demands to illustrate the differences between the scenarios. Water demands for some purveyors under the No Action and action alternatives are the same as those under Existing Conditions, while others are increased to a full contract amount or 2030 level. See CALSIM II modeling assumptions for specific differences (Appendix 5A, *BDCP EIR/EIS Modeling Technical Appendix*).

[b] USFWS/NMFS Biological Opinions (BiOps) RPAs are described in Appendix 3D, *Defining Existing Conditions, No Action Alternative, No Project Alternative, and Cumulative Impact Conditions,* and Appendix 5A, *BDCP EIR/EIS Modeling Technical Appendix*.

Table 8-63. Scenario Comparisons Performed for Impact Assessment Purposes

Comparison	Purpose of Comparison
1 Existing Conditions versus Alternatives (including No Action Alternative)	A required comparison to current conditions for CEQA purposes. Shows effects due not only to changes in conveyance and operational criteria defined by the alternative (CM1), including meeting fall X2, but also the effects of future surface water demands and climate change/sea level rise. [a]
2 No Action Alternative versus Project Alternatives	Identifies potential alternative-specific effects caused by changes in conveyance and operating criteria (CM1).

Notes:

[a] The CEQA baseline, "Existing Conditions", is defined in Appendix 3D, and for the purposes of quantitative water quality assessments, is represented by Existing Conditions modeling runs, not historical water quality monitoring data as presented in Section 8.1.3.

8.4.2.3 Effects Determinations

Both qualitative and quantitative water quality assessments have been conducted to determine the anticipated changes in water quality that may occur throughout the affected environment from implementing an each alternative, relative to the water quality conditions that would occur under the Existing Conditions or the No Action Alternative. The water quality effects of the action or alternative would be adverse (under NEPA) and significant (under CEQA) if implementation of an alternative would result in one of the numbered conditions below. As defined and used for assessment purposes, these conditions serve as both effects criteria under NEPA and thresholds of significance under CEQA. As is explained in more detail below, the thresholds build on, and add detail to, general questions posed in the sample Initial Study checklist found in Appendix G to the CEQA Guidelines. The refinements to the language set forth in that document reflects the application of professional judgment and experience to the more general language found in the original.

1. Cause exceedance of applicable state or federal numeric or narrative water quality objectives/criteria, or other relevant water quality effects thresholds identified for this assessment (applicable objectives/criteria are identified in Appendix 8A and the constituent-specific assessments in Section 8.3.1.7), by frequency, magnitude, and geographic extent that would result in adverse effects to one or more beneficial uses within affected water bodies.
2. Increase levels of a bioaccumulative pollutant by frequency, magnitude, and geographic extent such that the affected water body (or portion of a water body) would be expected to have measurably higher body burdens of the bioaccumulative pollutant in aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish) or humans consuming those organisms.
3. Cause long-term degradation of water quality in one or more water body of the affected environment, resulting in sufficient use of available assimilative capacity such that occasionally exceeding water quality objectives/criteria would be likely and would result in substantially increased risk for adverse effects to one or more beneficial uses.
4. Further degrade water quality by measurable levels, on a long-term basis, for one or more parameters that are already impaired and, thus, included on the State's Clean Water Act Section 303(d) list for the water body, such that beneficial use impairment would be made discernibly worse.
5. Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, in a manner which would result in substantial erosion or siltation on- or off-site.

The third effect assessment criterion/threshold listed above is triggered not by increased exceedances of water quality standards or adverse impacts on beneficial uses, but rather by the more sensitive threshold of demonstrated water quality degradation, on a long-term basis, that eliminates a substantial amount of the receiving water body's available assimilative capacity, thereby resulting in water quality conditions that substantially increase the likelihood of water quality objectives/criteria exceedances and adverse effects to beneficial uses. This effects assessment criterion/threshold would not be met if a substantial amount of available assimilative capacity is used under the alternative assessed, yet substantial assimilative capacity remains such that exceeding water quality objectives/criteria would be rare, if it were to occur at all and, therefore, resulting water quality poses negligible risk for adverse effects to beneficial uses.

Similarly, the fourth effect assessment criterion/threshold above is met not by demonstrated or potential adverse effects to beneficial uses, but rather the more sensitive criteria/threshold of "measurable degradation," on a long-term basis, under already impaired conditions. This effect assessment criterion/threshold is included in recognition that an adverse effects determination should be more sensitive when water quality conditions are already impaired in a water body and, therefore, any measurable worsening, on a long-term basis, may be considered substantial and adverse. This fourth effects assessment criterion/threshold provides meaningful sensitivity for already impaired conditions by requiring measurable changes, on a long-term basis, rather than "any" change at any time (i.e., a change that could be calculated, but may not be measureable in the actual environment, or may not occur frequently enough to measurably alter water quality on a long-term basis).

The fifth effect assessment criterion/threshold listed above applies to alteration of drainage patterns, which occurs through construction of various components of the project. Consequently, effects of the project were assessed relative to this criterion/threshold fully in the sections relating to effects of construction only.

As indicated above, these thresholds/criteria set forth above were derived from questions relating to hydrology and water quality in Appendix G (Section IX) of the CEQA Guidelines. Without refinements, thresholds derived literally from that source would read as follows:

- Violate any water quality standards (criterion 1);
- Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, in a manner which would result in substantial erosion or siltation on- or off-site (criterion 5);
- Otherwise substantially degrade water quality (criteria 3 and 4).

Appendix G thresholds of significance relating specifically to hydrology and flooding, and whether the project would substantially increase the rate or amount of surface runoff in a manner which would result in flooding on- or off-site, are addressed in Chapter 6, *Surface Water*. The above-listed Appendix G thresholds have been integrated into the five numbered effects criteria/thresholds listed above and the applicable water quality objectives/criteria are identified in Appendix 8A and in Section 8.3.1.7.

The first bulleted Appendix G threshold, "violate any water quality standard," was refined for application in effects criterion/threshold #1. This is because a "water quality standard" contains three components: 1) the beneficial uses of the water body to be protected, 2) the criteria/objectives that, when met, result in water quality protective of the designated beneficial uses, and 3) an antidegradation policy. Therefore, effects criterion/threshold #1 started with the basic concept behind this first Appendix G threshold, and was further refined to account for the frequency, magnitude, and geographic extent with which a water quality criterion or objective could be exceeded, thereby giving the assessor the ability to relate such exceedances to adverse effects on beneficial uses (i.e., actual adverse environmental effects). As such, effects criterion/threshold #1 will identify significant impacts under CEQA when water quality under an alternative is anticipated to change substantially, thereby causing adverse effects to beneficial uses, and will avoid making such determinations when the violation of a water quality standard is too infrequent, low in magnitude, and/or isolated geographically to actually cause any adverse effects on beneficial uses of the water body or water body segment.

Similarly, the third bulleted Appendix G threshold of "… substantially degrade water quality," is vague as written and thus not sufficiently specific to allow meaningful or precise application as a threshold of significance. Therefore, it too has been refined and expanded into effects criteria/thresholds #3 and #4 enumerated above.

Finally, the second bulleted CEQA Appendix G threshold has been included directly as effects criterion/threshold #5. Consequently, the applicable water quality thresholds of significance identified in Section IX of Appendix G of the CEQA Guidelines have been fully incorporated into the five numbered effects criteria/thresholds used to assess the identified water quality changes under the alternatives for the purposes of making impact determinations for CEQA purposes.

8.4.3 Effects and Mitigation Approaches

8.4.3.1 No Action Alternative

Per the description of comparisons made in this chapter which are discussed in section 8.3.2.2, this section contains the comparison of the No Action Alternative vs. Existing Conditions for CEQA purposes.

Under the No Action Alternative, the facilities and operations of the SWP and CVP would continue to be similar to Existing Conditions with the following changes.

- Effects of sea level rise and climate change on system operations.
- An increase in demands and the buildout of facilities associated with water rights and CVP and SWP contracts of about 443 TAF per year, north of Delta at the future level of development. This is an increase in CVP M&I service contracts (253 TAF per year) and water rights (184 TAF per year) related primarily to urban M&I use, especially in the communities in El Dorado, Placer, and Sacramento Counties.
- An increase in demands associated with SWP contracts, up to full contract amounts, south of Delta at the future level of development. SWP M&I demands, which under the existing level of development vary on hydrologic conditions between 3.0 and 4.1 MAF per year, under the future condition are at maximum contract amounts in all hydrologic conditions. This represents a potential 25% increase on average in south of Delta demands under SWP M&I contracts between existing and future levels of development due to assumed additional development and demographics.
- New urban intake/Delta export facilities:
    - Freeport Regional Water Project (see Appendix 5A, *BDCP EIR/S Modeling* for information on additional EBMUD demand of about 26 TAF/YR on the average with increased demand in dry years)
    - 30 million-gallon-per-day City of Stockton Delta Water Supply Project
    - Delta-Mendota Canal–California Aqueduct Intertie
    - Contra Costa Water District Alternative Intake and 55 TAF/YR increased demand
    - South Bay Aqueduct rehabilitation, to 430 cfs capacity, from the junction with California Aqueduct to Alameda County Flood Control and Water Conservation District Zone 7.
- An increase in supplies for wildlife refuges including Firm Level 2 supplies of about 8 TAF per year at the future level of development. In addition, there is a shift in refuge demands from south to north (24 TAF per year reduction in south of Delta and 32 TAF per year increase in north of Delta).
- Implementation of the Fall X2 RPA action (see Appendix 5A, *BDCP EIR/S Modeling*), which requires maintenance of X2 at specific locations in wet and above normal years in September and October, plus releases in November to augment Delta outflow dependent on hydrology.

A detailed description of the modeling assumptions associated with the No Action Alternative is included in Appendix 5A, *BDCP EIR/S Modeling.*

Impact WQ-1: Effects on Ammonia Concentrations Resulting from Facilities Operations and Maintenance

Upstream of the Delta

Substantial point sources of ammonia-N do not exist upstream of the SRWTP in the Sacramento River watershed, in the watersheds of the eastern tributaries (Cosumnes, Mokelumne, and Calaveras Rivers), or upstream of the Delta in the San Joaquin River watershed. Nonpoint sources of ammonia-N within the watersheds are also relatively low, thus resulting in generally low ammonia-N concentrations in the reservoirs and rivers of the watersheds. Consequently, any modified reservoir operations and subsequent changes in river flows under the No Action Alternative, relative to Existing Conditions, are expected to have negligible, if any, effects on reservoir and river ammonia-N concentrations upstream of Freeport in the Sacramento River watershed and upstream of the Delta in the San Joaquin River watershed. Any negligible changes in ammonia-N concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regards to ammonia.

Delta

As summarized in Table 8-40, under the No Action Alternative, it is assumed that SRWTP upgrades would be in place, and thus that the average monthly effluent ammonia concentration would not exceed 1.5 mg/L-N in April through October and 2.4 mg/L-N in November through March. In comparison, the permitted average monthly effluent ammonia concentration under the Existing Conditions is 33 mg/L-N, with actual monthly average ammonia concentration in the effluent being approximately 24 mg/L-N (Central Valley Water Board 2010e). Because of this, ammonia concentrations in the Sacramento River downstream of the SRWTP would be substantially lower under the No Action Alternative, relative to Existing Conditions. As shown in Figure 8-52, Sacramento River ammonia concentrations currently are of the same magnitude as San Joaquin River and San Francisco Bay concentrations of ammonia during the January through March period of the year, and much greater than these two sources for the remainder of the year. Consequently, a substantial decrease in Sacramento River ammonia concentrations is expected to decrease ammonia concentrations for all areas of the Delta that are influenced by Sacramento River water. Additionally, San Joaquin River and San Francisco Bay concentrations are similar to each other throughout the year (Figure 8-52), indicating that any change in source water fraction from BAY to SJR or from SJR to BAY at locations in the Delta would not substantially alter concentrations at these locations. Therefore, at locations which are not influenced notably by Sacramento River water, concentrations are expected to remain relatively unchanged. Any negligible increases in ammonia-N concentrations that may occur at certain locations in the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to ammonia.

SWP/CVP Export Service Areas

The assessment of effects on ammonia in the SWP/CVP Export Service Areas is based on assessment of ammonia-N concentrations at Banks and Jones pumping plants. The dominant source waters influencing the Banks and Jones pumping plants are the Sacramento and San Joaquin Rivers (see

Appendix 8D). As discussed above for the Plan Area, for areas of the Delta that are influenced by Sacramento River water, including Banks and Jones pumping plants, ammonia concentrations are expected to decrease under the No Action Alternative, relative to Existing Conditions. This decrease in ammonia-N concentrations for water exported via the south Delta pumps is not expected to result in adverse effects on beneficial uses or substantially degrade water quality of exported water, with regards to ammonia.

In summary, based on the discussion above, effects on ammonia of facilities operations and maintenance are considered to be not adverse.

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

Ammonia-N concentrations are generally low in the reservoirs and rivers of the watersheds, owing to the lack of substantial point and nonpoint sources of ammonia-N upstream of the SRWTP in the Sacramento River watershed, in the watersheds of the eastern tributaries (Cosumnes, Mokelumne, and Calaveras Rivers), or upstream of the Delta in the San Joaquin River watershed. Consequently, any modified reservoir operations and subsequent changes in river flows under the No Action Alternative, relative to Existing Conditions, are expected to have negligible, if any, effects on reservoir and river ammonia-N concentrations upstream of Freeport in the Sacramento River watershed and upstream of the Delta in the San Joaquin River watershed.

Ammonia-N concentrations in the Sacramento River downstream of the SRWTP would be substantially lower under the No Action Alternative, relative to Existing Conditions, due to upgrades to the SRWTP that are assumed to be in place, and thus, ammonia concentrations for all areas of the Delta that are influenced by Sacramento River water are expected to decrease. At locations which are not influenced notably by Sacramento River water, concentrations are expected to remain relatively unchanged, due to the similarity in SJR and BAY concentrations and the lack of expected changes in either of these concentrations.

The assessment of effects on ammonia in the SWP/CVP Export Service Areas is based on assessment of ammonia-N concentrations at Banks and Jones pumping plants. As discussed above for the Plan Area, for areas of the Delta that are influenced by Sacramento River water, including Banks and Jones pumping plants, ammonia-N concentrations are expected to decrease under the No Action Alternative, relative to Existing Conditions.

Based on the above, there would be no substantial, long-term increase in ammonia-N concentrations in the rivers and reservoirs upstream of the Delta, in the Plan Area, or the waters exported to the SWP/CVP Export Service Areas under the No Action Alternative relative to Existing Conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent from ammonia that would cause adverse effects on any beneficial uses of waters in the affected environment. Because ammonia concentrations would not be expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects on beneficial uses would occur. Ammonia is not 303(d) listed within the affected environment and thus any minor increases that may occur in some areas would not make any existing ammonia-related impairment measurably worse because no such impairments currently exist. Because ammonia-N is not bioaccumulative, minor increases that may occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant.

Impact WQ-3: Effects on Boron Concentrations Resulting from Existing Facilities Operations and Maintenance

Upstream of the Delta

Under the No Action Alternative, greater water demands (see Table 8-55) and climate change would alter the magnitude and timing of reservoir releases and river flows upstream of the Delta in the Sacramento River watershed and east-side tributaries, relative to Existing Conditions. Because substantial sources of boron do not exist upstream of the Delta in the watersheds of the Sacramento River and eastside tributaries, concentrations of boron in surface water are low and often below detection limits (see "Affected Environment-Environmental Setting" section). Consequently, changes in the magnitude and timing of reservoir releases and river flows upstream of the Delta would have negligible, if any, effect on boron sources, and ultimately the concentration of boron in the Sacramento River, the east-side tributaries, and the various reservoirs of the related watersheds. Consequently, the No Action Alternative would not be expected to cause exceedance of boron objectives or substantially degrade water quality with respect to boron and thus, would not adversely affect any beneficial uses of the Sacramento River, the east-side tributaries, or their associated reservoirs upstream of the Delta.

South of the Delta, the San Joaquin River is a substantial source of boron. While tributaries and associated reservoirs of the lower San Joaquin are likely negligible sources of boron, loading in the lower San Joaquin watershed contributes to relatively high concentrations which can be sourced to agricultural irrigation of soils containing boron and use of water imported from the south Delta. Average boron concentrations in the lower San Joaquin River at Vernalis are inversely correlated to net river flow and the dilution provided by this flow. Under the No Action Alternative, long-term average flows at Vernalis would decrease 6% relative to Existing Conditions (as a result of climate change and increased water demands) (Appendix 5A). Based on best-fit regressions of annual average San Joaquin River flow and boron, these decreases in flow would correspond to a potential increase in long-term average boron of about 2% relative to Existing Conditions (Appendix 8F, Table 24). The relatively small increase would not cause boron concentrations to exceed applicable objectives relative to Existing Conditions and would not cause substantial long-term water quality degradation with regards to boron. Accordingly, with respect to the 303(d) listing of the lower San Joaquin River impairment for boron would not be made discernibly worse. The No Action Alternative also would not be expected to adversely affect necessary TMDL actions implemented to reduce boron loading in the lower San Joaquin River because the modeled increases are associated with less dilution of the existing load and boron loading would not be anticipated to change measurably. Consequently, the small increases in lower San Joaquin River boron levels that may occur under the No Action Alternative, relative to Existing Conditions, would not be expected to adversely affect any beneficial uses of the lower San Joaquin River.

Delta

Relative to Existing Conditions, the No Action Alternative would result in generally similar long-term annual average boron concentrations, or decreased average concentrations, at ten of the eleven Delta assessment locations for the 16-year period modeled (i.e., 1976–1991), and would increase only at the Jones Pumping Plant location by about 3% (Appendix 8F, Table Bo-2). Increased monthly average concentrations would occur under the No Action Alternative at nine of the assessment locations during the months of December through June, with decreased or similar concentrations occurring only at two interior Delta locations (i.e., SF Mokelumne River at Staten Island and San Joaquin River at Buckley Cove). For the drought year period modeled (i.e., 1987–1991), the No Action Alternative would result in increased annual average concentrations at six locations (up to a maximum 4% increase at the Jones Pumping Plant) relative to Existing Conditions.

With respect to the 2,000 μg/L EPA drinking water human health advisory objective (i.e., for children), the long-term annual average and monthly average boron concentrations, for either the 16-year period or drought period modeled, are low and would never exceed this objective at any of the eleven Delta assessment locations under the No Action Alternative (i.e., maximum long-term average concentration of about 417 μg/L at the Sacramento River at Mallard Island), which represents a slight decrease from the Existing Conditions (Appendix 8F, Table Bo-3A). Long-term average boron concentrations would be similar or slightly lower at most Delta assessment locations, and no changes would result in measureable long-term use of assimilative capacity (i.e., less than 3% reduction) or further degradation of water quality conditions with respect to the 2,000 μg/L objective (Appendix 8F, Table Bo-4). Consequently, boron levels that may occur under the No Action Alternative, relative to Existing Conditions, would not be expected to adversely affect municipal water supply beneficial uses of the Delta.

Similarly, under the No Action Alternative, the long-term annual average and monthly average boron concentrations for either the 16-year period or drought period modeled would never exceed the lowest agricultural objective of 500 μg/L contained in the San Francisco Bay RWQCB (Region 2) Basin Plan at any Delta assessment location except at the Sacramento River at Mallard Island and San Joaquin River at Antioch locations (Appendix 8F, Table Bo-3A). However, the agricultural beneficial use is not an existing designated use at Mallard Island within the Region 2 Basin Plan, and the Antioch location is in the far western Delta and not a location of agricultural diversions (California Department of Water Resources 1993). Small reductions in the modeled long-term average assimilative capacity would occur only at the Jones and Banks pumping plants, Old River at Rock Slough, and Sacramento River at Emmaton locations (e.g., maximum reduction of 3% at Jones Pumping Plant for both the 16-year and 4% for the modeled drought period) (Appendix 8F, Table Bo-5). Moreover, the reduced assimilative capacity would not lead to an increased frequency of exceedances of objectives because the absolute concentrations would be well below the lowest 500 μg/L objective for the protection of agricultural beneficial uses, as indicated in plots of monthly average boron concentrations for representative interior and south Delta locations (i.e., Franks Tract, Old River at Rock Slough, Jones Pumping Plant, and Old River at Tracy Road) (Appendix 8F, Figure Bo-2). Consequently, the small increases in average boron concentrations that may occur under the No Action Alternative, relative to Existing Conditions, would not be expected to adversely affect municipal or agricultural water supply beneficial uses of the Delta, or substantially degrade water quality with respect to boron.

SWP/CVP Export Service Areas

Under the No Action Alternative, relatively small increases would occur in long-term average boron concentrations at the Jones and Banks pumping plants relative to the Existing Conditions (i.e., up to 4% at Jones pumping plant for both the 16-year and drought period modeled) (Appendix 8F, Table Bo-2). With respect to the 303(d) listing of the lower San Joaquin River impairment for boron, increased boron concentrations in exported water to the San Joaquin River basin could lead to increased loading in the lower San Joaquin River since boron is principally related to irrigation water deliveries. However, the absolute average boron concentrations at Jones Pumping Plant would be low relative to applicable objectives (Appendix 8F, Figure Bo-2), and the reduction in assimilative capacity would be minor (i.e., 4% reduction for the drought period modeled) compared to the Existing Conditions (Appendix 8F, Table Bo-5). Thus, the long-term increased boron concentrations would not be expected to cause further measurable degradation in the lower San Joaquin River that would make the existing impairment discernibly worse or adversely affect necessary TMDL actions implemented to reduce boron loading. Consequently, the small increases in average boron concentrations that may occur under the No Action Alternative, relative to Existing Conditions, would not be expected to adversely affect municipal or agricultural water supply beneficial uses in the SWP and CVP service area, or substantially degrade water quality with respect to boron.

In summary, the effects of additional future climate change/sea level rise under the No Action Alternative conditions would result in relatively small increases in long-term average boron concentrations in the lower San Joaquin River and several Delta locations. However, the predicted changes would not be expected to cause exceedances of applicable objectives or further measurable water quality degradation, and thus would not constitute an adverse effect on water quality.

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

Boron is not a constituent of concern in the Sacramento River watershed upstream of the Delta, thus river flow rate and reservoir storage reductions that would occur under the No Action Alternative, relative to Existing Conditions, would not be expected to result in a substantial adverse change in boron levels. Additionally, relative to Existing Conditions, the No Action Alternative would not result in reductions in river flow rates (i.e., less dilution) or increased boron loading such that there would be any substantial increase in boron concentrations upstream of the Delta in the San Joaquin River watershed.

It is expected there would be no substantial change in Delta boron levels (i.e., <4% increase at any assessment location) in response to a shift in the Delta source water percentages under this alternative or substantial degradation of these water bodies. With respect to the 303(d) listing of boron in the lower San Joaquin River for the agricultural water supply beneficial use, the potential small increase in long-term average boron concentration associated with reduced flows and exported water at the Jones Pumping Plant would not be expected to cause substantial additional boron loading, or further degradation at measurable levels in the lower San Joaquin River, and thus would not cause the existing impairment to be discernibly worse.

Boron is not a bioaccumulative constituent, thus any increased concentrations under the No Action Alternative would not result in adverse boron bioaccumulation effects to aquatic life or humans. Relative to Existing Conditions, the No Action Alternative would not result in substantially increased boron concentrations such that frequency of exceedances of municipal and agricultural water supply objectives would increase. The levels of boron degradation that may occur under the No Action Alternative would not be of sufficient magnitude to cause substantially increased risk of exceeding objectives or adverse effects to municipal or agricultural beneficial uses, or any other beneficial uses, within the affected environment. Based on these findings, this impact is determined to be less than significant.

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

Upstream of the Delta

Under the No Action Alternative, greater water demands (see Table 8-55) will alter the magnitude and timing of reservoir releases upstream of the Delta, relative to Existing Conditions. As shown in Table 8-43, the Sacramento River watershed and eastside tributaries are negligible sources of bromide to the Delta. While greater water demands under the No Action Alternative would alter the magnitude and timing of reservoir releases north and east of the Delta, these activities would have negligible, if any, effect on the sources, and ultimately the concentration of bromide in the Sacramento River, the eastside tributaries, and the various reservoirs of the related watersheds. Consequently, the No Action Alternative would not be expected to adversely affect the MUN beneficial use, or any other beneficial uses, of the Sacramento River, the eastside tributaries, or their associated reservoirs upstream of the Delta.

South of the Delta, the San Joaquin River is a substantial source of bromide. While tributaries and associated reservoirs of the lower San Joaquin are likely negligible sources of bromide, bromide on the lower San Joaquin is relatively high and can be sourced to agriculture irrigation water imported from the southern Delta. Agricultural irrigation drainage is the primary source of bromide on the lower San Joaquin River, where concentrations at Vernalis are inversely correlated to net river flow and the dilution provided by this flow. Under the No Action Alternative, long-term average flows at Vernalis would decrease 6% relative to Existing Conditions (Appendix 5A). Based on best-fit regressions of annual average San Joaquin River flow and bromide, these decreases in flow would correspond to a possible increase in long-term average bromide of about 3% relative to Existing Conditions (Appendix 8E, *Bromide*, Table 22). The relatively small magnitude of this increase is considered to be less than substantial. Moreover, there are no existing municipal intakes on the lower San Joaquin River. Consequently, the small increases in lower San Joaquin River bromide levels that may occur under the No Action Alternative, relative to Existing Conditions, would not be expected to adversely affect the MUN beneficial use, or any other beneficial uses, of the lower San Joaquin River.

Delta

Relative to Existing Conditions, the No Action Alternative would result in small decreases in long-term average bromide concentrations at all modeled Delta assessment locations with the exception being the Sacramento River at Emmaton for the drought period (Appendix 8E, *Bromide* Table 2). Long-term average concentrations of seawater-derived constituents decrease under the No Action Alternative relative to Existing Conditions because the No Action Alternative includes Fall X2 operations, while Existing Conditions does not (Appendix 3D, 5A). Therefore, even though sea level rise is included in the No Action Alternative, and not in Existing Conditions, the effect of Fall X2 on bromide is generally greater than sea level rise. For the modeled drought period, long-term bromide concentrations at Emmaton are predicted to increase by about 8%.

The modeled frequency with which bromide concentration exceeds 50 and 100 μg/L would change only slightly at all 11 assessment locations, with some Delta assessment locations experiencing improved water quality relative to bromide (Appendix 8E, *Bromide*, Table 2). However, small increases in modeled concentration threshold exceedances would occur at some Delta interior and western Delta assessment locations. In the Delta interior at Rock Slough and Franks Tract, the frequency of exceeding 100 μg/L would increase by a maximum of about 3 percentage points (4 percentage points for modeled drought period). Larger increases would occur in the western Delta, however, where the frequency of exceeding 100 μg/L would increase by as much as 7 percentage points at Emmaton (2 percentage points for modeled drought period). The greater frequencies of exceedance can be sourced primarily to the assumptions of sea level rise in the late long-term. While the greater influence of sea water would result in slightly more frequent bromide conditions exceeding 50 and 100 μg/L in these select interior and western Delta locations, the resulting conditions would not be expected to adversely affect MUN beneficial uses, or any other beneficial use, particularly when considering the relatively small change in long-term annual average concentration.

The seasonal intakes at Mallard Slough and City of Antioch are infrequently used due to water quality constraints related to sea water intrusion. On a long-term average basis, bromide at these locations is in excess of 3,000 μg/L, but during seasonal periods of high Delta outflow can be <300 μg/L. Given these seasonal constraints on use, mass balance modeling predicts that use of these intakes would most frequently occur during the months of February, March, and April of wet and above normal water year types when water quality suitable for diversion would be most typically available. Focusing on this period of most likely seasonal use (February–April of wet and above normal water years), under the No Action Alternative average bromide concentrations would increase about 5% at the City of Antioch intake and would decrease about 4% at the Mallard Slough intake relative to Existing Conditions (Appendix 8E, *Bromide*, Table 23). Such a relatively small predicted increase in bromide concentrations at the City of Antioch intake would not be expected to adversely affect MUN beneficial uses, or any other beneficial use, while decreases at Mallard Slough would be considered beneficial.

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, *Bromide*, Tables 3 and 24).

SWP/CVP Export Service Areas

Under the No Action Alternative, long-term average bromide concentrations at the Banks and Jones pumping plants would decrease by as much as 13% relative to Existing Conditions (Appendix 8E, *Bromide* Table 2). As explained above for the Delta, long-term average concentrations of seawater-derived constituents decrease under the No Action Alternative relative to Existing Conditions because the No Action Alternative includes Fall X2, while Existing Conditions does not (Appendix 3D, 5A). Therefore, even though sea level rise is included in the No Action Alternative, and not in Existing Conditions, the effect of Fall X2 on bromide is generally greater than sea level rise. The frequency with which bromide would exceed bromide concentration thresholds at the Banks and Jones pumping plants, relative to Existing Conditions, would remain unchanged or would improve slightly, including years of drought (Appendix 8E, *Bromide*, Table 2). Consequently water exported into the SWP/CVP Export Service Areas through these south Delta pumps would be of similar or slightly better quality with regards to bromide under the No Action Alternative, relative to Existing Conditions.

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, *Bromide*, Table 3).

Maintenance of SWP and CVP facilities under the No Action Alternative 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.

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

While greater water demands under the No Action Alternative would alter the magnitude and timing of reservoir releases north and east of the Delta, these activities would have negligible, if any, effect on the sources of bromide, and ultimately the concentration of bromide in the Sacramento River, the eastside tributaries, and the various reservoirs of the related watersheds. However, south of the Delta, the San Joaquin River is a substantial source of bromide, primarily due to the use of irrigation water imported from the southern Delta. Concentrations of bromide at Vernalis are inversely correlated to net river flow. Under the No Action Alternative, long-term average flows at Vernalis would decrease only slightly, resulting in less than substantial predicted increases in long-term average bromide of about 3% relative to Existing Conditions.

Relative to Existing Conditions, the No Action Alternative would result in small decreases in long-term average bromide concentrations at all modeled Delta assessment locations with the exception being the Sacramento River at Emmaton for the drought period. For the modeled drought period, long-term bromide concentrations at Emmaton are predicted to increase by about 8%. Small increases in modeled concentration threshold exceedances would occur at some Delta interior and western Delta assessment locations, including Rock Slough, Franks Tract, and Emmaton, but the resulting conditions would not be expected to adversely affect MUN beneficial uses, or any other beneficial use. Moreover, the small (i.e., ≤5%) predicted increase in long-term average bromide concentrations at the City of Antioch intake would not be expected to adversely affect MUN beneficial uses while decreases at Mallard Slough would be considered beneficial.

The assessment of effects on bromide in the SWP/CVP Export Service Areas is based on assessment of changes in bromide concentrations at Banks and Jones pumping plants. Long-term average bromide concentrations at the Banks and Jones pumping plants are predicted to decrease by as much as 13% relative to Existing Conditions while exceedance of bromide concentration thresholds at the Banks and Jones pumping plants, would remain largely unchanged.

Based on the above, the No Action Alternative would not cause exceedance of applicable state or federal numeric or narrative water quality objectives/criteria because none exist for bromide. The No Action Alternative would not result in any substantial change in long-term average bromide concentration or exceed 50 and 100 μg/L assessment threshold concentrations by frequency, magnitude, and geographic extent that would result in adverse effects on any beneficial uses within affected water bodies. Bromide is not a bioaccumulative constituent and thus concentrations under this alternative would not result in bromide bioaccumulating in aquatic organisms. Increases in exceedances of the 100 μg/L assessment threshold concentration would be 7 percentage points or less at all locations assessed, which is considered to be less-than substantial long-term degradation of water quality. The levels of bromide degradation that may occur under the No Action Alternative would not be of sufficient magnitude to cause substantially increased risk for adverse effects on any beneficial uses of water bodies within the affected environment. Bromide is not 303(d) listed and thus the minor increases in long-term average bromide concentrations would not affect an existing beneficial use impairment because no such use impairment currently exists for bromide. Based on these findings, this impact is less than significant.

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

Upstream of the Delta

Under the No Action Alternative, greater water demands (see Table 8-55) and climate change would alter the magnitude and timing of reservoir releases and river flows upstream of the Delta in the Sacramento River watershed and eastside tributaries, relative to Existing Conditions. Because substantial sources of chloride do not exist upstream of the Delta, concentrations of chloride in surface water are low and often below detection limits (see "Affected Environment-Environmental Setting" section). Consequently, changes in the magnitude and timing of reservoir releases and river flows upstream of the Delta would have negligible, if any, effect on chloride sources, and ultimately the concentration of chloride in the Sacramento River, the eastside tributaries, and the various reservoirs of the related watersheds. Consequently, the No Action Alternative would not be expected to cause exceedance of chloride objectives/criteria or substantially degrade water quality with respect to chloride and thus would not adversely affect any beneficial uses of the Sacramento River, the eastside tributaries, or their associated reservoirs upstream of the Delta.

South of the Delta, the San Joaquin River has generally elevated chloride concentrations compared to the Sacramento River and east side tributaries; however, average monthly and maximum concentrations are below the applicable drinking water MCL of 250 mg/L and the EPA chronic aquatic life criterion of 230 mg/L (Table Cl-2). The chloride in the lower San Joaquin River can be sourced to accumulation of salts in agricultural drainage from irrigation water imported from the southern Delta. Chloride concentrations at Vernalis are inversely correlated to net river flow and the dilution provided by the flow. Under the No Action Alternative, long-term average flows at Vernalis would decrease by an estimated 6% relative to Existing Conditions (as a result of climate change and increased water demands) (Appendix 5A, CALSIM Flow Data for Vernalis). Based on best-fit regressions of annual average San Joaquin River flow and chloride, these decreases in flow would correspond to a potential increase in long-term average chloride concentrations of about 2% relative to Existing Conditions (Appendix 8G, Table Cl-62). The relatively small increase would not cause chloride concentrations to exceed applicable objectives relative to existing concentrations and would not cause substantial long-term water quality degradation with regards to chloride. Moreover, there are no existing municipal supply intakes on the lower San Joaquin River. Consequently, the small increases in lower San Joaquin River chloride levels that may occur under the No Action Alternative, relative to Existing Conditions, would not be expected to adversely affect any beneficial uses of the lower San Joaquin River.

Delta

Relative to Existing Conditions, modeling predicts that the No Action Alternative would result primarily in small decreases in long-term average chloride concentrations for the 16-year period modeled (i.e., 1976–1991) at all Delta assessment locations (Appendix 8G, Table Cl-1 and Table Cl-2). Long-term average concentrations of seawater-derived constituents decrease under the No Action Alternative relative to Existing Conditions because the No Action Alternative includes Fall X2, while Existing Conditions does not (Appendix 3D, 5A). Therefore, even though sea level rise is included in the No Action Alternative, and not in Existing Conditions, the effect of Fall X2 on chloride is generally greater than sea level rise. In the months of February through June, monthly average chloride concentrations would increase at all of the assessment locations except two interior Delta locations (i.e., SF Mokelumne River at Staten Island and San Joaquin River at Buckley Cove). For the other months of the year (i.e., July through January), the changes in chloride concentrations would be variable with increases and decreases occurring at all eleven assessment locations. The Sacramento River at Emmaton location in the western Delta would exhibit the largest seasonal increases compared to Existing Conditions, ranging from 11% to 48% during the months of December through June. For the drought year period modeled (i.e., 1987–1991), the annual average chloride concentration would remain unchanged or decrease at ten of the assessment locations, but increase by about 12% compared to Existing Conditions at the Sacramento River at Emmaton location (Appendix 8G, Table Cl-1 and Table Cl-2). The comparison to Existing Conditions reflects changes in chloride due to both increased demands and changed hydrology and Delta hydrodynamic conditions associated with climate change and sea level rise. The following outlines the modeled chloride changes relative to the applicable objectives and effects on beneficial uses in Delta waters.

Municipal and Industrial Beneficial Uses–Relative to Existing Conditions

Estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3) were used to evaluate the 150 mg/L Bay-Delta WQCP objective for municipal and industrial beneficial uses on a basis of the percent of years the chloride objective is exceeded for the modeled 16-year period. The objective is exceeded if chloride concentrations exceed 150 mg/L for a specified number of days in a given water year at both the Antioch and Contra Costa Pumping Plant #1 locations. For No Action Alternative, the modeled frequency of objective exceedance would remain unchanged relative to Existing Conditions. The modeled frequency of exceedance is predicted to be 6% under Existing Conditions and 6% under the No Action Alternative (Appendix 8G, Table Cl-64). Similarly, estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3) were also used to evaluate the 250 mg/L Bay-Delta WQCP objective for chloride at Contra Costa Pumping Plant #1 where daily average objectives apply. The basis for the evaluation was the predicted number of days the objective was exceeded for the modeled 16-year period. For the No Action Alternative, the modeled frequency of objective exceedance would decrease slightly, from 6% of modeled days under Existing Conditions, to 4% of modeled days under the No Action Alternative (Appendix 8G, Table Cl-63).

Given the limitations inherent to estimating future chloride concentrations (see Section 8.3.1.3), estimation of chloride concentrations through both a mass balance approach and an EC-chloride relationship approach was used to evaluate the 250 mg/L Bay-Delta WQCP objectives in terms of both frequency of exceedance and use of assimilative capacity. When utilizing the mass balance approach, modeled monthly average chloride concentrations at the Barker Slough at North Bay Aqueduct for the 16-year period would not exceed the objective, which represents no change from the Existing Conditions (Appendix 8G, Table Cl-3). The modeled frequency of exceedances at the

Banks pumping plant would decrease slightly from 4% under Existing Conditions to 2%. At the Contra Costa Canal at Pumping Plant #1, the modeled frequency of exceedances of this objective would decrease about 10% from 24% to 14%. Chloride concentrations in the western Delta can exceed the applicable 250 mg/L objective frequently in the low-flow fall and early winter months under Existing Conditions. Consequently, water is diverted from the San Joaquin River at Antioch and Mallard Slough municipal intakes only when salinity conditions are acceptable. The frequency of exceedances of the objective at the San Joaquin at Antioch location for the 16-year period modeled would increase from 66% under Existing Conditions to 73% for a net increase of about 7% and would increase 1% (i.e., from 85% under Existing Conditions to 86%) at the Sacramento River at Mallard Island location. Moreover, the increased chloride concentrations would occur during the months of January through June, thus reducing water quality during the period of seasonal municipal diversions (Appendix 8G, Figure Cl-1). The available assimilative capacity would decrease substantially at the Antioch location in the months of March and April (i.e., maximum reduction of 39% for the 16-year period modeled and 97% for the drought period only) when chloride concentrations would be near, or exceed, the objectives, thus increasing the risk of exceeding objectives (Appendix 8G, Table Cl-5).

In comparison, when utilizing the chloride-EC relationship to model monthly average chloride concentrations for the 16-year period, trends in frequency of exceedance and use of assimilative capacity are similar to that discussed when utilizing the mass balance modeling approach (Appendix 8G, Table Cl-4). Based on the additional predicted seasonal and annual exceedances of one or both Bay Delta WQCP objectives for chloride, and the associated long-term water quality degradation and use of assimilative capacity, the potential exists for adverse effects on the municipal and industrial beneficial uses in the western Delta, particularly at the Antioch location, through reduced opportunity for diversion of water with acceptable chloride levels.

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

Tom Paine Slough in the southern Delta is on the 303(d) list for chloride with respect to the secondary MCL of 250 mg/L. The plot of monthly average chloride concentrations at the Old River at Tracy Bridge for the 16-year period modeled, which represents the nearest DSM2-modeled location to Tom Paine in the south Delta, would be well below the MCL and generally would be similar, or reduced slightly, compared to Existing Conditions (Appendix 8G, Figure Cl-2).

Suisun Marsh is on the 303(d) list for chloride in association with the Bay-Delta WQCP objectives for maximum allowable salinity during the months of October through May, which establish appropriate seasonal salinity conditions for fish and wildlife beneficial uses. The Sacramento River at Mallard Island, Sacramento River at Collinsville, and Montezuma Slough at Beldon's Landing within the marsh, are DSM2-modeled locations representative of source water quality conditions for the marsh that is supported by inflowing flood tide waters from the west, and ebb tide flows of Sacramento River water into Montezuma Slough through the Suisun Marsh Salinity Control Gates located near the Collinsville location. Long-term average chloride concentrations at the Sacramento River at the Mallard Island location for the 16-year period modeled would decrease slightly by 140 mg/L (-5%) compared to Existing Conditions (Appendix 8G, Table Cl-1). The plots of monthly average chloride concentrations for the Sacramento River at Collinsville (Appendix 8G, Figure Cl-3) and Montezuma Slough at Beldon's Landing (Appendix 8G, Figure Cl-4) for the 16-year period modeled indicate that, compared to Existing Conditions, chloride concentrations would be similar or lower during the months of October through May. Consequently, chloride concentrations at Tom

Paine Slough and Suisun Marsh would not be further degraded on a long-term basis or adversely affect necessary actions to reduce chloride loading for any TMDLs developed.

SWP/CVP Export Service Areas

Under the No Action Alternative, long-term average chloride concentrations at the Banks and Jones pumping plants would decrease by as much as 12% relative to Existing Conditions for the 16-year period modeled (Appendix 8G, *Chloride*, Table Cl-1). The modeled frequency of exceedances of applicable water quality objectives/criteria would decrease at the Banks and Jones pumping plants, relative to Existing Conditions for both the 16-year period modeled and the drought period (Appendix 8G, *Chloride*, Table Cl-3). As explained above for the Delta, long-term average concentrations of seawater-derived constituents decrease under the No Action Alternative relative to Existing Conditions because the No Action Alternative includes Fall X2, while Existing Conditions does not (Appendix 3D, 5A). Therefore, even though sea level rise is included in the No Action Alternative, and not in Existing Conditions, the effect of Fall X2 on chloride is generally greater than sea level rise. Consequently, water exported into the SWP and CVP service area would generally be of similar or slightly better quality with regards to chloride under the No Action Alternative relative to Existing Conditions.

Results of the modeling approach which used relationships between EC and chloride (see Section 8.3.1.3) were consistent with the discussion above, and assessment of chloride using these data results in the same conclusions as are presented above for the mass-balance approach (Appendix 8G, Table Cl-2 and Table Cl-4).

Maintenance of SWP and CVP facilities under the No Action Alternative would not be expected to create new sources of chloride or contribute towards a substantial change in existing sources of chloride in the affected environment. Maintenance activities would not be expected to cause any substantial change in chloride such that any beneficial uses would be adversely affected anywhere in the affected environment.

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

Chloride is not a constituent of concern in the Sacramento River watershed upstream of the Delta, thus river flow rate and reservoir storage reductions that would occur under the No Action Alternative, relative to Existing Conditions, would not be expected to result in a substantial adverse change in chloride levels. Additionally, relative to Existing Conditions, the No Action Alternative would not result in reductions in river flow rates (i.e., less dilution) or increased chloride loading such that there would be any substantial increase in chloride concentrations upstream of the Delta in the San Joaquin River watershed.

It is expected there would be substantial changes in Delta chloride levels in response to a shift in the Delta source water percentages under this alternative or substantial degradation of these water bodies. Relative to Existing Conditions, the No Action Alternative would result in substantially increased chloride concentrations such that frequency of exceedances of the 250 mg/L Bay-Delta WQCP objective would increase at the San Joaquin River at Antioch (by 7%) and at Mallard Slough (by 1%), and long-term degradation may occur, that may result in adverse effects on the municipal and industrial water supply beneficial use. With respect to the 303(d) listings, the small increases in average chloride concentrations would not cause further degradation on a long-term basis that would adversely affect necessary actions to reduce chloride loading for any TMDLs developed for Tom Paine Slough and Suisun Marsh wetlands.

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

Chloride is not a bioaccumulative constituent, thus any increased concentrations under the No Action Alternative would not result in adverse chloride bioaccumulation effects to aquatic life or humans. However, based on these findings, this impact is determined to be significant due to increased chloride concentrations and objective exceedances, and additional long-term degradation, in the western Delta and associated effects on the municipal and industrial water supply beneficial uses.

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

Upstream of the Delta

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

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

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

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

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

Delta

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

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

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

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

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

Some waterways in the eastern, southern, and western Delta are listed on the state's Clean Water Act section 303(d) list as impaired due to low oxygen levels. ATMDL for the Deep Water Ship channel in the eastern Delta has been approved and identifies the factors contributing to low DO in the Deep Water Ship Channel as oxygen demanding substances from upstream sources, Deep Water Ship Channel geometry, and reduced flow through the Deep Water Ship Channel (Central Valley Water Board 2005:28). The TMDL takes a phased approach to allow more time to gather additional informational on source and linkages to the DO impairment, while at the same time moving forward on making improvements to DO conditions. One component of the TMDL implementation activities is an aeration device demonstration project. It is expected that under the No Action Alternative that DO levels in the Deep Water Ship Channel would remain similar to those under Existing Conditions or improve as the TMDL-required studies are completed and actions are implemented to improve DO levels. DO levels in other Clean Water Act section 303(d)-listed waterways would not be expected to change relative to Existing Conditions, as the circulation of flows, tidal flow exchange, and re-aeration would continue to occur similar to Existing Conditions.

SWP/CVP Export Service Areas

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

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

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

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

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

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

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

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

Upstream of the Delta

The No Action Alternative would alter the magnitude and timing of water releases from reservoirs upstream of the Delta relative to Existing Conditions, altering downstream river flows relative to Existing Conditions. With respect to EC, an increase or decrease in river flow alone is not of concern. Measureable changes in the quality of the watershed runoff and reservoir inflows would not be expected to occur in the future; therefore, the EC levels in these reservoirs would not be expected to change relative to Existing Conditions. There could be increased discharges of EC-elevating parameters in the future in water bodies upstream of the Delta as a result of urban growth and increased runoff and wastewater discharges. The state has begun to aggressively regulate point-source discharge effects on Delta salinity-elevating parameters, capping dischargers at existing levels, and is expected to further regulate EC and related parameters upstream of and within the Delta in the future as salt management plans are developed. Based on these considerations, EC levels (highs, lows, typical conditions) in the Sacramento River and its tributaries, the eastside tributaries, or their associated reservoirs upstream of the Delta would not be expected to be outside the ranges occurring under Existing Conditions.

The effects on lower San Joaquin River EC would be somewhat different. Elevated EC in the San Joaquin River can be sourced to agricultural use of irrigation water imported from the southern Delta and applied on soils high in salts. This accumulation of salts is a primary contributor of elevated EC on the lower San Joaquin River. Tributary flows generally provide dilution of the high EC agricultural drainage waters. Under the No Action Alternative, long-term average flows at Vernalis would decrease 6% (as a result of climate change and increased water demands) relative to Existing Conditions (Appendix 5A). These decreases in flow, alone, would correspond to a possible increase in long-term average EC levels relative to Existing Conditions. The level of EC increase cannot be readily quantified but, based on estimated increase in bromide and chloride concentrations, to which EC is correlated, would be relatively small and on the order of about 3%. However, with the implementation of the adopted TMDL for the San Joaquin River at Vernalis and the ongoing development of the TMDL for the San Joaquin River upstream of Vernalis and its implementation, it is expected that EC levels would be improved under the No Action Alternative relative to Existing Conditions. Based on these considerations, substantial changes in EC levels in the San Joaquin River relative to Existing Conditions would not be expected of sufficient magnitude and geographic extent that would result in adverse effects on any beneficial uses, or substantially degrade the quality of these water bodies, with regard to EC.

Delta

Relative to Existing Conditions, the No Action Alternative would result in a fewer number of days when Bay-Delta WQCP compliance locations in the western, interior, and southern Delta would exceed EC objectives or be out of compliance with the EC objectives, with the exception of the Sacramento River at Emmaton (Appendix 8H, Table EC-1). Long-term average levels of seawater-derived constituents decrease under the No Action Alternative relative to Existing Conditions because the No Action Alternative includes Fall X2, while Existing Conditions does not (Appendix 3D, 5A). Therefore, even though sea level rise is included in the No Action Alternative, and not in Existing Conditions, the effect of Fall X2 is generally greater than sea level rise. For electrical conductivity, the Sacramento River at Emmaton is an exception, where sea level rise and increased water demands (see Table 8-62) combine to cause increases in electrical conductivity. The percent of days the Emmaton EC objective would be exceeded for the entire period modeled (1976–1991) would increase from 6% under Existing Conditions to 12% under the No Action Alternative. Further, the percent of days out of compliance with the EC objective would increase from 11% under Existing Conditions to 22% under the No Action Alternative. Average EC levels at the western, interior, and southern Delta compliance locations, other than the Sacramento River at Emmaton, would decrease from 1–14% for the entire period modeled and 0–7% during the drought period modeled (1987–1991) (Appendix 8H, Table EC-11). Average EC in the Sacramento River at Emmaton would increase 1% for the entire period modeled and 10% during the drought period modeled. On average, EC would increase at Emmaton during all months, except October and November (Appendix 8H, Table EC-11).

In Suisun Marsh, average EC for the entire period modeled would increase under the No Action Alternative, relative to Existing Conditions, during the months of January through May by 0.1–0.7 mS/cm, depending on the location and month (Appendix 8H, Table EC-21 through Table EC-25). The degree to which the average EC increases would cause exceedance of Bay-Delta WQCP objectives is unknown, because objectives are expressed as a monthly average of daily high tide EC, which does not have to be met if it can be demonstrated "equivalent or better protection will be provided at the location" (State Water Resources Control Board 2006:14). 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. Given the Bay-Delta WQCP narrative objective regarding "equivalent or better protection" in lieu of meeting specific numeric objectives, the small increase in EC relative to Existing Conditions would not be expected to adversely affect beneficial uses of Suisun Marsh under the No Action Alternative.

Given that the western Delta is Clean Water Act section 303(d) listed as impaired due to elevated EC, the increase in the incidence of exceedance of EC objectives and average EC levels at western Delta locations under the No Action Alternative, relative to Existing Conditions, has the potential to contribute to additional impairment and adversely affect beneficial uses. While Suisun Marsh also is Section 303(d) listed as impaired because of elevated EC, the potential increases in long-term average EC concentrations, relative to Existing Conditions, would not be expected to contribute to additional impairment, because the increase would be so small (<1 mS/cm) as to not be measurable and beneficial uses would not be adversely affected.

SWP/CVP Export Service Areas

At the Banks pumping plant, relative to Existing Conditions, the No Action Alternative would result in no additional exceedances of the Bay-Delta WQCP's 1,000 μmhos/cm EC objective during the drought period modeled; the frequency of exceedance for both conditions would be 2% (Appendix 8H, Table EC-10). When the entire period modeled is considered, the frequency of exceedances of the EC objective would increase slightly, from 1% under Existing Conditions to 2% under the No Action Alternative (Appendix 8H, Table EC-10). Because the EC objective is for agricultural beneficial use protection, for which longer-term crop exposure to elevated EC waters is a concern, this minimal increase in frequency of exceedance of the EC objective would not adversely affect this beneficial use.

For the entire period modeled, there would be no exceedance of the 1,000 μmhos/cm EC objective at the Jones pumping plant under Existing Conditions and the No Action Alternative (Appendix 8H, Table EC-10). Thus, there would be no adverse effect on the agricultural beneficial uses in the SWP/CVP Export Service Areas using water pumped at this location under the No Action Alternative.

Average EC levels for the entire period modeled would decrease at the Banks pumping plant by 7% and at the Jones pumping plant by 5% under the No Action Alternative, relative to Existing Conditions. As explained above for the Delta, long-term average levels of seawater-derived constituents decrease under the No Action Alternative relative to Existing Conditions because the No Action Alternative includes Fall X2, while Existing Conditions does not (Appendix 3D, 5A). Therefore, even though sea level rise is included in the No Action Alternative, and not in Existing Conditions, the effect of Fall X2 is generally greater than sea level rise. During the drought period modeled, average EC levels would decrease at the Banks pumping plant by 6% and at the Jones pumping plant by 5% under the No Action Alternative, relative to Existing Conditions. Consequently, in the long-term, water delivered to the SWP/CVP Export Service Areas through these south Delta pumps would be of similar or slightly better quality with regard to EC under the No Action Alternative, relative to Existing Conditions. (Appendix 8H, Table EC-11) Based on the long-term decreases in EC levels that would occur at the Banks and Jones pumping plants, the No Action Alternative would not cause long-term degradation of EC levels in the SWP/CVP Export Service Areas, relative to Existing Conditions.

Commensurate with the EC decrease in exported waters, an improvement in lower San Joaquin River EC levels would be expected since EC in the lower San Joaquin River is, in part, related to irrigation water deliveries from the Delta. While the magnitude of this expected lower San Joaquin River improvement in EC is difficult to predict, the relative decrease in overall loading of EC-elevating constituents to the SWP/CVP Export Service Areas would likely alleviate or lessen any expected increase in EC at Vernalis related to decreased annual average San Joaquin River flows (see discussion of Upstream of the Delta).

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

In summary, the increased frequency of exceedance of EC objectives and increased long-term and drought period average EC levels that would occur at western Delta compliance locations under the No Action Alternative would contribute to adverse effects on the agricultural beneficial uses. Given that the western Delta is Clean Water Act section 303(d) listed as impaired due to elevated EC, the increase in the incidence of exceedance of EC objectives and increases in long-term and drought period average EC in the western Delta under the No Action Alternative has the potential to contribute to additional beneficial use impairment. These increases in EC constitute an adverse effect on water quality.

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

River flow rate and reservoir storage reductions that would occur under the No Action Alternative, relative to Existing Conditions, would not be expected to result in a substantial adverse change in EC levels in the reservoirs and rivers upstream of the Delta, given that: changes in the quality of watershed runoff and reservoir inflows would not be expected to occur in the future; the state's aggressive regulation of point-source discharge effects on Delta salinity-elevating parameters and the expected further regulation as salt management plans are developed; the salt-related TMDLs adopted and being developed for the San Joaquin River; and the expected improvement in lower San Joaquin River average EC levels commensurate with the lower EC of the irrigation water deliveries from the Delta.

Relative to Existing Conditions, the No Action Alternative would not result in any substantial increases in long-term average EC levels in the SWP/CVP Export Service Areas. There would be no exceedance of the EC objective at the Jones pumping plant. At the Banks pumping plant there would be only a 1% increase in exceedance of the EC objective when the entire period modeled is considered, and no increase in the frequency of exceedance during the drought period. Average EC levels for the entire period modeled would decrease at both plants. Because the EC objective is for agricultural beneficial use protection, for which longer-term crop exposure to elevated EC waters is a concern, the minimal increase in the frequency of exceedance of the EC objective at the Banks pumping plant for the entire period modeled coupled with the long-term average decrease in EC levels at the pumping plants would not adversely affect this beneficial use.

In the Plan Area, the No Action Alternative would result in an increase in the frequency with which Bay-Delta WQCP EC objectives are exceeded in the Sacramento River at Emmaton for the entire period modeled (1976–1991) and during the drought period modeled (1987–1991). Further, long-term average EC levels would increase by 1% for the entire period modeled and 10% during the drought period modeled at Emmaton. The increases in drought period average EC levels that would occur in the Sacramento River at Emmaton would further degrade existing EC levels and thus contribute additionally to adverse effects on the agricultural beneficial use. Because EC is not bioaccumulative, the increases in long-term average EC levels would not directly cause bioaccumulative problems in aquatic life or humans. The western Delta is Clean Water Act section 303(d) listed for elevated EC and the increases in long-term average EC and increased frequency of exceedance of EC objectives that would occur in the Sacramento River at Emmaton could make beneficial use impairment measurably worse. This impact is considered to be significant.

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

Upstream of the Delta

Under the No Action Alternative, greater water demands and climate change would alter the magnitude and timing of reservoir releases and river flows upstream of the Delta in the Sacramento River watershed and east-side tributaries, relative to Existing Conditions.

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

The upstream of Delta areas in the north will benefit from the implementation of the Cache Creek, Sulfur Creek, Harley Gulch, and Clear Lake Mercury TMDLs (Central Valley Water Board 2011c, State Water Resources Control Board 2003) as well as the American River methylmercury TMDL. The TMDL for the American River was in process for CEQA scoping (Central Valley Water Board 2011d), but now will be incorporated into a statewide mercury TMDL under development by the State Water Board. These projects will target specific sources of mercury and methylation upstream of the Delta and could result in net improvement to Delta mercury loading in the future. The implementation of these projects could help to ensure that upstream of Delta environments will not be substantially degraded for water quality with respect to mercury or methylmercury.

Delta

As shown in Figures 8-53 and 8-54, comparisons in percentage change of assimilative capacity of waterborne mercury concentrations relative to the 25 ng/L ecological risk benchmark under the No Action Alternative compared to the Existing Condition would vary only slightly among stations. Peak losses of assimilative capacity for mercury would be less than 0.1% for all sites comparing Existing Conditions to the No Action Alternative. These changes are not expected to result in adverse effects to beneficial uses. Peak annual average methylmercury concentrations for drought conditions occurred at the San Joaquin River at Buckley Cove: 0.161 ng/L for Existing Conditions and 0.167 ng/L for the No Action Alternative (Appendix 8I, Table I-6). These differences are less than 5%. Methylmercury concentrations exceed criteria at all locations and no assimilative capacity exists. Monthly average waterborne concentrations of total and methylmercury, over the period of record, are shown in Appendix 8I Figures 8I-2 and 8I-3. Note that concentrations under Existing Conditions and the No Action Alternative are all very similar to each other (Appendix 8I, Figures 8I-2 and 8I-3, Tables I-5 and I-6).

Similarly, estimates of fish tissue mercury concentrations and exceedance quotients show almost no differences would occur among sites for the No Action Alternative as compared to Existing Conditions for the Delta sites (Figure 8-55, Appendix 8I, Table I-7a,b). Peak exceedance quotients for drought conditions are all at the San Joaquin River at Buckley Cove (4.3 for Existing Conditions; 4.5 for the No Action Alternative; Eq2 model, Table I-7b). These small differences of less than 10% are not expected to further degrade water quality, with regards to mercury, by measurable levels, and thus beneficial use impairment would not be made discernibly worse. Similar to waterborne concentrations of methylmercury, the fish tissue concentrations and exceedance quotients would be highest at the San Joaquin River, Buckley Cove site during drought years (Appendix 8I, Table I-7a,b). All modeled fish tissue mercury concentrations exceed tissue guidelines, with exceedance quotients greater than 1 (Appendix 8I, Table I-7a,b).

SWP/CVP Export Service Areas

The Banks and Jones pumping plants are expected to show only very small losses of assimilative capacity or changes in fish tissue concentration of mercury for the No Action Alternative in relation to Existing Conditions [less than 1% for assimilative capacity decreases; greatest decrease was at Jones Pumping Plant of 0.6% relative to Existing Conditions] (Figures 8-53 and 8-54, Appendix 8I, Table I-7). Any increases in mercury concentrations that may occur in water exported via Banks and Jones pumping plants are not expected to result in adverse effects to beneficial uses or substantially degrade the quality of exported water, with regards to mercury.

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

Under the No Action Alternative, greater water demands and climate change would alter the magnitude and timing of reservoir releases and river flows upstream of the Delta in the Sacramento River watershed and east-side tributaries, relative to Existing Conditions. Concentrations of mercury and methylmercury upstream of the Delta will not be substantially different relative to Existing Conditions due to the lack of important relationships between mercury/methylmercury concentrations and flow for the major rivers.

Methylmercury concentrations exceed criteria at all locations in the Delta for Existing Conditions and no assimilative capacity exists. However, monthly average waterborne concentrations of total and methylmercury, over the period of record, are very similar to each other among Alternatives. Similarly, estimates of fish tissue mercury concentrations show almost no differences would occur among sites for the No Action Alternative as compared to Existing Conditions for Delta sites.

Assessment of effects of mercury in the SWP and CVP Export Service Areas were based on effects on mercury concentrations and fish tissue mercury concentrations at the Banks and Jones pumping plants. The Banks and Jones pumping plants are expected to show only very small losses of assimilative capacity or changes in fish tissue concentration of mercury for the No Action Alternative as compared to Existing Conditions.

As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because mercury concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Because any increases in mercury or methylmercury concentrations are not likely to be measurable, changes in mercury concentrations or fish tissue mercury concentrations would not make any existing mercury-related impairment measurably worse. In comparison to Existing Conditions, the No Action Alternative would not increase levels of mercury by frequency, magnitude, and geographic extent such that the affected environment would be expected to have measurably higher body burdens of mercury in aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish) or humans consuming those organisms. This impact is considered to be less than significant.

Impact WQ-15: Effects on Nitrate Concentrations Resulting from Facilities Operations and Maintenance

Upstream of the Delta

Although point sources of nitrate do exist upstream of the Delta in the Sacramento River watershed, nitrate levels in the major rivers (Sacramento, Feather, American) are low, generally due to ample dilution available in the rivers relative to the magnitude of the discharges. Furthermore, while many dischargers have already improved facilities to remove more nitrate, many others are likely to do so over the next few decades. Non-point sources of nitrate within the Sacramento watersheds are also relatively low, thus resulting in generally low nitrate-N concentrations in the reservoirs and rivers of the watershed. Furthermore, there is no correlation between historical water year average nitrate concentrations and water year average flow in the Sacramento River at Freeport (Nitrate Appendix 8J, Figure 1). Consequently, any modified reservoir operations and subsequent changes in river flows under the No Action Alternative, relative to Existing Conditions, are expected to have negligible, if any, effects on average reservoir and river nitrate-N concentrations in the Sacramento River watershed upstream of the Delta.

In the San Joaquin River watershed, nitrate concentrations are higher than in the Sacramento watershed, owing to use of nitrate based fertilizers throughout the lower watershed. The correlation between historical water year average nitrate concentrations and water year average flow in the San

Joaquin River at Vernalis is a weak inverse relationship—that is, generally higher flows result in lower nitrate concentrations, while low flows result in higher nitrate concentrations (linear regression r^2=0.49, Nitrate Appendix 8J, Figure 2). Under the No Action Alternative, long-term average flows at Vernalis would decrease an estimated 6% relative to Existing Conditions (Appendix 5A). Given these relatively small decreases in flows and the weak correlation between nitrate and flows in the San Joaquin River, it is expected that nitrate concentrations in the San Joaquin River would be minimally affected, if at all, by anticipated changes in flow rates under the No Action Alternative.

Any negligible changes in nitrate-N concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regards to nitrate.

Delta

Results of the mixing calculations indicate that under the No Action Alternative, relative to Existing Conditions, nitrate concentrations throughout the Delta are anticipated to remain low (<1.4 mg/L-N) relative to adopted objectives (Nitrate Appendix 8J, Table 4 and 5). Although changes at specific Delta locations and for specific months may be substantial on a relative basis, the absolute concentration of nitrate in Delta waters would remain low (<1.4 mg/L-N) in relation to the drinking water MCL of 10 mg/L-N, as well as all other thresholds identified in Table 8-50. Long-term average nitrate concentrations are anticipated to remain below 1 mg/L-N at all 11 assessment locations except the San Joaquin River at Buckley Cove, where long-term average concentrations would be somewhat above 1 mg/L-N. Nevertheless, at this location, long-term average nitrate concentration would be somewhat reduced under the no Action Alternative, relative to Existing Conditions. No additional exceedances of the MCL are anticipated at any location (Nitrate Appendix 8J, Table 4). On a monthly average basis and on a long term annual average basis, for all modeled years and for the drought period (1987–1991) only, use of assimilative capacity available under Existing Conditions, relative to the drinking water MCL of 10 mg/L-N, was low or negligible (i.e., <3%) for all locations and months (Nitrate Appendix 8J, Table 6).

Nitrate concentrations will likely be higher than the modeling results indicate in certain locations. This includes in the Sacramento River between Freeport and Mallard Island and other areas in the Delta downstream of Freeport that are influenced by Sacramento River water. These increases are associated with ammonia and nitrate that are discharged from the SRWTP, which are not included in the modeling.

- Under Existing Conditions, most of the ammonia discharged from the SRWTP is converted to nitrate downstream of the facility's discharge at Freeport, and thus, nitrate concentrations under Existing Conditions in these areas are expected to be higher than the modeling predicts, the increase becoming greater with increasing distance downstream. However, the increase in nitrate concentrations downstream of the SRWTP is expected to be small—the existing increase appears to be from approximately 0.1 mg/L-N to approximately 0.4–0.5 mg/L-N over this reach, due to approximately a 1:1 conversion of ammonia-N to nitrate-N (Central Valley Water Board 2010a:32).
- Under the No Action Alternative, the planned upgrades to the SRWTP, which include nitrification/partial denitrification, would substantially decrease ammonia concentrations

in the discharge, but would increase nitrate concentrations in the discharge up to 10 mg/L-N, which is substantially higher than under Existing Conditions.

- Overall, under the No Action Alternative, the nitrogen load from the SRWTP discharge is expected to decrease (by up to 50%), relative to Existing Conditions, due to nitrification/partial dentrification ugrades at the SRWTP facility. Thus, while concentrations of nitrate downstream of the facility are expected to be higher than modeling results indicate for both Existing Conditions and the No Action Alternative, the increase is expected to be greater under Existing Conditions than for the No Action Alternative due to the upgrades that are assumed under the No Action Alternative.

The other areas in which nitrate concentrations will be higher than the modeling results indicate are immediately downstream of other wastewater treatment plants that practice nitrification, but not denitrification (e.g., City of Rio Vista Beach WWTF, Town of Discovery Bay WWTF, City of Stockton RWCF). For all such facilities in the Delta, the Regional Water Boards have issued NPDES permits that allow discharge of wastewater containing nitrate into the Delta, and under these permits, the State has determined that no beneficial uses are adversely affected by the discharge, and that the discharger's use of available assimilative capacity of the water body is acceptable. When dilution is necessary in order for the discharge to be in compliance with the Basin Plans (which incorporate the 10 mg/L-N MCL by reference), not all of the assimilative capacity of the receiving water is granted to the discharger. Thus, limited decreases in flows are not anticipated to result in systemic exceedances of the MCLs by these POTWs. Furthermore, NPDES permits are renewed on a 5-year basis, and thus, if under changes in flows, dilution was no longer sufficient to maintain nitrate below the MCL in the receiving water, the NPDES permit renewal process would address such cases.

Therefore, any increases in nitrate-N concentrations that may occur at certain locations within the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to nitrate.

SWP/CVP Export Service Areas

Assessment of effects of nitrate in the SWP and CVP Export Service Areas is based on effects on nitrate-N at the Banks and Jones pumping plants.

Results of the mixing calculations indicate that under the No Action Alternative, relative to Existing Conditions, long-term average nitrate concentrations at Banks and Jones pumping plants are anticipated to change negligibly (Nitrate Appendix 8J, Table 4 and 5). No additional exceedances of the MCL are anticipated (Nitrate Appendix 8J, Table 4). On a monthly average basis and on a long term annual average basis, for all modeled years and for the drought period (1987–1991) only, use of assimilative capacity available under Existing Conditions relative to the MCL was negligible (i.e., <3%) for both Banks and Jones pumping plants (Nitrate Appendix 8J, Table 6). As discussed above in the Delta region, nitrate-N concentrations would be higher than indicated in the mixing modeling results for areas receiving Sacramento River water, including Banks and Jones pumping plants, downstream of the SRWTP discharge at Freeport in the Existing Conditions (by < 1 mg/L-N), due to conversion of ammonia to nitrate within the Delta. For the No Action Alternative, nitrate levels would also be slightly higher than the mixing modeling results suggests because full nitrification/partial denitrification of the SRWTP discharge was not accounted for. Nonetheless, the total nitrogen load from the SRWTP is expected to decrease substantially due the facility's upgrades. Hence, long-term average nitrate-N concentrations would be expected to decrease under the No Action Alternative, relative to Existing Conditions.

Any short-term, negligible increases in nitrate-N concentrations that may occur in water exported via Banks and Jones pumping plants are not expected to result in adverse effects to beneficial uses of exported water or substantially degrade the quality of exported water, with regards to nitrate.

In summary, based on the discussion above, effects on nitrate of facilities operation and maintenance are considered to be not adverse.

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

Nitrate-N concentrations are generally low in the reservoirs and rivers of the watersheds, owing to substantial dilution available for point sources and the lack of substantial nonpoint sources of nitrate-N upstream of the SRWTP in the Sacramento River watershed, and in the watersheds of the eastern tributaries (Cosumnes, Mokelumne, and Calaveras Rivers). Although higher in the San Joaquin River watershed, nitrate-N concentrations are not well-correlated with flow rates. Consequently, any modified reservoir operations and subsequent changes in river flows under the No Action Alternative, relative to Existing Conditions, are expected to have negligible, if any, effects on reservoir and river nitrate-N concentrations upstream of Freeport in the Sacramento River watershed and upstream of the Delta in the San Joaquin River watershed.

In the Delta, results of the mixing calculations indicate that under the No Action Alternative, relative to Existing Conditions, nitrate concentrations throughout the Delta are anticipated to remain low (<1.4 mg/L-N) relative to adopted objectives. No additional exceedances of the MCL are anticipated at any location, and use of assimilative capacity available under Existing Conditions, relative to the drinking water MCL of 10 mg/L-N, was low or negligible (i.e., <3%) for all locations and months.

Assessment of effects of nitrate in the SWP and CVP Export Service Areas is based on effects on nitrate-N concentrations at the Banks and Jones pumping plants. Results of the mixing calculations indicate that under the No Action Alternative, relative to Existing Conditions, long-term average nitrate concentrations at Banks and Jones pumping plants are anticipated to change negligibly. No additional exceedances of the MCL are anticipated, and use of assimilative capacity available under Existing Conditions, relative to the MCL was negligible (i.e., <3%) for both Banks and Jones pumping plants for all months.

Based on the above, there would be no substantial, long-term increase in nitrate-N concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the waters exported to the CVP and SWP service areas under the No Action Alternative relative to Existing Conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment from nitrate. Because nitrate concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Nitrate is not 303(d) listed within the affected environment and thus any minor increases that may occur in some areas would not make any existing nitrate-related impairment measurably worse because no such impairments currently exist. Because nitrate is not bioaccumulative, minor increases that may occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant.

Impact WQ-17: Effects on Dissolved Organic Carbon Concentrations Resulting from Facilities Operations and Maintenance

Upstream of the Delta

Under the No Action Alternative, greater water demands (see Table 8-55) will alter the magnitude and timing of reservoir releases upstream of the Delta, relative to Existing Conditions. While greater water demands under the No Action Alternative would alter the magnitude and timing of reservoir releases north, south and east of the Delta, these activities would have no substantial effect on the various watershed sources of DOC. Moreover, long-term average flow and DOC at Sacramento River at Hood and San Joaquin River at Vernalis are poorly correlated; therefore, changes in river flows would not be expected to cause a substantial long-term change in DOC concentrations upstream of the Delta. Consequently, long-term average DOC concentrations under the No Action Alternative would not be expected to change by frequency, magnitude and geographic extent, relative to Existing Conditions and, and thus, would not adversely affect the MUN beneficial use, or any other beneficial uses, in water bodies of the affected environment located upstream of the Delta.

Delta

Relative to Existing Conditions, the No Action Alternative would result in mostly minor changes (i.e., up to 4% increases and 6% decreases) in long-term average DOC concentrations at all Delta assessment locations. Increases in long-term average DOC concentrations for the 16-year (1976–1991) hydrologic period modeled would not be greater than 0.1 mg/L, with the largest predicted change occurring at Rock Slough during the 1987–1991 drought period modeled, where average DOC concentration would be predicted to increase by approximately 4% (Appendix 8K, DOC Table 1). At all 11 assessment locations, modeled long-term average DOC concentrations under the No Action Alternative would exceed 2 mg/L 94–100% of the time. The frequency with which average DOC concentration exceeds the 3 mg/L threshold would change only slightly, with exception to predicted changes at both the Banks and Jones pumping plants.

At the Banks pumping plant, the frequency with which average DOC concentration would exceed 3 mg/L would increase from 64% under Existing Conditions to 71% under the No Action Alternative (an increase from 57% to 75% during the drought year period of 1987–1991) (Appendix 8K, DOC Table 1). At the Jones pumping plant, the frequency that long-term average DOC concentration would exceed 3 mg/L would increase from 71% under Existing Conditions to 80% under the No Action Alternative (an increase from 72% to 90% for the drought period modeled). In contrast, however, the relative frequency long-term average DOC concentrations would exceed 4 mg/L at the Banks and Jones pumping plants would be small. At the Banks pumping plant, the frequency long-term average DOC concentrations would exceed 4 mg/L would increase from 33% under Existing Conditions to 35% under the No Action Alternative (an increase from 42% to 43% for the drought period), while at the Jones pumping plant the modeled exceedance frequency would rise from 26% to 28% (with no predicted change in frequency of exceedance for the drought period). Trends in concentration threshold exceedances at the other assessment locations would follow that described for the Banks and Jones pumping plants, but the overall magnitude of threshold exceedance change would be less. While the No Action Alternative would generally lead to slightly higher long-term average DOC concentration in the western and southern Delta, the predicted change would not be expected to be of magnitude that would adversely affect MUN beneficial uses, or any other beneficial use, particularly when considering the relatively small change in long-term annual average concentration (i.e., ≤0.1 mg/L).

SWP/CVP Export Service Areas

With respect to the potential for effects resulting from No Action Alternative induced changes on long-term average DOC concentrations in the water exported via the Banks and Jones pumping plants, long-term average DOC concentrations would increase only slightly. Under the No Action Alternative, long-term average DOC concentrations at the Banks and Jones pumping plants would increase by as much as 3% relative to Existing Conditions (Appendix 8K, DOC Table 1). A greater frequency of exports greater than 3 and 4 mg/L would be predicted to occur at both Banks and Jones pumping plants, as previously discussed for the Delta, although the increased frequency of 4 mg/L would be comparatively small (see Delta discussion above). As previously stated, the predicted change in long-term average DOC concentrations relative to existing conditions would not be expected to be of sufficient magnitude to adversely affect the MUN beneficial use, or any other beneficial use, within the SWP and CVP Service Area.

Maintenance of SWP and CVP facilities under the No Action Alternative would not be expected to create new sources of DOC or contribute towards a substantial change in existing sources of DOC in the affected environment. Maintenance activities would not be expected to cause any substantial change in long-term average DOC concentrations such that the MUN beneficial use, or any other beneficial use, would be adversely affected anywhere in the affected environment.

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

While greater water demands under the No Action Alternative would alter the magnitude and timing of reservoir releases north, south and east of the Delta, these activities would have no substantial effect on the various watershed sources of DOC. Moreover, long-term average flow and DOC at Sacramento River at Hood and San Joaquin River at Vernalis are poorly correlated; therefore, changes in river flows would not be expected to cause a substantial long-term change in DOC concentrations upstream of the Delta.

Relative to Existing Conditions, the No Action Alternative would result in mostly minor changes (i.e., up to 4% increases and 6% decreases) in long-term average DOC concentrations at all Delta assessment locations, with the largest increase (i.e., 4%) occurring at Rock Slough during the modeled drought period. While the No Action Alternative would generally lead to slightly higher long-term average DOC concentration (i.e., ≤0.1 mg/L) in the western and southern Delta, the predicted change would not be expected to be of magnitude that would adversely affect MUN beneficial uses, or any other beneficial use.

The assessment of No Action Alternative effects on DOC in the SWP/CVP Export Service Areas is based on assessment of changes in DOC concentrations at Banks and Jones pumping plants. Relative to existing condition, long-term average DOC concentrations would increase only slightly at Banks and Jones pumping plants. The predicted change in long-term average DOC concentrations relative to Existing Conditions would not be expected to be of sufficient magnitude to adversely affect MUN beneficial uses, or any other beneficial use, within the SWP and CVP Service Area.

Based on the above, the No Action Alternative would not result in any substantial change in long-term average DOC concentration upstream of the Delta or result in substantial increase in the frequency with which long-term average DOC concentrations exceeds 2, 3, or 4 mg/L levels at the 11 assessment locations analyzed for the Delta. Modeled long-term average DOC concentrations would increase by no more than 0.1 mg/L at any single Delta assessment location (i.e., ≤4% relative increase). The increases in long-term average DOC concentration that could occur within the Delta would not be of sufficient magnitude to adversely affect the MUN beneficial use, or any other beneficial uses, of Delta waters or waters of the SWP and CVP Service Area. Because DOC is not bioaccumulative, the increases in long-term average DOC concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Finally, DOC is not causing beneficial use impairments and thus is not 303(d) listed for any water body within the affected environment. Thus, the increases in long-term average DOC that could occur at various locations would not make any beneficial use impairment measurably worse. Because long-term average DOC concentrations would not be expected to increase substantially, no long-term water quality degradation with respect to DOC would be expected to occur and, thus, no significant impacts on beneficial uses would occur. This impact would be less than significant.

Impact WQ-19: Effects on Pathogens Resulting from Facilities Operations and Maintenance

Upstream of the Delta

Under the No Action Alternative, the only pathogen sources expected to change in the watersheds upstream of the Delta relative to Existing Conditions would be associated with population growth, i.e., increased municipal wastewater discharges and development contributing to increased urban runoff.

Increased municipal wastewater discharges resulting from future population growth would not be expected to measurably increase pathogen concentrations in receiving waters due to state and federal water quality regulations requiring disinfection of effluent discharges and the state's implementation of Title 22 filtration requirements for many wastewater dischargers in the Sacramento River and San Joaquin River watersheds.

Pathogen loading from urban areas would generally occur in association with both dry and wet weather runoff from urban landscapes. Municipal stormwater regulations and permits have become increasingly stringent in recent years, and such further regulation of urban stormwater runoff is expected to continue in the future. Municipalities may implement BMPs for reducing pollutant loadings from urban runoff, particularly in response to NPDES stormwater-related regulations requiring reduction of pollutant loading in urban runoff. The ability of these BMPs to consistently reduce pathogen loadings and the extent of future implementation is uncertain, but would be expected to improve as new technologies are continually tested and implemented. Also, some of the urbanization may occur on lands used by other pathogens sources, such as grazing lands, resulting in a change in pathogen source, but not necessarily an increase (and possibly a decrease) in pathogen loading.

Pathogen concentrations in the Sacramento and San Joaquin Rivers have a minimal relationship to flow rate in these rivers, although most of the high concentrations observed have been during the wet months (Tetra Tech 2007). Further, urban runoff contributions during the dry season would be expected to be a relatively small fraction of the rivers' total flow rates. During wet weather events, when urban runoff contributions would be higher, the flows in the rivers also would be higher. Given the small magnitude of urban runoff contributions relative to the magnitude of river flows, that pathogen concentrations in the rivers have a minimal relationship to river flow rate, and the expected reduced pollutant loadings in response to NPDES stormwater-related regulations, river flow rate and reservoir storage reductions that would occur under the No Action Alternative, relative to Existing Conditions, would not be expected to result in a substantial adverse change in pathogen concentrations in the reservoirs and rivers upstream of the Delta. As such, the No Action Alternative would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or U.S. EPA-recommended pathogen criteria would be exceeded in water bodies of the affected environment located upstream of the Delta or substantially degrade the quality of these water bodies, with regard to pathogens.

Delta

The *Conceptual Model for Pathogens and Pathogen Indicators in the Central Valley and Sacramento-San Joaquin Delta* (Tetra Tech 2007) provides a comprehensive evaluation of factors affecting pathogen levels in the Delta. The Pathogens Conceptual Model characterizes relative pathogen contributions to the Delta from the Sacramento and San Joaquin Rivers and various pathogen sources, including wastewater discharges and urban runoff. Contributions from the San Francisco Bay to the Delta are not addressed. The Pathogens Conceptual Model is based on a database compiled by the Central Valley Drinking Water Policy Group in 2004–2005, supplemented with data from Natomas East Main Drainage Canal Studies, North Bay Aqueduct sampling, and the USGS. Data for multiple sites in the Sacramento River and San Joaquin River watersheds, and in the Delta were compiled. Indicator species evaluated include fecal coliforms, total coliforms, and *E. coli*. Because of its availability, *Cryptosporidium* and *Giardia* data for the Sacramento River also were evaluated. Key results of the data evaluation are:

Total Coliform

- In the Sacramento Valley, the highest total coliform concentrations (>10,0000 MPN/100 ml) were located near urban areas.
- Similarly high total coliform concentrations were not observed in the San Joaquin Valley, because reported results were capped at about 2,400 MPN/100 ml, though a large number of results were reported as being greater than this value.
- The data should not to be interpreted to conclude that Sacramento River has higher total coliform concentrations; rather, the "appearance" of the lower total coliform concentrations in the San Joaquin Valley is attributed to a lower upper limit of reporting (2,400 MPN/100 ml versus 10,000 MPN/100 ml).

E. coli

- Comparably high concentrations observed in the Sacramento River and San Joaquin River watersheds for waters affected by urban environments and intensive agriculture.
- The highest concentrations in the San Joaquin River were not at the most downstream location monitored, but rather at an intermediate location near Hills Ferry.

- *E. coli* concentrations in the Delta were somewhat higher than in the San Joaquin River and Sacramento River, indicating the importance of in-Delta sources and influence of distance of pathogen source on concentrations at a particular location in the receiving waters.
- Temporal (seasonal) trends were weak, however, the highest concentrations in the Sacramento River were observed during the wet months and the lowest concentrations were observed in July and August.

Fecal Coliform

- There was limited data from which to make comparisons/observations.

Cryptosporidium and Giardia

- Data were available only for the Sacramento River, limiting the ability to make comparisons between sources.
- Often not detected and when detected, concentrations typically less than 1 organism per liter.
- There may be natural/artificial barriers/processes that limit transport to water. Significant die off of those that reach the water contribute to the low frequency of detection.

The Pathogens Conceptual Model found that coliform indicators vary by orders of magnitudes over small distances and short time-scales. Concentrations appear to be more closely related to what happens in the proximity of a sampling station, rather than what happens in the larger watershed where significant travel time and concomitant pathogen die-off can occur. Sites in the Delta close to urban discharges had elevated concentrations of coliform organisms. The highest total coliform and *E. coli* concentrations were observed in the discharge from the Natomas East Main Drainage Canal and several stations near sloughs, indicating the relative influence of urban and wildlife pathogen sources on receiving water concentrations.

The effects of the No Action Alternative relative to Existing Conditions would be changes in the relative percentage of water throughout the Delta being comprised of various source waters (i.e., water from the Sacramento River, San Joaquin River, Bay water, eastside tributaries, and agricultural return flow), due to potential changes in inflows particularly from the Sacramento River watershed due to increased water demands (see Table 8-55) and somewhat modified SWP and CVP operations. However, it is expected there would be no substantial change in Delta pathogen concentrations in response to a shift in the Delta source water percentages under this alternative or substantial degradation of these water bodies, with regard to pathogens. This conclusion is based on the Pathogens Conceptual Model, which found that pathogen sources in close proximity to a Delta site appear to have the greatest influence on pathogen levels at the site, rather than the primary source(s) of water to the site. In-Delta potential pathogen sources, including water-based recreation, tidal habitat, wildlife, and livestock-related uses, would continue under this alternative.

SWP/CVP Export Service Areas

The No Action Alternative is not expected to result in substantial changes in pathogen levels in Delta waters, relative to Existing Conditions. As such, there is not expected to be substantial, if even measurable, changes in pathogen concentrations in the SWP/CVP Export Service Areas waters under the No Action Alternative relative to Existing Conditions.

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

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

River flow rate and reservoir storage reductions that would occur under the No Action Alternative, relative to Existing Conditions, would not be expected to result in a substantial adverse change in pathogen concentrations in the reservoirs and rivers upstream of the Delta, given the small magnitude of urban runoff contributions relative to the magnitude of river flows, that pathogen concentrations in the rivers have a minimal relationship to river flow rate, and the expected reduced pollutant loadings in response to NPDES stormwater-related regulations.

It is expected there would be no substantial change in Delta pathogen concentrations in response to a shift in the Delta source water percentages under this alternative or substantial degradation of these water bodies, with regard to pathogens. This conclusion is based on the Pathogens Conceptual Model, which found that pathogen sources in close proximity to a Delta site appear to have the greatest influence on pathogen levels at the site, rather than the primary source(s) of water to the site. In-Delta potential pathogen sources, including water-based recreation, tidal habitat, wildlife, and livestock-related uses, would continue under this alternative.

There is not expected to be substantial, if even measurable, changes in pathogen concentrations in the SWP/CVP Export Service Areas waters under the No Action Alternative, relative to Existing Conditions, because the No Action Alternative is not expected to result in substantial changes in pathogen levels in Delta waters relative to Existing Conditions.

As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because pathogen concentrations are not expected to increase substantially, no long-term water quality degradation for pathogens is expected to occur and, thus, no adverse effects on beneficial uses would occur. The San Joaquin River in the Stockton Deep Water Ship Channel is Clean Water Act section 303(d) listed for pathogens. Because no measurable increase in Deep Water Ship Channel pathogen concentrations are expected to occur on a long-term basis, further degradation and impairment of this area is not expected to occur. Finally, pathogens are not bioaccumulative constituents. This impact is considered to be less than significant.

Impact WQ-21: Effects on Pesticide Concentrations Resulting from Facilities Operations and Maintenance

Residues of "legacy" OC pesticides enter rivers primarily through surface runoff and erosion of terrestrial soils during storm events, and through resuspension of riverine bottom sediments, the combination of which to this day may contribute to excursions above water quality objectives (Central Valley Water Board 2010c). Operation of the CVP/SWP does not affect terrestrial sources, but may result in geomorphic changes to the affected environment that ultimately could result in changes to sediment suspension and deposition. However, as discussed in greater detail for Turbidity/TSS, operations under any alternative would not be expected to change TSS or turbidity levels (highs, lows, typical conditions) to any substantial degree. Changes in the magnitude, frequency, and geographic distribution of legacy pesticides in water bodies of the affected environment that would result in new or more severe adverse effects on aquatic life or other beneficial uses, relative to Existing Conditions or the No Action Alternative, would not be expected to occur. Therefore, the pesticide assessment focuses on the present use pesticides for which substantial information is available, namely diazinon, chlorpyrifos, pyrethroids, and diuron.

Upstream of the Delta

Pyrethroid and OP insecticides are applied to agricultural fields, orchards, row crops, and confined animal facilities on an annual basis, with peaks in agricultural application during the winter dormant season (January–February) and during field cropping in the spring and summer. Applications of diuron occur year-round, but the majority of diuron is applied to road rights-of-way as a pre-emergent and early post emergent weed treatment during the late fall and early winter (Green and Young 2006). Pyrethroid insecticides and urban use herbicides are additionally applied around urban and residential structures and landscapes on an annual basis. These applications throughout the upstream watershed represent the source and potential pool of these pesticides that may enter the rivers upstream of the Delta by way of surface runoff and/or drift. Principal factors contributing to pesticide loading in the Sacramento River watershed include the amount of pesticide used and amount of precipitation (Guo et al. 2004). Although urban dry weather runoff occurs, this is generally believed to be less significant source of pesticides to main stem receiving waters, but for pyrethroids a recent study concluded that municipal wastewater treatment plants in Sacramento and Stockton represent a continuous year-round source of pyrethroids to the lower Sacramento and San Joaquin River's (Weston and Lydy 2010).

Pesticide-related toxicity has historically been observed throughout the affected environment regardless of season or water year type; however, toxicity is generally observed with increased incidence during spring and summer months of April to June, coincident with the peak in irrigated agriculture in the Sacramento and San Joaquin Valleys, as well as the winter rainy season, particularly December through February, coincident with urban and agricultural storm-water runoff and the orchard dormant spraying season (Fox and Archibald 1997). Although OP insecticide incidence and related toxicity can be observed throughout the year, diazinon is most frequently observed during the winter months and chlorpyrifos is most frequently observed in the summer irrigation months (Central Valley Water Board 2007). These seasonal trends coincide with their use, where diazinon is principally used as an orchard dormant season spray, and chlorpyrifos is primarily used on crops during the summer.

Application of diuron peaks in the late fall and early winter. Coincidently, diuron is found most frequently in surface waters during the winter precipitation and runoff months of January through March (Green and Young 2006), although diruon can be found much less frequently in surface waters throughout the year (Johnson et al. 2010).

Monitoring for pyrethroid insecticides in main-stem rivers is limited and detections are rather few. With the replacement of many traditionally OP related uses, however, it is conservatively assumed that pyrethroid incidence and associated toxicity could ultimately take a pattern of seasonality similar to that of the chlorpyrifos or diazinon.

In comparison to the Valley floor, relatively small amounts of pesticides are used in watersheds upstream of project reservoirs. Water released from reservoirs flow through urban and agricultural areas at which point these waters may acquire a burden of pesticide from agricultural or urban sourced discharges. These discharges with their potential burden of pesticides are effectively diluted by reservoir water. Under the No Action Alternative, no activity of the SWP or CVP would substantially drive a change in pesticide use, and thus pesticide sources would remain unaffected.

Nevertheless, changes in the timing and magnitude of reservoir releases could have an effect on available dilution capacity along river segments such as the Sacramento, Feather, American, and San Joaquin Rivers.

Under the No Action Alternative, winter (November–March) and summer (April–October) season average flow rates on the Sacramento River at Freeport, American River at Nimbus, Feather River at Thermalito and the San Joaquin River at Vernalis would change relative to Existing Conditions. Averaged over the entire period of record, seasonal mean flow rates would largely remain unchanged on the Sacramento River and Feather Rivers (Appendix 8L, Seasonal average flows Tables 1-4). Summer average flow rates on the American River would decrease by 16% relative to Existing Conditions. During the winter months, however, average flow rates would increase by as much as 9% on the American River. Similarly, summer average flow rates on the San Joaquin River would decrease by 12% relative to Existing Conditions, while winter average flow rates would increase slightly.

As previously stated, historically chlorpyrifos is used in greater amounts in agriculture in the summer, and consequently observed in surface waters with greater frequency in the summer, while diazinon and diuron are used and observed in surface water with greater frequency in the winter. While flow reductions in the summer on the American River would not coincide with urban stormwater discharges, summer flow reductions on the San Joaquin River would correspond to the agricultural irrigation season. However, summer average flow reductions of up to 12%, relative to Existing Conditions, are not considered of sufficient magnitude to substantially increase in-river concentrations or alter the long-term risk of pesticide-related effects on aquatic life beneficial uses. Greater long-term average flow reductions, and corresponding reductions in dilution/assimilative capacity, would be necessary before long-term risk of pesticide related effects on aquatic life beneficial uses would be adversely altered.

Delta

Sources of diuron, OP and pyrethroid insecticides to the Plan Area include direct input of surface runoff from in-Delta agriculture and Delta urbanized areas as well as inputs from rivers upstream of the Delta. Similar to Upstream of the Delta, CVP/SWP operations would not affect these sources.

Studies documenting pesticide associated toxicity in the Delta demonstrate the dynamic nature of pesticide input. Pesticide loads entering the Delta, but originating outside of the Delta, do so typically in pulses and particularly after significant precipitation induced surface runoff events (Kuivila and Foe 1995). Through the greater hydraulic capacity of the Delta, and through tidal mixing, these pulses become diluted and spread about the Delta. Although it is difficult to definitively conclude that either the Sacramento River or San Joaquin River is a consistently dominant source of pesticide, a compilation of Delta diazinon and chlorpyrifos data suggest that these two OP insecticides have both been more frequently observed in the San Joaquin River, and at concentrations more frequently exceeding OP specific aquatic life criteria (Central Valley Water Board 2006).

No similar observation as to incidence frequency can be made regarding pyrethroid insecticides, primarily owing to a dearth of monitoring data. Pyrethroid insecticides have been observed in Delta waterways, but there is little evidence supporting any particular geographic or seasonal trend (Werner et al. 2010). Unlike that for chlorpyrifos and diazionon, data for pyrethroids are insufficient to determine the relative loading from particular source waters.

Diuron has been detected in the Delta throughout the year, but with greater magnitude and frequency during the winter storm season. Unlike that for chlorpyrifos and diazionon, data for diuron are insufficient to determine the relative loading from particular source waters.

Granting the assessment challenges imposed by data limitations, there does appear sufficient information to suggest that the San Joaquin River, in comparison to the Sacramento River, is a greater contributor of OP insecticides in terms of greater frequency of incidence and presence at concentrations exceeding water quality benchmarks. Although data is insufficient to make similar observations pertaining to diuron, trends in pyrethroid use suggest that pyrethroid insecticides may in the near future reflect the historic trends of OP insecticides, namely that of relative frequency, magnitude, seasonality and geographic distribution. Based on these general observations, this assessment utilizes source water fingerprinting to make qualitative judgments as to increased risk of pesticide related aquatic life toxicity and judgments as to the possibility of associated long-term degradation to water quality.

Percent change in monthly average source water fraction were evaluated for the modeled 16-year (1976–1991) hydrologic period and a representative drought period (1987–1991), with special attention given to changes in San Joaquin River, Sacramento River and Delta Agriculture sources water fractions. For the No Action Alternative, San Joaquin River fractions would not increase more than 10% at any of the 11 modeled assessment locations, with exception to Jones pumping plant during the modeled drought period, where San Joaquin River fraction would increase 12–14% in October and November relative to Existing Conditions, yet would continue to represent less than 43% of the total source water volume (Appendix 8D, Source Water Fingerprinting). Similarly, Sacramento River fractions would not increase more than 10% at any of the 11 modeled assessment locations. However, these large fractional increases in Sacramento River occur through near equal replacement of San Joaquin River water and, as such, would likely represent an overall decrease in risk of pesticide-related toxicity to aquatic life. There would be no modeled increases in Delta agricultural fractions greater than 2%.

These modeled changes in the source water fractions of Sacramento, San Joaquin and Delta agriculture water are not of sufficient magnitude to substantially alter the long-term risk of pesticide-related toxicity to aquatic life within the Delta, nor would such changes result in adverse pesticide-related effects on any other beneficial uses of Delta waters.

SWP/CVP Export Service Areas

Assessment of effects in SWP and CVP Export Service Areas is based on effects seen in the Delta at the Banks and Jones pumping plants. Under the No Action Alternative, Sacramento, San Joaquin and in-Delta Agricultural source water fractions at Banks would not increase more than 5% in any month relative to Existing Conditions (Appendix 8D, Source Water Fingerprinting). At Jones during the modeled drought period, San Joaquin River source water fractions would increase by as much as 12–14% in October and November relative to Existing Conditions, yet would continue to represent less than 43% of the total source water volume. These modeled changes in the source water fractions of Sacramento, San Joaquin and Delta agriculture water are not of sufficient magnitude to substantially alter the long-term risk of pesticide-related toxicity to aquatic life beneficial uses, or any other beneficial uses, in water bodies of the SWP and CVP service area.

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

Sources of pesticides upstream of the Delta include direct input of pesticide containing surface runoff from agriculture and urbanized areas. Flows in rivers receiving these discharges dilute these pesticide inputs. Relative to Existing Conditions, however, modeled changes in long-term average flows on the Sacramento, Feather, American, and San Joaquin Rivers are of insufficient magnitude to substantially increase the long-term risk of pesticide-related water quality degradation and related toxicity to aquatic life in these water bodies upstream of the Delta.

In the Delta, sources of pesticides include direct input of surface runoff from Delta agriculture and Delta urbanized areas as well as inputs from rivers upstream of the Delta. While facilities operations and maintenance activities would not affect these sources, changes in Delta source water fraction could change the relative risk associated with pesticide related toxicity to aquatic life. Under the No Action Alternative, however, modeled changes in source water fractions relative to Existing Conditions are of insufficient magnitude to substantially alter the long-term risk of pesticide-related toxicity to aquatic life within the Delta, nor would such changes result in adverse pesticide-related effects on any other beneficial uses of Delta waters.

The assessment of the No Action Alternative effects on pesticides in the SWP/CVP Export Service Areas is based on assessment of changes predicted at Banks and Jones pumping plants. As just discussed regarding effects to pesticides in the Delta, modeled changes in source water fractions at the Banks and Jones pumping plants are of insufficient magnitude to substantially alter the long-term risk of pesticide-related toxicity to aquatic life beneficial uses, or any other beneficial uses, in water bodies of the SWP and CVP export service area.

Based on the above, the No Action Alternative would not result in any substantial change in long-term average pesticide concentration or result in substantial increase in the anticipated frequency with which long-term average pesticide concentrations would exceed aquatic life toxicity thresholds or other beneficial use effect thresholds upstream of the Delta, at the 11 assessment locations analyzed for the Delta, or the SWP and CVP service area. Numerous pesticides are currently used throughout the affected environment, and while some of these pesticides may be bioaccumulative, those present-use pesticides for which there is sufficient evidence for their presence in waters affected by SWP and CVP operations (i.e., diazinon, chlorpyrifos, diuron, and pyrethroids) are not considered bioaccumulative, and thus changes in their concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Furthermore, while there are numerous 303(d) listings throughout the affected environment that name pesticides as the cause for beneficial use impairment, the modeled changes in upstream river flows and Delta source water fractions would not be expected to make any of these beneficial use impairments measurably worse. Because long-term average pesticide concentrations are not expected to increase substantially, no long-term water quality degradation with respect to pesticides is expected to occur and, thus, no adverse effects on beneficial uses would occur. This impact is considered to be less than significant.

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

Upstream of the Delta

A conceptual model of nutrients in the Delta stated that: “previous attempts to relate concentration data to flow data in the Central Valley and Delta showed little correlation between the two variables

(Tetra Tech 2006b, *Conceptual Model for Organic Carbon in the Central Valley*). One possible reason is that the Central Valley and Delta system is a highly managed system with flows controlled by major reservoirs on most rivers" (Tetra Tech 2006b:4-1 to 4-2). Attempts made in the Nitrate section of this chapter also showed weak correlation between nitrate and flows for major source waters to the Delta. The linear regressions between average dissolved ortho-phosphate concentrations and average flows in the San Joaquin and Sacramento Rivers were derived for this analysis (Figure 8-58). As expected, neither relationship is very strong, although over the large range in flows for the Sacramento River, the relationship is stronger than for the San Joaquin River. However, over smaller changes in flows, neither relationship can function as a predictor of phosphorus concentrations because the variability in the data over small to medium ranges of flows (i.e., < 10,000 CFS) is large.

Because phosphorus loading to waters upstream of the Delta is not anticipated to change, and because changes in flows do not necessarily result in changes in concentrations or loading of phosphorus to these water bodies, substantial changes in phosphorus concentration are not anticipated for the No Action Alternative, relative to Existing Conditions. Any negligible changes in phosphorus concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regards to phosphorus.

Delta

Because phosphorus concentrations in the major source waters to the Delta are similar for much of the year, phosphorus concentrations in the Delta are not anticipated to change substantially on a long term-average basis. Phosphorus concentrations may increase during January through March at locations where the source fraction of San Joaquin River water increases, due to the higher concentration of phosphorus in the San Joaquin River during these months compared to Sacramento River water or San Francisco Bay water. Based on the DSM2 fingerprinting results (see Appendix 8D), together with source water concentrations shown in Figure 8-56, the magnitude of increases during these months may range from negligible up to approximately 0.05 mg/L. However, there are no state or federal objectives/criteria for phosphorus and thus any increases would not cause exceedances of objectives/criteria. Because algal growth rates are limited by availability of light in the Delta, increases in phosphorus levels that may occur at some locations and times within the Delta would be expected to have little effect on primary productivity in the Delta. Moreover, such increases in concentrations would not be anticipated to be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to phosphorus.

SWP/CVP Export Service Areas

The assessment of effects of phosphorus under the No Action Alternative in the SWP and CVP Export Service Areas is based on effects on phosphorus at the Banks and Jones pumping plants.

As noted in the Delta Region section above, phosphorus concentrations in the Delta (including Banks and Jones pumping plants) are not anticipated to change substantially on a long term-average basis. During January through March, phosphorus concentrations may increase as a result of more San Joaquin River water reaching Banks and Jones pumping plants and the higher concentration of phosphorus in the San Joaquin River. However, based on the DSM2 fingerprinting results (see Appendix 8D), together with source water concentrations shown in Figure 8-56, the magnitude of this increase is expected to be negligible (<0.01 mg/L-P). Additionally, there are no state or federal objectives for phosphorus. Moreover, given the many factors that contribute to potential algal blooms in the SWP and CVP canals within the Export Service Area, and the lack of studies that have shown a direct relationship between nutrient concentrations in the canals and reservoirs and problematic algal blooms in these water bodies, there is no basis to conclude that any seasonal increases in phosphorus concentrations at the levels expected under this alternative, should they occur, would increase the potential for problem algal blooms in the SWP and CVP Export Service Area.

Any increases in phosphorus concentrations that may occur in water exported via Banks and Jones pumping plants are not expected to result in adverse effects to beneficial uses of exported water or substantially degrade the quality of exported water, with regards to phosphorus.

In summary, based on the discussion above, effects on phosphorus of facilities operations and maintenance are considered to be not adverse.

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

Because phosphorus loading to waters upstream of the Delta is not anticipated to change, and because changes in flows do not necessarily result in changes in concentrations or loading of phosphorus to these water bodies, substantial changes in phosphorus concentration upstream of the Delta are not anticipated for the No Action Alternative, relative to Existing Conditions.

Because phosphorus concentrations in the major source waters to the Delta are similar for much of the year, phosphorus concentrations in the Delta are not anticipated to change substantially on a long term-average basis under the No Action Alternative, relative to Existing Conditions. Algal growth rates are limited by availability of light in the Delta, and therefore any minor increases in phosphorus levels that may occur at some locations and times within the Delta would be expected to have little effect on primary productivity in the Delta.

The assessment of effects of phosphorus under the No Action Alternative in the SWP and CVP Export Service Areas is based on effects on phosphorus at the Banks and Jones pumping plants. As noted above, phosphorus concentrations in the Delta (including Banks and Jones pumping plants) are not anticipated to change substantially on a long term-average basis.

Based on the above, there would be no substantial, long-term increase in phosphorus concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the waters exported to the CVP and SWP service areas under the No Action Alternative relative to Existing Conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because phosphorus concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Phosphorus is not 303(d) listed within the affected environment and thus any minor increases that may occur in some areas would not make any existing phosphorus-related impairment measurably worse because no such impairments currently exist. Because phosphorus is not bioaccumulative, minor increases that may occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant.

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

Upstream of the Delta

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

Non-point sources of selenium in the San Joaquin River watershed are associated with discharges of subsurface agricultural drainage to the river or its tributaries. Selenium concentrations in the San Joaquin River upstream of the Delta comply with NTR criteria and Basin Plan objectives at Vernalis under Existing Conditions, and they are expected to do so under the No Action Alternative. This is because a TMDL has been developed by the Central Valley Water Board (2001), the Grassland Bypass Project has established limits that will result in reduced inputs of selenium to the Delta, and the Central Valley Water Board (2010a) and State Water Board (2010d, 2010e) have established Basin Plan objectives that are expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta, as previously discussed in 8.1.1.10. Selenium concentrations at Vernalis are generally higher during lower San Joaquin River flows, with considerable variability in concentrations below about 3,000 cubic feet per second (cfs), as shown in Appendix 8M (Table 31 and Figures 4 through 17). The only three monthly average selenium concentrations greater than 2 μg/L were in March 2002 (2.3 μg/L) and February and March 2003 (2.1 and 2.3 μg/L), when monthly average flows were 1,879 to 2,193 cfs. Modeling of flows for the San Joaquin River at Vernalis indicates that average annual flows under the No Action Alternative will vary by less than 10 percent from Existing Conditions (Appendix 5A). Given these relatively small decreases in flows and the considerable variability in the relationship between selenium concentrations and flows in the San Joaquin River, it is expected that selenium concentrations in the San Joaquin River would be minimally affected, if at all, by anticipated changes in flow rates under the No Action Alternative. Thus, available information indicates selenium concentrations are well below the Basin Plan objective and are likely to remain so. Any negligible changes in selenium concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies as related to selenium.

Delta

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

Toxicity Level Exceedance Quotients (i.e., modeled tissue concentration divided by Toxicity Level benchmarks) for selenium concentrations in all biota for all years and for drought years, and Level of Concern Exceedance Quotients (i.e., modeled tissue divided by Level of Concern benchmarks) for selenium concentrations in all biota for all years are less than 1.0 (indicating low probability of adverse effects) except for sturgeon in the western Delta. 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 drought years are less than 1.0. Figures 8-61 through 8-64 show the Exceedance Quotients based on the lowest benchmarks for whole-body fish, bird eggs (invertebrate diet), bird eggs (fish diet), and fish fillets 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 M.A-2). Detailed analyses of selenium concentrations in biota are presented in Appendix 8M (Tables M-1 through M-30) and Addendum M.A to Appendix 8M (Table M.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).

Relative to Existing Conditions, the No Action Alternative would result in small changes 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 Contra Costa PP for drought years, and the largest decrease at Buckley Cove for drought years (Table M-11). 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 (Figures 8-61 through 8-63). However, Exceedance Quotients for these exceedances of the lower benchmarks are between 1.0 and 1.5, indicating a low risk to biota in the Delta. 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 exceed both the low and high toxicity benchmarks, but there would be essentially no change relative to Existing Conditions (Table M.A-2).

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 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 small changes in average selenium concentrations in water at both modeled Export Service Area assessment locations with the largest increase being at the Jones Pumping Plant (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 8-60 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-10A) for Existing Conditions (range 0.37–0.58 µg/L) and the No Action Alternative (range 0.37–0.59 µg/L) would be below the ecological risk benchmark (2 µg/L).

Relative to Existing Conditions, the No Action Alternative would result in small changes 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-11). Concentrations of selenium in biota would be expected to exceed only the lower benchmark (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 (Figure 8-63). However, Exceedance Quotients for these exceedances of the lower benchmarks are between 1.0 and 1.1, indicating a low risk to biota in the Export Service Areas, and they do not differ substantially among Existing Conditions and the No Action Alternative. Selenium concentrations in whole-body fish, bird eggs (invertebrate diet), and fish fillets would not exceed the screening value of the lower benchmarks (Figures 8-61, 8-62, and 8-64).

Relative to Existing Conditions, the No Action Alternative would result in essentially no change in selenium concentrations at the Export Service Area locations. The No Action Alternative would not be expected to substantially increase the frequency with which applicable benchmarks would be exceeded in the Export Service Areas or substantially degrade the quality of water in the Export Service Areas, with regard to selenium.

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

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

Relative to Existing Conditions, modeling estimates indicate that the No Action Alternative would result in essentially no change in selenium concentrations throughout the Delta, though conditions would slightly improve at Buckley Cove.

Assessment of effects of selenium in the SWP and CVP Export Service Areas is based on effects on selenium concentrations at the Banks and Jones pumping plants. Relative to Existing Conditions, the No Action Alternative would result in essentially no change in selenium concentrations at those two pumping plant locations.

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

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

Upstream of the Delta

Relative to Existing Conditions, under the No Action Alternative sources of trace metals would not be expected to change substantially with exception to sources related to population growth, such as increased municipal wastewater discharges and development contributing to increased urban runoff. Facility operations could have an effect on these sources if concentrations of dissolved metals were closely correlated to river flow, suggesting that changes in river flow, and the related capacity to dilute these sources, could ultimately have a substantial effect on long-term metals concentrations.

On the Sacramento River, available dissolved trace metals data and river flow at Freeport are poorly associated (Appendix 8N, Figure 1). Similarly, dissolved copper, iron, and manganese concentrations on the San Joaquin River at Vernalis are poorly associated (Appendix 8N, Figure 2). While there is an insufficient number of data for the other trace metals to observe trends at Vernalis, it is reasonable to assume that these metals similarly show poor association to San Joaquin River flow, as shown for the corresponding dissolved metals on the Sacramento River.

Given the poor association of dissolved trace metal concentrations with flow, river flow rate and reservoir storage reductions that would occur under the No Action Alternative, relative to Existing Conditions, would not be expected to result in a substantial adverse change in trace metal concentrations in the reservoirs and rivers upstream of the Delta. As such, the 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 water bodies of the affected environment located upstream of the Delta or substantially degrade the quality of these water bodies, with regard to trace metals.

Delta

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

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

Relative to Existing Conditions, 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.

SWP/CVP Export Service Areas

The No Action Alternative is not expected to result in substantial changes in trace metal concentrations in Delta waters. As such, there is not expected to be substantial changes in trace metal concentrations in the SWP/CVP export service area waters, exported from the Delta through the south Delta pumps, under the No Action Alternative.

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

While greater water demands under the No Action Alternative would alter the magnitude and timing of reservoir releases north, south and east of the Delta, these activities would have no substantial effect on the various watershed sources of trace metals. Moreover, long-term average flow and trace metals at Sacramento River at Hood and San Joaquin River at Vernalis are poorly correlated; therefore, changes in river flows would not be expected to cause a substantial long-term change in trace metal concentrations upstream of the Delta.

Average and 95th percentile trace metal concentrations are very similar across the primary source waters to the Delta. Given this similarity, very large changes in source water fraction would be necessary to effect a relatively small change in trace metal concentration at a particular Delta location. Moreover, average and 95th percentile trace metal concentrations for these primary source waters are all below their respective water quality criteria, including those that are hardness-based without a WER adjustment. No mixing of these three source waters could result in a metal concentration greater than the highest source water concentration, and given that trace metals do not already exceed water quality criteria, more frequent exceedances of criteria in the Delta would not be expected to occur under the No Action Alternative.

The assessment of the No Action Alternative effects on trace metals in the SWP/CVP Export Service Areas is based on assessment of changes in trace metal concentrations at Banks and Jones pumping plants. As just discussed regarding similarities in Delta source water trace metal concentrations, the No Action Alternative is not expected to result in substantial changes in trace metal concentrations in Delta waters, including Banks and Jones pumping plants, therefore effects on trace metal concentrations in the SWP/CVP Export Service Area are expected to be negligible.

Based on the above, there would be no substantial long-term increase in trace metal concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the SWP/CVP export service area waters under the No Action Alternative relative to Existing Conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because trace metal concentrations are not expected to increase substantially, no long-term water quality degradation for trace metals is expected to occur and, thus, no adverse effects to beneficial uses would occur. Furthermore, negligible change in long-term trace metal concentrations throughout the affected environment would not be expected to make any existing beneficial use impairments measurably worse. The trace metals discussed in this assessment are not considered bioaccumulative, and thus would not directly cause bioaccumulative problems in aquatic life or humans. This impact is considered to be less than significant.

Impact WQ-29: Effects on TSS and Turbidity Resulting from Facilities Operations and Maintenance

Upstream of the Delta

TSS concentrations and turbidity levels in rivers upstream of the Delta are affected primarily by: 1) TSS concentrations and turbidity levels of the water released from the upstream reservoirs, 2) erosion occurring within the river channel beds, which is affected by river flow velocity and bank protection, 3) TSS concentrations and turbidity levels of tributary inflows, point-source inputs, and nonpoint runoff as influenced by surrounding land uses; and 4) phytoplankton, zooplankton and other biological material in the water.

The No Action Alternative would alter the magnitude and timing of water releases from reservoirs upstream of the Delta relative to Existing Conditions, altering downstream river flows relative to Existing Conditions. With respect to TSS and turbidity, an increase in river flow is generally the concern, as this increases shear stress on the channel, suspending particles resulting in higher TSS concentrations and turbidity levels. Schoellhamer et al. (2007b) noted that suspended sediment concentration was more affected by season than flow, with the higher concentrations for a given flow rate occurring during “first flush events” and lower concentrations occurring during spring snowmelt events. Because of such a relationship, the changes in mean monthly average river flows under the No Action Alternative are not expected to cause river TSS concentrations or turbidity levels (highs, lows, typical conditions) to be outside the ranges occurring under Existing Conditions. Consequently, this alternative is expected to have minimal effect on TSS concentrations and turbidity levels in the reservoirs and rivers upstream of the Delta, relative to Existing Conditions.

Changes in land use that would occur relative to Existing Conditions could have minor effects on TSS concentrations and turbidity levels throughout this portion of the affected environment. Site-specific and temporal exceptions may occur due to localized temporary construction activities, dredging activities, development, or other land use changes. These localized actions would generally require agency permits that would regulate and limit both their short-term and long-term effects on TSS concentrations and turbidity levels to less-than-substantial levels.

Delta

TSS concentrations and turbidity levels in Delta waters are affected by TSS concentrations and turbidity levels of the Delta inflows (and associated sediment load). TSS concentrations and turbidity levels within Delta waters also are affected by fluctuation in flows within the channels due to the tides, with sediments depositing as flow velocities and turbulence are low at periods of slack tide, and sediments becoming suspended when flow velocities and turbulence increase when tides are near the maximum. TSS and turbidity variations can also be attributed to phytoplankton, zooplankton and other biological material in the water.

Under the No Action Alternative there would be no project actions implemented within or affecting the Delta region of the affected environment. Any land use changes that may occur under this alternative would not be expected to have permanent, substantial effects on TSS concentrations and turbidity levels of Delta waters, relative to Existing Conditions. Furthermore, this alternative would not cause the TSS concentrations or turbidity levels in the rivers contributing inflows to the Delta to be outside the ranges occurring under Existing Conditions. Consequently, this alternative is expected to have minimal effect on TSS concentrations and turbidity levels in the Delta region, relative to Existing Conditions. As such, any minor TSS and turbidity changes that may occur under the No Action Alternative would not be of sufficient frequency, magnitude, and geographic extent that would result in adverse effects on beneficial uses in the Delta region, or substantially degrade the quality of these water bodies, with regard to TSS and turbidity.

SWP/CVP Export Service Areas

The No Action Alternative is expected to have minimal effect on TSS concentrations and turbidity levels in Delta waters, including water exported at the south Delta pumps, relative to Existing Conditions. As such, the No Action Alternative is expected to have minimal effect on TSS concentrations and turbidity levels in the SWP/CVP Export Service Areas waters relative to Existing Conditions.

The effects on TSS and turbidity from implementing the No Action Alternative is determined to not be adverse.

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

Changes river flow rate and reservoir storage that would occur under the No Action Alternative, relative to Existing Conditions, would not be expected to result in a substantial adverse change in TSS concentrations and turbidity levels in the reservoirs and rivers upstream of the Delta, given that suspended sediment concentrations are more affected by season than flow. Site-specific and temporal exceptions may occur due to localized temporary construction activities, dredging activities, development, or other land use changes would be site-specific and temporal, which would be regulated to limit both their short-term and long-term effects on TSS and turbidity levels to less than substantial levels.

Within the Delta, any land use changes that may occur would not be expected to have permanent, substantial effects on TSS concentrations and turbidity levels. Furthermore, this alternative would not cause the TSS concentrations or turbidity levels in the river contributing inflows to the Delta to be outside the ranges occurring under Existing Conditions. Consequently, this alternative is expected to have minimal effect on TSS concentrations and turbidity levels in the Delta region, relative to Existing Conditions.

There is not expected to be substantial, if even measurable, changes in TSS concentrations and turbidity levels in the SWP/CVP Export Service Areas waters under the No Action Alternative, relative to Existing Conditions, because the No Action Alternative is not expected to result in substantial changes in TSS concentrations and turbidity levels in Delta waters, relative to Existing Conditions.

Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives where such objectives are not exceeded under Existing Conditions. Because TSS concentrations and turbidity levels are not expected to be substantially different from Existing Conditions, long-term water quality degradation is not expected, and, thus, beneficial uses are not expected to be adversely affected. Finally, TSS and turbidity are neither bioaccumulative nor Clean Water Act section 303(d) listed constituents. This impact is considered to be less than significant.

Impact WQ-31: Water Quality Effects Resulting from Construction-Related Activities

Under the No Action Alternative, existing facilities and operations would be continued and none of the Conservation Measures 1–22 associated with the BDCP alternatives would be implemented. However, construction activities would occur in the affected environment over time that are not directly associated with the BDCP alternatives (herein termed “non-BDCP” effects). Routine non-BDCP construction activities that may occur for urbanization and infrastructure to accommodate population growth would generally be anticipated to involve relatively dispersed, temporary, and intermittent land disturbances across the affected environment. Major, or more complex, non-BDCP infrastructure construction projects that are identified under the No Action Alternative which may involve substantial construction activities and potential construction-related water quality effects are identified in Appendix 3D, *Defining Existing Conditions, the No Action/No Project Alternative, and Cumulative Impact Conditions* and include:

- Levee rehabilitation projects in the Delta by DWR and local reclamation districts.
- Suisun Channel (Slough) Operations and Maintenance (shipping channel dredging)
- Sacramento Deep Water Ship Channel Project (shipping channel dredging).
- San Joaquin River Restoration Program.
- Dutch Slough Tidal Marsh Restoration Project.
- Suisun Marsh restoration activities (tidal marsh restoration)
- Yolo Bypass Salmonid Habitat Restoration and Fish Passage.

Potential construction-related water quality effects associated with non-BDCP activities may include discharges of turbidity/TSS due to the erosion of disturbed soils and associated sedimentation entering surface water bodies or other construction-related wastes (e.g., concrete, asphalt, cleaning agents, paint, and trash). Construction activities also may result in temporary or permanent changes in stormwater generation or drainage and runoff patterns (i.e., velocity, volume, and direction) that may cause or contribute to soil erosion and offsite sedimentation, such as creation of additional impervious surfaces (e.g., pavement, buildings, compacted soils), blockage or restriction of existing drainage channels, or general surface drainage changes from grading and excavation activity. Additionally, the use of heavy earthmoving equipment may result in spills and leakage of oils, gasoline, diesel fuel, and related petroleum contaminants used in the fueling and operation of such construction equipment.

Some construction-related contaminants, such as PAHs that may be in some fuel and oil petroleum byproducts, may be bioaccumulative in aquatic and terrestrial organisms. Construction activities also may disturb areas where bioaccumulative constituents are present in the soil (e.g., mercury, selenium, organochlorine pesticides, PCBs, dioxin/furan compounds), or may disturb soils that contain constituents included on the Section 303(d) lists of impaired water bodies in the affected environment. While the 303(d)-listed Delta channels impaired by mercury are widespread, impairment by selenium, pesticides, PCBs, and dioxin/furan compounds is more limited, and there are no 303(d) listings for PAH impairment. Bioaccumulation of constituents in the aquatic foodchain, and 303(d)-related impaired water bodies, arise as a result of long-term loading of a constituent or a pervasive and widespread source of constituent discharge (e.g., mercury). However, as a result of the generally localized disturbances, and intermittent and temporary nature of construction-related activities, construction would not be anticipated to result in contaminant discharges of substantial magnitude or duration to contribute to long-term bioaccumulation processes, or cause measureable long-term degradation such that existing 303(d) impairments would be made discernibly worse or TMDL actions to reduce loading would be adversely affected.

It is assumed that non-BDCP construction activities would be regulated, as necessary, under state grading and erosion control regulations, proponent-defined CEQA-NEPA mitigation measures and BMPs, and applicable environmental permits such as the State Water Board's NPDES Stormwater General Permit for Stormwater Discharges Associated with Construction and Land Disturbance Activities (Order No. 2009-0009-DWQ/NPDES Permit No. CAS000002, as amended by Order No. 2010-0014-DWQ), project-specific waste discharge requirements (WDRs) or CWA Section 401 water quality certification from the appropriate Regional Water Board, CDFW Streambed Alteration Agreements, and USACE CWA Section 404 dredge and fill permits. Consequently, relative to the Existing Conditions, the potential contaminant discharges associated with construction-related activities that may occur under the No Action Alternative would be avoided and minimized upon implementation of BMPs and adherence to permit terms and conditions. Consequently, construction-related activities would not be expected to cause constituent discharges of sufficient magnitude to result in a substantial increased frequency of exceedances of water quality objectives/criteria, or substantially degrade water quality with respect to the constituents of concern, and thus would not adversely affect any beneficial uses in water bodies upstream of the Delta, within the Delta, or in the SWP and CVP service area.

***CEQA Conclusion*:** BDCP construction-related contaminant discharges under the No Action Alternative would not occur. Other reasonably foreseeable projects that are independent from BDCP would result in construction related impacts that are temporary and intermittent in nature and would involve negligible, if any, discharges of bioaccumulative or 303(d) listed constituents to water bodies of the affected environment. As such, construction activities would therefore not contribute to bioaccumulation of contaminants in organisms or humans or cause 303(d) impairments to be discernibly worse. Relative to Existing Conditions, the construction-related effects of other projects in the Delta would not be expected to cause or contribute to a substantial increased frequency of exceedances of water quality objectives/criteria, or substantially degrade water quality on a long-term average basis with respect to the constituents of concern, and thus would not adversely affect any beneficial uses in water bodies upstream of the Delta, within the Delta, or in the SWP and CVP service area. Based on these findings, this impact is determined to be less than significant.

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

Alternative 1A would convey up to 15,000 cfs of water from the north Delta to the south Delta through pipelines/tunnels via five screened intakes on the east bank of the Sacramento River between Clarksburg and Walnut Grove (i.e., Intakes 1 through 5). Intakes 1 through 5 would introduce large, multi-story industrial concrete and steel structures approximately 55 feet in height from river bottom to the top of the structure with a length of 900–1,600 feet depending on the location. A new 600 acre Byron Tract Forebay, adjacent to and south of Clifton Court Forebay, would be constructed which would provide water to the south Delta pumping plants. Construction of a 750 acre Intermediate Forebay near Hood is also included in this Alternative.

Construction of all structural components under Alternative 1A could potentially occur over a period of 9 or more years, although construction of individual components would occur on shorter time scales (See Appendix 3C). Water supply and conveyance operations would follow the guidelines described as Scenario A, which does not include fall X2. CM1–CM3 would manage the routing, timing, and amount of flow through the Delta. CM4–CM11 would restore, enhance, and manage physical habitats on a natural community scale. CM11–CM22 are designed to reduce other stressors on a species scale. See Chapter 3, *Description of Alternatives*, Section 3.5.2, for additional details on Alternative 1A.

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 1A, over the long term, average annual delta exports are anticipated to increase by 312 TAF relative to Existing Conditions, and by 1016 TAF relative to the No Action Alternative. Since, over the long-term, approximately 50% 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 1–Old River at Rock Slough for ALL years (1976–1991), which shows increased SJR percentage and decreased SAC percentage under the alternative, relative to Existing Conditions and the No Action Alternative.

Under Alternative 1A, long-term average annual Delta outflow is anticipated to decrease 323 TAF relative to Existing Conditions due to both changes in operations (including north Delta intake capacity of 15,000 cfs and numerous other operational components of Scenario A) and climate change/sea level rise (see Chapter 5, *Water Supply*, for more information). The result of this is increased sea water intrusion in the west Delta. The increase of sea water intrusion in the west Delta under Alternative 1A is greater relative to the No Action alternative because the No Action alternative includes operations to meet Fall X2, whereas Existing Conditions and Alternative 1A do not. Long-term average annual Delta outflow is anticipated to decrease under Alternative 1A by 1072 TAF relative to the No Action Alternative, due only to changes in operations. The increases in sea water intrusion (represented by an increase in BAY percentage) can be seen, for example, in Appendix 8D, ALT 1A–Sacramento River at Mallard Island for ALL years (1976–1991).

Impact WQ-1: Effects on Ammonia Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative, Alternative 1A would have negligible, if any, effect on ammonia concentrations in the rivers and reservoirs upstream of the Delta relative to Existing Conditions and the No Action Alternative. Any negligible increases in ammonia-N concentrations that could occur in the water bodies of the affected environment in the Upstream of the Delta Region would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regard to ammonia.

Delta

As summarized in Table 8-40, it is assumed that SRWTP effluent ammonia concentrations would be substantially lower under Alternative 1A than under Existing Conditions, and would be the same as would occur under the No Action Alternative. Thus, for the same reasons stated for the No Action Alternative, Alternative 1A would not result in substantial increases in ammonia concentrations in the Plan Area, relative to Existing Conditions.

Because the SRWTP discharge ammonia concentrations are assumed to be the same under Alternative 1A as would occur under the No Action Alternative, the primary mechanism that could potentially increase ammonia concentrations in the Delta under Alternative 1A, relative to the No Action Alternative, is decreased flows in the Sacramento River, which would lower dilution available to the SRWTP discharge. This change would be attributable only to operations of Alternative 1A, since the same assumptions regarding water demands, climate change, and sea level rise are included in both Alternative 1A and the No Action Alternative.

Table 8-64. Estimated Ammonia-N (mg-L as N) Concentrations in the Sacramento River Downstream of the Sacramento Regional Wastewater Treatment Plant for the No Action Alternative and Alternative 1A

	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
Alternative 1A	0.068	0.089	0.068	0.060	0.057	0.060	0.058	0.062	0.063	0.065	0.073	0.077	0.067

To address this possibility, a simple mixing calculation was performed to assess concentrations of ammonia downstream of the SRWTP discharge (i.e., downstream of Freeport) under Alternative 1A and the No Action Alternative. Monthly average CALSIM II flows at Freeport and the upstream ammonia concentration (0.04 mg/L-N; Central Valley Water Board 2010a:5) were used, together with the SRWTP permitted average dry weather flow (181 mgd) and seasonal ammonia concentration (1.5 mg/L-N in Apr-Oct, 2.4 mg/L-N in Nov-Mar), to estimate the average change in ammonia concentrations downstream of the SRWTP. Table 8-64 shows monthly average and long term annual average predicted concentrations under the two scenarios.

As Table 8-64 shows, estimated ammonia-N concentrations in the Sacramento River downstream of Freeport (upon full mixing of the SRWTP discharge with river water) under Alternative 1A and the No Action Alternative are expected to be similar. Minor increases in ammonia-N concentrations would occur during July through September and in November, and remaining months would be unchanged or have a minor decrease. A minor increase in the annual average concentration would occur under Alternative 1A, compared to the No Action Alternative. Moreover, the estimated concentrations downstream of Freeport under Alternative 1A would be similar to existing source water concentrations for the San Francisco Bay and San Joaquin River. Consequently, changes in source water fraction anticipated under Alternative 1A, relative to the No Action Alternative, would not be expected to substantially increase ammonia concentrations at any Delta locations.

Any negligible increases in ammonia-N concentrations that could occur at certain locations in the Delta would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to ammonia.

SWP/CVP Export Service Areas

The assessment of effects on ammonia in the SWP and CVP Export Service Area is based on assessment of ammonia-N concentrations at Banks and Jones pumping plants. The dominant source waters influencing the Banks and Jones pumping plants are the Sacramento and San Joaquin Rivers (see Appendix 8D). As discussed above for the Plan Area, for areas of the Delta that are influenced by Sacramento River water, including Banks and Jones pumping plants, ammonia-N concentrations are expected to decrease under Alternative 1A, relative to Existing Conditions (in association with less diversion of water influenced by the SRWTP). This decrease in ammonia-N concentrations for water exported via the south Delta pumps is not expected to result in an adverse effect on beneficial uses or substantially degrade water quality of exported water, with regards to ammonia.

NEPA Effects: As discussed above for the Plan Area, for all areas of the Delta, including Banks and Jones pumping plants, ammonia-N concentrations would not be expected to substantially differ under Alternative 1A, relative to No Action Alternative. Any negligible increases in ammonia-N concentrations that could occur at Banks and Jones pumping plants would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to ammonia. In summary, based on the discussion above, effects on ammonia from implementation of CM1 are considered to be not adverse.

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

Ammonia-N concentrations are generally low in the reservoirs and rivers of the watersheds, owing to the lack of substantial point and nonpoint sources of ammonia-N upstream of the SRWTP in the Sacramento River watershed, in the watersheds of the eastern tributaries (Cosumnes, Mokelumne, and Calaveras Rivers), or upstream of the Delta in the San Joaquin River watershed. Consequently, any modified reservoir operations and subsequent changes in river flows under Alternative 1A, relative to Existing Conditions, are expected to have negligible, if any, effects on reservoir and river ammonia-N concentrations upstream of Freeport in the Sacramento River watershed and upstream of the Delta in the San Joaquin River watershed.

Ammonia-N concentrations in the Sacramento River downstream of the SRWTP would be substantially lower under Alternative 1A, relative to Existing Conditions, due to upgrades to the SRWTP that are assumed to be in place, and thus, ammonia concentrations for all areas of the Delta that are influenced by Sacramento River water are expected to decrease. At locations which are not influenced notably by Sacramento River water, concentrations are expected to remain relatively unchanged, due to the similarity in SJR and BAY concentrations and the lack of expected changes in either of these concentrations.

The assessment of effects on ammonia in the SWP/CVP Export Service Areas is based on assessment of ammonia-N concentrations at Banks and Jones pumping plants. As discussed above for the Plan Area, for areas of the Delta that are influenced by Sacramento River water, including Banks and Jones pumping plants, ammonia-N concentrations are expected to decrease under the Alternative 1A, relative to Existing Conditions.

Based on the above, there would be no substantial, long-term increase in ammonia-N concentrations in the rivers and reservoirs upstream of the Delta, in the Plan Area, or the waters exported to the CVP and SWP service areas under Alternative 1A relative to Existing Conditions. As such, 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. Because ammonia concentrations would not be expected to increase substantially, no long-term water quality degradation would be expected to occur and, thus, no significant impacts on beneficial uses would occur. Ammonia is not 303(d) listed within the affected environment and thus any minor increases that could occur in some areas would not make any existing ammonia-related impairment measurably worse because no such impairments currently exist. Because ammonia-N is not bioaccumulative, minor increases that could occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact would be considered less than significant. No mitigation is required.

Impact WQ-2: Effects on Ammonia Concentrations Resulting from Implementation of CM2–CM22

***NEPA Effects*:** Some habitat restoration activities would occur on lands in the Delta formerly used for irrigated agriculture. Although this may decrease ammonia loading to the Delta from agriculture, increased biota in those areas as a result of restored habitat may increase ammonia loading originating from flora and fauna. Ammonia loaded from organisms is expected to be converted rapidly to nitrate by established microbial communities. Thus, these land use changes would not be expected to substantially increase ammonia concentrations in the Delta. CM2–CM11 would not substantially increase ammonia concentrations in the water bodies of the affected environment. Additionally, implementation of CM12–CM22 would not be expected to substantially alter ammonia concentrations in the affected environment. The effects of ammonia from implementation of CM2–22 are considered to be not adverse.

***CEQA Conclusion*:** There would be no substantial, long-term increase in ammonia-N concentrations in the rivers and reservoirs upstream of the Delta, in the Plan Area, or the waters exported to the CVP and SWP service areas due to implementation of CM2–CM22 relative to Existing Conditions. As such, implementation of these conservations measures would not be expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause significant impacts on any beneficial uses of waters in the affected environment. Because ammonia concentrations would not be expected to increase substantially from implementation of these conservation measures, no long-term water quality degradation would be expected to occur and, thus, no significant impact on beneficial uses would occur. Ammonia is not 303(d) listed within the affected environment and thus any minor increases that could occur in some areas would not make any existing ammonia-related impairment measurably worse because no such impairments currently exist. Because ammonia-N is not bioaccumulative, minor increases that could occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered less than significant. No mitigation is required.

Impact WQ-3: Effects on Boron Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Under Alternative 1A there would be no expected change to the sources of boron in the Sacramento and east-side tributary watersheds. Boron loading in these watersheds would remain unchanged and resultant changes in flows from altered system-wide operations would have negligible, if any, effects on the concentration of boron in the rivers and reservoirs of these watersheds. Under Alternative 1A, the modeled long-term annual average flows on the lower San Joaquin River at Vernalis would decrease by an estimated 6%, relative to Existing Conditions (in association with changed operations, climate change, and increased water demands), and would remain virtually the same relative to the No Action Alternative considering only changes associated with Alternative 1A operations (Appendix 5A). The reduced flow would result in possible increases in long-term average boron concentrations of about 2%, relative to the Existing Conditions, with no change relative to the No Action Alternative (Appendix 8F, Table 24). However, the small increases in lower San Joaquin River boron levels that may occur under Alternative 1A, relative to Existing Conditions would not result in an increased frequency of exceedances of any applicable objectives or criteria. Moreover, any negligible change in boron concentration would not be expected to cause further degradation at measurable levels in the lower San Joaquin River, and thus would not cause the existing impairment there to be discernibly worse. Consequently, Alternative 1A would not be expected to cause exceedance of boron objectives/criteria or substantially degrade water quality with respect to boron, and thus would not adversely affect any beneficial uses of the Sacramento River, the east-side tributaries, associated reservoirs upstream of the Delta, or the lower San Joaquin River.

Delta

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

Relative to the Existing Conditions and the No Action Alternative, Alternative 1A would result in similar or reduced long-term average boron concentrations for the 16-year period modeled at northern and eastern Delta locations (i.e., 14% reduction at North Bay Aqueduct at Barker Slough and 6% reduction at the San Joaquin River at Buckley Cove, compared to Existing Conditions) (Appendix 8F, Table Bo-6). Moreover, the direction and magnitude of predicted changes for Alternative 1A are similar between the alternatives, thus, the effects relative to Existing Conditions and the No Action Alternative are discussed together. The comparison to Existing Conditions reflects changes 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. The comparison to the No Action Alternative reflects changes due only to operations.

The long-term average boron concentrations for the 16-year period modeled would increase at interior and western Delta locations (by as much as 8% at the SF Mokelumne River at Staten Island, 13% at Franks Tract, 10% at Old River at Rock Slough, and 9% at the Sacramento River at Emmaton) (Appendix 8F, Table Bo-6). Additionally, implementation of tidal habitat restoration under CM4 would increase the tidal exchange volume in the Delta, and thus may contribute to increased boron concentrations in the Bay source water as a result of increased salinity intrusion. More discussion of the assessment methods for changes in source water concentrations caused by project-related hydrodynamic changes is included in Section 8.3.1.3. While uncertain, the magnitude of boron increases may be greater than indicated herein and would affect the western Delta assessment locations the most (since they are influenced to the greatest extent by the Bay source water), and thus would not be anticipated to substantially affect agricultural use of water because diversions occur primarily at interior Delta locations.

The long-term annual average and monthly average boron concentrations, for either the 16-year period or drought period modeled, would never exceed the 2,000 μg/L human health advisory objective (i.e., for children) or 500 μg/L agricultural objective at any of the eleven Delta assessment locations, which represents no change from the Existing Conditions and No Action Alternative conditions (Appendix 8F, Table Bo-3A). Increased boron concentrations would result in minor reductions in the modeled long-term average assimilative capacity with respect to the 2,000 μg/L human health advisory objective. The reductions in long-term average assimilative capacity of up to 6% at interior Delta locations (i.e., Franks Tract and Old River at Rock Slough) also would be small with respect to the 500 μg/L agricultural objective (Appendix 8F, Table Bo-7). However, because the absolute boron concentrations would still be well below the lowest 500 μg/L objective for the protection of the agricultural beneficial use under Alternative 1A, the levels of boron degradation would not be of sufficient magnitude to substantially increase the risk of exceeding objectives or cause adverse effects to municipal and agricultural water supply beneficial uses, or any other beneficial uses, in the Delta (Appendix 8F, Figure Bo-2).

SWP/CVP Export Service Areas

Under Alternative 1A, improvement in long-term average boron concentrations would occur at the Banks and Jones pumping plants as a result of export of a greater proportion of low-boron Sacramento River water. Long-term average boron concentrations for the modeled 16-year hydrologic period at these locations would decrease by as much as 22% at Banks and by as much as 18% at Jones relative to Existing Conditions and No Action Alternative (Appendix 8F, Table Bo-6). Commensurate with the decrease in boron concentrations in exported water to the San Joaquin River basin, there could be reduced boron loading and concentrations in the lower San Joaquin River related to irrigation water deliveries from the Delta. While the magnitude of this expected lower San Joaquin River improvement in boron is difficult to predict, the relative decrease in overall loading of boron to the export service area would likely alleviate or lessen any expected increase in boron concentrations at Vernalis associated with flow reductions (see discussion of Upstream of the Delta), as well as locations in the Delta receiving a large fraction of San Joaquin River water, such as much of the south Delta. Reduced export boron concentrations also may contribute to reducing the existing 303(d) impairment in the lower San Joaquin River and associated TMDL actions for reducing boron loading.

Maintenance of SWP and CVP facilities under Alternative 1A would not be expected to create new sources of boron or contribute towards a substantial change in existing sources of boron in the affected environment. Maintenance activities would not be expected to cause any substantial increases in boron concentrations or degradation with respect to boron such that objectives would be exceeded more frequently, or any beneficial uses would be adversely affected anywhere in the affected environment.

***NEPA Effects*:** In summary, relative to the No Action Alternative conditions, Alternative 1A would result in relatively small increases in long-term average boron concentrations in the Delta and not appreciably change boron levels in the lower San Joaquin River. However, the predicted changes would not be expected to cause exceedances of applicable objectives or further measurable water quality degradation, and thus would not constitute an adverse effect on water quality.

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

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

Small increased boron levels predicted for interior and western Delta locations (i.e., up to 13% increase) in response to a shift in the Delta source water percentages and tidal habitat restoration under this alternative would not be expected to cause exceedances of objectives, or substantial degradation of these water bodies. Alternative 1A maintenance also would not result in any substantial increases in boron concentrations in the affected environment. Boron concentrations would be reduced in water exported from the Delta to the CVP/SWP Export Service Areas, thus reflecting a potential improvement to boron loading in the lower San Joaquin River.

Boron is not a bioaccumulative constituent, thus any increased concentrations under Alternative 1A would not result in adverse boron bioaccumulation effects to aquatic life or humans. Relative to Existing Conditions, Alternative 1A would not result in substantially increased boron concentrations such that frequency of exceedances of municipal and agricultural water supply objectives would increase. The levels of boron degradation that may occur under Alternative 1A would not be of sufficient magnitude to cause substantially increased risk for adverse effects to municipal or agricultural beneficial uses within the affected environment. Long-term average boron concentrations would decrease in Delta water exports to the SWP and CVP service area, which may contribute to reducing the existing 303(d) impairment of agricultural beneficial uses in the lower

San Joaquin River. Based on these findings, this impact is determined to be less than significant. No mitigation is required.

Impact WQ-4: Effects on Boron Concentrations Resulting from Implementation of CM2–CM22

NEPA Effects: The implementation of the other conservation measures (i.e., CM2–CM22), of which most do not involve land disturbance, present no new direct sources of boron to the affected environment, including areas Upstream of the Delta, within the Plan Area, and the SWP/CVP Export Service Area, nor would they affect channel flows or Delta hydrodynamic conditions. As noted above, the potential effects of implementation of tidal habitat restoration (i.e., CM4) on Delta hydrodynamic conditions is addressed above in the discussion of Impact WQ-3. The potential channel flow effects of CM2 for actions in the Yolo Bypass also were accounted for in the CALSIM II and DSM2 modeling, and thus were addressed in the discussion for Impact WQ-3. Habitat restoration activities in the Delta (i.e., CM4–10), including restored tidal wetlands, floodplain, and related channel margin and off-channel habitats, while involving increased land and water interaction within these habitats, would not be anticipated to contribute boron which is primarily associated with source water inflows to the Delta (i.e., San Joaquin River, agricultural drainage, and Bay source water). Moreover, some habitat restoration conservation measures (CM4–CM10) would occur on lands within the Delta currently used for irrigated agriculture, thus replacing agricultural land uses with restored habitats. The potential reduction in irrigated lands within the Delta may result in reduced discharges of agricultural field drainage with elevated boron concentrations, which would be considered an improvement compared to Existing Conditions. CM3 and CM11 provide the mechanism, guidance, and planning for the land acquisition and thus would not, themselves, affect boron levels in the Delta. CM12–CM22 involve actions that target reduction in other stressors at the species level involving actions such as methylmercury reduction management (CM12), improving DO in the Stockton Deep Water Ship Channel (CM14), and urban stormwater treatment (CM19). None of the CM12–CM22 actions would contribute to substantially increasing boron levels in the Delta. Consequently, as they pertain to boron, implementation of CM2–CM22 would not be expected to adversely affect any of the beneficial uses of the affected environment.

CEQA Conclusion: Implementation of the CM2–CM22 for Alternative 1A would not present new or substantially changed sources of boron to the affected environment upstream of the Delta, within Delta, or in the SWP and CVP service area. As such, their implementation would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or other criteria would be exceeded in water bodies of the affected environment located upstream of the Delta, within the Delta, or in the SWP and CVP Service Area or substantially degrade the quality of these water bodies, with regard to boron. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

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

Upstream of the Delta

Under Alternative 1A there would be no expected change to the sources of bromide in the Sacramento River and eastside tributary watersheds. Bromide loading in these watersheds would remain unchanged and resultant changes in flows from altered system-wide operations under Alternative 1A would have negligible, if any, effects on the concentration of bromide in the rivers and reservoirs of these watersheds. Consequently, Alternative 1A would not be expected to adversely affect the MUN beneficial use, or any other beneficial uses, of the Sacramento River, the eastside tributaries, or their associated reservoirs upstream of the Delta.

Under Alternative 1A, modeling indicates that long-term annual average flows on the San Joaquin River would decrease by 6% relative to Existing Conditions and would remain virtually the same relative to No Action Alternative (Appendix 5A). These decreases in flow would result in possible increases in long-term average bromide concentrations of about 3%, relative to Existing Conditions and less than <1% relative to the No Action Alternative (Appendix 8E, Bromide Table 22). The small increases in lower San Joaquin River bromide levels that may occur under Alternative 1A, relative to existing and No Action Alternative conditions would not be expected to adversely affect the MUN beneficial use, or any other beneficial uses, of the lower San Joaquin River.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2-22 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for CM2-22. 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 would be less than 27% at the remaining assessment locations. Due to the relatively small differences between modeled Existing Conditions and No Action Alternative, changes in the frequency with which concentration thresholds of 50 µg/L and 100 µg/L are exceeded are of similar magnitude to those previously described for the existing condition comparison (Appendix 8E, *Bromide,* Table 4). Unlike the comparison to Existing Conditions, the comparison to the No Action Alternative reflects changes in bromide due only to operations.

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

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

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

SWP/CVP Export Service Areas

Under Alternative 1A, improvement in long-term average bromide concentrations would occur at the Banks and Jones pumping plants. Long-term average bromide concentrations for the modeled 16-year hydrologic period at these locations would decrease by as much as 37% relative to Existing Conditions and 28% relative to the No Action Alternative. Relative changes in long-term average bromide concentrations would be less during drought conditions (≤31%), but would still represent considerable improvement (Appendix 8E, Bromide Table 4). As a result, less frequent bromide concentration exceedances of the 50 µg/L and 100 µg/L assessment thresholds would be predicted and an overall improvement in water quality would be experienced respective to bromide in the SWP/CVP Export Service Areas. Commensurate with the decrease in exported bromide, an improvement in lower San Joaquin River bromide would also be observed because 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, *Bromide*, Table 5).

Similar to the discussion pertaining to the No Action Alternative, maintenance of SWP and CVP facilities under Alternative 1A would not be expected to create new sources of bromide or contribute a substantial change in existing sources of bromide in the affected environment. Maintenance activities would not be expected to cause any substantial change in bromide such that MUN beneficial uses, or any other beneficial use, would be adversely affected anywhere in the affected environment.

NEPA Effects: In summary, Alternative 1A operations and maintenance, relative to the No Action Alternative, would result in small increases (i.e., <1%) in long-term average bromide concentrations at Vernalis related to relatively small declines in long-term average flow on the San Joaquin River. However, Alternative 1A operation and maintenance activities would cause substantial degradation to water quality with respect to bromide at Barker Slough, source of the North Bay Aqueduct. Resultant substantial change in long-term average bromide at Barker Slough could necessitate changes in water treatment plant operations or require treatment plant upgrades in order to maintain DBP compliance, and thus would constitute an adverse effect on water quality. Mitigation Measure WQ-5 is available to reduce these effects (implementation of this measure along with a separate, non-environmental commitment as set forth in EIR/EIS Appendix 3B, *Environmental Commitments*, relating to the potential increased treatment costs associated with bromide-related changes would reduce these effects).

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

Under Alternative 1A there would be no expected change to the sources of bromide in the Sacramento and eastside tributary watersheds. Bromide loading in these watersheds would remain unchanged and resultant changes in flows from altered system-wide operations under Alternative 1A would have negligible, if any, effects on the concentration of bromide in the rivers and reservoirs of these watersheds. However, south of the Delta, the San Joaquin River is a substantial source of bromide, primarily due to the use of irrigation water imported from the southern Delta. Concentrations of bromide at Vernalis are inversely correlated to net river flow. Under Alternative 1A, long-term average flows at Vernalis would decrease only slightly, resulting in less than substantial predicted increases in long-term average bromide of about 3% relative to Existing Conditions.

Relative to Existing Conditions, Alternative 1A would result in small decreases in long-term average bromide concentration at most Delta assessment locations, with principal exceptions being the North Bay Aqueduct at Barker Slough, Staten Island, and Emmaton on the Sacramento River. Overall effects would be greatest at Barker Slough, where substantial increases in long-term average bromide concentrations would be predicted. The increase in long-term average bromide concentrations predicted for Barker Slough would result in a substantial change in source water quality to existing drinking water treatment plants drawing water from the North Bay Aqueduct. These modeled increases in bromide at Barker Slough could lead to adverse changes in the formation of disinfection byproducts at drinking water treatment plants such that considerable water treatment plant upgrades would be necessary in order to achieve equivalent levels of drinking water health protection.

The assessment of effects on bromide in the SWP/CVP Export Service Areas is based on assessment of changes in bromide concentrations at Banks and Jones pumping plants. Under Alternative 1A, substantial improvement would occur at the Banks and Jones pumping plants, where predicted long-term average bromide concentrations are predicted to decrease by as much as 37% relative to Existing Conditions. An overall improvement in bromide-related water quality would be predicted in the SWP/CVP Export Service Areas.

Based on the above, Alternative 1A operation and maintenance would not result in any substantial change in long-term average bromide concentration upstream of the Delta. Furthermore, under Alternative 1A, water exported from the Delta to the SWP/CVP Export Service Areas would be substantially improved relative to bromide. Bromide is not bioaccumulative, therefore change in long-term average bromide concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Additionally, bromide is not a constituent related to any 303(d) listings. Alternative 1A operation and maintenance activities would not cause substantial degradation to water quality respective to bromide in the Plan Area with the exception of water quality at Barker Slough, source of the North Bay Aqueduct. At Barker Slough, modeled long-term annual average concentrations of bromide would increase by 38%, and 94% during the modeled drought period. For the modeled 16-year hydrologic period the frequency of predicted bromide concentrations exceeding 100 μg/L would increase from 0% under Existing Conditions to 22% under Alternative 1A, while for the modeled drought period, the frequency would increase from 0% to 48%. Substantial changes in long-term average bromide could necessitate changes in water treatment plant operation or require treatment plant upgrades in order to maintain DBP compliance. The modeled change at Barker Slough is substantial and, therefore, would represent a substantially increased risk for significant impacts on existing MUN beneficial uses should treatment upgrades not be undertaken. The impact would be significant.

Implementation of Mitigation Measure WQ-5 along with a separate, non-environmental commitment relating to the potential increased treatment costs associated with bromide-related changes would reduce these effects. While mitigation measures to reduce these water quality effects in affected water bodies to less than significant levels are not available, implementation of Mitigation Measure WQ-5 is recommended to attempt to reduce the effect that increased bromide concentrations may have on Delta beneficial uses. However, because the effectiveness of this mitigation measure to result in feasible measures for reducing water quality effects is uncertain, this impact is considered to remain significant and unavoidable.

In addition to and to supplement Mitigation Measure WQ-5, the BDCP proponents have incorporated into the BDCP, as set forth in EIR/EIS Appendix 3B, *Environmental Commitments*, a separate, non-environmental commitment to address the potential increased water treatment costs that could result from bromide-related concentration effects on municipal water purveyor operations. Potential options for making use of this financial commitment include funding or providing other assistance towards implementation of the North Bay Aqueduct Alternative Intake Project (AIP), acquiring alternative water supplies, or other actions to indirectly reduce the effects of elevated bromide and DOC in existing water supply diversion facilities. Please refer to Appendix 3B, *Environmental Commitments*, for the full list of potential actions that could be taken pursuant to this commitment in order to reduce the water quality treatment costs associated with water quality effects relating to chloride, electrical conductivity, and bromide.

Mitigation Measure WQ-5: Avoid, Minimize, or Offset, as Feasible, Adverse Water Quality Conditions

It remains to be determined whether, or to what degree, the available and existing salinity response and countermeasure actions of SWP and CVP facilities or municipal water purveyors would be capable of offsetting the actual level of changes in bromide that may occur from implementation of Alternative 1A. Therefore, to determine the feasibility of reducing the effects of increased bromide levels, and potential adverse effects on beneficial uses associated with CM1 operations (and hydrodynamic effects of tidal restoration under CM4), the proposed mitigation requires a series of phased actions to identify and evaluate existing and possible feasible actions, followed by development and implementation of the actions, if determined to be necessary. The development and implementation of any mitigation actions shall be focused on those incremental effects attributable to implementation of Alternative 1A operations only. Development of mitigation actions for the incremental bromide effects attributable to climate change/sea level rise are not required because these changed conditions would occur with or without implementation of Alternative 1A. The goal of specific actions would be to reduce/avoid additional degradation of Barker Slough water quality conditions with respect to the CALFED bromide goal.

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

Impact WQ-6: Effects on Bromide Concentrations Resulting from Implementation of CM2–CM22

***NEPA Effects*:** CM2–CM22 would present no new sources of bromide to the affected environment, including areas Upstream of the Delta, within the Plan Area, and the SWP/CVP Export Service Areas. As they pertain to bromide, implementation of these conservation measures would not be expected to adversely affect MUN beneficial use, or any other beneficial uses, of the affected environment.

With exception to habitat restoration areas that would effectively alter Delta hydrodynamics, habitat restoration and the various land-disturbing conservation measures proposed for Alternative 1A would not present new or substantially changed sources of bromide to the study area. Modeling scenarios included assumptions regarding how certain habitat restoration activities would affect Delta hydrodynamics (CM2 and CM4), and thus such hydrodynamic effects of these restoration measures were included in the assessment of CM1 facilities operations and maintenance (see Impact WQ-1).

Some habitat restoration activities would occur on lands in the Delta formerly used for irrigated agriculture. Such replacement or substitution of land use activity would not be expected to result in new or increased sources of bromide to the Delta. Implementation of CM2–CM11 would not be expected to adversely affect MUN beneficial use, or any other beneficial uses, within the affected environment.

In summary, implementation of CM2–CM22 under Alternative 1A, relative to the No Action Alternative, would have negligible, if any, effects on bromide concentrations. The effects on bromide from implementing CM2–CM22 are determined to not be adverse.

***CEQA Conclusion*:** Implementation of CM2–CM22 under Alternative 1A would not present new or substantially changed sources of bromide to the study area. Some conservation measures may replace or substitute for existing irrigated agriculture in the Delta. This replacement or substitution would not be expected to substantially increase or present new sources of bromide. Implementation of CM2–CM22 would have negligible, if any, effects on bromide concentrations throughout the affected environment, would not cause exceedance of applicable state or federal numeric or narrative water quality objectives/criteria because none exist for bromide, and would not cause changes in bromide concentrations that would result in significant impacts on any beneficial uses within affected water bodies. Implementation of CM2–CM22 would not cause significant long-term water quality degradation such that there would be greater risk of significant impacts on beneficial uses, would not cause greater bioaccumulation of bromide, and would not further impair any beneficial uses due to bromide concentrations because no uses are currently impaired due to bromide levels. This impact is therefore considered less than significant. No mitigation is required.

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

Upstream of the Delta

Under Alternative 1A there would be no expected change to the sources of chloride in the Sacramento and eastside tributary watersheds. Chloride loading in these watersheds would remain unchanged and resultant changes in flows from altered system-wide operations would have negligible, if any, effects on the concentration of chloride in the rivers and reservoirs of these watersheds. Under Alternative 1A, the modeled long-term annual average flows on the lower San Joaquin River at Vernalis would decrease by an estimated 6%, relative to Existing Conditions in association with climate change and increased water demands, and would remain virtually the same relative to No Action Alternative (Appendix 5A). The reduced flow would result in possible increases in long-term average chloride concentrations of about 2%, relative to the Existing Conditions, and no change relative to No Action Alternative (Appendix 8G, Table Cl-62). However, the small increases in lower San Joaquin River chloride levels that could occur under Alternative 1A, relative to Existing Conditions would not result in an increased frequency of exceedances of any applicable objectives or criteria. Consequently, Alternative 1A would not be expected to cause exceedance of chloride objectives/criteria or substantially degrade water quality with respect to chloride, and thus would not adversely affect any beneficial uses of the Sacramento River, the eastside tributaries, associated reservoirs upstream of the Delta, or the San Joaquin River.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of

CM2-22 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for CM2-22. See section 8.3.1.3 for more information.

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

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

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

Municipal and Industrial Beneficial Uses–Relative to Existing Conditions

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

Similarly, estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3) were also used to evaluate the 250 mg/L Bay-Delta WQCP objective for chloride at Contra Costa Pumping Plant #1 where daily average objectives apply. The basis for the evaluation was the predicted number of days the objective was exceeded for the modeled 16-year period. For Alternative 1A, the modeled frequency of objective exceedance would decrease by approximately one half, from 6% of modeled days under Existing Conditions, to 3% of modeled days under Alternative 1A (Appendix 8G, Table Cl-63).Given the limitations inherent to estimating future chloride concentrations (see Section 8.3.1.3), estimation of chloride concentrations through both a mass balance approach and an EC-chloride relationship approach was used to evaluate the 250 mg/L Bay-Delta WQCP objectives in terms of both frequency of exceedance and use of assimilative capacity. When utilizing the mass balance approach to model monthly average chloride concentrations for the 16-year period, the predicted frequency of exceeding the 250 mg/L objective would increase at the San Joaquin River at Antioch location from 66% under Existing Conditions to 74%, and would increase by 2% at the Sacramento River at Mallard Island location (i.e., from 85% under Existing Conditions to 87%) (Appendix 8G, Table Cl-9). The increased chloride concentrations at the Antioch and Mallard Slough locations would occur during the months of January through June, thus reducing water quality during the period of seasonal freshwater diversions (Appendix 8G, Figure Cl-1). The available assimilative capacity would decrease substantially at the Antioch location in the months of March and April (i.e., maximum reduction of 66% for the 16-year period modeled, and 100% reduction, or elimination of assimilative capacity, during the drought period modeled) (Appendix 8G, Table Cl-9). Similar to modeling results that predicted daily exceedance frequency, the frequency of monthly average exceedances at the Contra Costa Canal at Pumping Plant #1 would decrease (Appendix 8G, Table Cl-9); however, available assimilative capacity would be reduced compared to the Existing Conditions up to 100% in October (i.e., eliminated) (Appendix 8G, Table Cl-11). Additional long-term degradation at the Antioch and Contra Costa Canal at Pumping Plant #1 locations would occur when chloride concentrations would be near, or exceed, the objectives, thus increasing the risk of exceeding objectives.

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

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

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

With respect to the 303(d) listing for chloride in Tom Paine Slough, the monthly average chloride concentrations for the 16-year period modeled at Old River at Tracy Road would generally be similar or lower compared to Existing Conditions, and thus, would not be further degraded on a long-term basis (Appendix 8G, Figure Cl-2). With respect to Suisun Marsh, the long-term average chloride concentration at the Sacramento River at Mallard Island for the 16-year period modeled would increase by 91 mg/L (4%) compared to Existing Conditions (Appendix 8G, Table Cl-7) and chloride concentrations would increase in some months during October through May at Mallard Island (Appendix 8G, Figure Cl-1) and in the Sacramento River at Collinsville (Appendix 8G, Figure Cl-3). Monthly average chloride concentrations at the Montezuma Slough at Beldon's Landing would increase substantially compared to Existing Conditions in October through May, with over a doubling of concentrations in December through February (Appendix 8G, Figure Cl-4). Therefore, additional, measurable long-term degradation would occur in Suisun Marsh that potentially would adversely affect the necessary actions to reduce chloride loading for any TMDL that is developed.

Municipal Beneficial Uses–Relative to No Action Alternative

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

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

Similar to Existing Conditions, a comparative assessment of modeling approaches was utilized to evaluate the 250 mg/L Bay-Delta WQCP objectives in terms of both frequency of exceedance and use of assimilative capacity on a monthly average basis. When utilizing the mass balance approach to model monthly average chloride concentrations for the 16-year period, the exceedance frequency of the 250 mg/L objective is predicted relative to the No Action Alternative would increase slightly by 1% at the Antioch location (i.e., from 73% to 74%), by 7% at the Contra Costa Canal at Pumping Plant #1 (i.e., from 14% to 21%), and by 1% at Mallard Island (i.e., from 86% to 87%) (Appendix 8G, Table Cl-9). The available assimilative capacity for the 16-year period modeled would be reduced at the Antioch location during the months of February and March by approximately 28% and 44%, respectively, compared to the No Action Alternative (Appendix 8G, Table Cl-11). The available assimilative capacity would be reduced at the Contra Costa Canal at Pumping Plant #1 in September through April compared to the No Action Alternative (i.e., reduction ranging from 18% in January up to 100%, or eliminated, in October), reflecting substantial degradation during the months October through December when average concentrations would be near, or exceed, the objective.

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

Alternative. As discussed in Section 8.3.1.3, in cases of such disagreement, the approach that yielded the more conservative predictions was used as the basis for determining adverse impacts.

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

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

With respect to the 303(d) listing for chloride, relative to the No Action Alternative, monthly average chloride concentrations near Tom Paine Slough for the 16-year period modeled would not be further degraded under Alternative 1A (Appendix 8G, Figure Cl-2); however, concentrations at source water channel locations for the Suisun Marsh would increase in some months during October through May compared to the No Action Alternative (Appendix 8G, Figures Cl-1, Cl-3 and Cl-4). Therefore, additional, measurable long-term degradation would occur in Suisun Marsh that potentially would adversely affect the necessary actions to reduce chloride loading for any TMDL that is developed.

SWP/CVP Export Service Areas

Under Alternative 1A, long-term average chloride concentrations based on the mass balance analysis of modeling results for the 16-year period modeled at the Banks and Jones pumping plants would decrease by as much as 32% relative to Existing Conditions and 20% compared to No Action Alternative (Appendix 8G, *Chloride*, Table Cl-7). The modeled frequency of exceedances of applicable water quality objectives/criteria would decrease relative to Existing Conditions and No Action Alternative, for both the 16-year period and the drought period modeled (Appendix 8G, *Chloride*, Table Cl-9). Consequently, water exported to the SWP/CVP service area would generally be of similar or better quality with regard to chloride relative to Existing Conditions and the No Action Alternative conditions.

Results of the modeling approach which used relationships between EC and chloride (see Section 8.3.1.3) were consistent with the discussion above, and assessment of chloride using these data results in the same conclusions as are presented above for the mass-balance approach (Appendix 8G, Table Cl-8 and Table Cl-10).

Commensurate with the decrease in chloride concentrations exported to the San Joaquin Valley for agricultural irrigation, an improvement in lower San Joaquin River chloride would also be anticipated to occur because chloride loading from agricultural drainage would be reduced. While difficult to predict, the relative decrease in overall loading of chloride to the SWP/CVP Export Service Areas would likely alleviate or lessen any expected increase in chloride at Vernalis related to decreased annual average San Joaquin River flows (see discussion of Upstream of the Delta).

Maintenance of SWP and CVP facilities would not be expected to create new sources of chloride or contribute a substantial change in existing sources of chloride in the affected environment. Maintenance activities would not be expected to cause any substantial change in chloride such that any long-term water quality degradation would occur, thus, beneficial uses would not be adversely affected.

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

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

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

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

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

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

While mitigation measures to reduce these water quality effects in affected water bodies to less than significant levels are not available, implementation of Mitigation Measure WQ-7 is recommended to attempt to reduce the effect that increased chloride concentrations may have on Delta beneficial uses. However, because the effectiveness of this mitigation measure to result in feasible measures for reducing water quality effects is uncertain, this impact is considered to remain significant and unavoidable.

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

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

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

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

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

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

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

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

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

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

Impact WQ-8: Effects on Chloride Concentrations Resulting from Implementation of CM2–CM22

NEPA Effects: The implementation of the other conservation measures (i.e., CM2–CM22), of which most do not involve land disturbance, present no new direct sources of chloride to the affected environment, including areas Upstream of the Delta, within the Plan Area, and the SWP/ CVP Export Service Area, nor would they affect channel flows or Delta hydrodynamic conditions. As noted above, the potential effects of implementation of tidal habitat restoration (i.e., CM4) on Delta hydrodynamic conditions is addressed above in the discussion of Impact WQ-8. The potential channel flow effects of CM2 for actions in the Yolo Bypass also were accounted for in the CALSIM II and DSM2 modeling, and thus were addressed in the discussion for Impact WQ-8. CM3 and CM11 provide the mechanism, guidance, and planning for the land acquisition and thus would not, themselves, affect chloride levels in the Delta. CM12–CM22 involve actions that target reduction in other stressors at the species level involving actions such as methylmercury reduction management (CM12), improving DO in the Stockton Deep Water Ship Channel (CM14), and urban stormwater treatment (CM19). None of CM12–CM22 would contribute to substantially increasing chloride levels in the Delta. Consequently, as they pertain to chloride, implementation of CM2–CM22 would not be expected to adversely affect any of the beneficial uses of the affected environment. Moreover, some habitat restoration conservation measures (CM4–CM10) would occur on lands within the Delta currently used for irrigated agriculture, thus replacing agricultural land uses with restored tidal wetlands, floodplain, and related channel margin and off-channel habitats. The potential reduction in irrigated lands within the Delta may result in reduced discharges of agricultural field drainage with elevated chloride concentrations, which would be considered an improvement compared to Existing Conditions.

CEQA Conclusion: Implementation of the CM2–CM22 for Alternative 1A would not present new or substantially changed sources of chloride to the affected environment upstream of the Delta, within Delta, or in the SWP/CVP service area. Replacement of irrigated agricultural land uses in the Delta with habitat restoration conservation measures may result in some reduction in discharge of agricultural field drainage with elevated chloride concentrations, thus resulting in improved water quality conditions. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

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

Upstream of the Delta

For the same reasons stated for the No Action Alternative, Alternative 1A would not result in substantial decreases in DO levels in the rivers and reservoirs upstream of the Delta relative to Existing Conditions and the No Action Alternative. Any minor decreases in DO levels that could occur under Alternative 1A would not be of sufficient frequency, magnitude, and geographic extent to result in adverse effects on beneficial uses within the Upstream of the Delta Region, or substantially degrade the quality of these water bodies, with regard to DO.

Delta

For the same reasons stated for the No Action Alternative, Alternative 1A would not result in substantial decreases in DO levels in the Delta relative to Existing Conditions and the No Action Alternative. Any minor decreases in DO levels that could occur under Alternative 1A would not be of sufficient frequency, magnitude, and geographic extent to result in adverse effects on beneficial uses in the Plan Area, or substantially degrade the quality of these water bodies, with regard to DO.

SWP/CVP Export Service Areas

The water delivered to the SWP/CVP Export Service Areas would differ from that under Existing Conditions as it would consist of water directly withdrawn from the Delta at the current export pumps and water diverted from the Sacramento River at Hood. DO levels in the vicinity of the south

Delta export pumps may be reduced occasionally, but would not be anticipated to be substantially lower at this location on a long-term basis, relative to Existing Conditions. The DO levels in water entering the canals from the new facilities that diverted the water from the Sacramento River at Hood would be expected to be equal to or higher than DO levels at the south Delta export pumps, and would be expected to have similar or lower levels of oxygen demanding substances. Hence, the typical DO level of water entering the SWP/CVP Export Service Areas waters would not be expected to be substantially lower than that under Existing Conditions. DO dynamics within the exposed canals and the downstream reservoirs would remain similar to that under Existing Conditions. Consequently, effects on DO levels in the SWP/CVP Export Service Areas would not be adverse under Alternative 1A relative to Existing Conditions.

***NEPA Effects*:** For the same reasons given above, substantial adverse effects on DO levels in the SWP/CVP Export Service Areas are not expected to occur under Alternative 1A relative to the No Action Alternative. The effects on dissolved oxygen from implementing CM1 is determined to not be adverse.

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

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

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

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

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

Impact WQ-10: Effects on Dissolved Oxygen Resulting from Implementation of CM2–CM22

NEPA Effects**:** CM2–CM22 would not be expected to contribute to adverse DO levels in the Delta. The increased habitat provided by CM2–CM11 could contribute to an increased biochemical or sediment demand, through contribution of organic carbon and the action of plants decaying. However, similar habitat exists currently in the Delta and is not identified as contributing to adverse DO conditions. Although additional DOC loading to the Delta may occur (see impact WQ-18), only a fraction of the DOC is available to microorganisms that would consume oxygen as part of the decay and mineralization process. Since decreases in dissolved organic carbon are not typically observed in Delta waterways due to these processes, any increase in DOC is unlikely to contribute to adverse DO levels in the Delta. CM14, an oxygen aeration facility in the Stockton Deep Water Ship Channel to meet TMDL objectives established by the Central Valley Water Board, would maintain DO levels above those that impair fish species when covered species are present. CM19, which would fund projects to contribute to reducing pollutant discharges in stormwater, would be expected to reduce biochemical oxygen demand load and, thus, would not adversely affect DO levels. The remaining conservation measures would not be expected to affect DO levels because they are actions that do not affect the presence of oxygen-demanding substances. The effects on dissolved oxygen from implementing CM2–CM22 is determined to not be adverse.

CEQA Conclusion**:** It is expected that DO levels in the Upstream of the Delta Region, in the Plan Area, or in the SWP/CVP Export Service Areas following implementation of CM2–CM22 under Alternative 1A would not be substantially different from existing DO conditions. Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would result in significant impacts on any beneficial uses within affected water bodies. Because no substantial changes in DO levels would be expected, long-term water quality degradation would not be expected, and, thus, beneficial uses would not be adversely affected. Various Delta waterways are 303(d)-listed for low DO, but because no substantial decreases in DO levels would be expected, greater degradation and impairment of these areas would not be expected. Implementation of CM14 would have a net beneficial effect on DO conditions in the Stockton Deep Water Ship Channel. This impact would be less than significant. No mitigation is required.

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

Upstream of the Delta

For the same reasons stated for the No Action Alternative, EC levels (highs, lows, typical conditions) in the Sacramento River and its tributaries, the eastside tributaries, their associated reservoirs, and the San Joaquin River upstream of the Delta under Alternative 1A are not expected to be outside the ranges occurring under Existing Conditions or would occur under the No Action Alternative. Any minor changes in EC levels that may occur under Alternative 1A in water bodies upstream of the Delta would not be of sufficient magnitude, frequency and geographic extent that would cause adverse effects on beneficial uses or substantially degrade water quality with regard to EC.

Delta

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

Relative to Existing Conditions, Alternative 1A would result in a fewer number of days when Bay-Delta WQCP compliance locations in the western, interior, and southern Delta would exceed EC objectives or be out of compliance with the EC objectives, with the exception of the Sacramento River at Emmaton in the western Delta, the San Joaquin River at San Andreas Landing in the interior Delta, and Brandt Bridge in the southern Delta (Appendix 8H, Table EC-1). The percent of days the Emmaton EC objective would be exceeded for the entire period modeled (1976–1991) would increase from 6% under Existing Conditions to 27% under Alternative 1A. Further, the percent of days out of compliance at Emmaton would increase from 11% under Existing Conditions to 39% under Alternative 1A. The percent of days the San Andreas Landing EC objective would be exceeded would increase from 1% under Existing Conditions to 2% under Alternative 1A. Further, the percent of days out of compliance with the EC objective would increase from 1% under Existing Conditions to 5% under Alternative 1A. At Brandt Bridge, the increase in days of EC objective exceedance and days out of compliance would be <1%. Average EC levels at the western and southern Delta compliance locations, except at Emmaton in the western Delta, would decrease from 1–27% for the entire period modeled and 2–28% during the drought period modeled (1987–1991) (Appendix 8H, Table EC-12). At Emmaton, average EC would increase 16% for both the entire period modeled and the drought period modeled. Also, at the two interior Delta compliance locations, there would be increases in average EC: the S. Fork Mokelumne River at Terminous average EC would increase 4% for the entire period modeled and 3% during the drought period modeled; and San Joaquin River at San Andreas Landing average EC would increase 12% for the entire and drought periods modeled. On average, EC would increase at Emmaton during all months except October and November. Average EC would increase at San Andreas Landing during all months except November. Average EC in the S. Fork Mokelumne River at Terminous would increase during all months (Appendix 8H, Table EC-12). Of the Clean Water Act section 303(d) listed sections of the Delta–western, northwestern, and southern–the Sacramento River at Emmaton would have a modest increase in exceedance of the Bay-Delta WQCP EC objectives (21%) and the San Joaquin River at Brandt Bridge in the southern Delta would have a slight increase (<1%) in the exceedance of the Bay-Delta WQCP EC objectives (Appendix 8H, Table EC-1). Further, long-term average EC at Emmaton would increase by 16%, whereas the long-term average EC at the San Joaquin River would decrease by 2%, relative to Existing Conditions, for the entire period modeled (Appendix 8H, Table EC-12). Thus, Alternative 1A is not expected to contribute to additional impairment and adversely affect beneficial uses for section 303(d) listed southern Delta waterways, relative to Existing Conditions. However, the increase in incidence of exceedance of EC objectives and increases in long-term and drought period average EC at Emmaton in the western Delta, relative to Existing Conditions, has the potential to contribute to additional impairment and potentially adversely affect beneficial uses. The comparison to Existing Conditions reflects changes in EC due to both Alternative 1A operations (including north Delta intake capacity of 15,000 cfs and numerous other operational components of Scenario A) and climate change/sea level rise.

Relative to the No Action Alternative, the percent of days exceeding EC objectives and percent of days out of compliance would increase at: Sacramento River at Emmaton, San Joaquin River at Jersey Point, San Andreas Landing, Brandt Bridge, and Prisoners Point; and Old River near Middle River at Tracy Bridge (Appendix 8H, Table EC-1). The increase in percent of days exceeding the EC objective would be 2% or less and the increase in percent of days out of compliance would be 4% or less, with the exception of Emmaton, which would have a 15% increase in percent of days exceeding the EC objective and 17% increase in percent of days out of compliance. Average EC would increase at some compliance locations for the entire period modeled: Sacramento River at Emmaton (15%), San Joaquin River at Jersey Point (3%), S. Fork Mokelumne River at Terminous (5%), San Joaquin River at San Andreas Landing (18%), and San Joaquin River at Prisoners Point (9%) (Appendix 8H, Table EC-12). For the drought period modeled, the locations with an average EC increase would be: Sacramento River at Emmaton (5%), S. Fork Mokelumne River at Terminous (4%), San Joaquin River at San Andreas Landing (13%), San Joaquin River at Brandt Bridge (1%), Old River at Tracy Bridge (1%), and San Joaquin River at Prisoners Point (4%) (Appendix 8H, Table EC-12). Given that the western and southern Delta are Clean Water Act section 303(d) listed as impaired due to elevated EC, the increase in the incidence of exceedance of EC objectives and increases in long-term and drought period average EC at the western and southern Delta locations under Alternative 1A, relative to the No Action Alternative, has the potential to contribute to additional impairment and potentially adversely affect beneficial uses. The comparison to the No Action Alternative reflects changes in EC due only to Alternative 1A operations (including north Delta intake capacity of 15,000 cfs and numerous other operational components of Scenario A).

For Suisun Marsh, October–May is the period when Bay-Delta WQCP EC objectives for protection of fish and wildlife apply. Average EC for the entire period modeled would increase under Alternative 1A, relative to Existing Conditions, during the months of February through May by 0.1–0.8 mS/cm in the Sacramento River at Collinsville (Appendix 8H, Table EC-21). Long-term average EC would decrease relative to Existing Conditions in Montezuma Slough at National Steel during October–May (Appendix 8H, Table EC-22). The most substantial increase would occur near Beldon Landing, with long-term average EC levels increasing by 1.8–6.1 mS/cm, depending on the month, which would be a doubling or tripling of long-term average EC relative to Existing Conditions (Appendix 8H, Table EC-23). Sunrise Duck Club and Volanti Slough also would have long-term average EC increases during all months of 1.9–4.0 mS/cm (Appendix 8H, Tables EC-24 and EC-25). The degree to which the long-term average EC increases would cause exceedance of Bay-Delta WQCP objectives is unknown, because objectives are expressed as a monthly average of daily high tide EC, which does not have to be met if it can be demonstrated "equivalent or better protection will be provided at the location" (State Water Resources Control Board 2006:14). 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 be substantial and it is uncertain the degree to which current management plans for the Suisun Marsh would be able to address these substantially higher EC levels and protect beneficial uses. Thus, these increased EC levels in Suisun Marsh are considered to have a potentially adverse effect on marsh beneficial uses. Long-term average EC increases in Suisun Marsh under Alternative 1A relative to the No Action Alternative would be similar to the increases relative to Existing Conditions. Suisun Marsh is Clean Water Act section 303(d) listed as impaired due to elevated EC, and the potential increases in long-term average EC concentrations could contribute to additional impairment, because the increases would be double or triple that relative to Existing Conditions and the No Action Alternative.

SWP/CVP Export Service Areas

At the Banks and Jones pumping plants, Alternative 1A would result in no exceedances of the Bay-Delta WQCP's 1,000 μmhos/cm EC objective for the entire period modeled (Appendix 8H, Table EC-10). Thus, there would be no adverse effect on the beneficial uses in the SWP/CVP Export Service Areas using water pumped at this location under Alternative 1A.

At the Banks pumping plant, relative to Existing Conditions, average EC levels under Alternative 1A would decrease 22% for the entire period modeled and 18% during the drought period modeled. Relative to the No Action Alternative, average EC levels would decrease by 16% for the entire period modeled and 13% during the drought period modeled. (Appendix 8H, Table EC-12)

At the Jones pumping plant, relative to Existing Conditions, average EC levels under Alternative 1A would decrease 19% for the entire period modeled and 17% during the drought period modeled. Relative to the No Action Alternative, average EC levels would decrease by 15% for the entire period modeled and 13% during the drought period modeled. (Appendix 8H, Table EC-12)

Based on the decreases in long-term average EC levels that would occur at the Banks and Jones pumping plants, Alternative 1A would not cause degradation of water quality with respect to EC in the SWP/CVP Export Service Areas; rather, Alternative 1A would improve long-term average EC conditions in the SWP/CVP Export Service Areas.

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

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

***NEPA Effects*: In summary, the increased frequency of exceedance of EC objectives and increased long-term and drought period average EC levels that would occur at western and southern Delta compliance locations under Alternative 1A, relative to the No Action Alternative, would contribute to adverse effects on the agricultural beneficial uses. Given that the western and southern Delta are Clean Water Act section 303(d) listed as impaired due to elevated EC, the increase in the incidence of exceedance of EC objectives and increases in long-term and drought period average EC in the western and southern Delta under Alternative 1A has the potential to contribute to additional beneficial use impairment. The increases in long-term average EC levels that would occur in Suisun Marsh would further degrade existing EC levels and could contribute additionally to adverse effects on the fish and wildlife beneficial uses. Suisun Marsh is section 303(d) listed as impaired due to elevated EC, and the potential increases in long-term average EC levels could contribute to additional beneficial use impairment. These increases in EC constitute an adverse effect on water quality. Mitigation Measure WQ-11 would be available to reduce these effects (implementation of this measure along with a separate, non-environmental commitment as set forth in EIR/EIS

Appendix 3B, *Environmental Commitments*, relating to the potential EC-related changes would reduce these effects).

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

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

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

In the Plan Area, Alternative 1A would result in an increase in the frequency with which Bay-Delta WQCP EC objectives for agricultural beneficial use protection are exceeded in the San Joaquin River at San Andreas Landing (1%; interior Delta) and Sacramento River at Emmaton (21%; western Delta) for the entire period modeled (1976–1991). Further, for the entire and drought periods modeled, average EC levels would increase by 12% at San Andreas Landing and by 16% at Emmaton. Because EC is not bioaccumulative, the increases in long-term average EC levels would not directly cause bioaccumulative problems in aquatic life or humans. The interior Delta is not Clean Water Act section 303(d) listed for elevated EC, however, the western Delta is. The increases in long-term and drought period average EC levels and increased frequency of exceedance of EC objectives that would occur in the San Joaquin River at San Andreas Landing and in the Sacramento River at Emmaton would potentially contribute to adverse effects on the agricultural beneficial uses in the interior and western Delta. This impact is considered to be significant.

Further, relative to Existing Conditions, Alternative 1A would result in substantial increases in long-term average EC during the months of October through May in Suisun Marsh, such that EC levels at would be up to double or triple that occurring under Existing Conditions. The increases in long-term average EC levels that would occur in Suisun Marsh would further degrade existing EC levels and could contribute additionally to adverse effects on the fish and wildlife beneficial uses. Because EC is not bioaccumulative, the increases in long-term average EC levels would not directly cause bioaccumulative problems in wildlife. Suisun Marsh is Clean Water Act section 303(d) listed for elevated EC and the increases in long-term average EC that would occur in the marsh could make beneficial use impairment measurably worse. This impact is considered to be significant.

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

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

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

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

Mitigation Measure WQ-11a: Conduct Additional Evaluation and Modeling of Increased EC Levels Following Initial Operations of CM1

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

Mitigation Measure WQ-11b: Consult with CDFW/USFWS, and Suisun Marsh Stakeholders, to Identify Potential Actions to Avoid or Minimize EC Level Increases in the 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-12: Effects on Electrical Conductivity Resulting from Implementation of CM2–CM22

NEPA Effects: The implementation of the other conservation measures (i.e., CM2–CM22) present no new direct sources of EC to the affected environment, including areas upstream of the Delta, within the Delta region, and in the SWP/CVP Export Service Areas. As they pertain to EC, implementation of these conservation measures would not be expected to adversely affect any of the beneficial uses of the affected environment. Moreover, some habitat restoration conservation measures would occur on lands within the Delta currently used for irrigated agriculture. Such replacement or substitution of land use activity is not expected to result in new or increased sources of EC to the Delta and, in fact, could decrease EC through elimination of high EC agricultural runoff.

CM4 would result in substantial tidal habitat restoration that would increase the magnitude of daily tidal water exchange at the restoration areas, and alter other hydrodynamic conditions in adjacent Delta channels. The DSM2 modeling included assumptions regarding possible locations of tidal habitat restoration areas, and how restoration would affect Delta hydrodynamic conditions, and thus the effects of this restoration measure on Delta EC were included in the assessment of CM1 facilities operations and maintenance.

Implementation of CM2–CM22 would not be expected to adversely affect EC levels in the affected environment and thus would not adversely affect beneficial uses or substantially degrade water quality with regard to EC within the affected environment. The effects on EC from implementing CM2–CM22 is determined to not be adverse.

CEQA Conclusion: Implementation of CM2–CM22 under Alternative 1A would not present new or substantially changed sources of EC to the affected environment. Some conservation measures may replace or substitute for existing irrigated agriculture in the Delta. This replacement or substitution is not expected to substantially increase or present new sources of EC, and could actually decrease EC loads to Delta waters. Thus, implementation of CM2–CM22 would have negligible, if any, adverse effects on EC levels throughout the affected environment and would not cause exceedance of applicable state or federal numeric or narrative water quality objectives/criteria that would result in adverse effects on any beneficial uses within affected water bodies. Further, implementation of CM2–CM22 would not cause significant long-term water quality degradation such that there would be greater risk of adverse effects on beneficial uses. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

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

Upstream of the Delta

Under Alternative 1A, the magnitude and timing of reservoir releases and river flows upstream of the Delta in the Sacramento River watershed and east-side tributaries would be altered, relative to Existing Conditions and the No Action Alternative.

The Sacramento River at Freeport and San Joaquin River at Vernalis (as summarized for water quality average concentrations in Tables 8-48 and 8-49) were examined for flow/concentration relationships for mercury and methylmercury. No significant, predictive regression relationships were discovered for mercury or methylmercury, except for total mercury with flow at Freeport (monthly or annual)(Figures I-10 through I-13, Appendix 8I). Such a positive relationship between total mercury and flow is to be expected based on the association of mercury with suspended sediment and the mobilization of sediments during storm flows. However, the changes in flow in the Sacramento River under Alternative 1A relative to Existing Conditions and the No Action Alternative are not of the magnitude of storm flows, in which substantial sediment-associated mercury is mobilized. Therefore mercury loading should not be substantially different due to changes in flow. In addition, even though it may be flow-affected, total mercury concentrations remain well below criteria at upstream locations. Any negligible changes in mercury concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies as related to mercury. Both waterborne methylmercury concentrations and largemouth bass fillet mercury concentrations are expected to remain above guidance levels at upstream of Delta locations, but will not change substantially relative to Existing Conditions or the No Action Alternative due to changes in flows under Alternative 1A.

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

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2-22 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for CM2-22. 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, Table I-6). All modeled input concentrations exceeded the methylmercury TMDL guidance objective of 0.06 ng/L, therefore percentage change in assimilative capacity was not evaluated for methylmercury.

Fish tissue estimates show only small or no increases in exceedance quotients based on long-term annual average concentrations for mercury at the Delta locations. The greatest increase was at Mokelumne River (South Fork) at Staten Island (8% relative to Existing Conditions and 10% relative to the No Action Alternative) (Figure 8-55, Appendix 8I, Table I-8b).

SWP/CVP Export Service Areas

The analysis of mercury and methylmercury in the SWP/CVP Export Service Areas was based on concentrations estimated at the Banks and Jones pumping plants. Both waterborne total and methylmercury concentrations for Alternative 1A are projected to be lower than Existing Conditions and the No Action Alternative at the Jones and Banks pumping plants (Appendix 8I, Figures 8I-2 and 8I-3). Therefore, mercury and methlymercury show increased assimilative capacity at these locations (Figures 8-53 and 8-54).

The largest improvements in bass tissue mercury concentrations and exceedance quotients for Alternative 1A, at any location within the Delta relative to Existing Conditions and the No Action Alternative are expected for the export pump locations (specifically, at Banks Pumping plant, 9% improvement relative to Existing Conditions, 11% relative to the No Action Alternative) (Figure 8-55, Appendix 8I, Table I-8a,b).

***NEPA Effects*:** Based on the above discussion, the effects of mercury and methylmercury in comparison of Alternative 1A to the No Action Alternative (as waterborne and bioaccumulated forms) are not considered to be adverse.

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

Under Alternative 1A, greater water demands and climate change would alter the magnitude and timing of reservoir releases and river flows upstream of the Delta in the Sacramento River watershed and east-side tributaries, relative to Existing Conditions. Concentrations of mercury and methylmercury upstream of the Delta will not be substantially different relative to Existing Conditions due to the lack of important relationships between mercury/methylmercury concentrations and flow for the major rivers.

Methylmercury concentrations exceed criteria at all locations in the Delta and no assimilative capacity exists. However, monthly average waterborne concentrations of total and methylmercury, over the period of record, are very similar to Existing Conditions. Similarly, estimates of fish tissue mercury concentrations show almost no differences would occur among sites for Alternative 1A as compared to Existing Conditions for Delta sites.

Assessment of effects of mercury in the SWP and CVP Export Service Areas were based on effects on mercury concentrations and fish tissue mercury concentrations at the Banks and Jones pumping plants. The Banks and Jones pumping plants are expected to show increased assimilative capacity for waterborne mercury and decreased fish tissue concentrations of mercury for Alternative 1A as compared to Existing Conditions.

As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because mercury concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Because any increases in mercury or methylmercury concentrations are not likely to be measurable, changes in mercury concentrations or fish tissue mercury concentrations would not make any existing mercury-related impairment measurably worse. In comparison to Existing Conditions, Alternative 1A would not increase levels of mercury by frequency, magnitude, and geographic extent such that the affected environment would be expected to have measurably higher body burdens of mercury in aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish) or humans consuming those organisms. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-14: Effects on Mercury Concentrations Resulting from Implementation of CM2–CM22

NEPA Effects: Some habitat restoration activities under Alternative 1A would occur on lands in the Delta formerly used for irrigated agriculture. Tidal and other restoration proposed under Alternative 1A have the potential to increase water residence times and increase accumulation of organic sediments that are known to enhance methylmercury bioaccumulation in biota in the restored habitat. Therefore, increases in mercury methylation in the habitat restoration areas is possible but uncertain depending on the specific restoration design implemented at a particular Delta location. Increased methylmercury due to the restoration areas would constitute an additional loading of methylmercury to the Delta, independent of effects of the hydrodynamics associated with the restoration areas. Models to estimate the potential for methylmercury formation in restored areas are not currently available. However, DSM2 modeling for Alternative 1A operations does incorporate assumptions for certain habitat restoration activities proposed under CM2 and CM4 (see Section 8.3.1.3) that result in changes to Delta hydrodynamics compared to the No Action Alternative. These modeled restoration assumptions provide some insight into potential hydrodynamic changes that could be expected related to implementing CM2 and CM4 and are considered in the evaluation of the potential for increased mercury and methylmercury concentrations under Alternative 1A.

BDCP Conservation Measure 12 (CM12) addresses the potential for methylmercury bioaccumulation associated with restoration activities and acknowledges the uncertainties associated with mitigating or minimizing this potential effect. CM12 proposes project-specific mercury management plans for restoration actions that will incorporate relevant approaches recommended in Phase 1 Methylmercury TMDL control studies. Specific approaches recommended under CM12 that are intended to minimize or mitigate for potential increases in methylmercury bioaccumulation at future restoration sites include:

- Characterizing mercury, methylmercury, organic carbon, iron, and sulfate concentrations to better inform restoration design,
- Sequestering methylmercury at restoration sites using low intensity chemical dosing techniques,
- Minimizing microbial methylation associated with anoxic conditions by reducing the amount of organic material at a restoration site (this approach could limit the benefit of restoration areas by limiting the amount of carbon supplied by these areas to the Delta as a whole. In some cases, this would run directly counter to the goals and objectives of the BDCP. This approach should not be implemented in such a way that it reduces the benefits to the Delta ecosystem provided by restoration areas),
- Designing restoration sites to enhance photo degeneration that converts methylmercury into a biologically unavailable, inorganic form of mercury,
- Remediating restoration site soils with iron to reduce methylation in sulfide rich soils, and
- Considering capping mercury laden sediments, where possible to reduce methylation potential at a site.

Because of the uncertainties associated with site-specific estimates of methylmercury concentrations and the uncertainties in source modeling and tissue modeling, the effectiveness of methylmercury management proposed under CM12 to reduce methylmercury concentrations would need to be evaluated separately for each restoration effort, as part of design and implementation. Because of this uncertainty and the known potential for methylmercury creation in the Delta this potential effect of implementing CM2–CM22 is considered adverse.

***CEQA Conclusion*:** There would be no substantial, long-term increase in mercury or methylmercury concentrations or loads in the rivers and reservoirs upstream of the Delta or the waters exported to the CVP and SWP service areas due to implementation of CM2–CM22 relative to Existing Conditions. However, uptake of mercury from water and/or methylation of inorganic mercury may increase to an unquantified degree as part of the creation of new, marshy, shallow, or organic-rich restoration areas. Methylmercury is 303(d)-listed within the affected environment, and therefore any potential measurable increase in methylmercury concentrations would make existing mercury-related impairment measurably worse. Because mercury is bioaccumulative, increases in water-borne mercury or methylmercury that could occur in some areas could bioaccumulate to somewhat greater levels in aquatic organisms and would, in turn, pose health risks to fish, wildlife, or humans. Design of restoration sites under Alternative 1A would be guided by CM12 which requires development of site specific mercury management plans as restoration actions are implemented. The effectiveness of minimization and mitigation actions implemented according to the mercury management plans is not known at this time although the potential to reduce methylmercury concentrations exists based on current research. Although the BDCP will implement CM12 with the goal to reduce this potential effect the uncertainties related to site specific restoration conditions and the potential for increases in methylmercury concentrations in the Delta result in this potential impact being considered significant. No mitigation measures would be available until specific restoration actions are proposed. Therefore this programmatic impact is considered significant and unavoidable.

Impact WQ-15: Effects on Nitrate Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative, Alternative 1A would have negligible, if any, adverse effects on nitrate concentrations in the rivers and reservoirs upstream of the Delta in the Sacramento River watershed, relative to Existing Conditions and the No Action Alternative.

Under Alternative 1A, modeling indicates that long-term annual average flows on the San Joaquin River would decrease by an estimated 6%, relative to Existing Conditions, and would remain virtually the same relative to the No Action Alternative (Appendix 5A). Given these relatively small decreases in flows and the weak correlation between nitrate and flows in the San Joaquin River (see Nitrate Appendix 8J, Figure 2), it is expected that nitrate concentrations in the San Joaquin River would be minimally affected, if at all, by changes in flow rates under Alternative 1A.

Any negligible changes in nitrate-N concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regards to nitrate.

Delta

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

Results of the mixing calculations indicate that under Alternative 1A, relative to Existing Conditions, and the No Action Alternative, nitrate concentrations throughout the Delta are anticipated to remain low (<1.4 mg/L-N) relative to adopted objectives (Nitrate Appendix 8J Table 7 and 8). Although changes at specific Delta locations and for specific months may be substantial on a relative basis, the absolute concentration of nitrate in Delta waters would remain low (<1.4 mg/L-N) in relation to the drinking water MCL of 10 mg/L-N, as well as all other thresholds identified in Table 8-50. Long-term average nitrate concentrations are anticipated to remain below 1 mg/L-N at all 11 assessment locations except the San Joaquin River at Buckley Cove, where long-term average concentrations would be somewhat above 1 mg/L-N. Nevertheless, at this location, long-term average nitrate concentration would be somewhat reduced under Alternative 1A, relative to Existing Conditions, and would be nearly the same (i.e., any increase would be negligible) as that under the No Action Alternative. No additional exceedances of the MCL are anticipated at any location (Nitrate Appendix 8J, Table 7). On a monthly average basis and on a long term annual average basis, for all modeled years and for the drought period (1987–1991) only, use of assimilative capacity available under Existing Conditions, and the No Action Alternative, relative to the drinking water MCL of 10 mg/L-N, was low or negligible (i.e., <4%) for all locations and months (Nitrate Appendix 8J, Table 9).

Nitrate concentrations will likely be higher than the modeling results indicate in certain locations. This includes in the Sacramento River between Freeport and Mallard Island and other areas in the Delta downstream of Freeport that are influenced by Sacramento River water. These increases are associated with ammonia and nitrate that are discharged from the SRWTP, which are not included in the modeling.

- Under Existing Conditions, most of the ammonia discharged from the SRWTP is converted to nitrate downstream of the facility's discharge at Freeport, and thus, nitrate concentrations under Existing Conditions in these areas are expected to be higher than the modeling predicts, the increase becoming greater with increasing distance downstream. However, the increase in nitrate concentrations downstream of the SRWTP is expected to be small—the existing increase appears to be from approximately 0.1 mg/L-N to approximately 0.4–0.5 mg/L-N over this reach, due to approximately a 1:1 conversion of ammonia-N to nitrate-N (Central Valley Water Board 2010a:32).

- Under Alternative 1A, the planned upgrades to the SRWTP, which include nitrification/partial denitrification, would substantially decrease ammonia concentrations in the discharge, but would increase nitrate concentrations in the discharge up to 10 mg/L-N, which is substantially higher than under Existing Conditions.

- Overall, under Alternative 1A, the nitrogen load from the SRWTP discharge is expected to decrease (by up to 50%), relative to Existing Conditions, due to nitrification/partial dentrification ugrades at the SRWTP facility. Thus, while concentrations of nitrate downstream of the facility are expected to be higher than modeling results indicate for both Existing Conditions and Alternative 1A, the increase is expected to be greater under Existing Conditions than for Alternative 1A due to the upgrades that are assumed under Alternative 1A.

The other areas in which nitrate concentrations will be higher than the modeling results indicate are immediately downstream of other wastewater treatment plants that practice nitrification, but not denitrification (e.g., City of Rio Vista Beach WWTF, Town of Discovery Bay WWTF, City of Stockton RWCF). For all such facilities in the Delta, the Regional Water Boards have issued NPDES permits that allow discharge of wastewater containing nitrate into the Delta, and under these permits, the State has determined that no beneficial uses are adversely affected by the discharge, and that the discharger's use of available assimilative capacity of the water body is acceptable. When dilution is necessary in order for the discharge to be in compliance with the Basin Plans (which incorporate the 10 mg/L-N MCL by reference), not all of the assimilative capacity of the receiving water is granted to the discharger. Thus, limited decreases in flows are not anticipated to result in systemic exceedances of the MCLs by these POTWs. Furthermore, NPDES permits are renewed on a 5-year basis, and thus, if under changes in flows, dilution was no longer sufficient to maintain nitrate below the MCL in the receiving water, the NPDES permit renewal process would address such cases.

Therefore, any increases in nitrate-N concentrations that may occur at certain locations within the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to nitrate.

SWP/CVP Export Service Areas

Assessment of effects of nitrate in the SWP and CVP Export Service Areas is based on effects on nitrate-N at the Banks and Jones pumping plants.

Results of the mixing calculations indicate that under Alternative 1A, relative to Existing Conditions and the No Action Alternative, nitrate concentrations at Banks and Jones pumping plants are anticipated to decrease on a long-term average annual basis (Nitrate Appendix 8J, Table 7 and 8). During the late summer, particularly in the drought period assessed, concentrations are expected to increase substantially on a relative basis (i.e., >50%), but the absolute value of these changes (i.e., in mg/L-N) is small. Additionally, given the many factors that contribute to potential algal blooms in the SWP and CVP canals within the Export Service Area, and the lack of studies that have shown a direct relationship between nutrient concentrations in the canals and reservoirs and problematic algal blooms in these water bodies, there is no basis to conclude that these small (i.e., generally <0.3 mg/L-N), seasonal increases in nitrate concentrations would increase the potential for problem algal blooms in the SWP and CVP Export Service Area. No additional exceedances of the MCL are anticipated (Nitrate Appendix 8J, Table 7). On a monthly average basis and on a long term annual average basis, for all modeled years and for the drought period (1987–1991) only, use of assimilative capacity available under Existing Conditions and the No Action Alternative, relative to the 10 mg/L-N MCL, was negligible (<4%) for both Banks and Jones pumping plants (Nitrate Appendix 8J, Table 9).

Any increases in nitrate-N concentrations that may occur in water exported via Banks and Jones pumping plants are not expected to result in adverse effects to beneficial uses or substantially degrade the quality of exported water, with regards to nitrate.

NEPA Effects**:** In summary, based on the discussion above, the effects on nitrate from implementing CM1 are considered to be not adverse.

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

Nitrate-N concentrations are generally low in the reservoirs and rivers of the watersheds, owing to substantial dilution available for point sources and the lack of substantial nonpoint sources of nitrate-N upstream of the SRWTP in the Sacramento River watershed, and in the watersheds of the eastern tributaries (Cosumnes, Mokelumne, and Calaveras Rivers). Although higher in the San Joaquin River watershed, nitrate-N concentrations are not well-correlated with flow rates. Consequently, any modified reservoir operations and subsequent changes in river flows under Alternative 1A, relative to Existing Conditions, are expected to have negligible, if any, effects on reservoir and river nitrate-N concentrations upstream of Freeport in the Sacramento River watershed and upstream of the Delta in the San Joaquin River watershed.

In the Delta, results of the mixing calculations indicate that under Alternative 1A, relative to Existing Conditions, nitrate concentrations throughout the Delta are anticipated to remain low (<1.4 mg/L-N) relative to adopted objectives. No additional exceedances of the MCL are anticipated at any location, and use of assimilative capacity available under Existing Conditions, relative to the drinking water MCL of 10 mg/L-N, was low or negligible (i.e., <4%) for all locations and months.

Assessment of effects of nitrate in the SWP and CVP Export Service Areas is based on effects on nitrate-N concentrations at the Banks and Jones pumping plants. Results of the mixing calculations indicate that under Alternative 1A, relative to Existing Conditions, long-term average nitrate concentrations at Banks and Jones pumping plants are anticipated to change negligibly. No additional exceedances of the MCL are anticipated, and use of assimilative capacity available under Existing Conditions, relative to the MCL was negligible (i.e., <4%) for both Banks and Jones pumping plants for all months.

Based on the above, there would be no substantial, long-term increase in nitrate-N concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the waters exported to the CVP and SWP service areas under Alternative 1A relative to Existing Conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because nitrate concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Nitrate is not 303(d) listed within the affected environment and thus any increases that may occur in some areas and months would not make any existing nitrate-related impairment measurably worse because no such impairments currently exist. Because nitrate is not bioaccumulative, increases that may occur in some areas and months would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-16: Effects on Nitrate Concentrations Resulting from Implementation of CM2–CM22

***NEPA Effects*: **Some habitat restoration activities included in CM2–CM11 would occur on lands within the Delta formerly used for agriculture. It is expected that this will decrease nitrate concentrations in the Delta, due to less use of nitrate-based fertilizers, relative to the No Action Alternative. Modeling scenarios included assumptions regarding how certain habitat restoration activities (i.e., CM2 and CM4) would affect Delta hydrodynamics, and thus such effects of these restoration measures were included in the assessment of CM1 facilities operations and maintenance (see Impact WQ-1). In general, aside from changes in Delta hydrodynamics resulting from habitat restoration discussed in Impact WQ-1, CM2–CM11 proposed for Alternative 1A are not expected to increase nitrate concentrations in water bodies of the affected environment, relative to the No Action Alternative.

Because urban stormwater is a source of nitrate in the affected environment, CM19, Urban Stormwater Treatment, is expected to slightly reduce nitrate loading to the Delta, thus slightly decreasing nitrate-N concentrations relative to the No Action Alternative. Implementation of CM12–CM18 and CM20–CM22 is not expected to substantially alter nitrate concentrations in any of the water bodies of the affected environment.

The effects on nitrate from implementing CM2–22 are considered to be not adverse.

CEQA Conclusion: There would be no substantial, long-term increase in nitrate-N concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the waters exported to the CVP and SWP service areas due to implementation of CM2–CM22 under Alternative 1A, relative to Existing Conditions. Because urban stormwater is a source of nitrate in the affected environment, CM19, Urban Stormwater Treatment, is expected to slightly reduce nitrate loading to the Delta. As such, implementation of these conservation measures is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because nitrate concentrations are not expected to increase substantially due to these conservation measures, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Nitrate is not 303(d) listed within the affected environment and thus any minor increases that may occur in some areas would not make any existing nitrate-related impairment measurably worse because no such impairments currently exist. Because nitrate is not bioaccumulative, minor increases that may occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-17: Effects on Dissolved Organic Carbon Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Under Alternative 1A, there would be no substantial change to the sources of DOC within the watersheds upstream of the Delta. Moreover, long-term average flow and DOC levels in the Sacramento River at Hood and San Joaquin River at Vernalis are poorly correlated. Thus changes in system operations and resulting reservoir storage levels and river flows would not be expected to cause a substantial long-term change in DOC concentrations in the water bodies upstream of the Delta. Any negligible changes in DOC levels in water bodies upstream of the Delta under Alternative 1A, relative to Existing Conditions and the No Action Alternative, would not be of sufficient frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regard to DOC.

Delta

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

Relative to Existing Conditions, Alternative 1A would result in small increases (i.e., between 1 and 9%) in long-term average DOC concentrations at some interior Delta locations. In particular, modeled increases in long-term average DOC would be greatest at Franks Tract, with net average DOC concentration increases for the 16-year (1976–1991) hydrologic period modeled of 0.3 mg/L, equivalent to an approximate 9% relative increase (0.2 mg/L for the drought period, 8% relative increase) (Appendix 8K, DOC Table 2). Long-term increases of not greater than 0.3 mg/L (≤8%) would be predicted to occur at Staten Island, Rock Slough, and Contra Costa PP No. 1 as well. At all 11 assessment locations, modeled long-term average DOC concentrations exceed 2 mg/L 92-100%

of the time. However, increases in long-term average DOC in the Delta interior would result in more frequent exceedances of the 3 mg/L concentration threshold, with the largest magnitude effect occurring at Rock Slough and Contra Costa PP No. 1. At Rock Slough, the frequency long-term average DOC concentrations would exceed 3 mg/L would increase from 52% under Existing Conditions to 66% under Alternative 1A (an increase from 47% to 63% for the drought period). At Contra Costa PP No. 1, the frequency long-term average DOC concentrations would exceed 3 mg/L would increase from 52% under Existing Conditions to 68% under Alternative 1A (an increase from 45% to 67% for the drought period). In contrast, however, the relative frequency long-term average DOC concentrations would exceed 4 mg/L at Rock Slough and Contra Costa PP No. 1 would be small. At Rock Slough, an increase in the frequency long-term average DOC would exceed 4 mg/L would only occur for the drought period, increasing from 32% under Existing Conditions to 40% under Alternative 1A, while at Contra Costa PP No. 1 the modeled exceedance frequency for the 16-year hydrologic period would rise from 32% to 34% (an increase from 35% to 42% for the drought period). Concentration threshold exceedances at the other assessment locations would be similar or less. While Alternative 1A would generally lead to slightly higher long-term average DOC concentrations (≤0.3 mg/L) within the Delta interior and some municipal water intakes, the predicted change would not be expected to adversely affect MUN beneficial uses, or any other beneficial use. This comparison to Existing Conditions reflects changes in DOC 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 generally result in a similar magnitude of change to that discussed for the comparison to Existing Conditions. Maximum increases of not greater than 0.3 mg/L DOC (i.e., ≤9%) would be predicted at Staten Island, Franks Tract, Rock Slough, and Contra Costa PP No. 1(Appendix 8K, DOC Table 2). Threshold concentration exceedance frequency trends would also be similar to that discussed for the existing condition comparison, with exception to the predicted 4 mg/L exceedance frequency at Buckley Cove. In comparison to the No Action Alternative, the frequency which long-term average DOC concentrations exceeded 4 mg/L at Buckley Cove would increase from 27% to 33% (42% to 62% for the modeled drought period). While the Alternative 1A would generally lead to slightly higher long-term average DOC concentrations at some Delta assessment locations when compared to the No Action Alternative, the predicted change would not be expected to adversely affect MUN beneficial uses, or any other beneficial use, particularly when considering the relatively small change in long-term annual average concentration. Unlike the comparison to Existing Conditions, this comparison to the No Action Alternative reflects changes in DOC due to only Alternative 1A operations.

The Stage 1 Disinfectants and Disinfection Byproduct Rule adopted by U.S. EPA in 1998, as part of the Safe Drinking Water Act, requires drinking water utilities to reduce TOC concentrations by specified percentages prior to disinfection. EPA's action thresholds begin at 2–4 mg/L TOC and, depending on source water alkalinity, may require a drinking water utility to employ treatment to achieve as much as a 35% reduction in TOC. These requirements were adopted because organic carbon, such as DOC, can react with disinfectants during the water treatment disinfection process to form DBPs, such as THMs which pose potential lifetime carcinogenic risks to humans. Moreover, a CUWA convened expert panel reviewed Delta source water quality and DBP formation potential in an effort to develop Delta source water quality targets for treated drinking water. This panel found that source water between 4 and 7 mg/L TOC would allow continued flexibility in treatment technology necessary to achieve existing drinking water criteria for DBPs.

Water treatment plants that utilize Delta water are currently designed and operated to meet EPA's 1998 requirements based on the ambient concentrations and seasonal variability that currently exists in the Delta. Substantial changes in ambient DOC concentrations would need to occur for significant changes in plant design or operations to be triggered. The increases in long-term average DOC concentrations estimated to occur at various Delta locations under Alternative 1A are of sufficiently small magnitude that they would not require existing drinking water treatment plants to substantially upgrade treatment for DOC removal above levels currently employed.

Relative to Existing Conditions and No Action Alternative conditions, Alternative 1A would lead to predicted improvements in long-term average DOC concentrations at Barker Slough, as well as Banks and Jones pumping plants (discussed below). At Barker Slough, long-term average DOC concentrations would be predicted to decrease by as much as 0.1–0.2 mg/L, depending on baseline conditions comparison and modeling period.

SWP/CVP Export Service Areas

Under Alternative 1A, modeled long-term average DOC concentrations would decrease at Banks and Jones pumping plants, relative to Existing Conditions and the No Action Alternative. Relative to Existing Conditions, long-term average DOC concentrations would be predicted to decrease by 0.4 mg/L at both pumping plants, although in drought years the decrease would be 0.1 mg/L at Banks pumping plant and <0.1 mg/L at Jones pumping plant (Appendix 8K, DOC Table 2). Such decreases in long-term average DOC would result in generally lower exceedance frequencies for concentration thresholds, although the frequency of exceedance during the modeled drought period (i.e., 1987–1991) would be predicted to increase. For the Banks pumping plant during the drought period, exceedance of the 3 mg/L threshold would increase from 57% under Existing Conditions to 88% under Alternative 1A, while at the Jones pumping plant, exceedance frequency would increase from 72% to 87%. There would be comparatively fewer increases in the frequency of exceeding the 4 mg/L threshold at Banks, while at Jones pumping plant the exceedance frequency for the 4 mg/L threshold would decrease. Comparisons to the No Action Alternative yield similar trends, but with slightly small magnitude drought period changes. Overall, modeling results for the SWP/CVP Export Service Areas predict an overall improvement in Export Service Areas water quality, although somewhat more frequent exports of >3 mg/L DOC water would likely occur for drought periods.

Similar to the discussion pertaining to the No Action Alternative, maintenance of SWP and CVP facilities under Alternative 1A would not be expected to create new sources of DOC or contribute towards a substantial change in existing sources of DOC in the affected area. Maintenance activities would not be expected to cause any substantial change in long-term average DOC concentrations such that MUN beneficial uses, or any other beneficial use, would be adversely affected.

***NEPA Effects*:** In summary, Alternative 1A, relative to the No Action Alternative, would not cause a substantial long-term change in DOC concentrations in the water bodies upstream of the Delta. Long-term average DOC concentrations at Banks and Jones pumping plants are predicted to decrease by as much as 0.5 mg/L, while long-term average DOC concentrations for some Delta interior locations, including Contra Costa PP #1, are predicted to increase by as much as 0.3 mg/L. The increase in long-term average DOC concentration that could occur within the Delta interior would not be of sufficient magnitude to adversely affect the MUN beneficial use, or any other beneficial uses, of Delta waters. The effect of Alternative 1A operations and maintenance (CM1) on DOC is determined not to be adverse.

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

While greater water demands under the Alternative 1A would alter the magnitude and timing of reservoir releases north, south and east of the Delta, these activities would have no substantial effect on the various watershed sources of DOC. Moreover, long-term average flow and DOC at Sacramento River at Hood and San Joaquin River at Vernalis are poorly correlated; therefore, changes in river flows would not be expected to cause a substantial long-term change in DOC concentrations upstream of the Delta.

Relative to Existing Conditions, Alternative 1A would result in relatively small increases (i.e., ≤9%) in long-term average DOC concentrations at some Delta interior locations, including Franks Tract, Staten Island, Rock Slough, and Contra Costa PP No. 1. However, these increases would not substantially increase the frequency with which long-term average DOC concentrations exceeds 2, 3, or 4 mg/L. While Alternative 1A would generally lead to slightly higher long-term average DOC concentrations (≤0.3 mg/L) within the Delta interior and some municipal water intakes, the predicted change would not be expected to adversely affect MUN beneficial uses, or any other beneficial use.

The assessment of Alternative 1A effects on DOC in the SWP/CVP Export Service Areas is based on assessment of changes in DOC concentrations at Banks and Jones pumping plants. Relative to the existing condition, long-term average DOC concentrations would decrease by as much as 0.4 mg/L at Banks and Jones pumping plants, although slightly more frequent export of >3 mg/L DOC water is predicted during periods of drought. Nevertheless, an overall improvement in DOC-related water quality would be predicted in the SWP/CVP Export Service Areas.

Based on the above, Alternative 1A operation and maintenance would not result in any substantial change in long-term average DOC concentration upstream of the Delta or result in substantial increase in the frequency with which long-term average DOC concentrations exceeds 2, 3, or 4 mg/L levels at the 11 assessment locations analyzed for the Delta. Modeled long-term average DOC concentrations would increase by no more than 0.3 mg/L at any single Delta assessment location (i.e., ≤9% relative increase), with long-term average concentrations estimated to remain at or below 4.0 mg/L at all Delta locations assessed, with the exception of Buckley Cove on the San Joaquin River during the drought period modeled. Nevertheless, long-term average concentrations at Buckley Cove are predicted to remain the same during the drought period, relative to Existing Conditions. The increases in long-term average DOC concentration that could occur within the Delta would not be of sufficient magnitude to adversely affect the MUN beneficial use, or any other beneficial uses, of Delta waters or waters of the SWP/CVP Service Area. Because DOC is not bioaccumulative, the increases in long-term average DOC concentrations would not cause bioaccumulative problems in aquatic life or humans. Finally, DOC is not causing beneficial use impairments and thus is not 303(d) listed for any water body within the affected environment. Thus, the increases in long-term average DOC that could occur at various locations would not make any beneficial use impairment measurably worse. Because long-term average DOC concentrations are not expected to increase substantially, no long-term water quality degradation with respect to DOC is expected to occur and, thus, no adverse effects on beneficial uses would occur This impact is considered to be less than significant. No mitigation is required.

Impact WQ-18: Effects on Dissolved Organic Carbon Concentrations Resulting from Implementation of CM2–CM22

NEPA Effects**:** The mostly non-land disturbing CM12–CM22 present no new sources of DOC to the affected environment, including areas Upstream of the Delta, within the Plan Area, and the SWP/CVP Export Service Area. Implementation of methylmercury control measures (CM12) and urban stormwater treatment measures (CM19) may result in beneficial effects, to the extent that control measures treat or reduce organic carbon loading from tidal wetlands and urban land uses. Control of nonnative aquatic vegetation (CM13) may include killing mature aquatic vegetation in place, leading to their decay and contribution to DOC in Delta channels. However, this measure is not expected to be a significant source of long-term DOC loading as vegetation control would be sporadic and on an as needed basis, with decreasing need for treatments in the long-term as nonnative vegetation is eventually controlled and managed. Implementation of CM12–CM22 would not be expected to have substantial, if even measurable, effect on DOC concentrations upstream of the Delta, within the Delta, and in the SWP/CVP service areas. Consequently, any negligible increases in DOC levels in these areas of the affected environment are not expected to be of sufficient frequency, magnitude and geographic extent that they would adversely affect the MUN beneficial use, or any other beneficial uses, of the affected environment, nor would potential increases substantially degrade water quality with regards to DOC.

For CM2–CM11, effects on DOC concentrations can generally be considered in terms of: (1) alternative-caused change in Delta hydrodynamics, and (2) alternative-caused change in Delta DOC sources. Change in Delta hydrodynamics involves a two part process, including the conveyance facilities and operational scenarios of CM1, as well as the change in Delta channel geometry and open water areas that would occur as a consequence of implementing tidal wetland restoration measures such as that described for CM4. Modeling scenarios included assumptions regarding how these habitat restoration activities would affect Delta hydrodynamics, and thus the effects of these restoration measures, via their effects on delta hydrodynamics, were included in the assessment of CM1 facilities operations and maintenance (see Impact WQ-17). The potential for these same conservation measures to change Delta DOC sources are addressed below.

CM2, CM3, CM8, CM9, and CM11 could include activities that would target increasing primary production (i.e., algae growth) within the Delta. Algae currently are not estimated to be a major source of DOC in the Delta (CALFED Bay-Delta Program 2008a: 4, 6), and comprise mostly the particulate fraction of TOC. Conventional drinking water treatment removes much of the POC from raw source water; therefore, conservation measure activities targeted at increased algae production are not expected to contribute substantial amounts of new DOC, or adversely affect MUN beneficial use, or any other beneficial uses, of the affected environment.

CM4–CM7 and CM10 include land disturbing restoration activities known to be sources of DOC. Research within the Delta has focused primarily on non-tidal wetlands and flooding of Delta island peat soils. The dynamics of DOC production and export from wetlands and seasonally flooded soils is complex, as well as highly site and circumstance specific. Age and configuration of a wetland significantly affects the amount of DOC that may be generated in a wetland. In a study of a permanently flooded non-tidal constructed wetland on Twitchell Island, initial DOC loading was determined to be much greater (i.e., approximately 10 times greater) than equivalent area of agricultural land, but trends in annual loading led researchers to estimate that loading from the wetland would be equivalent to that of agriculture within about 15 years (Fleck et. al. 2007: 18). It was observed that the majority of the wetland load originated from seepage through peat soils.

Trends in declining load were principally associated with flushing of mobile DOC from submerged soils, the origins of which were related to previous agricultural activity prior to restoration to wetland. Peaks in annual loading, however, would be different, where peaks in agricultural drainage occur in winter months while peaks in wetland loading occur in spring and summer months. As such, age, configuration, location, operation, and season all factor into DOC loading, and long-term average DOC concentrations in the Delta.

Available evidence suggests that restoration activities establishing new tidal and non-tidal wetlands, new riparian and new seasonal floodplain habitat could potentially lead to new substantial sources of localized DOC loading within the Delta. If established in areas presently used for agriculture, these restoration activities could result in a substitution and temporary increase in localized DOC loading for years. Presently, the specific design, operational criteria, and location of these activities are not well established. Depending on localized hydrodynamics, such restoration activities could contribute substantial amounts of DOC to municipal raw water if established near municipal intakes. Substantially increased DOC concentrations in municipal source water may create a need for existing drinking water treatment plants to upgrade treatment systems in order to achieve EPA Stage 1 Disinfectants and Disinfection Byproduct Rule action thresholds. While treatment technologies sufficient to achieve the necessary DOC removals exist, implementation of such technologies would likely require substantial investment in new or modified infrastructure.

In summary, the habitat restoration elements of CM4–CM7 and CM10 under Alternative 1A would present new localized sources of DOC to the study area, and in some circumstances would substitute for existing sources related to replaced agriculture. Depending on localized hydrodynamics and proximity to municipal drinking water intakes, such restoration activities could contribute substantial amounts of DOC to municipal raw water. Substantial increases in municipal raw water DOC could necessitate changes in water treatment plant operations or require treatment plant upgrades in order to maintain DBP compliance, and thus would constitute an adverse effect on water quality. Mitigation Measure WQ-18 is available to reduce these effects.

CEQA Conclusion: Implementation of CM2, CM3, CM8, CM9, and CM11–CM22 would not present new or substantially changed sources of organic carbon to the affected environment of the Delta, and thus would not contribute substantially to changes in long-term average DOC concentrations in the Delta. Therefore, related long-term water quality degradation would not be expected to occur and, thus, no adverse effects on beneficial uses would occur through implementation of CM2, CM3, CM8, CM9, and CM11–CM22. Furthermore, DOC is not bioaccumulative, therefore changes in DOC concentrations would not cause bioaccumulative problems in aquatic life or humans. Nevertheless, implementation of CM4–CM7 and 10 would present new localized sources of DOC to the study area, and in some circumstances would substitute for existing sources related to replaced agriculture. Depending on localized hydrodynamics and proximity to municipal drinking water intakes, such restoration activities could contribute substantial amounts of DOC to municipal raw water. The potential for substantial increases in long-term average DOC concentrations related to the habitat restoration elements of CM4–CM7 and 10 could contribute to long-term water quality degradation with respect to DOC and, thus, adversely affect MUN beneficial uses. The impact is considered to be significant and mitigation is required. It is uncertain whether implementation of Mitigation Measure WQ-18 would reduce identified impacts to a less-than-significant level. Hence, this impact remains significant and unavoidable.

In addition to and to supplement Mitigation Measure WQ-18, the BDCP proponents have incorporated into the BDCP, as set forth in EIR/EIS Appendix 3B, *Environmental Commitments*, a

separate, non-environmental commitment to address the potential increased water treatment costs that could result from DOC concentration effects on municipal and industrial water purveyor operations. Potential options for making use of this financial commitment include funding or providing other assistance towards implementing treatment for DOC and/or DBPs or DOC source control strategies. Please refer to Appendix 3B, *Environmental Commitments*, for the full list of potential actions that could be taken pursuant to this commitment in order to reduce the water quality treatment costs associated with water quality effects relating to DOC.

Mitigation Measure WQ-18: Design Wetland and Riparian Habitat Features to Minimize Effects on Municipal Intakes

Design wetland and riparian habitat features taking into consideration effects on Delta hydrodynamics and impacts on municipal intakes. Locate restoration features such that impacts on municipal intakes are minimized and habitat benefits are maximized. Incorporate design features to control the load and/or timing of DOC exports from habitat restoration features. This could include design elements to control seepage from non-tidal wetlands (e.g., incorporation of slurry walls into levees), and features to increase retention time and decrease tidal exchange in tidal wetlands and riparian and channel margin habitat designs. For restoration features directly connected to open channel waters, this could include designing wetlands with only channel margin exchanges to decrease DOC loading. Stagger construction of wetlands and channel margin/riparian sites both spatially and temporally so as to allow aging of the restoration features and associated decreased creation of localized "hot spots" and net Delta loading.

Establish measures to help guide the design and creation of the target wetland habitats. At a minimum, the measures should limit potential increases in long-term average DOC concentrations, and thus guide efforts to site, design, and maintain wetland and riparian habitat features, consistent with the biological goals and objectives of the BDCP. For example, restoration activities could be designed and located with the goal of preventing, consistent with the biological goals and objectives of the BDCP, net long-term average DOC concentration increases of greater than 0.5 mg/L at any municipal intake location within the Delta.

However, it must be noted that some of these measures could limit the benefit of restoration areas by limiting the amount of carbon supplied by these areas to the Delta as a whole. In some cases, these measures would run directly counter to the goals and objectives of the BDCP. This mitigation measure should not be implemented in such a way that it reduces the benefits to the Delta ecosystem provided by restoration areas. As mentioned above, the BDCP proponents have incorporated into the BDCP, as set forth in EIR/EIS Appendix 3B, *Environmental Commitments*, a separate, non-environmental commitment to address the potential increased water treatment costs that could result from DOC concentration effects on municipal and industrial water purveyor operations.

Impact WQ-19: Effects on Pathogens Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative, Alternative 1A would not result in substantial, and would likely result in immeasurable, increases in pathogen concentrations in the rivers and reservoirs upstream of the Delta, relative to Existing Conditions and the No Action

Alternative. Effects due to the operation and maintenance of the conveyance facilities are expected to be immeasurable, on an annual and long-term average basis.

Delta

For the same reasons stated for the No Action Alternative, Alternative 1A would not result in substantial, and would likely result in immeasurable, increases in pathogen concentrations in the Delta region relative to Existing Conditions and the No Action Alternative. Effects due to the operation and maintenance of the conveyance facilities are expected to be immeasurable, on an annual and long-term average basis.

SWP/CVP Export Service Areas

The water delivered to the SWP/CVP Export Service Areas would differ from that under Existing Conditions and the No Action Alternative, as it would consist of water diverted from the Sacramento River at Hood in addition to the water directly withdrawn from the Delta at the current export pumps.

The Pathogens Conceptual Model (Tetra Tech 2007, Figure 3-7) reports the median *E. coli* concentration in the Sacramento River at Hood is the same order of magnitude (10^1) as the median *E. coli* concentration at the Contra Costa Water District's Pumping Plant #1 and the Delta Pumping Plant Headworks (referred to herein as the Banks pumping plant), with the median Banks pumping plant concentrations being higher than the Sacramento River and Pumping Plant #1 median concentrations (data for comparison of total coliforms and fecal coliforms is not presented in Tetra Tech 2007 and, thus, only *E. coli* is discussed). Based on the Pathogen Conceptual Model's findings that Delta *E. coli* concentrations appear to be largely influenced by localized sources and that Sacramento River *E. coli* concentrations are lower than Delta concentrations, the diversion of Sacramento River water at Hood is not expected to measurably increase the *E. coli* concentration in the SWP/CVP Export Service Areas waters.

Furthermore, the following average pathogen concentrations for the Sacramento River at River Mile 44 (which is upstream of Hood and downstream of the Sacramento Regional Wastewater Treatment Plant) are reported in the Pathogens Conceptual Model (Tetra Tech 2007, Figure 3-4):

Cryptosporidium: 0.12 oocysts/L (31% of samples detected)

Giardia: 0.9 cysts/L ml (66% of samples detected)

Pathogen concentrations in SWP/CVP Export Service Areas waters, particularly *Giardia* and *Cryptosporidium* concentrations, are of concern because the concentration of these pathogens dictates the level treatment required for the drinking water supply. The *California State Water Project Sanitary Survey, 2006 Update* (State Water Project Contractors Authority 2007) reported *Giardia* and *Cryptosporidium* concentrations for locations throughout the SWP. These pathogens were not frequently detected and the concentrations reported were such that the waters would be classified as "Bin 1" under the Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR), meaning no additional treatment required under the Rule, though some waters required additional monitoring to confirm this classification. Based on the levels of *Cryptosporidium* in the Sacramento River, this alternative would not be expected to adversely affect the municipal and domestic water supply uses in the service areas, as the water would be classified as "Bin 1" with respect to the LT2ESWTR, meaning no additional treatment required.

With respect to the remaining beneficial uses in the service area (e.g., recreation), an increased proportion of water coming from the Sacramento River would not adversely affect those uses in the SWP/CVP Export Service Areas. As described above, the pathogen levels in the Sacramento River are similar to or lower than the water diverted at the Delta export pumps. Further, it is localized sources of pathogens that appear to have the greatest influence on concentrations (Tetra Tech 2007). Thus, an increased proportion of Sacramento River water diverted to the SWP/CVP Export Service Areas would result in minimal changes in pathogen levels in the SWP/CVP Export Service Areas waters.

For the same reasons stated for the No Action Alternative, Alternative 1A is expected to have minimal effects on pathogen concentrations in SWP/CVP Export Service Areas waters relative to Existing Conditions and No Action Alternative.

NEPA Effects: The effects on pathogens from implementing CM1 is determined to not be adverse.

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

River flow rate and reservoir storage reductions that would occur due to implementation of CM1 (water facilities and operations) under Alternative 1A, relative to Existing Conditions, would not be expected to result in a substantial adverse change in pathogen concentrations in the reservoirs and rivers upstream of the Delta, given the small magnitude of urban runoff contributions relative to the magnitude of river flows, that pathogen concentrations in the rivers have a minimal relationship to river flow rate, and the expected reduced pollutant loadings in response to NPDES stormwater-related regulations.

It is expected there would be no substantial change in Delta pathogen concentrations in response to a shift in the Delta source water percentages under this alternative or substantial degradation of these water bodies, with regard to pathogens. This conclusion is based on the Pathogens Conceptual Model, which found that pathogen sources in close proximity to a Delta site appear to have the greatest influence on pathogen levels at the site, rather than the primary source(s) of water to the site. In-Delta potential pathogen sources, including water-based recreation, tidal habitat, wildlife, and livestock-related uses, would continue under this alternative.

In the SWP/CVP Export Service Areas waters, relative to Existing Conditions, an increased proportion of water coming from the Sacramento River would not adversely affect beneficial uses in the SWP/CVP Export Service Areas. The pathogen levels in the Sacramento River are similar to or lower than the water diverted at the Delta export pumps. Further, it is localized sources of pathogens that appear to have the greatest influence on concentrations. Thus, an increased proportion of Sacramento River water diverted to the SWP/CVP Export Service Areas would result in minimal changes in pathogen levels in the SWP/CVP Export Service Areas waters.

Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because pathogen concentrations are not expected to increase substantially, no long-term water quality degradation for pathogens is expected to occur and, thus, no adverse effects on beneficial uses would occur. The San Joaquin River in the Stockton Deep Water Ship Channel is Clean Water Act section 303(d) listed for pathogens. Because no measurable increase in Deep Water Ship Channel pathogen concentrations are expected to occur on a long-term basis, further degradation and impairment of this area is not expected to occur. Finally, pathogens are not bioaccumulative constituents. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-20: Effects on Pathogens Resulting from Implementation of CM2–CM22

***NEPA Effects*:** CM2–CM11 would involve habitat restoration actions, and CM22 involves waterfowl and shorebird areas. Tidal wetlands are known to be sources of coliforms originating from aquatic, terrestrial, and avian wildlife that inhabit these areas (Desmarais et al. 2001, Grant et al. 2001, Evanson and Ambrose 2006, Tetra Tech 2007). Specific locations of restoration areas for this alternative have not yet been established. However, most low-lying land suitable for restoration is unsuitable for livestock. Therefore, it is likely that the majority of land to be converted to wetlands would be crop-based agriculture or fallow/idle land. Because of a great deal of scientific uncertainty in the loading of coliforms from these various sources, the resulting change in coliform loading is uncertain, but it is anticipated that coliform loading to Delta waters would increase. Based on findings from the Pathogens Conceptual Model that pathogen concentrations are greatly influenced by the proximity to the source, this could result in localized increases in wildlife-related coliforms relative to the No Action Alternative. The Delta currently supports similar habitat types and, with the exception of the Clean Water Act section 303(d) listing for the Stockton Deep Water Ship Channel, is not recognized as exhibiting pathogen concentrations that rise to the level of adversely affecting beneficial uses. As such, the potential increase in wildlife-related coliform concentrations due to tidal habitat creation is not expected to adversely affect beneficial uses.

CM19, which would fund projects to contribute to reducing pollutant discharges in stormwater, would be expected to reduce pathogen load relative to the No Action Alternative. The remaining conservation measures would not be expected to affect pathogen levels, because they are actions that do not affect the presence of pathogen sources. The effects on pathogens from implementing CM2–CM22 is determined to not be adverse.

***CEQA Conclusion*:** Based on findings from the Pathogens Conceptual Model that pathogen concentrations are greatly influenced by the proximity to the source, implementation of CM2–CM11 and CM22 could result in localized increases in wildlife-related coliforms relative to Existing Conditions. The Delta currently supports similar habitat types and, with the exception of the Clean Water Act section 303(d) listing for the Stockton Deep Water Ship Channel, is not recognized as exhibiting pathogen concentrations that rise to the level of adversely affecting beneficial uses. As such, the potential increase in wildlife-related coliform concentrations due to tidal habitat creation is not expected to adversely affect beneficial uses. Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because pathogen concentrations are not expected to increase substantially, no long-term water quality degradation for pathogens is expected to occur and, thus, no adverse effects on beneficial uses would occur. The San Joaquin River in the Stockton Deep Water Ship Channel is Clean Water Act section 303(d) listed for pathogens. Because no measurable increase in Deep Water Ship Channel pathogen concentrations are expected to occur on a long-term basis, further degradation and impairment of this area is not expected to occur. Finally, pathogens are not bioaccumulative constituents. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-21: Effects on Pesticide Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative, under Alternative 1A no specific operations or maintenance activity of the SWP or CVP would substantially drive a change in pesticide use, and thus pesticide sources would remain unaffected upstream of the Delta. Nevertheless, changes in the timing and magnitude of reservoir releases could have an effect on available dilution capacity along river segments such as the Sacramento, Feather, American, and San Joaquin Rivers.

Under Alternative 1A, winter (November–March) and summer (April–October) season average flow rates on the Sacramento River at Freeport, American River at Nimbus, Feather River at Thermalito and the San Joaquin River at Vernalis would change. Averaged over the entire period of record, seasonal average flow rates on the Sacramento would decrease no more than 7% during the summer and 2% during the winter relative to Existing Conditions (Appendix 8L, Seasonal average flows Tables 1-4). On the Feather River, average flow rates would decrease by as much as 5% during the summer, but would increase by as much as 12% in the winter, while on the American River average flow rates would decrease by as much as 16% in the summer but would increase by as much as 9% in the winter. Seasonal average flow rates on the San Joaquin River would decrease by as much as 12% in the summer, but increase by as much as 1% in the winter relative to Existing Conditions. In comparison to the No Action Alternative, the relative magnitude change in seasonal average flows would be similar, with exception to the estimated change on the American River and San Joaquin River relative to No Action Alternative. In comparison to No Action Alternative, there would be no estimated change in season average flows on the San Joaquin River (i.e., 0% summer and winter change) and there would only be a 1% decrease of summer average flows on the American River.

For the same reasons stated for the No Action Alternative, decreased seasonal average flow of ≤16% is not considered to be of sufficient magnitude to substantially increase pesticide concentrations or alter the long-term risk of pesticide-related toxicity to aquatic life, nor adversely affect other beneficial uses of water bodies upstream of the Delta.

Delta

Sources of diuron, OP and pyrethroid insecticides to the Plan Area include direct input of surface runoff from in-Delta agriculture and Delta urbanized areas as well as inputs from rivers upstream of the Delta. Similar to Upstream of the Delta, CVP/SWP operations would not affect these sources.

Under Alternative 1A, the distribution and mixing of Delta source waters would change. Percent change in monthly average source water fraction were evaluated for the modeled 16-year (1976–1991) hydrologic period and a representative drought period (1987–1991), with special attention given to changes in San Joaquin River, Sacramento River and Delta Agriculture sources water fractions. Relative to Existing Conditions, under Alternative 1A modeled San Joaquin River fractions would increase greater than 10% at Franks Tract, Rock Slough, and Contra Costa PP No. 1 (Appendix 8D, Source Water Fingerprinting). At Franks Tract, source water fractions when modeled for the 16-year hydrologic period would increase 13–15% during February and March. San Joaquin River source water fractions when modeled for the 16-year hydrologic period would increase 14–16% during February and March at Rock Slough and 13–17% during March and April at Contra Costa PP

No. 1. Sacramento River fractions would increase greater than 10% at Buckley Cove as well. At Buckley Cove, Sacramento River source water fractions when modeled for the 16-year hydrologic period would increase by 11% during August, and 11–14% during July and August during the modeled drought period. Relative to Existing Conditions, there would be no modeled increases in Delta agricultural fractions greater than 7%. These modeled changes in the source water fractions of Sacramento, San Joaquin and Delta agriculture water are not of sufficient magnitude to substantially alter the long-term risk of pesticide-related toxicity to aquatic life, nor adversely affect other beneficial uses of the Delta. This comparison to Existing Conditions reflects changes in Delta source water fractions 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.

When compared to the No Action Alternative, changes in source water fractions would be similar in season, geographic extent, and magnitude to those discussed for Existing Conditions with exception to Buckley Cove. At Buckley Cove, modeled drought period San Joaquin River fractions would increase 15% in July and 26% in August when compared to No Action Alternative (Appendix 8D, Source Water Fingerprinting). These increases would primarily balance through decreases in Sacramento River water and eastside tributary waters. Nevertheless, the San Joaquin River would only account for 37% of the total source water volume at Buckley Cove in July and August during the modeled drought period. As such, these modeled changes in the source water fractions of Sacramento, San Joaquin and Delta agriculture water are not of sufficient magnitude to substantially alter the long-term risk of pesticide-related toxicity to aquatic life, nor adversely affect other beneficial uses of the Delta. Unlike the comparison to Existing Conditions, the comparison to the No Action Alternative reflects changes in Delta source water fractions due only to Alternative 1A operations.

SWP/CVP Export Service Areas

Assessment of effects in SWP/CVP Export Service Areas is based on effects seen in the Plan Area at the Banks and Jones pumping plants. Under Alternative 1A, Sacramento River source water fractions would increase substantially at both Banks and Jones pumping plants relative to Existing Conditions and the No Action Alternative (Appendix 8D, Source Water Fingerprinting). Source water fractions would generally increase from 13–53% for the period of December through June for the modeled 16-year hydrologic period and 13–40% from the period of March through May for the modeled drought period. These increases in Sacramento source water fraction would primarily balance through equivalent decreases in San Joaquin River fraction. Based on the general observation that San Joaquin River, in comparison to the Sacramento River, is a greater contributor of OP insecticides in terms of greater frequency of incidence and presence at concentrations exceeding water quality benchmarks, modeled increases in Sacramento River fraction at Banks and Jones would generally represent an improvement in export water quality respective to pesticides.

NEPA Effects**:** In summary, the changes in long-term average flows on the Sacramento, Feather, American, and San Joaquin Rivers, under Alternative 1A relative to the No Action Alternative, are of insufficient magnitude to substantially increase the long-term risk of pesticide-related water quality degradation and related toxicity to aquatic life in these water bodies upstream of the Delta. Similarly, modeled changes in source water fractions to the Delta are of insufficient magnitude to substantially alter the long-term risk of pesticide-related water quality degradation and related toxicity to aquatic life in the Delta or CVP/SWP export service areas. The effects on pesticides from operations and maintenance (CM1) are determined not to be adverse.

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

Sources of pesticides upstream of the Delta include direct input of pesticide containing surface runoff from agriculture and urbanized areas. Flows in rivers receiving these discharges dilute these pesticide inputs. Relative to Existing Conditions, however, modeled changes in long-term average flows on the Sacramento, Feather, American, and San Joaquin Rivers are of insufficient magnitude to substantially increase the long-term risk of pesticide-related water quality degradation and related toxicity to aquatic life in these water bodies upstream of the Delta.

In the Delta, sources of pesticides include direct input of surface runoff from Delta agriculture and Delta urbanized areas as well as inputs from rivers upstream of the Delta. While facilities operations and maintenance activities would not affect these sources, changes in Delta source water fraction could change the relative risk associated with pesticide related toxicity to aquatic life. Under Alternative 1A, however, modeled changes in source water fractions relative to Existing Conditions are of insufficient magnitude to substantially alter the long-term risk of pesticide-related toxicity to aquatic life within the Delta, nor would such changes result in adverse pesticide-related effects on any other beneficial uses of Delta waters.

The assessment of Alternative 1A effects on pesticides in the SWP/CVP Export Service Areas is based on assessment of changes predicted at Banks and Jones pumping plants. As just discussed regarding effects to pesticides in the Delta, modeled changes in source water fractions at the Banks and Jones pumping plants are of insufficient magnitude to substantially alter the long-term risk of pesticide-related toxicity to aquatic life beneficial uses, or any other beneficial uses, in water bodies of the SWP and CVP export service area.

Based on the above, Alternative 1A would not result in any substantial change in long-term average pesticide concentration or result in substantial increase in the anticipated frequency with which long-term average pesticide concentrations would exceed aquatic life toxicity thresholds or other beneficial use effect thresholds upstream of the Delta, at the 11 assessment locations analyzed for the Delta, or the SWP/CVP service area. Numerous pesticides are currently used throughout the affected environment, and while some of these pesticides may be bioaccumulative, those present-use pesticides for which there is sufficient evidence for their presence in waters affected by SWP and CVP operations (i.e., diazinon, chlorpyrifos, diuron, and pyrethroids) are not considered bioaccumulative, and thus changes in their concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Furthermore, while there are numerous 303(d) listings throughout the affected environment that name pesticides as the cause for beneficial use impairment, the modeled changes in upstream river flows and Delta source water fractions would not be expected to make any of these beneficial use impairments measurably worse. Because long-term average pesticide concentrations are not expected to increase substantially, no long-term water quality degradation with respect to pesticides is expected to occur and, thus, no adverse effects on beneficial uses would occur. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-22: Effects on Pesticide Concentrations Resulting from Implementation of CM2–CM22

With the exception of CM13, the mostly non-land disturbing CM12–CM22 present no new sources of pesticides to the affected environment, including areas Upstream of the Delta, within the Plan Area, and the SWP/CVP Export Service Area. Implementation of urban stormwater treatment measures (CM19) may result in beneficial effects, to the extent that control measures treat or reduce pesticide loading from urban land uses. However, control of nonnative aquatic vegetation (CM13) associated with tidal habitat restoration efforts would include killing invasive and nuisance aquatic vegetation through direct application of herbicides or through alternative mechanical means. Use and selection of type of herbicides would largely be circumstance specific, but would follow existing control methods used by the California Department of Boating and Waterways (CDBW). The CDBW's use of herbicides is regulated by permits and regulatory agreements with the Central Valley Water Board, US Fish and Wildlife Service, and National Marine Fisheries Service and is guided by research conducted on the efficacy of vegetation control in the Delta through herbicide use. Through a program of adaptive management and assessment, the CDBW has employed a program of herbicide use that reduces potential environmental impacts, nevertheless, the CDBW found that impacts on water quality and associated aquatic beneficial uses would continue to occur and could not be avoided, including non-target impacts on aquatic invertebrates and beneficial aquatic plants (California Department of Boating and Waterways 2006).

In addition to the potential beneficial and adverse effects of CM19 and CM13, respectively, the various restoration efforts of CM2–CM11 could involve the conversion of active or fallow agricultural lands to natural landscapes, such as wetlands, grasslands, floodplains, and vernal pools. In the long-term, conversion of agricultural land to natural landscapes could possibly result in a limited reduction in pesticide use throughout the Delta. In the short-term, tidal and non-tidal wetland restoration, as well as seasonal floodplain restoration (i.e., CM4, CM5, and CM10) over former agricultural lands may include the contamination of water with pesticide residues contained in the soils. Present use pesticides typically degrade fairly rapidly, and in such cases where pesticide containing soils are flooded, dissipation of those pesticides would be expected to occur rapidly. Moreover, seasonal floodplain restoration (CM5) and Yolo Bypass enhancements (CM2) may be managed alongside continuing agriculture, where pesticides may be used on a seasonal basis and where water during flood events may come in contact with residues of these pesticides. Similarly, however, rapid dissipation would be expected, particularly in the large volumes of water involved in flooding. During these flooding events, pesticides potentially suspended in water would not be expected to cause toxicity to aquatic life or cause substantial adverse effects on any other beneficial uses of these water bodies.

NEPA Effects: In summary, CM13 of Alternative 1A proposes the use of herbicides to control invasive aquatic vegetation around habitat restoration sites. Herbicides directly applied to water could adversely affect non-target aquatic life, such as aquatic invertebrates and beneficial aquatic plants. Use of herbicides could potentially exceed aquatic life toxicity objectives with sufficient frequency and magnitude such that beneficial uses would be adversely affected, thus constituting an adverse effect on water quality. Mitigation Measure WQ-22 would be available to reduce this effect.

CEQA Conclusion: With the exception of CM13, implementation of CM2–CM22 would not present new or substantially increased sources of pesticides in the Plan Area. In the long-term, implementation of conservation measures could possibly result in a limited reduction in pesticide use throughout the Delta through the potential repurposing of active or fallow agricultural land for natural habitat purposes. In the short-term, the repurposing of agricultural land associated with CM4, CM5, and CM10 may expose water used for habitat restoration to pesticide residues. Moreover, CM2 and CM5 may be managed alongside continuing agriculture, where pesticides may be used on a seasonal basis and where water during flood events may come in contact with residues of these pesticides. However, rapid dissipation would be expected, particularly in the large volumes of water involved in flooding, such that aquatic life toxicity objectives would not be exceeded by frequency, magnitude, and geographic extent whereby adverse effects on beneficial uses would be expected. Conservation Measures 2–22 do not include the use of pesticides known to be bioaccumulative in animals or humans, nor do the conservation measures propose the use of any pesticide currently named in a Section 303(d) listing of the affected environment. CM13 proposes the use of herbicides to control invasive aquatic vegetation around habitat restoration sites. Herbicides directly applied to water could include adverse effects on non-target aquatic life, such as aquatic invertebrates and beneficial aquatic plants. As such, aquatic life toxicity objectives could be exceeded with sufficient frequency and magnitude such that beneficial uses would be impacted. Potential environmental effects related only to CM13 are considered significant and unavoidable. Mitigation Measure WQ-22 is available to partially reduce this impact of pesticides on water quality; however, no feasible mitigation is available that would reduce it to a level that would be less than significant. This impact is therefore considered significant and unavoidable.

Mitigation Measure WQ-22: Implement Principals of Integrated Pest Management

Implement the principals of integrated pest management (IPM) in the management of invasive aquatic vegetation under CM13, including the selective use of pesticides applied in a manner that minimizes risks to human health, nontarget organisms and the aquatic ecosystem. In doing so, the BDCP proponents will consult with the Central Valley Water Board, USFWS, NMFS, and CDBW to obtain effective IPM strategies such as selective application of pesticides, timing of applications in order to minimize tidal dispersion, and timing to target the invasive plant species at the most vulnerable times such that less herbicide can be used or the need for repeat applications can be reduced.

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

Upstream of the Delta

The conveyance facilities operations and maintenance (CM1) for Alternative 1A will not contribute additional sources of phosphorus to the water bodies upstream of the Delta. Because phosphorus loading to waters upstream of the Delta is not anticipated to change under Alternative 1A, and because changes in flows do not necessarily result in changes in concentrations or loading of phosphorus to these water bodies, as discussed for the No Action Alternative, substantial changes in phosphorus concentration are not anticipated in any of the water bodies of the affected environment located upstream of the Delta under Alternative 1A, relative to Existing Conditions or the No Action Alternative. Any negligible changes in phosphorus concentrations that may occur in these water bodies would not be of frequency, magnitude and geographic extent that would exceed adopted phosphorus objectives/criteria (because there are none), adversely affect any beneficial uses, or substantially degrade the quality of these water bodies, with regards to phosphorus.

Delta

As discussed for the No Action Alternative, because phosphorus concentrations in the major source waters to the Delta are similar for much of the year, phosphorus concentrations in the Delta are not anticipated to change substantially on a long term-average basis. Additionally, activities associated with CM1 will not contribute additional sources of phosphorus to the Delta. Phosphorus concentrations may increase during January through March at locations where the source fraction of San Joaquin River water increases, due to the higher concentration of phosphorus in the San Joaquin River during these months compared to Sacramento River water or San Francisco Bay water. Based on the DSM2 fingerprinting results (see Appendix 8D), together with source water concentrations show in Figure 8-56, the magnitude of increase during these months may range from negligible up to approximately 0.05 mg/L. However, there are no state or federal objectives for phosphorus, and because algal growth rates are limited by availability of light in the Delta, and thus increases or decreases in nutrient levels are, in general, expected to have little effect on productivity, any changes in phosphorus concentrations that may occur at certain locations within the Delta are not anticipated to be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to phosphorus.

SWP/CVP Export Service Areas

Assessment of effects of phosphorus in the SWP and CVP Export Service Areas is based on effects on phosphorus at the Banks and Jones pumping plants.

Based on the DSM2 fingerprinting results (see Appendix 8D), together with source water concentrations show in Figure 8-56, long-term average monthly and annual phosphorus concentrations at Banks and Jones pumping plants are anticipated to decrease as a result of Sacramento River water replacing San Joaquin River water in exports. During drought conditions, phosphorus concentrations may increase during certain months, but these increases are expected to be negligible (<0.01 mg/L). There are no state or federal objectives for phosphorus. Moreover, given the many factors that contribute to potential algal blooms in the SWP and CVP canals within the Export Service Area, and the lack of studies that have shown a direct relationship between nutrient concentrations in the canals and reservoirs and problematic algal blooms in these water bodies, there is no basis to conclude that any seasonal increases in phosphorus concentrations at the levels expected under this alternative, should they occur, would increase the potential for problem algal blooms in the SWP and CVP Export Service Area.

Any increases in phosphorus concentrations that may occur in water exported via Banks and Jones pumping plants are not expected to result in adverse effects to beneficial uses of exported water or substantially degrade the quality of exported water, with regards to phosphorus.

NEPA Effects: The effects on phosphorus from implementing CM1 are determined to not be adverse.

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

Because phosphorus loading to waters upstream of the Delta is not anticipated to change, and because changes in flows do not necessarily result in changes in concentrations or loading of phosphorus to these water bodies, substantial changes in phosphorus concentration upstream of the Delta are not anticipated for Alternative 1A, relative to Existing Conditions.

Because phosphorus concentrations in the major source waters to the Delta are similar for much of the year, phosphorus concentrations in the Delta are not anticipated to change substantially on a long term-average basis under Alternative 1A, relative to Existing Conditions. Algal growth rates are limited by availability of light in the Delta, and therefore any minor increases in phosphorus levels that may occur at some locations and times within the Delta would be expected to have little effect on primary productivity in the Delta.

The assessment of effects of phosphorus under Alternative 1A in the SWP and CVP Export Service Areas is based on effects on phosphorus at the Banks and Jones pumping plants. As noted above, phosphorus concentrations in the Delta (including Banks and Jones pumping plants) are not anticipated to change substantially on a long term-average basis.

Based on the above, there would be no substantial, long-term increase in phosphorus concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the waters exported to the CVP and SWP service areas under the Alternative 1A relative to Existing Conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/ criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because phosphorus concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Phosphorus is not 303(d) listed within the affected environment and thus any minor increases that may occur in some areas would not make any existing phosphorus-related impairment measurably worse because no such impairments currently exist. Because phosphorus is not bioaccumulative, minor increases that may occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-24: Effects on Phosphorus Concentrations Resulting from Implementation of CM2–CM22

***NEPA Effects*:** CM2–CM11 include activities that create additional aquatic habitat within the affected environment, and therefore may increase the total amount of algae and plant-life within the Delta. These activities would not affect phosphorus loading to the affected environment, but may affect phosphorus dynamics and speciation. For example, water column concentrations of total phosphorus may increase or decrease in localized areas as a result of increased or decreased suspended solids, while ortho-phosphate concentrations may be locally altered as a result of changing planktonic and macroinvertebrate species contributing to the cycling of phosphorus within the affected environment. Additionally, depending on age, configuration, location, operation, and season, some of the restoration measures included under these conservation measures may function to remove or sequester phosphorus, but since presently, the specific design, operational criteria, and location of these activities are not well established, the degree to which this would occur is unknown. Overall, phosphorus concentrations are not expected to change substantially in the affected environment as a result of CM2–CM22. Because increases or decreases in phosphorus levels are, in general, expected to have little effect on productivity, any changes in phosphorus concentrations that may occur at certain locations within the affected environment are not anticipated to be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to phosphorus.

Because urban stormwater is a source of phosphorus in the affected environment, CM19, Urban Stormwater Treatment, is expected to slightly reduce phosphorus loading to the Delta, thus slightly decreasing phosphorus concentrations relative to the No Action Alternative. Implementation of CM12–CM18 and CM20–CM22 is not expected to substantially alter phosphorus concentrations in the affected environment.

The effects on phosphorus from implementing CM2–22 are considered to be not adverse.

***CEQA Conclusion*:** There would be no substantial, long-term increase in phosphorus concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the waters exported to the CVP and SWP service areas due to implementation of CM2–CM22 under Alternative 1A relative to Existing Conditions. Because urban stormwater is a source of phosphorus in the affected environment, CM19, Urban Stormwater Treatment, is expected to slightly reduce phosphorus loading to the Delta. As such, implementation of these conservation measures is not expected to cause adverse effects on any beneficial uses of waters in the affected environment. Because phosphorus concentrations are not expected to increase substantially due to these conservation measures, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Phosphorus is not 303(d) listed within the affected environment and thus any minor increases that may occur in some areas would not make any existing phosphorus-related impairment measurably worse because no such impairments currently exist. Because phosphorus is not bioaccumulative, minor increases that may occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant. No mitigation is required.

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

Upstream of the Delta

For the same reasons stated for the No Action Alternative, Alternative 1A would have negligible, if any, effect on selenium concentrations in the rivers and reservoirs upstream of the Delta relative to Existing Conditions and the No Action Alternative. Any negligible increases in selenium concentrations that could occur in the water bodies of the affected environment in the Upstream of the Delta Region would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regard to selenium.

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 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for CM2-22. See section 8.3.1.3 for more information.

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 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, Table M-10A). These small changes in selenium concentrations in water are reflected in small percent changes (10% or less) in available assimilative capacity for selenium (based on 2 µg/L ecological risk benchmark) for all years. Relative to Existing Conditions, Alternative 1A would result in the largest modeled increase in available assimilative capacity at Buckley Cove (5%) and the largest decrease at Contra Costa PP (2%) (Figure 8-59). Relative to the No Action Alternative, the largest modeled increase in available assimilative capacity would be at Mokelumne River (South Fork) at Staten Island (Staten Island) (1%) and the largest decrease would be at Franks Tract (2%) (Figure 8-60). Although there are some small negative changes in selenium concentrations in water, the effect of Alternative 1A is generally minimal for the Delta locations. Furthermore, the modeled selenium concentrations in water (Appendix 8M, Table M-11) for Alternative 1A (range 0.21–0.70 µg/L) are similar to those for Existing Conditions (range 0.21–0.76 µg/L), and the No Action Alternative (range 0.21–0.69 µg/L), and all would be below the ecological risk benchmark (2 µg/L).

Relative to Existing Conditions and the No Action Alternative, Alternative 1A would result in small changes in estimated selenium concentrations in biota (whole-body fish, bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets) (Appendix 8M, Table M-12 and Addendum M.A to Appendix 8M, Table M.A-2). Relative to Existing Conditions, 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 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.A-2). Although all of these values exceed both the low and high toxicity benchmarks, it is unlikely that the modeled increases in whole-body selenium for sturgeon would be measurable in the environment (see also the discussion of results provided in Addendum M.A to Appendix 8M).

Relative to Existing Conditions and the No Action Alternative, Alternative 1A would result in essentially no change in selenium concentrations throughout the Delta. Alternative 1A would not be expected to substantially increase the frequency with which applicable benchmarks would be exceeded in the Delta or substantially degrade the quality of water in the Delta, with regard to selenium.

SWP/CVP Export Service Areas

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 changes in average selenium concentrations in water at the two modeled Export Service Area assessment locations relative to Existing Conditions and the No Action Alternative (Appendix 8M, Table M-10A). These small changes in selenium concentrations in water are reflected in small percent changes (10% or less) in available assimilative capacity for selenium (based on 2 μg/L ecological risk benchmark) for all years. Relative to Existing Conditions and the No Action Alternative, Alternative 1A would result in small increases in available assimilative capacity at Jones PP (6% and 7%, respectively) and at Banks PP (6% and 5%, respectively), and have a small positive effect on the Export Service Area locations (Figures 8-59 and 8-60). Furthermore, the modeled selenium concentrations in water (Table 8.3-E-Se) for Alternative 1A (range 0.37–0.50 μg/L) are similar to those for Existing Conditions (range 0.37–0.58 μg/L) and the No Action Alternative (range 0.37–0.59 μg/L), and all would be well below the ecological risk benchmark (2 μg/L).

Relative to Existing Conditions and the No Action Alternative, Alternative 1A would result in small changes in estimated selenium concentrations in biota (whole-body fish, bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets) (Appendix 8M, Table M-12). Relative to Existing Conditions and the No Action Alternative, the largest increase of selenium concentrations in biota under Alternative 1A would be at Banks PP for drought years, and the largest decrease would be at Jones PP for all years (except for bird eggs [assuming a fish diet] at Jones PP for drought years). Relative to the No Action Alternative, the largest increase under Alternative 1A would be at Banks PP for drought years (except for bird eggs [assuming a fish diet] at Banks PP for all years), and the largest decrease would be at Jones PP for all years (except for bird eggs [assuming a fish diet] at Jones PP for drought years). However, concentrations in biota would not exceed any benchmarks for Alternative 1A (Figures 8-61 through 8-64).

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

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

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

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

Relative to Existing Conditions, modeling estimates indicate that Alternative 1A would result in essentially no change in selenium concentrations in water or biota throughout the Delta.

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 1A would slightly decrease the frequency with which applicable benchmarks would be exceeded or slightly improve the quality of water in selenium concentrations at the Banks and Jones pumping plants locations.

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

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

***NEPA Effects*:** In general, with the possible exception of changes in Delta hydrodynamics resulting from habitat restoration, CM2–CM11 would not substantially increase selenium concentrations in the water bodies of the affected environment. Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, and thus such effects of these restoration measures were included in the assessment of CM1 facilities operations and maintenance (see Impact WQ-25).

However, implementation of these conservation measures may increase water residence time within the restoration areas. Increased restoration area water residence times could potentially increase the bioaccumulation of selenium in biota, thereby potentially increasing fish tissue and bird egg concentrations of selenium, but models are not available to quantitatively estimate the level of changes in residence time and the associated selenium bioavailability. If increases in fish tissue or bird egg selenium were to occur, the increases would likely be of concern only where fish tissues or bird eggs are already elevated in selenium to near or above thresholds of concern. That is, where biota concentrations are currently low and not approaching thresholds of concern, changes in residence time alone would not be expected to cause them to then approach or exceed thresholds of concern. In consideration of this factor, although the Delta as a whole is a 303(d)-listed water body for selenium, and although monitoring data of fish tissue or bird eggs in the Delta are sparse, the most likely areas in which biota tissues would be at levels high enough that additional bioaccumulation due to increased residence time from restoration areas would be a concern are the western Delta and Suisun Bay, and the South Delta in areas that receive San Joaquin River water.

The western Delta and Suisun Bay receive elevated selenium loads from North San Francisco Bay (including San Pablo Bay, Carquinez Strait, and Suisun Bay) and from the San Joaquin River. Point sources of selenium in North San Francisco Bay (i.e., refineries) that contribute selenium to Suisun Bay are expected to be reduced through a TMDL under development by the San Francisco Bay Water Board (San Francisco Bay Water Board 2012) that is expected to result in decreasing discharges of selenium. Nonpoint sources of selenium in the San Joaquin Valley that contribute selenium to the San Joaquin River, and thus the Delta and Suisun Bay, will be controlled through a TMDL developed by the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the Grassland Bypass Project, and Basin Plan objectives (Central Valley Water Board 2010c, d) that are expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta. If selenium levels are not sufficiently reduced via these efforts, it is expected that the State Water Board and the San Francisco Bay and Central Valley Water Boards would initiate additional actions to further control sources of selenium.

The South Delta receives elevated selenium loads from the San Joaquin River. In contrast to Suisun Bay and possibly the western Delta in the future, the South Delta lacks the overbite clam (*Corbula* [*Potamocorbula*] *amurensis*), which is considered a key driver of selenium bioaccumulation in Suisun Bay, due to its high bioaccumulation of selenium and its role in the benthic food web that includes long-lived sturgeon. The South Delta does have *Corbicula fluminea*, another bivalve that bioaccumulates selenium, but it is not as invasive as the overbite clam and thus likely makes up a smaller fraction of sturgeon diet. Also, as mentioned above, nonpoint sources of selenium in the San Joaquin Valley that contribute selenium to the Delta will be controlled through a TMDL developed by the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the Grassland Bypass Project, and Basin Plan objectives (Central Valley Water Board 2010c, d) that are expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta. Further, if selenium levels in the San Joaquin River are not sufficiently reduced via these efforts, it is expected that the State Water Board and Central Valley Water Board would initiate additional TMDLs to further control nonpoint sources of selenium.

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

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

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

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

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

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

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

Impact WQ-27: Effects on Trace Metal Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative, Alternative 1A would result in negligible, and likely immeasurable, increases in trace metal concentrations in the rivers and reservoirs upstream of the Delta, relative to Existing Conditions and the No Action Alternative. Effects due to the operation and maintenance of the conveyance facilities are expected to be immeasurable, on an annual and long-term average basis. As such, Alternative 1A would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or CTR criteria would be exceeded in water bodies of the affected environment located upstream of the Delta or substantially degrade the quality of these water bodies, with regard to trace metals.

Delta

For the same reasons stated for the No Action Alternative, Alternative 1A would not result in substantial increases in trace metal concentrations in the Delta relative to Existing Conditions and the No Action Alternative. Effects due to the operation and maintenance of the conveyance facilities are expected to be negligible, on a long-term average basis. As such, Alternative 1A 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 Delta waters, with regard to trace metals.

SWP/CVP Export Service Areas

For the same reasons stated for the No Action Alternative, Alternative 1A would not result in substantial increases in trace metal concentrations in the water exported from the Delta or diverted from the Sacramento River through the proposed conveyance facilities. As such, there is not expected to be substantial changes in trace metal concentrations in the SWP/CVP export service area waters under Alternative 1A, relative to Existing Conditions and the No Action Alternative. As such, Alternative 1A would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or CTR criteria would be exceeded in the water bodies of the affected environment in the SWP and CVP Service Area or substantially degrade the quality of these water bodies, with regard to trace metals.

NEPA Effects: In summary, Alternative 1A, relative to the No Action Alternative, would not cause a substantial increase in long-term average trace metals concentrations within the affected environment, nor would it cause an increased frequency of water quality objective/criteria exceedances within the affected environment. The effect on trace metals is determined not to be adverse.

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

While greater water demands under the Alternative 1A would alter the magnitude and timing of reservoir releases north, south and east of the Delta, these activities would have no substantial effect on the various watershed sources of trace metals. Moreover, long-term average flow and trace metals at Sacramento River at Hood and San Joaquin River at Vernalis are poorly correlated; therefore, changes in river flows would not be expected to cause a substantial long-term change in trace metal concentrations upstream of the Delta.

Average and 95th percentile trace metal concentrations are very similar across the primary source waters to the Delta. Given this similarity, very large changes in source water fraction would be necessary to effect a relatively small change in trace metal concentration at a particular Delta location. Moreover, average and 95th percentile trace metal concentrations for these primary source waters are all below their respective water quality criteria, including those that are hardness-based without a WER adjustment. No mixing of these three source waters could result in a metal concentration greater than the highest source water concentration, and given that trace metals do not already exceed water quality criteria, more frequent exceedances of criteria in the Delta would not be expected to occur under the Alternative 1A.

The assessment of the Alternative 1A effects on trace metals in the SWP/CVP Export Service Areas is based on assessment of changes in trace metal concentrations at Banks and Jones pumping plants. As just discussed regarding similarities in Delta source water trace metal concentrations, the Alternative 1A is not expected to result in substantial changes in trace metal concentrations in Delta waters, including Banks and Jones pumping plants, therefore effects on trace metal concentrations in the SWP/CVP Export Service Area are expected to be negligible.

Based on the above, there would be no substantial long-term increase in trace metal concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the SWP/CVP export service area waters under Alternative 1A relative to Existing Conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because trace metal concentrations are not expected to increase substantially, no long-term water quality degradation for trace metals is expected to occur and, thus, no adverse effects to beneficial uses would occur. Furthermore, any negligible changes in long-term trace metal concentrations that may occur in water bodies of the affected environment would not be expected to make any existing beneficial use impairments measurably worse. The trace metals discussed in this assessment are not considered bioaccumulative, and thus would not directly cause bioaccumulative problems in aquatic life or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-28: Effects on Trace Metal Concentrations Resulting from Implementation of CM2–CM22

NEPA Effects: Implementation of CM2–CM22 present no new sources of trace metals to the affected environment, including areas upstream of the Delta, within the Delta, or in the SWP and CVP service areas. However, CM19, which would fund projects to contribute to reducing pollutant discharges in stormwater, would be expected to reduce trace metal loading to surface waters of the affected environment. The remaining conservation measures would not be expected to affect trace metal levels, because they are actions that do not affect the presence of trace metal sources. As they pertain to trace metals, implementation of these conservation measures would not be expected to adversely affect beneficial uses of the affected environment or substantially degrade water quality with respect to trace metals.

In summary, implementation of CM2–CM22 under Alternative 1A, relative to the No Action Alternative, would have negligible, if any, effect on trace metals concentrations. The effect on trace metals from implementing CM2–CM22 is determined not to be adverse.

CEQA Conclusion: Implementation of CM2–CM22 under Alternative 1A would not cause substantial long-term increase in trace metal concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the SWP/CVP export service area. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because trace metal concentrations are not expected to increase substantially, no long-term water quality degradation for trace metals is expected to occur and, thus, no adverse effects to beneficial uses would occur. Furthermore, any negligible changes in long-term trace metal concentrations that may occur throughout the affected environment would not be expected to make any existing beneficial use impairments measurably worse. The trace metals discussed in this assessment are not considered bioaccumulative, and thus would not directly cause bioaccumulative problems in aquatic life or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-29: Effects on TSS and Turbidity Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative, Alternative 1A is expected to have minimal effect on TSS concentrations and turbidity levels (highs, lows, typical conditions) in reservoirs and rivers upstream of the Delta relative to Existing Conditions and the No Action Alternative. Any minor increases in TSS concentrations and turbidity levels that may occur under Alternative 1A would not be of sufficient frequency, magnitude, and geographic extent that would result in adverse effects on beneficial uses within the Upstream of the Delta Region, or substantially degrade the quality of these water bodies, with regard to TSS and turbidity.

Delta

The TSS concentrations and turbidity levels of Delta inflows under operational and maintenance conditions of Alternative 1A are not expected to be substantially different from those occurring under Existing Conditions or would occur under the No Action Alternative. However, the implementation of this alternative would change the quantity of Delta inflows, which would affect Delta hydrodynamics and, thus, erosion and deposition potential in certain Delta channels. Localized changes in TSS concentrations and turbidity levels could occur, depending on how rapidly the Delta hydrodynamics are altered and the channels equilibrate with the new tidal flux regime, after implementation of this alternative. The magnitude of increases in TSS concentrations and turbidity levels in the affected channels due to higher potential of erosion cannot be readily quantified. However, geomorphic changes associated with sediment transport and deposition are usually gradual, occurring over years. Because the diversions would not substantially affect flows in high storm events, it is expected that the TSS concentrations and turbidity levels in the affected channels would not be substantially different from the levels under Existing Conditions or the No Action Alternative. Consequently, any notable increases in TSS concentrations and turbidity levels that may occur under Alternative 1A would likely be short-term in nature and long-term changes under this alternative would not be of sufficient frequency, magnitude and geographic extent that would result in adverse effects on beneficial uses in the Delta region, or substantially degrade the quality of these water bodies, with regard to TSS and turbidity.

SWP/CVP Export Service Areas

The water delivered to the SWP/CVP Export Service Areas would differ from that under Existing Conditions and the No Action Alternative, as it would consist of water diverted directly from the Sacramento River at Hood in addition to water withdrawn from the Delta at the current export pumps. Historical median turbidity levels in the Sacramento River at Hood (11 NTU) and in the Delta waters at the Harvey O. Banks Pumping Plant Headworks (11 NTU) are similar (Figure 8-47) and mean turbidity levels differ by 5 NTU (13 NTU at Banks pumping plant and 18 NTU in the Sacramento River at Hood). Thus, it is expected that the TSS concentrations and turbidity levels in the vicinity of the south Delta export pumps would not be substantially different from the levels under the Existing Conditions or the No Action Alternative. Consequently, the increases in TSS concentrations and turbidity levels that may occur under Alternative 1A would not be of sufficient frequency, magnitude, and geographic extent that would result in adverse effects on beneficial uses within the SWP/CVP Export Service Areas or substantially degrade the quality of these water bodies, with regard to TSS and turbidity.

NEPA Effects: The effects on TSS and turbidity from implementing CM1 is determined to not be adverse.

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

Changes river flow rate and reservoir storage that would occur under Alternative 1A, relative to Existing Conditions, would not be expected to result in a substantial adverse change in TSS concentrations and turbidity levels in the reservoirs and rivers upstream of the Delta, given that suspended sediment concentrations are more affected by season than flow. Site-specific and temporal exceptions may occur due to localized temporary construction activities, dredging activities, development, or other land use changes would be site-specific and temporal, which would be regulated to limit both their short-term and long-term effects on TSS and turbidity levels to less than substantial levels.

Within the Delta, geomorphic changes associated with sediment transport and deposition are usually gradual, occurring over years, and high storm event inflows would not be substantially affected. Thus, it is expected that the TSS concentrations and turbidity levels in the affected channels would not be substantially different from the levels under Existing Conditions. Consequently, this alternative is expected to have minimal effect on TSS concentrations and turbidity levels in the Delta region, relative to Existing Conditions.

There is not expected to be substantial, if even measurable, changes in TSS concentrations and turbidity levels in the SWP/CVP Export Service Areas waters under Alternative 1A, relative to Existing Conditions, because this alternative is not expected to result in substantial changes in TSS concentrations and turbidity levels at the south Delta export pumps, relative to Existing Conditions.

Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives where such objectives are not exceeded under Existing Conditions. Because TSS concentrations and turbidity levels are not expected to be substantially different, long-term water quality degradation is not expected, and, thus, beneficial uses are not expected to be adversely affected. Finally, TSS and turbidity are neither bioaccumulative nor Clean Water Act section 303(d) listed constituents. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-30: Effects on TSS and Turbidity Resulting from Implementation of CM2–CM22

NEPA Effects: Creation of habitat and open water through implementation of CM2–CM11 could affect Delta hydrodynamics and, thus, erosion and deposition potential in certain Delta channels. The magnitude of increases in TSS concentrations and turbidity levels in the affected channels due to higher potential of erosion cannot be readily quantified. The increases in TSS concentrations and turbidity levels in the affected channels could be substantial in localized areas, depending on how rapidly the Delta hydrodynamics are altered and the channels equilibrate with the new tidal flux regime, after implementation of this alternative. However, geomorphic changes associated with sediment transport and deposition are usually gradual, occurring over years. Within the reconfigured channels there could be localized increases in TSS concentrations and turbidity levels, but within the greater Plan Area it is expected that the TSS concentrations and turbidity levels would not be substantially different from the levels under the No Action Alternative.

CM19, which would fund projects to contribute to reducing pollutant discharges in stormwater, would be expected to reduce TSS and turbidity in urban discharges relative to the No Action Alternative. The remaining conservation measures (i.e., CM12-CM18, CM20-CM22) would not be expected to affect TSS concentrations and turbidity levels, because they are actions that do not affect the presence of TSS and turbidity sources.

The effects on TSS and turbidity from implementing CM2–CM22 is determined to not be adverse.

CEQA Conclusion: It is expected that the TSS concentrations and turbidity levels Upstream of the Delta, in the Plan Area, and the SWP/CVP Export Service Areas due to implementation of CM2–CM22 under Alternative 1A would not be substantially different relative to Existing Conditions, except within localized areas of the Delta modified through creation of habitat and open water. Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives where such objectives are not exceeded under Existing Conditions. Because TSS concentrations and turbidity levels Upstream of the Delta, in the greater Plan Area, and in the SWP/CVP Export Service Areas are not expected to be substantially different, long-term water quality degradation is not expected relative to TSS and turbidity, and, thus, beneficial uses are not expected to be adversely affected. Finally, TSS and turbidity are neither bioaccumulative nor Clean Water Act section 303(d) listed constituents. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-31: Water Quality Effects Resulting from Construction-Related Activities (CM1–CM22)

This section addresses construction-related water quality effects to constituents of concern other than effects caused by changes in the operations and maintenance of CM1–CM22, which are addressed in terms of constituent-specific impact assessments elsewhere in this chapter. Under Alternative 1A, the majority of construction-related activities for CM1–CM22 would occur within the Delta. Few, if any, of the CM1–CM22 actions involve construction work in the SWP and CVP Service Area or areas upstream of the Delta. The conservation measures, or components of measures, that are anticipated to be constructed in areas upstream of the Delta would be limited to: (1) the Yolo Bypass Fishery Enhancement (CM2) (i.e., the Fremont Weir component of the action), (2) Conservation Hatcheries (CM18) (i.e., the new hatchery facility), and (3) Urban Stormwater Treatment (CM19).

Within the Delta, the construction-related activities for Alternative 1A would be most extensive for CM1 involving the new water conveyance facilities. Construction of water conveyance facilities would involve vegetation removal, material storage and handling, excavation, overexcavation for facility foundations, surface grading, trenching, road construction, levee construction, construction site dewatering, soil stockpiling, reusable tunnel material (RTM) dewatering basin construction and storage operations, and other general facility construction activities (i.e., concrete, steel, carpentry, and other building trades) over approximately 7,500 acres during the course of constructing the facilities. Vegetation would be removed (via grubbing and clearing) and grading and other earthwork would be conducted at the intakes, pumping plants, the intermediate forebay, the Byron Tract Forebay, canal and gates between the Byron Tract Forebay tunnel shafts and the approach canal to the Banks Pumping Plant, borrow areas, RTM and spoil storage areas, setback and transition levees, sedimentation basins, solids handling facilities, transition structures, surge shafts and towers, substations, transmission line footings, access roads, concrete batch plants, fuel stations, bridge abutments, barge unloading facilities, and laydown areas. Construction of each intake would take nearly 4 years to complete.

Habitat restoration activities in the Delta (i.e., CM4–CM10), including restored tidal wetlands, floodplain, and related channel margin and off-channel habitats, also would involve substantial in-water construction-related activities across widespread areas of the Delta. Construction activities also would occur for CM2 in the Yolo Bypass to implement fish enhancement features. Anticipated construction activities that may occur under CM11–CM22, if any, would involve relatively minor disturbances, and thus would not be anticipated to result in substantial discharges of any constituents of concern.

NEPA Effects: The types of potential construction-related materials used, soil and vegetation disturbance activities, potential contaminants associated with implementation of CM1–CM22 under Alternative 1A would result in similar potential contaminant discharges to water bodies and associated water quality effects to those discussed above for the No Action Alternative. Construction activities also may result in temporary or permanent changes in stormwater drainage and runoff patterns (i.e., velocity, volume, and direction) that may cause or contribute to soil erosion and offsite sedimentation. However, relative to Existing Conditions and the No Action Alternative conditions, these additional major land and in-water disturbances and related site development activities would be more widespread than non-BDCP projects, and therefore would increase the potential to cause direct discharges and stormwater runoff of contaminants to adjacent water bodies, particularly during the rainy season (generally October to April in California).

Land surface grading and excavation activities, or exposure of disturbed sites immediately following construction and prior to stabilization, could result in rainfall- and stormwater-related soil erosion, runoff, and offsite sedimentation in surface water bodies. The initial runoff following construction, or return of seasonal rains to previously disturbed sites, can result in runoff with peak pollutant levels and is referred to as “first flush” storm events. Soil erosion and runoff can also result in increased concentrations and loading of organic matter, nutrients (nitrogen and phosphorus), and other contaminants contained in the soil such as trace metals, pesticides, or animal-related pathogens. Graded and exposed soils also can be compacted by heavy machinery, resulting in reduced infiltration of rainfall and runoff, thus increasing the rate of runoff (and hence contaminants) to downstream water bodies. Construction activities necessary to develop the new habitat restoration areas for CM2 and CM4–CM10 would likely involve a variety of extensive conventional clearing and grading activities on relatively dry sites that are currently separated from the Delta channels by levees, construction of extensive new setback levees, excavation and soil placement for new wetland and other habitat feature development, and a variety of potential in-water construction activities such as excavation, sediment dredging, levee breaching, and hauling and placement or disposal of excavated sediment or dredge material. Construction activities for the proposed restoration sites, due to the direct connectivity with Delta channels, have the potential to result in direct discharge of eroded soil and construction-related contaminants, or indirectly through erosion and site inundation during the weeks or months following construction prior to stabilization of newly contoured and restored landforms and colonization by vegetation.

Construction activities also would be anticipated to involve the transport, handling, and use of a variety of hazardous substances and non-hazardous materials that may adversely affect water quality if discharged inadvertently to construction sites or directly to water bodies. Typical construction-related contaminants include petroleum products for refueling and maintenance of machinery (e.g., fuel, oils, solvents), concrete, paints and other coatings, cleaning agents, debris and trash, and human wastes. Construction activities also would involve large material storage and laydown areas, and occasional accidental spills of hazardous materials stored and used for construction may occur. Contaminants released or spilled on bare soil also may result in groundwater contamination. Construction would involve extensive excavation/trenching and other subsurface construction activities, trenching, or work in or near Delta channels requiring site-dewatering operations to isolate the construction site from surface and groundwater. Dewatering operations may contain elevated levels of suspended sediment or other constituents that may cause water quality degradation.

The intensity of construction activity along with the fate and transport characteristics of the chemicals used, would largely determine the magnitude, duration, and frequency of construction-related discharges and resulting concentrations and degradation associated with the specific constituents of concern. The potential water quality concerns associated with the major categories of contaminants that might be discharged as a result of construction activity include the following.

- Suspended sediment: May increase turbidity (i.e., reduce water clarity) that can affect aquatic organisms and increase the costs and effort of removal in municipal/industrial water supplies. Downstream sedimentation can affect aquatic habitat, or cause a nuisance if it affects functions of agricultural or municipal intakes, or boat navigation.
- Organic matter: May contribute turbidity and oxygen demanding substances (i.e., reduce dissolved oxygen levels) that can affect aquatic organisms. Organic carbon may increase the potential for disinfection byproduct formation in municipal drinking water supplies.

- Nutrients: May contribute nitrogen, phosphorus, and other key nutrients that can contribute to nuisance biostimulation of algae and vascular aquatic plants, which may affect municipal water supplies, recreation, aquatic life, and aesthetics.
- Petroleum hydrocarbons: May contribute toxic compounds to aquatic life, and oily sheens may reduce oxygen/gas transfer in water, foul aquatic habitats, and reduce water quality for municipal supplies, recreation, and aesthetics.
- Trace constituents (metals, pesticides, synthetic organic compounds): Compounds in eroded soil or construction-related materials (e.g., paints, coatings, cleaning agents) may be toxic to aquatic life.
- Pathogens: Bacteria, viruses, and protozoans may affect aquatic life and increase human health risks via municipal water supplies, reduced recreational water quality, or contaminated shellfish beds.
- Other inorganic compounds: Construction-related materials can contain inorganic compounds such as acidic/basic materials which can change pH and may adversely affect aquatic life and habitats. Concrete contains lime which can increase pH levels, and drilling fluids may alter pH.

Construction-related activities may contribute to the discharge of contaminants such as PAHs which may be bioaccumulative in aquatic organisms, and construction-related disturbances may contribute to discharge of contaminants in soils and sediments in the Delta that are associated with existing impairments identified for Delta water bodies on the state's Section 303(d) list.

For the purposes of this assessment, it is assumed that construction activities conducted for Alternative 1A would be conducted in conformance to applicable federal and state regulations pertaining to grading and erosion control, and contaminant spill control and response measures. The construction-related environmental commitments for water quality protection, as identified in Appendix 3B, *Environmental Commitments*, would be implemented by the BDCP proponents. The environmental commitments for construction-related water quality protection would be specifically designed as a part of the final design, included in construction contracts as a required element, and would be implemented for Alternative 1A to avoid, prevent, and minimize the potential discharges of constituents of concern to water bodies and associated adverse water quality effects and comply with state water quality regulations. Additionally, temporary and permanent changes in stormwater drainage and runoff would be minimized and avoided through construction of new or modified drainage facilities, as described in the Chapter 3, *Description of Alternatives*. Alternative 1A would include installation of temporary drainage bypass facilities, long-term cross drainage, and replacement of existing drainage facilities that would be disrupted due to construction of new facilities.

In particular, construction-related activities under Alternative 1A would be conducted in accordance with the environmental commitment to develop and implement BMPs for all activities that may result in discharge of soil, sediment, or other construction-related contaminants from facilities related to construction to surface water bodies, and obtain authorization for the construction activities under the State Water Board's NPDES Stormwater General Permit for Stormwater Discharges Associated with Construction and Land Disturbance Activities (Order No. 2009-0009-DWQ/NPDES Permit No. CAS000002). This General Construction NPDES Permit requires the preparation and implementation of SWPPPs, which are the principal plans within the required Permit Registration Documents (PRDs) that identify the proposed erosion control and pollution prevention BMPs that would be used to avoid and minimize construction-related erosion and contaminant discharges. The development of the SWPPPs, and applicability of other provisions of this General Construction Permit depends on the "risk" classification for the construction which is determined based on the potential for erosion to occur as well as the susceptibility of the receiving water to potential adverse effects of construction. While the determination of project risk level, and planning and development of the SWPPPs and BMPs to be implemented, would be completed as a part of final design and contracting for the work, the responsibility for compliance with the provisions of the General Construction Permit necessitates that BMPs are applied to all disturbance activities. In addition to the BMPs, the SWPPPs would include BMP inspection and monitoring activities, and identify responsibilities of all parties, contingency measures, agency contacts, and training requirements and documentation for those personnel responsible for installation, inspection, maintenance, and repair of BMPs. The General Construction Permit contains Numeric Action Levels (NALs) for pH and turbidity, and specifies storm event water quality monitoring to determine if construction is resulting in elevated discharges of these constituents, and monitoring for any non-visible contaminants determined to have been potentially released. If an NAL is determined to have been exceeded, the General Construction Permit requires the discharger to conduct a construction site and run-on evaluation to determine whether contaminant sources associated with the site's construction activity may have caused or contributed to the exceedance and immediately implement corrective actions if they are needed.

The BMPs that are routinely implemented in the construction industry and have proven successful at reducing adverse water quality effects include, but are not limited to, the following broad categories of actions (letters refer to categories of specific BMPs identified in Appendix 3B, *Environmental Commitments*), for which Appendix 3B identifies specific BMPs within these categories (See commitments to Develop and Implement Stormwater Pollution Prevention Plans and Develop and Implement Erosion and Sediment Control Plans):

- Waste Management and Spill Prevention and Response (BMP categories A.2 and A.3): Waste management BMPs are designed to minimize exposure of waste materials at all construction sites and staging areas such as waste collection and disposal practices, containment and protection of wastes from wind and rain, and equipment cleaning measures. Spill prevention and response BMPs involve planning, equipment, and training for personnel for emergency event response.
- Erosion and Sedimentation Control (BMP categories A.4 and A.5): Erosion control BMPs are designed to prevent erosion processes or events including scheduling work to avoid rain events, stabilizing exposed soils; minimize offsite sediment runoff; remove sediment from onsite runoff before it leaves the site; and slow runoff rates across construction sites. Identification of appropriate temporary and long-term seeding, mulching, and other erosion control measures as necessary. Sedimentation BMPs are designed to minimize offsite sediment runoff once erosion has occurred involving drainage controls, perimeter controls, detention/sedimentation basins, or other containment features.
- Good Housekeeping and Non-Stormwater Discharge Management (BMP category A.6 and A.7): Good housekeeping BMPs are designed to reduce exposure of construction sites and materials storage to stormwater runoff including truck tire tracking control facilities; equipment washing; litter and construction debris; and designated refueling and equipment inspection/maintenance practices Non-stormwater discharge management BMPs involve runoff measures for contaminants not directly associated with rain or wind including vehicle washing and street cleaning operations.

- Construction Site Dewatering and Pipeline Testing (BMP category A.8). Dewatering BMPs involve actions to prevent discharge of contaminants present in dewatering of groundwater during construction, discharges of water from testing of pipelines or other facilities, or the indirect erosion that may be caused by dewatering discharges.
- BMP Inspection and Monitoring (BMP category A.9): Identification of clear objectives for evaluating compliance with SWPPP provisions, and specific BMP inspection and monitoring procedures, environmental awareness training, contractor and agency roles and responsibilities, reporting procedures, and communication protocols.

In addition to the Category "A" BMPs for surface land disturbances identified in the environmental commitments (Appendix 3B, *Environmental Commitments*), BMPs implemented for Alternative 1A also would include the Category "B" BMPs for tunnel/pipeline construction that involves actions primarily to avoid and minimize sediment and contaminant discharges associated with RTM excavation, hauling, and RTM dewatering operations. Additionally, habitat restoration activities under CM2 and CM4–CM10 would be subject to implementation of the Category "C" BMPs (In-Water Construction BMPs) and Category "D" BMPs (Tidal and Wetland Restoration) designed to minimize disturbance and direct discharge of turbidity/suspended solids to the water during in-water construction activities. Category "E" BMPs identify general permanent post-construction actions that would be implemented for all terrestrial, in-water, and habitat restoration activities and would involve planning, design, and development of final site stabilization, revegetation, and drainage control features.

Finally, acquisition of applicable environmental permits may be required for specific conservation measures, which as described for the No Action Alternative, may include specific WDRs or CWA Section 401 water quality certifications from the appropriate Regional Water Boards, CDFW Streambed Alteration Agreements, and USACE CWA Section 404 dredge and fill permits. These other permit processes may include requirements to implement additional action-specific BMPs that may reduce potential adverse discharge effects of constituents of concern.

The potential construction-related contaminant discharges that could result from projects defined under Alternative 1A would not be anticipated to result in adverse water quality effects at a magnitude, frequency, or regional extent that would cause substantial adverse effects to aquatic life. Relative to Existing Conditions, this assessment indicates the following.

- Projects would be managed under state water quality regulations and project-defined actions to avoid and minimize contaminant discharges.
- Individual projects would generally be dispersed, and involve infrequent and temporary activities, thus not likely resulting in substantial exceedances of water quality standards or long-term degradation.
- Potential construction-related contaminant discharges under the Alternative 1A would not cause additional exceedance of applicable water quality objectives where such objectives are not exceeded under Existing Conditions. Long-term water quality degradation is not anticipated, and hence would not be expected to adversely affect beneficial uses.
- By the intermittent and temporary frequency of construction-related activities and potential contaminant discharges, the constituent-specific effects would not be of substantial magnitude or duration to contribute to long-term bioaccumulation processes, or cause measureable long-term degradation such that existing 303(d) impairments would be made discernibly worse or TMDL actions to reduce loading would be adversely affected.

Consequently, because the construction-related activities for the conservation measures would be conducted with implementation of environmental commitments, including but not limited to those identified in Appendix 3B, with respect to the Existing Conditions and No Action Alternative conditions, Alternative 1A would not be expected to cause constituent discharges of sufficient frequency and magnitude to result in a substantial increase of exceedances of water quality objectives/criteria, or substantially degrade water quality with respect to the constituents of concern, and thus would not adversely affect any beneficial uses in the Delta.

In summary, with implementation of environmental commitments in Appendix 3B, the potential construction-related water quality effects are considered to be not adverse.

CEQA Conclusion: In summary, with implementation of environmental commitments in Appendix 3B, the potential construction-related water quality effects with respect to the Existing Conditions are considered to be less than significant. No mitigation is required.

8.4.3.3 Alternative 1B—Dual Conveyance with East Alignment and Intakes 1–5 (15,000 cfs; Operational Scenario A)

Alternative 1B would be nearly identical to Alternative 1A except that the up to 15,000 cfs of water routed from the north Delta to the south Delta would be conveyed by gravity through a canal along the east side of the Delta instead of through pipelines/tunnels. Intakes 1 through 5 would be located on the east bank of the Sacramento River. An intermediate pumping plant north of the town of Holt would be constructed as well as a new 600 acre Byron Tract Forebay. Unlike Alternative 1A, there would be no intermediate forebay. Culvert and tunnel siphons would be utilized to divert canal water beneath existing water courses. Water supply and conveyance operations would follow the guidelines described as Scenario A, which does not include fall X2. CM2–CM22 would be implemented under this alternative, and these conservation measures would be the same as those under Alternative 1A. See Chapter 3, *Description of Alternatives*, Section 3.5.3, for additional details on Alternative 1B.

Water Quality Effects Resulting from Facilities Operations and Maintenance (CM1)

Alternative 1B has the same diversion and conveyance operations as Alternative 1A. The primary difference between the two alternatives is that conveyance under Alternative 1B would be in a lined or unlined canal, instead of pipeline. Because there would be no difference in conveyance capacity or operations, there would be no differences between these two alternatives in upstream of the Delta river flows or reservoir operations, Delta inflow, source fractions to various Delta locations, and hydrodynamics in the Delta. Conveyance of water in an open channel instead of a pipeline may result in differing physical properties (e.g., DO, pH, temperature) of the water upon reaching the south Delta export pumps than if the water was conveyed in a pipeline. However, the physical properties of water arriving at the south Delta export pumps would continue to change and would equilibrate to similar levels as Alternative 1A as it is conveyed throughout the SWP/CVP Export Service Areas. Because no substantial differences in water quality effects are anticipated anywhere in the affected environment under Alternative 1B compared to those described in detail for Alternative 1A, the water quality effects described for Alternative 1A also appropriately characterize effects under Alternative 1B.

Water Quality Effects Resulting from Implementation of CM2–CM22

Alternative 1B has the same conservation measures as Alternative 1A. Because no substantial differences in water quality effects are anticipated anywhere in the affected environment under Alternative 1B compared to those described in detail for Alternative 1A, the water quality effects described for Alternative 1A also appropriately characterize effects under Alternative 1B.

Impact WQ-31: Water Quality Effects Resulting from Construction-Related Activities (CM1–CM22)

The primary difference between Alternative 1B and Alternative 1A is that under Alternative 1B, a canal would be constructed for CM1 along the eastern side of the Delta to convey the Sacramento River water south, rather than a tunnel as the primary conveyance feature. As such, construction techniques and locations of major features of the conveyance system within the Delta would be different (see Chapter 3, *Description of Alternatives*, Section 3.5.3). Consequently, Alternative 1B would involve substantial land surface construction disturbance. Construction of the canal conveyance facilities also would involve vegetation grubbing/removal, grading, excavation, soil stockpiling, levee and siphon construction, trenching, temporary access road construction, and soil hauling and storage, and other activities over approximately 21,500 acres during the course of constructing the facilities. Additionally, numerous natural drainages and constructed ditches would be rerouted to pass over, under, or around the canal, thus involving disturbance and potential work in flowing water. The remainder of the facilities constructed under Alternative 1B, including CM2–CM22, would be very similar to, or the same as, those to be constructed for Alternative 1A.

NEPA Effects: The types of potential construction-related water quality effects associated with implementation of CM1 under Alternative 1B would be similar to the effects discussed for Alternative 1A, and the effects anticipated with implementation of CM2–CM22 would be essentially identical. Given the substantial differences in the conveyance features under CM1 with the construction of a canal, there would be differences in the location, magnitude, duration, and frequency of construction activities and related water quality effects. In particular, relative to the No Action Alternative conditions, construction of the major intakes and canal features for CM1 under Alternative 1B would involve extensive general construction activities, material handling/ storage/placement activities, surface soil grading/excavation/disposal and associated exposure of disturbed sites to erosion and runoff, and construction site dewatering operations. Nevertheless, the construction of CM1, and any individual components necessitated by CM2, and CM4–CM10, with the implementation of the BMPs specified in Appendix 3B, *Environmental Commitments*, would result in the potential water quality effects being largely avoided and minimized. The specific environmental commitments that would be implemented under Alternative 1B would be similar to those described for Alternative 1A with the exception that Category “B” BMPs for RTM dewatering basin construction and operations, if necessary at all, would be much reduced. Consequently, relative to the No Action Alternative, Alternative 1B would not be expected to cause exceedance of applicable water quality objectives/criteria or substantial water quality degradation with respect to constituents of concern, and thus would not adversely affect any beneficial uses upstream of the Delta, in the Delta, or in the SWP and CVP service area.

In summary, with implementation of environmental commitments in Appendix 3B, the potential construction-related water quality effects are considered to be not adverse.

CEQA Conclusion: Because environmental commitments would be implemented under Alternative 1B for construction-related activities along with agency-issued permits that also contain construction related mitigation requirements to protect water quality, the construction-related effects, relative to Existing Conditions, would not be expected to cause or contribute to substantial alteration of existing drainage patterns which would result in substantial erosion or siltation on- or off-site, substantial increased frequency of exceedances of water quality objectives/criteria, or substantially degrade water quality with respect to the constituents of concern on a long-term average basis, and thus would not adversely affect any beneficial uses in water bodies upstream of the Delta, within the Delta, or in the SWP and CVP service area. Moreover, because the construction-related activities would be temporary and intermittent in nature, the construction would involve negligible discharges, if any, of bioaccumulative or 303(d) listed constituents to water bodies of the affected environment. As such, construction activities would not contribute measurably to bioaccumulation of contaminants in organisms or humans or cause 303(d) impairments to be discernibly worse. Based on these findings, this impact is determined to be less than significant. No mitigation is required.

8.4.3.4 Alternative 1C—Dual Conveyance with West Alignment and Intakes W1–W5 (15,000 cfs; Operational Scenario A)

Alternative 1C would be nearly identical to Alternative 1A except that the up to 15,000 cfs of water routed from the north Delta to the south Delta would be conveyed through a canal/tunnel along the west side of the Delta instead of through pipelines/tunnels. Intakes 1 through 5 would be located on the west bank of the Sacramento River and diverted water would be carried by canals and tunnels to a new 600 acre forebay at Byron Tract. An intermediate pumping plant would be constructed, but there would be no intermediate forebay. Culvert and tunnel siphons would be utilized to divert canal water beneath existing water courses. Water supply and conveyance operations would follow the guidelines described as Scenario A, which does not include fall X2. CM2–CM22 would be implemented under this alternative, and these conservation measures would be the same as those under Alternative 1A. See Chapter 3, *Description of Alternatives,* Section 3.5.4, for additional details on Alternative 1C.

Water Quality Effects Resulting from Facilities Operations and Maintenance (CM1)

Alternative 1C has the same diversion and conveyance operations as Alternative 1A. The primary differences between the two alternatives are that conveyance under Alternative 1C would be in a lined or unlined canal, instead of pipeline, and the alignment of the canal would be along the western side of the Delta, rather than the eastern side. Because there would be no difference in conveyance capacity or operations, there would be no differences between these two alternatives in upstream of the Delta river flows or reservoir operations, Delta inflow, source fractions to various Delta locations, and hydrodynamics in the Delta. Conveyance of water in an open channel instead of a pipeline may result in differing physical properties (e.g., DO, pH, temperature) of the water upon reaching the south Delta export pumps than if the water was conveyed in a pipeline. However, the physical properties of water arriving at the south Delta export pumps would continue to change and would equilibrate to similar levels as Alternative 1A as it is conveyed throughout the SWP/CVP Export Service Areas. Because no substantial differences in water quality effects are anticipated anywhere in the affected environment under Alternative 1C compared to those described in detail for Alternative 1A, the water quality effects described for Alternative 1A also appropriately characterize effects under Alternative 1C.

Water Quality Effects Resulting from Implementation of CM2–CM22

Alternative 1C has the same conservation measures as Alternative 1A. Because no substantial differences in water quality effects are anticipated anywhere in the affected environment under Alternative 1C compared to those described in detail for Alternative 1A, the water quality effects described for Alternative 1A also appropriately characterize effects under Alternative 1C.

Impact WQ-31: Water Quality Effects Resulting from Construction-Related Activities (CM1–CM22)

The primary difference between Alternative 1C and Alternative 1A is that under Alternative 1C, a canal would be constructed for CM1 along the western side of the Delta to convey the Sacramento River water south, in addition to similar but shorter tunnel/pipeline features. Construction of water conveyance facilities would involve vegetation removal; constructing building pads, levees, canals, and a tunnel; excavation; overexcavation for facility foundations; surface grading; trenching; road construction; spoil storage; soil stockpiling; and other activities over approximately 17,400 acres during the course of constructing the facilities. Excavation of a large volume of borrow material would be required to construct the canals. As such, construction techniques and locations of major features of the conveyance system within the Delta would be different (see Chapter 3, *Description of Alternatives*, Section 3.5.4). The remainder of the facilities constructed under Alternative 1C, including CM2–CM22, would be very similar to, or the same as, those to be constructed for Alternative 1A.

NEPA Effects: The types of potential construction-related water quality effects associated with implementation of CM1 under Alternative 1C would be very similar to the effects discussed for Alternative 1A, and the effects anticipated with implementation of CM2–CM22 would be essentially identical. However, given the addition of extensive canal conveyance segments under CM1 in addition to the tunnel/pipeline features, there would be differences in the location, magnitude, duration, and frequency of construction activities and related water quality effects. In particular, relative to the No Action Alternative conditions, construction of the major canal features for CM1 under Alternative 1C would involve extensive general construction activities, material handling/storage/placement activities, surface soil grading/excavation/disposal and associated exposure of disturbed sites to erosion and runoff, and construction site dewatering operations. Nevertheless, the construction of CM1, and any individual components necessitated by CM2, and CM4–CM10, with the implementation of the BMPs specified in Appendix 3B, *Environmental Commitments*, and other agency permitted construction requirements would result in the potential water quality effects being largely avoided and minimized. The specific environmental commitments that would be implemented under Alternative 1C would be similar to those described for Alternative 1A (refer to Chapter 3, *Description of Alternatives* and Appendix 3B, *Environmental Commitments,* for additional information regarding the environmental commitments and environmental permits). However, this alternative would involve environmental commitments associated with both tunnel/pipeline and canal construction activities. Consequently, relative to No Action Alternative conditions, Alternative 1C would not be expected to cause exceedance of applicable water quality objectives/criteria or substantial water quality degradation with respect to constituents of concern, and thus would not adversely affect any beneficial uses upstream of the Delta, in the Delta, or in the SWP and CVP service area.

In summary, with implementation of environmental commitments in Appendix 3B, the potential construction-related water quality effects are considered to be not adverse.

CEQA Conclusion: Because environmental commitments would be implemented under Alternative 1C for construction-related activities, the construction-related effects, relative to Existing Conditions, would not be expected to cause or contribute to substantial alteration of existing drainage patterns which would result in substantial erosion or siltation on- or off-site, substantial increased frequency of exceedances of water quality objectives/criteria, or substantially degrade water quality with respect to the constituents of concern on a long-term average basis, and thus would not adversely affect any beneficial uses in water bodies upstream of the Delta, within the Delta, or in the SWP and CVP service area. Moreover, because the construction-related activities would be temporary and intermittent in nature, the construction would involve negligible discharges, if any, of bioaccumulative or 303(d) listed constituents to water bodies of the affected environment. As such, construction activities would not contribute measurably to bioaccumulation of contaminants in organisms or humans or cause 303(d) impairments to be discernibly worse. Based on these findings, this impact is determined to be less than significant. No mitigation is required.

8.4.3.5 Alternative 2A—Dual Conveyance with Pipeline/Tunnel and Five Intakes (15,000 cfs; Operational Scenario B)

Alternative 2A would convey up to 15,000 cfs of water from the north Delta to the south Delta through pipelines/tunnels from five screened intakes on the east bank of the Sacramento River between Clarksburg and Walnut Grove i.e., (Intakes 1 through 5). A new 600 acre Byron Tract Forebay, adjacent to and south of Clifton Court Forebay, would be constructed which would provide water to the south Delta pumping plants. In addition to the same physical/structural components described for Alternative 1A, Alternative 2A would include an operable barrier at the head of Old River and could potentially include two alternative intake and intake pumping plant locations located downstream of Steamboat and Sutter Sloughs (i.e., Intakes 6 and 7). Water supply and conveyance operations would follow the guidelines described as Scenario B, which includes fall X2. CM2–CM22 would be implemented under this alternative, and would be the same as those under Alternative 1A. See Chapter 3, *Description of Alternatives*, Section 3.5.5, for additional details on Alternative 2A.

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 2A, over the long term, average annual delta exports are anticipated to decrease by 76 TAF relative to Existing Conditions, and increase by 628 TAF relative to the No Action Alternative. Since, over the long-term, approximately 58% 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 2–Old River at Rock Slough for ALL years (1976–1991), which shows increased SJR percentage and decreased SAC percentage under the alternative, relative to Existing Conditions and the No Action Alternative.

Under Alternative 2A, long-term average annual Delta outflow is anticipated to increase 105 TAF relative to Existing Conditions, due to both changes in operations (including north Delta intake capacity of 15,000 cfs, Fall X2, and numerous other operational components of Scenario B) and climate change/sea level rise (see Chapter 5, *Water Supply*, for more information). The increase relative to Existing Conditions is partially because Alternative 2A includes operations to meet Fall X2, while Existing Conditions does not. Long-term average annual Delta outflow is anticipated to decrease under Alternative 2A by 645 TAF relative to the No Action Alternative, due only to changes in operations. The result of this is increased sea water intrusion in the west Delta. The increase in sea water intrusion (represented by an increase in BAY percentage) can be seen, for example, in Appendix 8D, ALT 2A–Sacramento River at Mallard Island for ALL years (1976–1991).

Impact WQ-1: Effects on Ammonia Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative, Alternative 2A would have negligible, if any, effect on ammonia concentrations in the rivers and reservoirs upstream of the Delta relative to Existing Conditions and the No Action Alternative. Any negligible increases in ammonia-N concentrations that could occur in the water bodies of the affected environment upstream of the Delta would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regard to ammonia.

Delta

Assessment of the effects of ammonia under Alternative 2A is the same as discussed under Alternative 1A, Impact WQ-1, except that because flows in the Sacramento River at Freeport would be different between the two alternatives, estimated monthly average and long term annual average predicted ammonia-N concentrations in the Sacramento River downstream of Freeport are different.

As Table 8-65 shows, estimated ammonia-N concentrations in the Sacramento River downstream of Freeport (upon full mixing of the SRWTP discharge with river water) under Alternative 2A and the No Action Alternative are expected to be similar. Minor increases in ammonia-N concentrations would occur during July through September, November, and January through March, and remaining months would be unchanged or have a minor decrease. A minor increase in the annual average concentration would occur under Alternative 2A, compared to the No Action Alternative. Moreover, the estimated concentrations downstream of Freeport under Alternative 2A would be similar to existing source water concentrations for the San Francisco Bay and San Joaquin River. Consequently, changes in source water fraction anticipated under Alternative 2A, relative to the No Action Alternative, would not be expected to substantially increase ammonia concentrations at any Delta locations.

Any negligible increases in ammonia-N concentrations that could occur at certain locations in the Delta would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to ammonia.

Table 8-65. Estimated Ammonia-N (mg-L as N) Concentrations in the Sacramento River Downstream of the Sacramento Regional Wastewater Treatment Plant for the No Action Alternative and Alternative 2A

	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
Alternative 2A	0.073	0.088	0.069	0.061	0.058	0.061	0.058	0.062	0.062	0.063	0.071	0.065	0.066

SWP/CVP Export Service Areas

The assessment of effects on ammonia in the SWP/CVP Export Service Area is based on assessment of ammonia-N concentrations at Banks and Jones pumping plants. Similar to the discussion for Alternative 1A, under Alternative 2A for areas of the Delta that are influenced by Sacramento River water, including Banks and Jones pumping plants, ammonia-N concentrations would be expected to decrease, relative to Existing Conditions (in association with less diversion of water influenced by the SRWTP). This decrease in ammonia-N concentrations for water exported via the south Delta pumps would not be expected to result in an adverse effect on beneficial uses or substantially degrade water quality of exported water, with regards to ammonia.

Furthermore, as discussed above for the Plan Area, for all areas of the Delta, including Banks and Jones pumping plants, ammonia-N concentrations would not be expected to substantially differ under Alternative 2A, relative to the No Action Alternative. Any negligible increases in ammonia-N concentrations that could occur at Banks and Jones pumping plants would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to ammonia.

NEPA Effects: In summary, based on the discussion above, effects on ammonia from implementation of CM1 are considered to be not adverse.

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

Ammonia-N concentrations are generally low in the reservoirs and rivers of the watersheds, owing to the lack of substantial point and nonpoint sources of ammonia-N upstream of the SRWTP in the Sacramento River watershed, in the watersheds of the eastern tributaries (Cosumnes, Mokelumne, and Calaveras Rivers), or upstream of the Delta in the San Joaquin River watershed. Consequently, any modified reservoir operations and subsequent changes in river flows under Alternative 2A, relative to Existing Conditions, are expected to have negligible, if any, effects on reservoir and river ammonia-N concentrations upstream of Freeport in the Sacramento River watershed and upstream of the Delta in the San Joaquin River watershed.

Ammonia-N concentrations in the Sacramento River downstream of the SRWTP would be substantially lower under Alternative 2A, relative to Existing Conditions, due to upgrades to the SRWTP that are assumed to be in place, and thus, ammonia concentrations for all areas of the Delta that are influenced by Sacramento River water are expected to decrease. At locations which are not influenced notably by Sacramento River water, concentrations are expected to remain relatively unchanged, due to the similarity in SJR and BAY concentrations and the lack of expected changes in either of these concentrations.

The assessment of effects on ammonia in the SWP/CVP Export Service Areas is based on assessment of ammonia-N concentrations at Banks and Jones pumping plants. As discussed above for the Plan Area, for areas of the Delta that are influenced by Sacramento River water, including Banks and Jones pumping plants, ammonia-N concentrations are expected to decrease under Alternative 2A, relative to Existing Conditions.

Based on the above, there would be no substantial, long-term increase in ammonia-N concentrations in the rivers and reservoirs upstream of the Delta, in the Plan Area, or the waters exported to the CVP and SWP service areas under Alternative 2A relative to Existing Conditions. As such, 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. Because ammonia concentrations would not be expected to increase substantially, no long-term water quality degradation would be expected to occur and, thus, no significant impact on beneficial uses would occur. Ammonia is not 303(d) listed within the affected environment and thus any minor increases that could occur in some areas would not make any existing ammonia-related impairment measurably worse because no such impairments currently exist. Because ammonia-N is not bioaccumulative, minor increases that could occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact would be considered less than significant. No mitigation is required.

Impact WQ-2: Effects on Ammonia Concentrations Resulting from Implementation of CM2–CM22

NEPA Effects: Effects of CM2–22 on ammonia under Alternative 2A are the same as those discussed for Alternative 1A and are considered to be not adverse.

CEQA Conclusion: Conservation Measures 2–22 proposed under Alternative 2A would be similar to those proposed under Alternative 1A. As such, effects on ammonia resulting from the implementation of CM2–CM22 would be similar to that previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-3: Effects on Boron Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Effects of CM1 on boron under Alternative 2A in areas upstream of the Delta would be very similar to the effects discussed for Alternative 1A. There would be no expected change to the sources of boron in the Sacramento and east-side tributary watersheds, and resultant changes in flows from altered system-wide operations would have negligible, if any, effects on the concentration of boron in the rivers and reservoirs of these watersheds. The modeled long-term annual average lower San Joaquin River flow at Vernalis would decrease slightly compared to Existing Conditions (in association with project operations, climate change, and increased water demands), and would be similar compared to the No Action Alternative considering only changes due to Alternative 2A operations. The reduced flow would result in possible increases in long-term average boron concentrations of up to about 3% relative to the Existing Conditions (Appendix 8F, Table 24). The increased boron concentrations would not increase the frequency of exceedances of any applicable objectives or criteria and would not be expected to cause further degradation at measurable levels in the lower San Joaquin River, and thus would not cause the existing impairment there to be discernibly worse. Consequently, Alternative 2A would not be expected to cause exceedance of boron objectives/criteria or substantially degrade water quality with respect to boron, and thus would not adversely affect any beneficial uses of the Sacramento River, the east-side tributaries, associated reservoirs upstream of the Delta, or the San Joaquin River.

Delta

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

Effects of CM1 on boron under Alternative 2A in the Delta would be very similar to the effects discussed for Alternative 1A. Relative to the Existing Conditions and No Action Alternative, Alternative 2A would generally result in unchanged or reduced long-term average boron concentrations for the 16-year period modeled at northern and eastern Delta locations. However, the average boron concentration at the eastern SJR at Buckley Cove location would increase relative to Existing Conditions (8%) but decrease relative to the No Action Alternative. Concentrations would increase at interior and western Delta locations (by as much as 3% at the SF Mokelumne River at Staten Island, 18% at Franks Tract, and 118% at Old River at Rock Slough) (Appendix 8F, Table Bo-8). The comparison to Existing Conditions reflects changes due to both Alternative 2A operations (including north Delta intake capacity of 15,000 cfs, Fall X2, and numerous other operational components of Scenario B) and climate change/sea level rise. The comparison to the No Action Alternative reflects changes due only to operations.

Implementation of tidal habitat restoration under CM4 also may contribute to increased boron concentrations at western Delta assessment locations (more discussion of this phenomenon is included in Section 8.3.1.3), and thus would not be anticipated to substantially affect agricultural diversions which occur primarily at interior Delta locations. The long-term annual average and monthly average boron concentrations, for either the 16-year period or drought period modeled, would never exceed the 2,000 μg/L human health advisory objective (i.e., for children) or 500 μg/L agricultural objective at any of the eleven Delta assessment locations, which represents no change from the Existing Conditions and No Action Alternative (Appendix 8F, Table Bo-3A). Reductions in long-term average assimilative capacity of up to 11% at interior Delta locations (i.e., Franks Tract and Old River at Rock Slough) and up to 12% at the SJR at Buckley Cove location relative to No Action Alternative, would occur with respect to the 500 μg/L agricultural objective (Appendix 8F, Table Bo-9). However, because the absolute boron concentrations would still be well below the lowest 500 μg/L objective for the protection of the agricultural beneficial use under Alternative 2A, the levels of boron degradation would not be of sufficient magnitude to substantially increase the risk of exceeding objectives or cause adverse effects to municipal and agricultural water supply beneficial uses, or any other beneficial uses, in the Delta (Appendix 8F, Figure Bo-2).

SWP/CVP Export Service Areas

Effects of CM1 on boron under Alternative 2A in the Delta would be very similar to the effects discussed for Alternative 1A. Under Alternative 2A, long-term average boron concentrations would decrease by as much as 25% at the Banks Pumping Plant and by as much as 27% at Jones Pumping Plant relative to Existing Conditions and No Action Alternative (Appendix 8F, Table Bo-8) as a result of export of a greater proportion of low-boron Sacramento River water. Commensurate with the decrease in exported boron concentrations, boron concentrations in the lower San Joaquin River may be reduced and would likely alleviate or lessen any expected increase in boron concentrations at Vernalis associated with flow reductions (see discussion of Upstream of the Delta), as well as locations in the Delta receiving a large fraction of San Joaquin River water. Reduced export boron concentrations also may contribute to reducing the existing 303(d) impairment in the lower San Joaquin River and associated TMDL actions for reducing boron loading.

Maintenance of SWP and CVP facilities under Alternative 2A would not be expected to create new sources of boron or contribute towards a substantial change in existing sources of boron in the affected environment. Maintenance activities would not be expected to cause any substantial increases in boron concentrations or degradation with respect to boron such that objectives would be exceeded more frequently, or any beneficial uses would be adversely affected anywhere in the affected environment.

NEPA Effects: In summary, relative to the No Action Alternative conditions, Alternative 2A would result in relatively small increases in long-term average boron concentrations in the Delta and not appreciably change boron levels in the lower San Joaquin River. However, the predicted changes would not be expected to cause exceedances of applicable objectives or further measurable water quality degradation, and thus would not constitute an adverse effect on water quality.

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

Boron is not a constituent of concern in the Sacramento River watershed upstream of the Delta, thus river flow rate and reservoir storage reductions that would occur under the Alternative 2A, relative to Existing Conditions, would not be expected to result in a substantial adverse change in boron levels. Additionally, relative to Existing Conditions, Alternative 2A would not result in reductions in river flow rates (i.e., less dilution) or increased boron loading such that there would be any substantial increases in boron concentration upstream of the Delta in the San Joaquin River watershed.

Small increased boron levels predicted for interior and western Delta locations in response to a shift in the Delta source water percentages and tidal habitat restoration under this alternative would not be expected to cause exceedances of objectives, or substantial degradation of these water bodies. Alternative 2A maintenance also would not result in any substantial increases in boron concentrations in the affected environment. Boron concentrations would be reduced in water exported from the Delta to the CVP/SWP Export Service Areas, thus reflecting a potential improvement to boron loading in the lower San Joaquin River.

Boron is not a bioaccumulative constituent, thus any increased concentrations under Alternative 2A would not result in adverse boron bioaccumulation effects to aquatic life or humans. Relative to Existing Conditions, Alternative 2A would not result in substantially increased boron concentrations such that frequency of exceedances of municipal and agricultural water supply objectives would increase. The levels of boron degradation that may occur under Alternative 2A would not be of sufficient magnitude to cause substantially increased risk for adverse effects to municipal or agricultural beneficial uses within the affected environment. Long-term average boron concentrations would decrease in Delta water exports to the SWP and CVP service area, which may contribute to reducing the existing 303(d) impairment of agricultural beneficial uses in the lower San Joaquin River. Based on these findings, this impact is determined to be less than significant. No mitigation is required.

Impact WQ-4: Effects on Boron Concentrations Resulting from Implementation of CM2–CM22

NEPA Effects: Effects of CM2–CM22 on boron under Alternative 2A are the same as those discussed for Alternative 1A and are determined to be not adverse.

CEQA Conclusion: Conservation Measures 2–22 proposed under Alternative 2A would be similar to those proposed under Alternative 1A. As such, effects on boron resulting from the implementation of CM2–CM22 would be similar to that previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

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

Upstream of the Delta

Under Alternative 2A there would be no expected change to the sources of bromide in the Sacramento and eastside tributary watersheds. Bromide loading in these watersheds would remain unchanged and resultant changes in flows from altered system-wide operations under Alternative 2A would have negligible, if any, effects on the concentration of bromide in the rivers and reservoirs of these watersheds. Consequently, Alternative 2A would not be expected to adversely affect the MUN beneficial use, or any other beneficial uses, of the Sacramento River, the eastside tributaries, or their associated reservoirs upstream of the Delta.

Under Alternative 2A, modeling indicates that long-term annual average flows on the San Joaquin River would decrease by 6%, relative to Existing Conditions and would remain virtually the same relative to the No Action Alternative (Appendix 5A). These decreases in flow would result in possible increases in long-term average bromide concentrations of about 3%, relative to Existing

Conditions, and less than <1% relative to the No Action Alternative (Appendix 8E, Bromide Table 22). The small increases in lower San Joaquin River bromide levels that could occur under Alternative 2A, relative to existing and the No Action Alternative conditions would not be expected to adversely affect the MUN beneficial use, or any other beneficial uses, of the lower San Joaquin River.

Delta

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

Under Alternative 2A, the geographic extent of effects pertaining to long-term average bromide concentrations in the Delta would be similar to that previously described for Alternative 1A, although the magnitude of predicted long-term change and relative frequency of concentration threshold exceedances would be different. Using the mass-balance modeling approach for bromide (see Section 8.3.1.3), relative to Existing Conditions, modeled long-term average bromide concentrations would increase at Staten Island, Emmaton (during the drought period only), and Barker Slough, while modeled long-term average bromide concentrations would decrease at all other assessment locations (Appendix 8E, Bromide Table 6). Overall effects would be greatest at Barker Slough, where predicted long-term average bromide concentrations would increase from 51 μg/L to 63 μg/L (22% relative increase) for the modeled 16-year hydrologic period and would increase from 54 μg/L to 94 μg/L (75% relative increase) for the modeled drought period. At Barker Slough, the predicted 50 μg/L exceedance frequency would decrease from 49% under Existing Conditions to 38% under Alternative 2A, but would increase from 55% to 63% during the drought period. At Barker Slough, the predicted 100 μg/L exceedance frequency would increase from 0% under Existing Conditions to 17% under Alternative 2A, and would increase from 0% to 38% during the drought period. Relative increases in long-term average bromide concentrations at Staten Island would be of similar magnitude to that described for Barker Slough, although modeled 100 μg/L exceedance frequency increases would be much less considerable. At Staten Island, the predicted 100 μg/L exceedance frequency would increase from 1% under Existing Conditions to 4% under Alternative 2A (0% to 2% during the drought period). Modeled long-term average concentration at Staten Island would be about 62 μg/L (about 63 μg/L in drought years). Changes in exceedance frequency of the 50 μg/L and 100 μg/L concentration thresholds, as well as relative change in long-term average concentration, at other assessment locations would be less substantial. The comparison to Existing Conditions reflects changes in bromide due to both Alternative 2A operations (including north Delta intake capacity of 15,000 cfs, Fall X2, and numerous other operational components of Scenario B) and climate change/sea level rise.

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

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

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

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

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

SWP/CVP Export Service Areas

Under Alternative 2A, improvement in long-term average bromide concentrations would occur at the Banks and Jones pumping plants. Long-term average bromide concentrations for the modeled 16-year hydrologic period at these locations would decrease by as much as 46% relative to Existing Conditions and 39% relative to the No Action Alternative. Relative change in long-term average bromide concentration would be less during drought conditions (≤34%), but would still represent considerable improvement (Appendix 8E, *Bromide*, Table 6). As a result, less frequent bromide concentration exceedances of the 50 μg/L and 100 μg/L assessment thresholds would be predicted and an overall improvement in Export Service Areas water quality would be experienced respective to bromide. Commensurate with the decrease in exported bromide, an improvement in lower San Joaquin River bromide would also be observed since bromide in the lower San Joaquin River is principally related to irrigation water deliveries from the Delta. While the magnitude of this expected lower San Joaquin River improvement in bromide is difficult to predict, the relative decrease in overall loading of bromide to the Export Service Areas would likely alleviate or lessen any expected increase in bromide concentrations at Vernalis (see discussion of Upstream of the Delta) as well as locations in the Delta receiving a large fraction of San Joaquin River water, such as much of the south Delta.

NEPA Effects: 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, *Bromide*, Table 7).

Similar to the discussion pertaining to the No Action Alternative, maintenance of SWP and CVP facilities under Alternative 2A 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.

In summary, Alternative 2A operations and maintenance, relative to the No Action Alternative, would result in small increases (i.e., <1%) in long-term average bromide concentrations at Vernalis related to relatively small declines in long-term average flow on the San Joaquin River. However, Alternative 2A operation and maintenance activities would cause substantial degradation to water quality with respect to bromide at Barker Slough, source of the North Bay Aqueduct. Resultant substantial change in long-term average bromide at Barker Slough could necessitate changes in water treatment plant operations or require treatment plant upgrades in order to maintain DBP compliance, and thus would constitute an adverse effect on water quality. Mitigation Measure WQ-5 is available to reduce these effects (implementation of this measure along with a separate, non-environmental commitment as set forth in EIR/EIS Appendix 3B, *Environmental Commitments*, relating to the potential increased treatment costs associated with bromide-related changes would reduce these effects).

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

Under Alternative 2A there would be no expected change to the sources of bromide in the Sacramento and eastside tributary watersheds. Bromide loading in these watersheds would remain unchanged and resultant changes in flows from altered system-wide operations under Alternative 2A would have negligible, if any, effects on the concentration of bromide in the rivers and reservoirs of these watersheds. However, south of the Delta, the San Joaquin River is a substantial source of bromide, primarily due to the use of irrigation water imported from the southern Delta. Concentrations of bromide at Vernalis are inversely correlated to net river flow. Under Alternative 2A, long-term average flows at Vernalis would decrease only slightly, resulting in less than substantial predicted increases in long-term average bromide of about 3% relative to Existing Conditions.

Relative to Existing Conditions, Alternative 2A would result in small decreases in long-term average bromide concentration at most Delta assessment locations, with principal exceptions being the North Bay Aqueduct at Barker Slough, Staten Island, and Emmaton on the Sacramento River. Overall effects would be greatest at Barker Slough, where substantial increases in long-term average bromide concentrations would be predicted. The increase in long-term average bromide concentrations predicted for Barker Slough would result in a substantial change in source water quality to existing drinking water treatment plants drawing water from the North Bay Aqueduct. These modeled increases in bromide at Barker Slough could lead to adverse changes in the formation of disinfection byproducts at drinking water treatment plants such that considerable water treatment plant upgrades would be necessary in order to achieve equivalent levels of drinking water health protection.

The assessment of effects on bromide in the SWP/CVP Export Service Areas is based on assessment of changes in bromide concentrations at Banks and Jones pumping plants. Under Alternative 2A, substantial improvement would occur at the Banks and Jones pumping plants, where predicted long-term average bromide concentrations are predicted to decrease by as much as 46% relative to Existing Conditions. An overall improvement in bromide-related water quality would be predicted in the SWP/CVP Export Service Areas.

Based on the above, Alternative 2A operation and maintenance would not result in any substantial change in long-term average bromide concentration upstream of the Delta. Furthermore, under Alternative 2A, water exported from the Delta to the SWP/CVP service area would be substantially improved relative to bromide. Bromide is not bioaccumulative, therefore change in long-term average bromide concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Additionally, bromide is not a constituent related to any 303(d) listings. Alternative 2A operation and maintenance activities would not cause substantial long-term degradation to water quality respective to bromide with the exception of water quality at Barker Slough, source of the North Bay Aqueduct. At Barker Slough, modeled long-term annual average concentrations of bromide would increase by 22%, and 75% during the modeled drought period. For the modeled 16-year hydrologic period the frequency of predicted bromide concentrations exceeding 100 μg/L would increase from 0% under Existing Conditions to 17% under Alternative 2A, while for the modeled drought period, the frequency would increase from 0% to 38%. Substantial changes in long-term average bromide could necessitate changes in treatment plant operation or require treatment plant upgrades in order to maintain DBP compliance. The model predicted change at Barker Slough is substantial and, therefore, would represent a substantially increased risk for adverse effects on existing MUN beneficial uses should treatment upgrades not be undertaken. The impact is considered significant.

Implementation of Mitigation Measure WQ-5 along with a separate, non-environmental commitment relating to the potential increased treatment costs associated with bromide-related changes would reduce these effects. While mitigation measures to reduce these water quality effects in affected water bodies to less than significant levels are not available, implementation of Mitigation Measure WQ-5 is recommended to attempt to reduce the effect that increased bromide concentrations may have on Delta beneficial uses. However, because the effectiveness of this mitigation measure to result in feasible measures for reducing water quality effects is uncertain, this impact is considered to remain significant and unavoidable. Please see Mitigation Measure WQ-5 under Impact WQ-5 in the discussion of Alternative 1A.

In addition to and to supplement Mitigation Measure WQ-5, the BDCP proponents have incorporated into the BDCP, as set forth in EIR/EIS Appendix 3B, *Environmental Commitments*, a separate, non-environmental commitment to address the potential increased water treatment costs that could result from bromide-related concentration effects on municipal water purveyor operations. Potential options for making use of this financial commitment include funding or providing other assistance towards implementation of the North Bay Aqueduct AIP, acquiring alternative water supplies, or other actions to indirectly reduce the effects of elevated bromide and DOC in existing water supply diversion facilities. Please refer to Appendix 3B, *Environmental Commitments*, for the full list of potential actions that could be taken pursuant to this commitment in order to reduce the water quality treatment costs associated with water quality effects relating to chloride, electrical conductivity, and bromide.

Mitigation Measure WQ-5: Avoid, Minimize, or Offset, as Feasible, Adverse Water Quality Conditions

Please see Mitigation Measure WQ-5 under Impact WQ-5 in the discussion of Alternative 1A.

Impact WQ-6: Effects on Bromide Concentrations Resulting from Implementation of CM2–CM22

***NEPA Effects*:** Conservation Measures 2–22 proposed under Alternative 2A would be the same as those proposed under Alternative 1A. As discussed for Alternative 1A, implementation of CM2–CM22 would not present new or substantially changed sources of bromide to the study area. Some conservation measures may replace or substitute for existing irrigated agriculture in the Delta. This replacement or substitution is not expected to substantially increase or present new sources of bromide. CM2–CM22 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.

In summary, implementation of CM2–CM22 under Alternative 2A, relative to the No Action Alternative, would have negligible, if any, effects on bromide concentrations. The effects on bromide from implementing CM2–CM22 are determined to not be adverse.

***CEQA Conclusion*:** Conservation Measures 2–22 proposed under Alternative 2A would be similar to those proposed under Alternative 1A. As such, effects on bromide resulting from the implementation of CM2–CM22 would be similar to that previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

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

Upstream of the Delta

Under Alternative 2A there would be no expected change to the sources of chloride in the Sacramento and eastside tributary watersheds. Chloride loading in these watersheds would remain unchanged and resultant changes in flows from altered system-wide operations would have negligible, if any, effects on the concentration of chloride in the rivers and reservoirs of these watersheds. The modeled long-term annual average flows on the lower San Joaquin River at Vernalis would decrease slightly compared to Existing Conditions and be similar compared to the No Action Alternative (as a result of climate change). The reduced flow would result in possible increases in long-term average chloride concentrations of up to about 3%, relative to the Existing Conditions and no change relative to No Action Alternative (Appendix 8G, Table Cl-62). The increased chloride concentrations would not increase the frequency of exceedances of any applicable objectives or criteria. Consequently, Alternative 2A would not be expected to cause exceedance of chloride objectives/criteria or substantially degrade water quality with respect to chloride, and thus would not adversely affect any beneficial uses of the Sacramento River, the eastside tributaries, associated reservoirs upstream of the Delta, or the San Joaquin River.

Delta

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

Relative to Existing Conditions, modeling predicts that Alternative 2A would result in similar or reduced long-term average chloride concentrations for the 16-year period modeled at most assessment locations, and, depending on modeling approach (see Section 8.3.1.3), and would result in increased concentrations at the North Bay Aqueduct at Barker Slough (i.e., ≤23%) and San Joaquin River at Staten Island (i.e., ≤18%) (Appendix 8G, *Chloride*, Table Cl-13 and Table Cl-14). Additionally, implementation of tidal habitat restoration under CM4 would increase the tidal exchange volume in the Delta, and thus may contribute to increased chloride concentrations in the Bay source water as a result of increased salinity intrusion. More discussion of this phenomenon is included in Section

8.3.1.3. Consequently, while uncertain, the magnitude of chloride increases may be greater than indicated herein and would affect the western Delta assessment locations the most which are influenced to the greatest extent by the Bay source water. The comparison to Existing Conditions reflects changes in chloride due to both Alternative 2A operations (including north Delta intake capacity of 15,000 cfs, Fall X2, and numerous other operational components of Scenario B) and climate change/sea level rise.

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

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

Municipal Beneficial Uses–Relative to Existing Conditions

Estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3) were used to evaluate the 150 mg/L Bay-Delta WQCP objective for municipal and industrial beneficial uses on a basis of the percent of years the chloride objective is exceeded for the modeled 16-year period. The objective is exceeded if chloride concentrations exceed 150 mg/L for a specified number of days in a given water year at both the Antioch and Contra Costa Pumping Plant #1 locations. For Alternative 2A, the modeled frequency of objective exceedance would approximately triple from 6% of years under Existing Conditions, to 19% of years under Alternative 2A (Appendix 8G, Table Cl-64).

Similarly, estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3) were also used to evaluate the 250 mg/L Bay-Delta WQCP objective for chloride at Contra Costa Pumping Plant #1 where daily average objectives apply. The basis for the evaluation was the predicted number of days the objective was exceeded for the modeled 16-year period. For Alternative 2A, the modeled frequency of objective exceedance would decrease by approximately one half, from 6% of modeled days under Existing Conditions, to 3% of modeled days under Alternative 2A (Appendix 8G, Table Cl-63).

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

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

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

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

With respect to the 303(d) listing for chloride in Tom Paine Slough, the monthly average chloride concentrations for the 16-year period modeled at Old River at Tracy Road would generally be similar compared to Existing Conditions, and thus, would not be further degraded on a long-term basis (Appendix 8G, Figure Cl-2). With respect to Suisun Marsh, the monthly average chloride concentrations for the 16-year period modeled would generally increase compared to Existing Conditions in some months during October through May at the Sacramento River at Collinsville (Appendix 8G, Figure Cl-3) and Mallard Island (Appendix 8G, Figure Cl-1), and would increase substantially at Montezuma Slough at Beldon’s Landing (i.e., over a doubling of concentration in December through February) (Appendix 8G, Figure Cl-4), thereby contributing to additional, measureable long-term degradation that potentially would adversely affect the necessary actions to reduce chloride loading for any TMDL that is developed.

Municipal Beneficial Uses–Relative to No Action Alternative

Similar to the assessment conducted for Existing Conditions, estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3) were used to evaluate the 150 mg/L Bay-Delta WQCP objective for municipal and industrial beneficial uses. For Alternative 2A, the modeled frequency of objective exceedance would increase from 6% under the No Action Alternative to 19% of years under Alternative 2A (Appendix 8G, Table Cl-64).

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

Similar to Existing Conditions, a comparative assessment of modeling approaches was utilized to evaluate the 250 mg/L Bay-Delta WQCP objectives in terms of both frequency of exceedance and use of assimilative capacity on a monthly average basis. When utilizing the mass balance approach to model monthly average chloride concentrations for the 16-year period, the exceedance frequency would be predicted to decrease slightly at the San Joaquin River at Antioch (i.e., from 73% for the No Action Alternative to 70%), decrease slightly at the Contra Costa Canal at Pumping Plant #1 (i.e., from 14% to 12%), and increase slightly at the Sacramento River at Mallard Island (i.e., from 86% to

88%) (Appendix 8G, Table Cl-15). The available assimilative capacity would be reduced at the Antioch location compared to the No Action Alternative (i.e., reduction of 25% in April, and 100% in April [i.e., eliminated] during the drought period modeled) (Appendix 8G, Table Cl-17). Available assimilative capacity also would be reduced at the Contra Costa Canal at Pumping Plant #1 by up to 17% and 12% in September and October of the 16-year modeled period, respectively, and up to 100% in the drought period) (Appendix 8G, Table Cl-17), reflecting substantial degradation at these locations during months when average concentrations would be near, or exceed, the objective.

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

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

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

With respect to the 303(d) listing for chloride, Alternative 1A would generally result in similar changes to those discussed for the comparison to Existing Conditions. Monthly average chloride concentrations at Tom Paine Slough would not be further degraded on a long-term basis (Appendix 8G, Figure Cl-2). Monthly average chloride concentrations at source water channel locations for the Suisun Marsh (Appendix 8G, Figures Cl-1, Cl-3 and Cl-4) would increase substantially in some months during October through May compared to the No Action Alternative conditions. Therefore, additional, measureable long-term degradation would occur in Suisun Marsh that potentially would adversely affect the necessary actions to reduce chloride loading for any TMDL that is developed.

SWP/CVP Export Service Areas

Under Alternative 2A, long-term average chloride concentrations based on the mass balance analysis of modeling results for the 16-year period modeled at the Banks and Jones pumping plants would decrease by as much as 33% relative to Existing Conditions and 29% compared to No Action Alternative (Appendix 8G, *Chloride*, Table Cl-13). The modeled frequency of exceedances of applicable water quality objectives/criteria would decrease relative to the Existing Conditions and No Action Alternative, for both the 16-year period and the drought period modeled (Appendix 8G, *Chloride*, Table Cl-15). Consequently, water exported into the SWP/CVP service area would generally be of similar or better quality with regards to chloride relative to Existing Conditions and the No Action Alternative conditions.

Results of the modeling approach which used relationships between EC and chloride (see Section 8.3.1.3) were consistent with the discussion above, and assessment of chloride using these data results in the same conclusions as are presented above for the mass-balance approach (Appendix 8G, Table Cl-14 and Table Cl-16).

Commensurate with the reduced chloride concentrations in water exported to the service area, reduced chloride loading in the lower San Joaquin River would be anticipated which would likely alleviate or lessen any expected increase in chloride at Vernalis related to decreased annual average San Joaquin River flows (see discussion of Upstream of the Delta).

Maintenance of SWP and CVP facilities would not be expected to create new sources of chloride or contribute towards a substantial change in existing sources of chloride in the affected environment. Maintenance activities would not be expected to cause any substantial change in chloride such that any long-term water quality degradation would occur, thus, beneficial uses would not be adversely affected anywhere in the affected environment.

***NEPA Effects*:** In summary, relative to the No Action Alternative conditions, Alternative 2A would result in increased water quality degradation and frequency of exceedance of the 150 mg/L municipal and industrial objective at Contra Costa Pumping Plant #1 and Antioch locations. The frequency of exceedances of the 250 mg/L municipal and industrial objective at interior and western Delta locations would generally decrease, however, further water quality degradation would occur. Measureable water quality degradation also would occur relative to the 303(d) impairment in Suisun Marsh. The predicted chloride increases constitute an adverse effect on water quality (see Mitigation Measure WQ-7 below; implementation of this measure along with a separate, non-environmental commitment relating to the potential increased chloride treatment costs would reduce these effects). Additionally, the predicted changes relative to the No Action Alternative conditions indicate that in addition to the effects of climate change/sea level rise, implementation of CM1 and CM4 under Alternative 2A would contribute substantially to the adverse water quality effects.

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

Chloride is not a constituent of concern in the Sacramento River watershed upstream of the Delta, thus river flow rate and reservoir storage reductions that would occur under the Alternative 2A, relative to Existing Conditions, would not be expected to result in a substantial adverse change in chloride levels. Additionally, relative to Existing Conditions, the Alternative 2A would not result in reductions in river flow rates (i.e., less dilution) or increased chloride loading such that there would be any substantial increase in chloride concentrations upstream of the Delta in the San Joaquin River watershed.

Relative to Existing Conditions, the Alternative 2A would result in substantially increased chloride concentrations in the Delta such that frequency of exceeding the 150 mg/L Bay-Delta WQCP objective would approximately triple. Moreover, the frequency of exceedance of the 250 mg/L Bay-Delta WQCP objective would increase at the San Joaquin River at Antioch and at Mallard Slough (by 3% each), and long-term degradation may occur, that may result in adverse effects on the municipal and industrial water supply beneficial use (see Mitigation Measure WQ-7 below; implementation of this measure along with a separate, non-environmental commitment relating to the potential increased chloride treatment costs would reduce these effects). Relative to the Existing Conditions, the modeled increased chloride concentrations and degradation in the western Delta could further contribute, at measurable levels (i.e., over a doubling of concentration), to the existing 303(d) listed impairment due to chloride in Suisun Marsh for the protection of fish and wildlife.

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

Chloride is not a bioaccumulative constituent, thus any increased concentrations under Alternative 2A would not result in substantial chloride bioaccumulation impacts on aquatic life or humans. Alternative 2A maintenance would not result in any substantial changes in chloride concentration upstream of the Delta or in the SWP/CVP Export Service Areas. However, this impact is determined to be significant due to increased chloride concentrations and degradation at western Delta locations and its effects on municipal and industrial water supply and fish and wildlife beneficial uses.

While mitigation measures to reduce these water quality effects in affected water bodies to less than significant levels are not available, implementation of Mitigation Measure WQ-7 is recommended to attempt to reduce the effect that increased chloride concentrations may have on Delta beneficial uses. However, because the effectiveness of this mitigation measure to result in feasible measures for reducing water quality effects is uncertain, this impact is considered to remain significant and unavoidable. Please see Mitigation Measure WQ-7 under Impact WQ-7 in the discussion of Alternative 1A.

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

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

Please see Mitigation Measure WQ-7 under Impact WQ-7 in the discussion of Alternative 1A.

Impact WQ-8: Effects on Chloride Concentrations Resulting from Implementation of CM2–CM22

***NEPA Effects*:** Under Alternative 2A, the types and geographic extent of effects on chloride concentrations in the Delta as a result of implementation of the other conservation measures (i.e., CM2–CM22) would be similar to, and undistinguishable from, those effects previously described for Alternative 1A. The conservation measures would present no new direct sources of chloride to the affected environment. Moreover, some habitat restoration conservation measures (CM4–CM10) would occur on lands within the Delta currently used for irrigated agriculture, thus replacing agricultural land uses with restored tidal wetlands, floodplain, and related channel margin and off-channel habitats. The potential reduction in irrigated lands within the Delta may result in reduced discharges of agricultural field drainage with elevated chloride concentrations, which would be considered an improvement compared to No Action Alternative conditions. In summary, based on the discussion above, the effects on chloride from implementing CM2-CM22 are considered to be not adverse.

***CEQA Conclusion*:** Implementation of the CM2–CM22 for Alternative 2A would not present new or substantially changed sources of chloride to the affected environment upstream of the Delta, within Delta, or in the SWP/CVP service area compared to Existing Conditions. Replacement of irrigated agricultural land uses in the Delta with habitat restoration conservation measures may result in some reduction in discharge of agricultural field drainage with elevated chloride concentrations, thus resulting in improved water quality conditions. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

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

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

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

River flow rate and reservoir storage reductions that would occur under Alternative 2A, relative to Existing Conditions, would not be expected to result in a substantial adverse change in DO levels in the reservoirs and rivers upstream of the Delta, given that mean monthly flows would remain within the ranges historically seen under Existing Conditions and the affected river are large and turbulent. Any reduced DO saturation level that may be caused by increased water temperature would not be expected to cause DO levels to be outside of the range seen historically. Finally, amounts of oxygen demanding substances and salinity would not be expected to change sufficiently to affect DO levels.

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

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

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

Impact WQ-10: Effects on Dissolved Oxygen Resulting from Implementation of CM2–CM22

***NEPA Effects*:** Effects of CM2–CM22 on DO under Alternative 2A are the same as those discussed for Alternative 1A and are considered to not be adverse.

***CEQA Conclusion*:** Conservation Measures 2–22 proposed under Alternative 2A would be similar to those proposed under Alternative 1A. As such, effects on DO resulting from the implementation of CM2–CM22 would be similar to that previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

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

Upstream of the Delta

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

Delta

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

Relative to Existing Conditions, Alternative 2A would result in an increase in the number of days the Bay-Delta WQCP EC objectives would be exceeded in the Sacramento River at Emmaton, San Joaquin River at San Andreas Landing and Prisoners Point, and Old River near Middle River and at Tracy Bridge (Appendix 8H, Table EC-2). The percent of days the Emmaton EC objective would be exceeded for the entire period modeled (1976–1991) would increase from 6% under Existing Conditions to 23% under Alternative 2A, and the percent of days out of compliance would increase from 11% under Existing Conditions to 35% under Alternative 2A. The percent of days the San Andreas Landing EC objective would be exceeded would increase from 1% under Existing Conditions to 4% under Alternative 2A, and the percent of days out of compliance with the EC objective would increase from 1% under Existing Conditions to 6% under Alternative 2A. The percent of days the Prisoners Point EC objective would be exceeded for the entire period modeled would increase from 6% under Existing Conditions to 25% under Alternative 2A, and the percent of days out of compliance with the EC objective would increase from 10% under Existing Conditions to 27% under Alternative 2A. The increase in percent of days exceeding the EC objectives and days out of compliance at the Old River locations would be 2% at Tracy Bridge and less than 1% at Middle River. Average EC levels at the western and southern Delta compliance locations would decrease from 0–37% for the entire period modeled. During the drought period modeled (1987-1991), average EC would decrease by 0–32%, at western and southern Delta locations, except Emmaton would have an increase in average EC of 9% (Appendix 8H, Table EC-13). At the two interior Delta locations, there would be increases in average EC: the S. Fork Mokelumne River at Terminous average EC would increase 5% for the entire period modeled and 4% during the drought period modeled; and San Joaquin River at San Andreas Landing average EC would increase 1% for the entire period modeled and 10% during the drought period modeled. On average, EC would increase at San Andreas Landing from February through September. Average EC in the S. Fork Mokelumne River at Terminous would increase during all months (Appendix 8H, Table EC-13). The comparison to Existing Conditions reflects changes in EC due to both Alternative 2A operations (including north Delta intake capacity of 15,000 cfs, Fall X2, and numerous other operational components of Scenario B) and climate change/sea level rise.

Relative to the No Action Alternative, the percent of days exceeding EC objectives and percent of days out of compliance would increase at: Sacramento River at Emmaton, San Joaquin River at Jersey Point, San Andreas Landing, and Prisoners Point; and Old River near Middle River and at Tracy Bridge (Appendix 8H, Table EC-2). The increase in percent of days exceeding the EC objective would be 24% at Prisoners Point and 11% or less at the remaining locations. The increase in percent of days out of compliance would be 26% at Prisoners Point and 13% or less at the remaining locations. For the entire period modeled, average EC levels would increase at all Delta compliance locations relative to the No Action Alternative, except in Three Mile Slough near the Sacramento River, the Sacramento Rivera t Emmaton, and the San Joaquin River at Jersey Point. The average EC increase would be 6% or less (Appendix 8H, Table EC-13). Similarly, during the drought period modeled, average EC would increase at all locations, except Three Mile Slough, Emmaton, and Jersey Point. The greatest average EC increase during the drought period modeled would occur in the San Joaquin River at San Andreas Landing (10%); the increase at the other locations would be 1–7% (Appendix 8H, Table EC-13). The comparison to the No Action Alternative reflects changes in EC due only to Alternative 2A operations (including north Delta intake capacity of 15,000 cfs, Fall X2, and numerous other operational components of Scenario B).

For Suisun Marsh, October–May is the period when Bay-Delta WQCP EC objectives for protection of fish and wildlife apply. Average EC would increase for the entire period modeled under Alternative 2A, relative to Existing Conditions, during the months of March through May by 0.3–0.6 mS/cm in the Sacramento River at Collinsville (Appendix 8H, Table EC-21). Long-term average EC would decrease relative to Existing Conditions in Montezuma Slough at National Steel during October–May (Appendix 8H, Table EC-22). The most substantial increase would occur near Beldon Landing, with long-term average EC levels increasing by 1.6–4.6 mS/cm, depending on the month, at least doubling during some months the long-term average EC relative to Existing Conditions (Appendix 8H, Table EC-23). Sunrise Duck Club and Volanti Slough also would have long-term average EC increases during all months of 0.5–2.4 mS/cm (Appendix 8H, Tables EC-24 and EC-25). The degree to which the long-term average EC increases would cause exceedance of Bay-Delta WQCP objectives is unknown, because objectives are expressed as a monthly average of daily high tide EC, which does not have to be met if it can be demonstrated "equivalent or better protection will be provided at the location" (State Water Resources Control Board 2006:14). 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 be substantial and it is uncertain the degree to which current management plans for the Suisun Marsh would be able to address these substantially higher EC levels and protect beneficial uses. Thus, these increased EC levels in Suisun Marsh are considered to have a potentially adverse effect on marsh beneficial uses. Long-term average EC increases in Suisun Marsh under Alternative 2A relative to the No Action Alternative would be similar to the increases relative to Existing Conditions.

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

SWP/CVP Export Service Areas

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

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

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

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

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

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

NEPA Effects: In summary, the increased frequency of exceedance of EC objectives and increased long-term and drought period average EC levels that would occur at western, interior, and southern Delta compliance locations under Alternative 2A, relative to the No Action Alternative, would contribute to adverse effects on the agricultural beneficial uses. In addition. the increased frequency of exceedance of the San Joaquin River at Prisoners Point EC objective and long-term and drought period average EC could contribute to adverse effects on fish and wildlife beneficial uses. Given that the western and southern Delta are Clean Water Act section 303(d) listed as impaired due to elevated EC, the increase in the incidence of exceedance of EC objectives and long-term average and drought period average EC in this portion of the Delta has the potential to contribute to additional beneficial use impairment. The increases in long-term average EC levels that would occur in Suisun Marsh would further degrade existing EC levels and could contribute additional to adverse effects on the fish and wildlife beneficial uses. Suisun Marsh is section 303(d) listed as impaired due to elevated EC, and the potential increases in long-term average EC levels could contribute to additional beneficial use impairment. These increases in EC constitute an adverse effect on water quality. Mitigation Measure WQ-11 would be available to reduce these effects (implementation of this measure along with a separate, non-environmental commitment as set forth in EIR/EIS Appendix 3B, *Environmental Commitments*, relating to the potential EC-related changes would reduce these effects).

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

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

Relative to Existing Conditions, Alternative 2A would not result in any substantial increases in long-term average EC levels in the SWP/CVP Export Service Areas. There would be no exceedance of the EC objective at the Jones and Banks pumping plants. Average EC levels for the entire period modeled would decrease at both plants and, thus, this alternative would not contribute to additional beneficial use impairment related to elevated EC in the SWP/CVP Export Service Areas waters. Rather, this alternative would improve long-term EC levels in the SWP/CVP Export Service Areas, relative to Existing Conditions.

In the Plan Area, Alternative 2A would result in an increase in the frequency with which Bay-Delta WQCP EC objectives are exceeded for the entire period modeled (1976–1991): in the Sacramento River at Emmaton (agricultural objective; 17% increase), in the San Joaquin River at San Andreas Landing (agricultural objective; 3% increase), and Prisoners Point (fish and wildlife objective; 19% increase), both in the interior Delta; and in Old River near Middle River and at Tracy Bridge (agricultural objectives; up to 2% increase), both in the southern Delta. Average EC levels at San Andreas Landing would increase by 1% during for the entire period modeled and 10% during the drought period modeled. The increases in long-term and drought period average EC levels and increased frequency of exceedance of EC objectives that would occur in the San Joaquin River at San Andreas Landing, and the increased exceedance of EC objectives in the Sacramento River at Emmaton would potentially contribute to adverse effects on the agricultural beneficial uses in the interior and western Delta. Further, the increased frequency of exceedance of the fish and wildlife objective at Prisoners Point could contribute to adverse effects on aquatic life. Because EC is not bioaccumulative, the increases in long-term average EC levels would not directly cause bioaccumulative problems in aquatic life or humans. The western and southern Delta are Clean Water Act section 303(d) listed for elevated EC and the increased frequency of exceedance of EC objectives that would occur in these portions of the Delta could make beneficial use impairment measurably worse. This impact is considered to be significant.

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

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

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

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

Please see Mitigation Measure WQ-11 under Impact WQ-11 in the discussion of Alternative 1A.

Impact WQ-12: Effects on Electrical Conductivity Resulting from Implementation of CM2–CM22

***NEPA Effects*:** Effects of CM2–CM22 on EC under Alternative 2A are the same as those discussed for Alternative 1A and are considered not to be adverse.

***CEQA Conclusion*:** Conservation Measures 2–22 proposed under Alternative 2A would be similar to those proposed under Alternative 1A. As such, effects on EC resulting from the implementation of CM2–CM22 would be similar to that previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

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

Upstream of the Delta

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

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

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

Delta

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

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

Fish tissue estimates show only small or no increases in exceedance quotients based on long-term annual average concentrations for mercury at the Delta locations. The greatest increase in exceedance quotients was 13% at Old River at Rock Slough relative to Existing Conditions, and 11 - 12% at the Mokelumne River (South Fork) at Staten Island, Franks Tract, and Old River at Rock Slough relative to the No Action Alternative (Figure 8-55; Appendix 8I, Table I-9b).

SWP/CVP Export Service Areas

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

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

***NEPA Effects*:** Based on the above discussion, the effects of mercury and methylmercury in comparison of Alternative 2A to the No Action Alternative (as waterborne and bioaccumulated forms) are not considered to be adverse.

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

Under Alternative 2A, greater water demands and climate change would alter the magnitude and timing of reservoir releases and river flows upstream of the Delta in the Sacramento River watershed and east-side tributaries, relative to Existing Conditions. Concentrations of mercury and methylmercury upstream of the Delta will not be substantially different relative to Existing Conditions due to the lack of important relationships between mercury/methylmercury concentrations and flow for the major rivers.

Methylmercury concentrations exceed criteria at all locations in the Delta and no assimilative capacity exists. However, monthly average waterborne concentrations of total and methylmercury, over the period of record, are very similar to Existing Conditions. Similarly, estimates of fish tissue mercury concentrations show almost no differences would occur among sites for Alternative 2A as compared to Existing Conditions for Delta sites.

Assessment of effects of mercury in the SWP and CVP Export Service Areas were based on effects on mercury concentrations and fish tissue mercury concentrations at the Banks and Jones pumping plants. The Banks and Jones pumping plants are expected to show increased assimilative capacity for waterborne mercury and decreased fish tissue concentrations of mercury for Alternative 2A as compared to Existing Conditions.

As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because mercury concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Because any increases in mercury or methylmercury concentrations are not likely to be measurable, changes in mercury concentrations or fish tissue mercury concentrations would not make any existing mercury-related impairment measurably worse. In comparison to Existing Conditions, Alternative 2A would not increase levels of mercury by frequency, magnitude, and geographic extent such that the affected environment would be expected to have measurably higher body burdens of mercury in aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish) or humans consuming those organisms. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-14: Effects on Mercury Concentrations Resulting from Implementation of CM2–CM22

NEPA Effects: Some habitat restoration activities under Alternative 2A would occur on lands in the Delta formerly used for irrigated agriculture. Tidal and other restoration proposed under Alternative 2A have the potential to increase water residence times and increase accumulation of organic sediments that are known to enhance methylmercury bioaccumulation in biota in the restored habitat. Therefore, increases in mercury methylation in the habitat restoration areas is possible but uncertain depending on the specific restoration design implemented at a particular Delta location. Models to estimate the potential for methylmercury formation in restored areas are not currently available. However, DSM2 modeling for Alternative 2A operations does incorporate assumptions for certain habitat restoration activities proposed under CM2 and CM4 (see Section

8.3.1.3) that result in changes to Delta hydrodynamics compared to the No Action Alternative. These modeled restoration assumptions provide some insight into potential hydrodynamic changes that could be expected related to implementing CM2 and CM4 and are considered in the evaluation of the potential for increased mercury and methylmercury concentrations under Alternative 2A.

BDCP Conservation Measure 12 (CM12) addresses the potential for methylmercury bioaccumulation associated with restoration activities and acknowledges the uncertainties associated with mitigating or minimizing this potential effect. CM12 proposes project-specific mercury management plans for restoration actions that will incorporate relevant approaches recommended in Phase 1 Methylmercury TMDL control studies. Specific approaches recommended under CM12 that are intended to minimize or mitigate for potential increases in methylmercury bioaccumulation at future restoration sites include:

- Characterizing mercury, methylmercury, organic carbon, iron, and sulfate concentrations to better inform restoration design,
- Sequestering methylmercury at restoration sites using low intensity chemical dosing techniques,
- Minimizing microbial methylation associated with anoxic conditions by reducing the amount of organic material at a restoration site,
- Designing restoration sites to enhance photo degeneration that converts methylmercury into a biologically unavailable, inorganic form of mercury,
- Remediating restoration site soils with iron to reduce methylation in sulfide rich soils, and
- Considering capping mercury laden sediments, where possible to reduce methylation potential at a site.

Because of the uncertainties associated with site-specific estimates of methylmercury concentrations and the uncertainties in source modeling and tissue modeling, the effectiveness of methylmercury management proposed under CM12 to reduce methylmercury concentrations would need to be evaluated separately for each restoration effort, as part of design and implementation. In summary, because of this uncertainty and the known potential for methylmercury creation in the Delta this potential effect of implementing CM2–CM22 is considered adverse.

CEQA Conclusion: There would be no substantial, long-term increase in mercury or methylmercury concentrations or loads in the rivers and reservoirs upstream of the Delta or the waters exported to the CVP and SWP service areas due to implementation of CM2–CM22 relative to Existing Conditions. However, uptake of mercury from water and/or methylation of inorganic mercury may increase to an unquantified degree as part of the creation of new, marshy, shallow, or organic-rich restoration areas. Methylmercury is 303(d)-listed within the affected environment, and therefore any potential measurable increase in methylmercury concentrations would make existing mercury-related impairment measurably worse. Because mercury is bioaccumulative, increases in water-borne mercury or methylmercury that could occur in some areas could bioaccumulate to somewhat greater levels in aquatic organisms and would, in turn, pose health risks to fish, wildlife, or humans. Design of restoration sites under Alternative 2A would be guided by CM12 which requires development of site specific mercury management plans as restoration actions are implemented. The effectiveness of minimization and mitigation actions implemented according to the mercury management plans is not known at this time although the potential to reduce methylmercury concentrations exists based on current research. Although the BDCP will implement CM12 with the goal to reduce this potential effect the uncertainties related to site specific restoration conditions and the potential for increases in methylmercury concentrations in the Delta result in this potential impact being considered significant. No mitigation measures would be available until specific restoration actions are proposed. Therefore this programmatic impact is considered significant and unavoidable.

Impact WQ-15: Effects on Nitrate Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative, Alternative 2A would have negligible, if any, impact on nitrate concentrations in the rivers and reservoirs upstream of the Delta in the Sacramento River watershed relative to Existing Conditions and the No Action Alternative.

Under Alternative 2A, modeling indicates that long-term annual average flows on the San Joaquin River would decrease by an estimated 6%, relative to Existing Conditions, and would remain virtually the same relative to the No Action Alternative (Appendix 5A). Given these relatively small decreases in flows and the weak correlation between nitrate and flows in the San Joaquin River (see Nitrate Appendix 8J, Figure 2), it is expected that nitrate concentrations in the San Joaquin River would be minimally affected, if at all, by changes in flow rates under Alternative 2A.

Any negligible changes in nitrate-N concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regards to nitrate.

Delta

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

Results of the mixing calculations indicate that under Alternative 2A, relative to Existing Conditions and the No Action Alternative, nitrate concentrations throughout the Delta are anticipated to remain low (<1.4 mg/L-N) relative to adopted objectives (Nitrate Appendix 8J, Table 10 and 11). Although changes at specific Delta locations and for specific months may be substantial on a relative basis, the absolute concentration of nitrate in Delta waters would remain low (<1.4 mg/L-N) in relation to the drinking water MCL of 10 mg/L-N, as well as all other thresholds identified in Table 8-50. Long-term average nitrate concentrations are anticipated to remain below 1 mg/L-N at all 11 assessment locations except the San Joaquin River at Buckley Cove, where long-term average concentrations would be somewhat above 1 mg/L-N. Nevertheless, at this location, long-term average nitrate concentration would be somewhat reduced under Alternative 2A, relative to Existing Conditions, and slightly increased relative to the No Action Alternative. No additional exceedances of the MCL are anticipated at any location (Nitrate Appendix 8J, Table 10). On a monthly average basis and on a long term annual average basis, for all modeled years and for the drought period (1987–1991) only, use of assimilative capacity available under Existing Conditions and the No Action Alternative, relative to the drinking water MCL of 10 mg/L-N, was low or negligible (i.e., <5%) for all locations and months, except San Joaquin River at Buckley Cove in August, which showed a 6.4% use of the assimilative capacity that was available under the No Action Alternative, for the drought period (1987–1991) (Nitrate Appendix 8J, Table 12).

Nitrate concentrations will likely be higher than the modeling results indicate in certain locations. This includes in the Sacramento River between Freeport and Mallard Island and other areas in the Delta downstream of Freeport that are influenced by Sacramento River water. These increases are associated with ammonia and nitrate that are discharged from the SRWTP, which are not included in the modeling.

- Under Existing Conditions, most of the ammonia discharged from the SRWTP is converted to nitrate downstream of the facility's discharge at Freeport, and thus, nitrate concentrations under Existing Conditions in these areas are expected to be higher than the modeling predicts, the increase becoming greater with increasing distance downstream. However, the increase in nitrate concentrations downstream of the SRWTP is expected to be small—the existing increase appears to be from approximately 0.1 mg/L-N to approximately 0.4–0.5 mg/L-N over this reach, due to approximately a 1:1 conversion of ammonia-N to nitrate-N (Central Valley Water Board 2010a:32).
- Under Alternative 2A, the planned upgrades to the SRWTP, which include nitrification/partial denitrification, would substantially decrease ammonia concentrations in the discharge, but would increase nitrate concentrations in the discharge up to 10 mg/L-N, which is substantially higher than under Existing Conditions.
- Overall, under Alternative 2A, the nitrogen load from the SRWTP discharge is expected to decrease (by up to 50%), relative to Existing Conditions, due to nitrification/partial dentrification ugrades at the SRWTP facility. Thus, while concentrations of nitrate downstream of the facility are expected to be higher than modeling results indicate for both Existing Conditions and Alternative 2A, the increase is expected to be greater under Existing Conditions than for Alternative 2A due to the upgrades that are assumed under Alternative 2A.

The other areas in which nitrate concentrations will be higher than the modeling results indicate are immediately downstream of other wastewater treatment plants that practice nitrification, but not denitrification (e.g., City of Rio Vista Beach WWTF, Town of Discovery Bay WWTF, City of Stockton RWCF). For all such facilities in the Delta, the Regional Water Boards have issued NPDES permits that allow discharge of wastewater containing nitrate into the Delta, and under these permits, the State has determined that no beneficial uses are adversely affected by the discharge, and that the discharger's use of available assimilative capacity of the water body is acceptable. When dilution is necessary in order for the discharge to be in compliance with the Basin Plans (which incorporate the 10 mg/L-N MCL by reference), not all of the assimilative capacity of the receiving water is granted to the discharger. Thus, limited decreases in flows are not anticipated to result in systemic exceedances of the MCLs by these POTWs. Furthermore, NPDES permits are renewed on a 5-year basis, and thus, if under changes in flows, dilution was no longer sufficient to maintain nitrate below the MCL in the receiving water, the NPDES permit renewal process would address such cases.

Therefore, any increases in nitrate-N concentrations that may occur at certain locations within the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to nitrate.

SWP/CVP Export Service Areas

Assessment of effects of nitrate in the SWP and CVP Export Service Areas is based on effects on nitrate-N at the Banks and Jones pumping plants.

Results of the mixing calculations indicate that under Alternative 2A, relative to Existing Conditions and the No Action Alternative, nitrate concentrations at Banks and Jones pumping plants are anticipated to decrease on a long-term average annual basis (Nitrate Appendix 8J, Table 10 and 11). During the late summer, particularly in the drought period assessed, concentrations are expected to increase substantially on a relative basis (i.e., >50%), but the absolute value of these changes (i.e., in mg/L-N) is small. Additionally, given the many factors that contribute to potential algal blooms in the SWP and CVP canals within the Export Service Area, and the lack of studies that have shown a direct relationship between nutrient concentrations in the canals and reservoirs and problematic algal blooms in these water bodies, there is no basis to conclude that these small (i.e., generally <0.3 mg/L-N), seasonal increases in nitrate concentrations would increase the potential for problem algal blooms in the SWP and CVP Export Service Area. No additional exceedances of the MCL are anticipated (Nitrate Appendix 8J, Table 10). On a monthly average basis and on a long term annual average basis, for all modeled years and for the drought period (1987–1991) only, use of assimilative capacity available under Existing Conditions and the No Action Alternative, relative to the 10 mg/L-N MCL, was negligible (<4%) for both Banks and Jones pumping plants (Nitrate Appendix 8J, Table 12).

Any increases in nitrate-N concentrations that may occur in water exported via Banks and Jones pumping plants are not expected to result in adverse effects to beneficial uses or substantially degrade the quality of exported water, with regards to nitrate.

***NEPA Effects*:** In summary, based on the discussion above, the effects on nitrate from implementing CM1 are considered to be not adverse.

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

Nitrate-N concentrations are generally low in the reservoirs and rivers of the watersheds, owing to substantial dilution available for point sources and the lack of substantial nonpoint sources of nitrate-N upstream of the SRWTP in the Sacramento River watershed, and in the watersheds of the eastern tributaries (Cosumnes, Mokelumne, and Calaveras Rivers). Although higher in the San Joaquin River watershed, nitrate-N concentrations are not well-correlated with flow rates. Consequently, any modified reservoir operations and subsequent changes in river flows under Alternative 2A, relative to Existing Conditions, are expected to have negligible, if any, effects on reservoir and river nitrate-N concentrations upstream of Freeport in the Sacramento River watershed and upstream of the Delta in the San Joaquin River watershed.

In the Delta, results of the mixing calculations indicate that under Alternative 2A, relative to Existing Conditions, nitrate concentrations throughout the Delta are anticipated to remain low (<1.4 mg/L-N) relative to adopted objectives. No additional exceedances of the MCL are anticipated at any location, and use of assimilative capacity available under Existing Conditions, relative to the drinking water MCL of 10 mg/L-N, was low or negligible (i.e., <5%) for virtually all locations and months.

Assessment of effects of nitrate in the SWP and CVP Export Service Areas is based on effects on nitrate-N concentrations at the Banks and Jones pumping plants. Results of the mixing calculations indicate that under Alternative 2A, relative to Existing Conditions, long-term average nitrate concentrations at Banks and Jones pumping plants are anticipated to change negligibly. No additional exceedances of the MCL are anticipated, and use of assimilative capacity available under Existing Conditions, relative to the MCL was negligible (i.e., <4%) for both Banks and Jones pumping plants for all months.

Based on the above, there would be no substantial, long-term increase in nitrate-N concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the waters exported to the CVP and SWP service areas under Alternative 2A relative to Existing Conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because nitrate concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Nitrate is not 303(d) listed within the affected environment and thus any increases that may occur in some areas and months would not make any existing nitrate-related impairment measurably worse because no such impairments currently exist. Because nitrate is not bioaccumulative, increases that may occur in some areas and months would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-16: Effects on Nitrate Concentrations Resulting from Implementation of CM2–22

NEPA Effects: Effects of CM2–22 on nitrate under Alternative 2A are the same as those discussed for Alternative 1A and are considered not to be adverse.

CEQA Conclusion: Conservation Measures 2–22 proposed under Alternative 2A would be similar to those proposed under Alternative 1A. As such, effects on nitrate resulting from the implementation of CM2–CM22 would be similar to that previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-17: Effects on Dissolved Organic Carbon Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Under Alternative 2A, there would be no substantial change to the sources of DOC within the watersheds upstream of the Delta. Moreover, long-term average flow and DOC levels in the Sacramento River at Hood and San Joaquin River at Vernalis are poorly correlated. Thus changes in system operations and resulting reservoir storage levels and river flows would not be expected to cause a substantial long-term change in DOC concentrations in the water bodies upstream of the Delta. Any negligible changes in DOC levels in water bodies upstream of the Delta under Alternative 2A, relative to Existing Conditions and the No Action Alternative, would not be of sufficient frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regards to DOC.

Delta

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

Under Alternative 2A, the geographic extent of effects pertaining to long-term average DOC concentrations in the Delta would be similar to that previously described for Alternative 1A, although the magnitude of predicted long-term change and relative frequency of concentration threshold exceedances would be slightly greater. Modeled effects would be greatest at Franks Tract, Rock Slough, and Contra Costa PP No. 1., where for the 16-year hydrologic period and the modeled drought period, long-term average concentration increases ranging from 0.3–0.4 mg/L would be predicted (≤12% net increase) (Appendix 8K, DOC Table 3). Increases in long-term average concentrations would correspond to more frequent concentration threshold exceedances, with the greatest change occurring at Rock Slough and Contra Costa PP No. 1 locations. For Rock Slough, long-term average DOC concentrations exceeding 3 mg/L would increase from 52% under Existing Conditions to 74% under the Alternative 2A (an increase from 47% to 70% for the drought period), and concentrations exceeding 4 mg/L would increase from 30% to 36% (32% to 38% for the drought period). For Contra Costa PP No. 1, long-term average DOC concentrations exceeding 3 mg/L would increase from 52% under Existing Conditions to 80% under Alternative 2A (45% to 80% for the drought period), and concentrations exceeding 4 mg/L would increase from 32% to 41% (35% to 42% for the drought period). Relative change in frequency of threshold exceedance for other assessment locations would be similar or less. While Alternative 2A would generally lead to slightly higher long-term average DOC concentrations (≤0.4 mg/L) at some municipal water intakes and Delta interior locations, the predicted change would not be expected to adversely affect MUN beneficial uses, or any other beneficial use. This comparison to Existing Conditions reflects changes in DOC due to both Alternative 2A operations (including north Delta intake capacity of 15,000 cfs, Fall X2, and numerous other operational components of Scenario B) and climate change/sea level rise.

In comparison, Alternative 2A relative to the No Action Alternative would generally result in a similar magnitude of change to that discussed for the comparison to Existing Conditions. Maximum increases of 0.2–0.3 mg/L DOC (i.e., ≤9%) would be predicted at Franks Tract, Rock Slough, and Contra Costa PP No. 1 relative to No Action Alternative (Appendix 8K, DOC Table 3). Threshold concentration exceedance frequency trends would also be similar to that discussed for the existing condition comparison, with exception to the predicted 4 mg/L exceedance frequency at Buckley Cove. In comparison to the No Action Alternative, the frequency which long-term average DOC concentrations exceeded 4 mg/L at Buckley Cove would increase slightly from 27% to 28% (42% to 50% for the modeled drought period). While the Alternative 2A would generally lead to slightly higher long-term average DOC concentrations at some Delta assessment locations when compared to No Action Alternative conditions, the predicted change would not be expected to adversely affect MUN beneficial uses, or any other beneficial use, particularly when considering the relatively small change in long-term annual average concentration. Unlike the comparison to Existing Conditions, this comparison to the No Action Alternative reflects changes in DOC due to only Alternative 2A operations.

As discussed for Alternative 1A, substantial change in ambient DOC concentrations would need to occur before significant changes in drinking water treatment plant design or operations are triggered. The increases in long-term average DOC concentrations estimated to occur at various Delta locations under Alternative 2A are of sufficiently small magnitude that they would not require existing drinking water treatment plants to substantially upgrade treatment for DOC removal above levels currently employed.

Relative to existing and No Action Alternative conditions, Alternative 2A would lead to predicted improvements in long-term average DOC concentrations at Barker Slough, as well as Banks and Jones pumping plants (discussed below). At Barker Slough, long-term average DOC concentrations would be predicted to decrease by as much as 0.1–0.2 mg/L, depending on baseline conditions comparison and modeling period.

SWP/CVP Export Service Areas

Under Alternative 2A, modeled long-term average DOC concentrations would decrease at Banks and Jones pumping plants for both the modeled 16-year hydrologic period and the modeled drought period. Relative to Existing Conditions, long-term average DOC concentrations at Banks would be predicted to decrease by 0.5 mg/L (0.2 mg/L during drought period) (Appendix 8K, DOC Table 3). At Jones, long-term average DOC concentrations would be predicted to decrease by 0.4 mg/L (<0.1 mg/L during drought period). Predicted decreases under relative to the No Action Alternative would be of similar magnitude. Such decreases in long-term average DOC would result in generally lower exceedance frequencies for concentration thresholds, although the frequency of exceedance during the modeled drought period (i.e., 1987–1991) would be predicted to increase. For the Banks pumping plant during the drought period, exceedance of the 3 mg/L threshold would increase from 57% under Existing Conditions to 84% under Alternative 2A, while at the Jones pumping plant, exceedance frequency would increase from 72% to 88%. There would be comparatively fewer increases in the frequency of exceeding the 4 mg/L threshold at Banks and Jones. Comparisons to the No Action Alternative yield similar trends, but with slightly smaller magnitude drought period changes. Overall, modeling results for the SWP/CVP Export Service Areas predict an overall improvement in Export Service Areas water quality, although more frequent exports of >3 mg/L DOC water would likely occur for drought periods.

Similar to the discussion pertaining to the No Action Alternative, maintenance of SWP and CVP facilities under Alternative 2A would not be expected to create new sources of DOC or contribute towards a substantial change in existing sources of DOC in the affected area. Maintenance activities would not be expected to cause any substantial change in long-term average DOC concentrations such that MUN beneficial uses, or any other beneficial use, would be adversely affected.

NEPA Effects**:** In summary, Alternative 2A, relative to the No Action Alternative, would not cause a substantial long-term change in DOC concentrations in the water bodies upstream of the Delta. Long-term average DOC concentrations at Banks and Jones pumping plants are predicted to decrease by as much as 0.6 mg/L, while long-term average DOC concentrations for some Delta interior locations, including Contra Costa PP #1, are predicted to increase by as much as 0.3 mg/L. The increase in long-term average DOC concentration that could occur within the Delta interior would not be of sufficient magnitude to adversely affect the MUN beneficial use, or any other beneficial uses, of Delta waters. The effect of Alternative 1A operations and maintenance (CM1) on DOC is determined not to be adverse.

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

While greater water demands under the Alternative 2A would alter the magnitude and timing of reservoir releases north, south and east of the Delta, these activities would have no substantial effect on the various watershed sources of DOC. Moreover, long-term average flow and DOC at Sacramento River at Hood and San Joaquin River at Vernalis are poorly correlated; therefore, changes in river flows would not be expected to cause a substantial long-term change in DOC concentrations upstream of the Delta.

Relative to Existing Conditions, Alternative 2A would result in relatively small increases (i.e., ≤12%) in long-term average DOC concentrations at some Delta interior locations, including Franks Tract, Rock Slough, and Contra Costa PP No. 1. However, these increases would not substantially increase the frequency with which long-term average DOC concentrations exceeds 2, 3, or 4 mg/L. While Alternative 2A would generally lead to slightly higher long-term average DOC concentrations (≤0.4 mg/L) within the Delta interior and some municipal water intakes, the predicted change would not be expected to adversely affect MUN beneficial uses, or any other beneficial use.

The assessment of Alternative 2A effects on DOC in the SWP/CVP Export Service Areas is based on assessment of changes in DOC concentrations at Banks and Jones pumping plants. Relative to the existing condition, long-term average DOC concentrations would decrease by as much as 0.5 mg/L at Banks and Jones pumping plants, although slightly more frequent export of >3 mg/L DOC water is predicted during periods of drought. Nevertheless, an overall improvement in DOC-related water quality would be predicted in the SWP/CVP Export Service Areas.

Based on the above, Alternative 2A operation and maintenance would not result in any substantial change in long-term average DOC concentration upstream of the Delta or result in substantial increase in the frequency with which long-term average DOC concentrations exceeds 2, 3, or 4 mg/L levels at the 11 assessment locations analyzed for the Delta. Modeled long-term average DOC concentrations would increase by no more than 0.4 mg/L at any single Delta assessment location (i.e., ≤12% relative increase), with long-term average concentrations estimated to remain at or below 4.0 mg/L at all Delta locations assessed, with the exception of Buckley Cove on the San Joaquin River during the drought period modeled. Nevertheless, long-term average concentrations at Buckley Cove are expected to decrease slightly during the drought period, relative to Existing Conditions. The increases in long-term average DOC concentration that could occur within the Delta would not be of sufficient magnitude to adversely affect the MUN beneficial use, or any other beneficial uses, of Delta waters or waters of the SWP/CVP Service Area. Because DOC is not bioaccumulative, the increases in long-term average DOC concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Finally, DOC is not causing beneficial use impairments and thus is not 303(d) listed for any water body within the affected environment. Thus, the increases in long-term average DOC that could occur at various locations would not make any beneficial use impairment measurably worse. Because long-term average DOC concentrations are not expected to increase substantially, no long-term water quality degradation with respect to DOC is expected to occur and, thus, no adverse effects on beneficial uses would occur. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-18: Effects on Dissolved Organic Carbon Concentrations Resulting from Implementation of CM2–CM22

***NEPA Effects*:** Conservation Measures 2–22 proposed under Alternative 2A would be the same as those proposed under Alternative 1A. As such, effects on DOC resulting from the implementation of CM2–CM22 would be similar to that previously discussed for Alternative 1A. In summary, CM4–CM7 and CM10 could contribute substantial amounts of DOC to raw drinking water supplies, largely depending on final design and operational criteria for the related wetland and riparian habitat restoration activities. Substantially increased long-term average DOC in raw water supplies could lead to a need for treatment plant upgrades in order to appropriately manage DBP formation in treated drinking water. This potential for future DOC increases would lead to substantially greater associated risk of long-term adverse effects on the MUN beneficial use.

In summary, the habitat restoration elements of CM4–CM7 and CM10 under Alternative 2A would present new localized sources of DOC to the study area, and in some circumstances would substitute for existing sources related to replaced agriculture. Depending on localized hydrodynamics and proximity to municipal drinking water intakes, such restoration activities could contribute substantial amounts of DOC to municipal raw water. Substantial increases in municipal raw water DOC could necessitate changes in water treatment plant operations or require treatment plant upgrades in order to maintain DBP compliance, and thus would constitute an adverse effect on water quality. Mitigation Measure WQ-18 is available to reduce these effects.

***CEQA Conclusion*:** Effects of CM4–7 and CM10 on DOC under Alternative 2A would be similar to those discussed for Alternative 1A. This impact is considered to be significant and mitigation is required. It is uncertain whether implementation of Mitigation Measure WQ-18 would reduce identified impacts to a less-than-significant level. Hence, this impact remains significant and unavoidable.

In addition to and to supplement Mitigation Measure WQ-18, the BDCP proponents have incorporated into the BDCP, as set forth in EIR/EIS Appendix 3B, *Environmental Commitments*, a separate, non-environmental commitment to address the potential increased water treatment costs that could result from DOC concentration effects on municipal and industrial water purveyor operations. Potential options for making use of this financial commitment include funding or providing other assistance towards implementing treatment for DOC and/or DBPs or DOC source control strategies. Please refer to Appendix 3B, *Environmental Commitments*, for the full list of potential actions that could be taken pursuant to this commitment in order to reduce the water quality treatment costs associated with water quality effects relating to DOC.

Mitigation Measure WQ-18: Design Wetland and Riparian Habitat Features to Minimize Effects on Municipal Intakes

Please see Mitigation Measure WQ-18 under Impact WQ-18 in the discussion of Alternative 1A.

Impact WQ-19: Effects on Pathogens Resulting from Facilities Operations and Maintenance (CM1)

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

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

River flow rate and reservoir storage reductions that would occur due to implementation of CM1 (water facilities and operations) under Alternative 2A, relative to Existing Conditions, would not be expected to result in a substantial adverse change in pathogen concentrations in the reservoirs and rivers upstream of the Delta, given the small magnitude of urban runoff contributions relative to the magnitude of river flows, that pathogen concentrations in the rivers have a minimal relationship to river flow rate, and the expected reduced pollutant loadings in response to NPDES stormwater-related regulations.

It is expected there would be no substantial change in Delta pathogen concentrations in response to a shift in the Delta source water percentages under this alternative or substantial degradation of these water bodies, with regard to pathogens. This conclusion is based on the Pathogens Conceptual Model, which found that pathogen sources in close proximity to a Delta site appear to have the greatest influence on pathogen levels at the site, rather than the primary source(s) of water to the site. In-Delta potential pathogen sources, including water-based recreation, tidal habitat, wildlife, and livestock-related uses, would continue under this alternative.

In the SWP/CVP Export Service Areas waters, relative to Existing Conditions, an increased proportion of water coming from the Sacramento River would not adversely affect beneficial uses in the SWP/CVP Export Service Areas. The pathogen levels in the Sacramento River are similar to or lower than the water diverted at the Delta export pumps. Further, it is localized sources of pathogens that appear to have the greatest influence on concentrations. Thus, an increased proportion of Sacramento River water diverted to the SWP/CVP Export Service Areas would result in minimal changes in pathogen levels in the SWP/CVP Export Service Areas waters.

Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because pathogen concentrations are not expected to increase substantially, no long-term water quality degradation for pathogens is expected to occur and, thus, no adverse effects on beneficial uses would occur. The San Joaquin River in the Stockton Deep Water Ship Channel is Clean Water Act section 303(d) listed for pathogens. Because no measurable increase in Deep Water Ship Channel pathogen concentrations are expected to occur on a long-term basis, further degradation and impairment of this area is not expected to occur. Finally, pathogens are not bioaccumulative constituents. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-20: Effects on Pathogens Resulting from Implementation of CM2–CM22

***NEPA Effects*:** Effects of CM2–CM22 on pathogens under Alternative 2A are the same as those discussed for Alternative 1A and are considered to not be adverse.

***CEQA Conclusion*:** Conservation Measures 2–22 proposed under Alternative 2A would be similar to those proposed under Alternative 1A. As such, effects on pathogens resulting from the implementation of CM2–CM22 would be similar to that previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-21: Effects on Pesticide Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative, under Alternative 2A no specific operations or maintenance activity of the SWP or CVP would substantially drive a change in pesticide use, and thus pesticide sources would remain unaffected upstream of the Delta. Nevertheless, changes in the timing and magnitude of reservoir releases could have an effect on available dilution capacity along river segments such as the Sacramento, Feather, American, and San Joaquin Rivers.

Under Alternative 2A, winter (November–March) and summer (April–October) season average flow rates on the Sacramento River at Freeport, American River at Nimbus, Feather River at Thermalito and the San Joaquin River at Vernalis would change. Relative to existing condition and the No Action Alternative, seasonal average flow rates on the Sacramento would decrease no more than 3% during the summer and 4% during the winter (Appendix 8L, Seasonal average flows Table 1-4). On the Feather River, average flow rates would decrease no more than 2% during the summer and winter, while on the American River average flow rates would decrease by as much as 15% in the summer but would increase by as much as 6% in the winter. Seasonal average flow rates on the San Joaquin River would decrease by as much as 12% in the summer, but increase by as much as 1% in the winter. For the same reasons stated for the No Action Alternative, decreased seasonal average flow of ≤15% is not considered to be of sufficient magnitude to substantially increase pesticide concentrations or alter the long-term risk of pesticide-related toxicity to aquatic life, nor adversely affect other beneficial uses of water bodies upstream of the Delta.

Delta

Sources of diuron, OP, and pyrethroid insecticides to the Plan Area include direct input of surface runoff from in-Delta agriculture and Delta urbanized areas as well as inputs from rivers upstream of the Delta. Similar to Upstream of the Delta, CVP/SWP operations would not affect these sources.

Under Alternative 2A, the distribution and mixing of Delta source waters would change. Percent change in monthly average source water fraction were evaluated for the modeled 16-year (1976–1991) hydrologic period and a representative drought period (1987–1991), with special attention given to changes in San Joaquin River, Sacramento River and Delta Agriculture sources water fractions. Relative to Existing Conditions, under Alternative 2A modeled San Joaquin River fractions would increase greater than 10% at Buckley Cove (drought period only), Franks Tract, Rock Slough, and Contra Costa PP No. 1 (Appendix 8D, Source Water Fingerprinting). At Buckley Cove, San Joaquin River source water fractions when modeled for the drought period would increase 15% in August. At Franks Tract, source water fractions when modeled for the 16-year hydrologic period would increase 13–17% during October through November and February through April. At Rock Slough, San Joaquin River source water fractions would increase 11–24% during September through March (11–15% during October and November of the modeled drought period). Similarly, San Joaquin River fractions at Contra Costa Pumping Plant No. 1 would increase 10–24% during October through April (11–13% during October and November of the modeled drought period). While the modeled 24% increases of San Joaquin River Fraction at Rock Slough and Contra Costa PP No. 1 in November are considerable, the resultant net fraction would be ≤30%. Relative to Existing Conditions, there would be no modeled increases in Sacramento River fractions greater than 13% (with exception to Banks and Jones, discussed below) and Delta agricultural fractions greater than

8%. These modeled changes in the source water fractions of Sacramento, San Joaquin and Delta agriculture water are not of sufficient magnitude to substantially alter the long-term risk of pesticide-related toxicity to aquatic life, nor adversely affect other beneficial uses of the Delta.

When compared to the No Action Alternative, changes in source water fractions would be similar in season, geographic extent, and magnitude to those discussed for Existing Conditions with exception to Buckley Cove. Relative to the No Action Alternative, on a source water basis Buckley Cove is comprised predominantly of water of San Joaquin River origin (i.e., typically >80% San Joaquin River) for all months of the year but July and August. In July and August, the combined operational effects on Delta hydrodynamics of the Delta Cross Channel being open, the absence of a barrier at Head of Old River, and seasonally high exports from south Delta pumps results in substantially lower San Joaquin River source water fraction at Buckley Cove relative to all other months of the year. Under the operational scenarios of Alternative 2A, however, modeled July and August San Joaquin River fractions at Buckley Cove would increase relative to the No Action Alternative, with increases of 16% in July (33% for the modeled drought period) and 25% in August (48% for the modeled drought period) (Appendix 8D, Source Water Fingerprinting). Despite these San Joaquin River increases, the resulting net San Joaquin River source water fraction for July and August would remain less than all other months. As a result, these modeled changes in the source water fractions are not of sufficient magnitude to substantially alter the long-term risk of pesticide-related toxicity to aquatic life, nor adversely affect other beneficial uses of the Delta.

SWP/CVP Export Service Areas

Assessment of effects in SWP/CVP Export Service Areas is based on effects seen in the Plan Area at the Banks and Jones pumping plants. Under Alternative 2A, Sacramento River source water fractions would increase substantially at both Banks and Jones pumping plants relative to Existing Conditions and the No Action Alternative (Appendix 8D, Source Water Fingerprinting). At Banks pumping plant, Sacramento source water fractions would generally increase from 23–50% for the period of January through June (22–25% for March through April of the modeled drought period) and at Jones pumping plant Sacramento source water fractions would generally increase from 34–59% for the period of January through June (16–51% for February through May of the modeled drought period). These increases in Sacramento source water fraction would primarily balance through equivalent decreases in San Joaquin River water. Based on the general observation that San Joaquin River, in comparison to the Sacramento River, is a greater contributor of OP insecticides in terms of greater frequency of incidence and presence at concentrations exceeding water quality benchmarks, modeled increases in Sacramento River fraction at Banks and Jones would generally represent an improvement in export water quality respective to pesticides.

***NEPA Effects*:** In summary, the changes in long-term average flows on the Sacramento, Feather, American, and San Joaquin Rivers, under Alternative 2A relative to the No Action Alternative, are of insufficient magnitude to substantially increase the long-term risk of pesticide-related water quality degradation and related toxicity to aquatic life in these water bodies upstream of the Delta. Similarly, modeled changes in source water fractions to the Delta are of insufficient magnitude to substantially alter the long-term risk of pesticide-related water quality degradation and related toxicity to aquatic life in the Delta or CVP/SWP export service areas. The effects on pesticides from operations and maintenance (CM1) are determined not to be adverse.

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

Sources of pesticides upstream of the Delta include direct input of pesticide containing surface runoff from agriculture and urbanized areas. Flows in rivers receiving these discharges dilute these pesticide inputs. Relative to Existing Conditions, however, modeled changes in long-term average flows on the Sacramento, Feather, American, and San Joaquin Rivers are of insufficient magnitude to substantially increase the long-term risk of pesticide-related water quality degradation and related toxicity to aquatic life in these water bodies upstream of the Delta.

In the Delta, sources of pesticides include direct input of surface runoff from Delta agriculture and Delta urbanized areas as well as inputs from rivers upstream of the Delta. While facilities operations and maintenance activities would not affect these sources, changes in Delta source water fraction could change the relative risk associated with pesticide related toxicity to aquatic life. Under Alternative 2A, however, modeled changes in source water fractions relative to Existing Conditions are of insufficient magnitude to substantially alter the long-term risk of pesticide-related toxicity to aquatic life within the Delta, nor would such changes result in adverse pesticide-related effects on any other beneficial uses of Delta waters.

The assessment of Alternative 2A effects on pesticides in the SWP/CVP Export Service Areas is based on assessment of changes predicted at Banks and Jones pumping plants. As just discussed regarding effects to pesticides in the Delta, modeled changes in source water fractions at the Banks and Jones pumping plants are of insufficient magnitude to substantially alter the long-term risk of pesticide-related toxicity to aquatic life beneficial uses, or any other beneficial uses, in water bodies of the SWP and CVP export service area.

Based on the above, Alternative 2A would not result in any substantial change in long-term average pesticide concentration or result in substantial increase in the anticipated frequency with which long-term average pesticide concentrations would exceed aquatic life toxicity thresholds or other beneficial use effect thresholds upstream of the Delta, at the 11 assessment locations analyzed for the Delta, or the SWP/CVP service area. Numerous pesticides are currently used throughout the affected environment, and while some of these pesticides may be bioaccumulative, those present-use pesticides for which there is sufficient evidence for their presence in waters affected by SWP and CVP operations (i.e., diazinon, chlorpyrifos, diuron, and pyrethroids) are not considered bioaccumulative, and thus changes in their concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Furthermore, while there are numerous 303(d) listings throughout the affected environment that name pesticides as the cause for beneficial use impairment, the modeled changes in upstream river flows and Delta source water fractions would not be expected to make any of these beneficial use impairments measurably worse. Because long-term average pesticide concentrations are not expected to increase substantially, no long-term water quality degradation with respect to pesticides is expected to occur and, thus, no adverse effects on beneficial uses would occur. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-22: Effects on Pesticide Concentrations Resulting from Implementation of CM2–CM22

NEPA Effects: Conservation Measures 2–22 proposed under Alternative 2A would be the same as those proposed under Alternative 1A. As such, effects on pesticides resulting from the implementation of CM2–CM22 would be similar to that previously discussed for Alternative 1A. In summary, CM13 proposes the use of herbicides to control invasive aquatic vegetation around habitat restoration sites. Herbicides directly applied to water could include adverse effects on non-target aquatic life, such as aquatic invertebrates and beneficial aquatic plants. As such, aquatic life toxicity objectives could be exceeded with sufficient frequency and magnitude such that beneficial uses would be impacted, thus constituting an adverse effect on water quality.

In summary, based on the discussion above, the effects on pesticides from implementing CM2-CM22 are considered to be adverse. Mitigation Measure WQ-22 would be available to reduce this adverse effect.

***CEQA Conclusion*:** Effects of CM2–CM22 on pesticides under Alternative 2A are similar to those discussed for Alternative 1A. Potential environmental effects related only to CM13 are considered to be significant. Mitigation is required. While Mitigation Measure WQ-22 is available to partially reduce this impact of pesticides, no feasible mitigation is available that would reduce it to a level that would be less than significant.

Mitigation Measure WQ-22: Implement Least Toxic Integrated Pest Management Strategies

Please see Mitigation Measure WQ-22 under Impact WQ-22 in the discussion of Alternative 1A.

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

***NEPA Effects*:** Effects of water facilities and operations (CM1) on phosphorus levels in water bodies of the affected environment under Alternative 2A would be very similar (i.e., nearly the same) to those discussed for Alternative 1A. Consequently, the environmental consequences to phosphorus levels discussed in detail for Alternative 1A also adequately represent the effects under Alternative 2A, which are considered to be not adverse. Based on this finding, this impact is considered to be not adverse.

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

Because phosphorus loading to waters upstream of the Delta is not anticipated to change, and because changes in flows do not necessarily result in changes in concentrations or loading of phosphorus to these water bodies, substantial changes in phosphorus concentration upstream of the Delta are not anticipated for Alternative 2A, relative to Existing Conditions.

Because phosphorus concentrations in the major source waters to the Delta are similar for much of the year, phosphorus concentrations in the Delta are not anticipated to change substantially on a long term-average basis under Alternative 2A, relative to Existing Conditions. Algal growth rates are limited by availability of light in the Delta, and therefore any minor increases in phosphorus levels that may occur at some locations and times within the Delta would be expected to have little effect on primary productivity in the Delta.

The assessment of effects of phosphorus under Alternative 2A in the SWP and CVP Export Service Areas is based on effects on phosphorus at the Banks and Jones pumping plants. As noted above, phosphorus concentrations in the Delta (including Banks and Jones pumping plants) are not anticipated to change substantially on a long term-average basis.

Based on the above, there would be no substantial, long-term increase in phosphorus concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the waters exported to the CVP and SWP service areas under Alternative 2A relative to Existing Conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because phosphorus concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Phosphorus is not 303(d) listed within the affected environment and thus any minor increases that may occur in some areas would not make any existing phosphorus-related impairment measurably worse because no such impairments currently exist. Because phosphorus is not bioaccumulative, minor increases that may occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-24: Effects on Phosphorus Concentrations Resulting from Implementation of CM2–CM22

***NEPA Effects*:** Effects of CM2–CM22 on phosphorus levels in water bodies of the affected environment under Alternative 2A would be very similar (i.e., nearly the same) to those discussed for Alternative 1A. Consequently, the environmental consequences to phosphorus levels from implementing CM2–CM22 discussed in detail for Alternative 1A also adequately represent the effects of these same actions under Alternative 2A, which are considered to be not adverse.

***CEQA Conclusion*:** Conservation Measures 2–22 proposed under Alternative 2A would be similar to those proposed under Alternative 1A. As such, effects on phosphorus resulting from the implementation of CM2–CM22 would be similar to that previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

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

Upstream of the Delta

For the same reasons stated for the No Action Alternative, Alternative 2A would have negligible, if any, effect on selenium concentrations in the rivers and reservoirs upstream of the Delta relative to Existing Conditions and the No Action Alternative. Any negligible increases in selenium concentrations that could occur in the water bodies of the affected environment upstream of the Delta would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regard to selenium.

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 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for CM2-22. See section 8.3.1.3 for more information.

Alternative 2A would result in small changes in average selenium concentrations in water at all modeled Delta assessment locations relative to Existing Conditions and the No Action Alternative (Appendix 8M, Table M-10A). These small changes in selenium concentrations in water are reflected in small percent changes (10% or less) in available assimilative capacity for selenium (based on 2 μg/L ecological risk benchmark) for all years. Relative to Existing Conditions, Alternative 2A would result in the largest modeled increase in available assimilative capacity at Buckley Cove (1%) and the largest decrease at Contra Costa PP (4%) (Figure 8-59). Relative to the No Action Alternative, the largest modeled increase would be at Staten Island (1%) and the largest decrease would be at Buckley Cove (4%) (Figure 8-60). Although some small negative changes (less than 5%) in selenium concentrations in water are expected, the effect of Alternative 2A would generally be minimal for the Delta locations. Furthermore, the modeled selenium concentrations in water (Appendix 8M, Table M-10A) for Alternative 2A (range 0.22–0.74 μg/L) would be very similar to those for Existing Conditions (range 0.21–0.76 μg/L) and the No Action Alternative (range 0.21–0.69 μg/L), and all would be below the ecological risk benchmark (2 μg/L).

Relative to Existing Conditions and the No Action Alternative, Alternative 2A would result in small changes in estimated selenium concentrations in biota (whole-body fish, bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets) (Appendix 8M, Table M-13 and Addendum M.A to Appendix 8M, Table M.A-2). Relative to Existing Conditions, the largest increase of selenium concentrations in biota would be at Contra Costa PP for all years and for the sturgeon at the San Joaquin River at Antioch in all years, and the largest decrease would be at Buckley Cove for drought years. Relative to the No Action Alternative, the largest increase would be at Buckley Cove for drought years (except for bird eggs [assuming a fish diet] at Old River at Rock Slough [hereafter Rock Slough] for all years) and for the sturgeon at the San Joaquin River at Antioch in all years; the largest decrease would be at Staten Island for drought years. Except for sturgeon in the western Delta, concentrations of selenium in whole-body fish and bird eggs (invertebrate and fish diets) would exceed only the lower benchmarks (4 and 6 mg/kg dry weight, respectively, indicating a low potential for effects), under drought conditions, at Buckley Cove for Existing Conditions, the No Action Alternative, and Alternative 2A (Figures 8-61 through 8-63). However, Exceedance Quotients for these exceedances of the lower benchmarks are between 1.0 and 1.5, indicating a low risk to biota in the Delta and no substantial difference from Existing Conditions and the No Action Alternative. Selenium concentrations in fish fillets would not exceed the screening value for protection of human health (Figure 8-64). For sturgeon in the western Delta, whole-body selenium concentrations would increase from 12.3 mg/kg under Existing Conditions and the No Action Alternative to 13.5 mg/kg under Alternative 2A, a 10% increase (Table M.A-2). Although all of these values exceed both the low and high toxicity benchmarks, it is unlikely that the modeled increases in whole-body selenium for sturgeon would be measurable in the environment (see also the discussion of results provided in Addendum M.A to Appendix 8M).

Relative to Existing Conditions and the No Action Alternative, Alternative 2A would result in essentially no change in selenium concentrations throughout the Delta. Alternative 2A would not be expected to substantially increase the frequency with which applicable benchmarks would be exceeded in the Delta or substantially degrade the quality of water in the Delta, with regard to selenium.

SWP/CVP Export Service Areas

Alternative 2A would result in small changes in average selenium concentrations in water at both modeled Export Service Area assessment locations relative to Existing Conditions and the No Action Alternative (Appendix 8M, Table M-10A). These small changes in selenium concentrations in water are reflected in small percent changes (10% or less) in available assimilative capacity for selenium (based on 2 µg/L ecological risk benchmark) for all years. Relative to Existing Conditions and the No Action Alternative, Alternative 2A would result in modeled increases in assimilative capacity at Jones PP (9% and 10%, respectively) and at Banks PP (5%) (Figures 8-59 and 8-60), and generally would have a small positive effect on the Export Service Area locations. Furthermore, the ranges of modeled selenium concentrations in water (Appendix 8M, Table M-10A) for Alternative 2A (range 0.37–0.45 µg/L) are similar to those for Existing Conditions (range 0.37–0.58 µg/L) and the No Action Alternative (range 0.37–0.59 µg/L), and would be well below the ecological risk benchmark (2 µg/L).

Relative to Existing Conditions and the No Action Alternative, Alternative 2A would result in minimal changes in estimated selenium concentrations in biota (whole-body fish, bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets) (Appendix 8M, Table M-13). The largest increase of selenium concentrations in biota would be at Banks PP for drought years, and the largest decrease would be at Jones PP for all years (except for bird eggs [assuming a fish diet] at Jones PP for drought years). Concentrations of selenium in biota would not exceed any benchmarks for Alternative 2A (Figures 8-61 through 8-64).

Thus, relative to Existing Conditions and the No Action Alternative, Alternative 2A would result in minimal changes in selenium concentrations at the Export Service Area locations. Selenium concentrations in water and biota would generally decrease for Alternative 2A and would not exceed ecological benchmarks at either location. Compared to Existing Conditions and the No Action Alternative at Jones PP under drought conditions, there would be a small positive change in selenium concentrations under Alternative 2A in that it would be expected to slightly decrease the frequency with which applicable benchmarks would be exceeded or slightly improve the quality of water at the Export Service Area locations, with regard to selenium.

NEPA Effects: Based on the discussion above, the effects on selenium (both as waterborne and as bioaccumulated in biota) from Alternative 2A are not considered to be adverse.

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

There are no substantial point sources of selenium in watersheds upstream of the Delta, and no substantial nonpoint sources of selenium in the watersheds of the Sacramento River and the eastern tributaries. Nonpoint sources in the San Joaquin Valley that contribute selenium to the Delta will be controlled through a TMDL developed by the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the Grassland Bypass Project, and Basin Plan objectives (Central Valley Water Board 2010c) and State Water Board (2010d, 2010e) that are expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta. Consequently, any modified reservoir operations and subsequent changes in river flows under Alternative 2A, relative to Existing Conditions, are expected to cause negligible changes in selenium concentrations in water.

Any negligible changes in selenium concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies as related to selenium.

Relative to Existing Conditions, modeling estimates indicate that Alternative 2A would result in essentially no change in selenium concentrations throughout the Delta.

Assessment of effects of selenium in the SWP and CVP Export Service Areas is based on effects on selenium concentrations at the Banks and Jones pumping plants. Relative to Existing Conditions, Alternative 2A would slightly decrease the frequency with which applicable benchmarks would be exceeded or slightly improve the quality of water in selenium concentrations at the Banks and Jones pumping plants locations.

Based on the above, selenium concentrations that would occur in water under Alternative 2A would not cause additional exceedances of applicable state or federal numeric or narrative water quality objectives/criteria, or other relevant water quality effects thresholds identified for this assessment (Appendix 8M, Table M-10A), by frequency, magnitude, and geographic extent that would result in adverse effects to one or more beneficial uses within affected water bodies. In comparison to Existing Conditions, water quality conditions under this alternative would not increase levels of selenium by frequency, magnitude, and geographic extent such that the affected environment would be expected to have measurably higher body burdens of selenium in aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish) or humans consuming those organisms. Water quality conditions under this alternative with respect to selenium would not cause long-term degradation of water quality in the affected environment, and therefore would not result in use of available assimilative capacity such that exceedances of water quality objectives/criteria would be likely and would result in substantially increased risk for adverse effects to one or more beneficial uses. This alternative would not further degrade water quality by measurable levels, on a long-term basis, for selenium and, thus, cause the 303(d)-listed impairment of beneficial use to be made discernibly worse. This alternative is considered to be less than significant. No mitigation is required.

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

NEPA Effects: In general, with the possible exception of changes in Delta hydrodynamics resulting from habitat restoration, CM2–CM11 would not substantially increase selenium concentrations in the water bodies of the affected environment. Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, and thus such effects of these restoration measures were included in the assessment of CM1 facilities operations and maintenance (see Impact WQ-25).

However, implementation of these conservation measures may increase water residence time within the restoration areas. Increased restoration area water residence times could potentially increase the bioaccumulation of selenium in biota, thereby potentially increasing fish tissue and bird egg concentrations of selenium, but models are not available to quantitatively estimate the level of changes in residence time and the associated selenium bioavailability. If increases in fish tissue or bird egg selenium were to occur, the increases would likely be of concern only where fish tissues or bird eggs are already elevated in selenium to near or above thresholds of concern. That is, where biota concentrations are currently low and not approaching thresholds of concern, changes in residence time alone would not be expected to cause them to then approach or exceed thresholds of concern. In consideration of this factor, although the Delta as a whole is a 303(d)-listed water body for selenium, and although monitoring data of fish tissue or bird eggs in the Delta are sparse, the most likely areas in which biota tissues would be at levels high enough that additional bioaccumulation due to increased residence time from restoration areas would be a concern are the western Delta and Suisun Bay, and the South Delta in areas that receive San Joaquin River water.

The western Delta and Suisun Bay receive elevated selenium loads from North San Francisco Bay (including San Pablo Bay, Carquinez Strait, and Suisun Bay) and from the San Joaquin River. Point sources of selenium in North San Francisco Bay (i.e., refineries) that contribute selenium to Suisun Bay are expected to be reduced through a TMDL under development by the San Francisco Bay Water Board (San Francisco Bay Water Board 2012) that is expected to result in decreasing discharges of selenium. Nonpoint sources of selenium in the San Joaquin Valley that contribute selenium to the San Joaquin River, and thus the Delta and Suisun Bay, will be controlled through a TMDL developed by the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the Grassland Bypass Project, and Basin Plan objectives (Central Valley Water Board 2010c, d) that are expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta. If selenium levels are not sufficiently reduced via these efforts, it is expected that the State Water Board and the San Francisco Bay and Central Valley Water Boards would initiate additional actions to further control sources of selenium.

The South Delta receives elevated selenium loads from the San Joaquin River. In contrast to Suisun Bay and possibly the western Delta in the future, the South Delta lacks the overbite clam (*Corbula* [*Potamocorbula*] *amurensis*), which is considered a key driver of selenium bioaccumulation in Suisun Bay, due to its high bioaccumulation of selenium and its role in the benthic food web that includes long-lived sturgeon. The South Delta does have *Corbicula fluminea*, another bivalve that bioaccumulates selenium, but it is not as invasive as the overbite clam and thus likely makes up a smaller fraction of sturgeon diet. Also, as mentioned above, nonpoint sources of selenium in the San Joaquin Valley that contribute selenium to the Delta will be controlled through a TMDL developed by the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the Grassland Bypass Project, and Basin Plan objectives (Central Valley Water Board 2010c, d) that are expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta. Further, if selenium levels in the San Joaquin River are not sufficiently reduced via these efforts, it is expected that the State Water Board and Central Valley Water Board would initiate additional TMDLs to further control nonpoint sources of selenium.

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

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

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

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

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

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

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

Impact WQ-27: Effects on Trace Metal Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative, Alternative 2A would result in negligible, and likely immeasurable, increases in trace metal concentrations in the rivers and reservoirs upstream of the Delta, relative to Existing Conditions and the No Action Alternative. Effects due to the operation and maintenance of the conveyance facilities are expected to be immeasurable, on an annual and long-term average basis. As such, Alternative 2A would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or CTR criteria would be exceeded in water bodies of the affected environment located upstream of the Delta or substantially degrade the quality of these water bodies, with regard to trace metals.

Delta

For the same reasons stated for the No Action Alternative, Alternative 2A would not result in substantial increases in trace metal concentrations in the Delta relative to Existing Conditions and the No Action Alternative. Effects due to the operation and maintenance of the conveyance facilities are expected to be negligible, on a long-term average basis. As such, Alternative 2A 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 Delta waters, with regard to trace metals.

SWP/CVP Export Service Areas

For the same reasons stated for the No Action Alternative, Alternative 2A would not result in substantial increases in trace metal concentrations in the water exported from the Delta or diverted from the Sacramento River through the proposed conveyance facilities. As such, there is not expected to be substantial changes in trace metal concentrations in the SWP/CVP export service area waters under Alternative 2A, relative to Existing Conditions and the No Action Alternative. As such, Alternative 2A would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or CTR criteria would be exceeded in the water bodies of the affected environment in the SWP and CVP Service Area or substantially degrade the quality of these water bodies, with regard to trace metals.

NEPA Effects: In summary, Alternative 2A, relative to the No Action Alternative, would not cause a substantial increase in long-term average trace metals concentrations within the affected environment, nor would it cause an increased frequency of water quality objective/criteria exceedances within the affected environment. The effect on trace metals is determined not to be adverse.

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

While greater water demands under the Alternative 2A would alter the magnitude and timing of reservoir releases north, south and east of the Delta, these activities would have no substantial effect on the various watershed sources of trace metals. Moreover, long-term average flow and trace metals at Sacramento River at Hood and San Joaquin River at Vernalis are poorly correlated; therefore, changes in river flows would not be expected to cause a substantial long-term change in trace metal concentrations upstream of the Delta.

Average and 95th percentile trace metal concentrations are very similar across the primary source waters to the Delta. Given this similarity, very large changes in source water fraction would be necessary to effect a relatively small change in trace metal concentration at a particular Delta location. Moreover, average and 95th percentile trace metal concentrations for these primary source waters are all below their respective water quality criteria, including those that are hardness-based without a WER adjustment. No mixing of these three source waters could result in a metal concentration greater than the highest source water concentration, and given that trace metals do not already exceed water quality criteria, more frequent exceedances of criteria in the Delta would not be expected to occur under the Alternative 2A.

The assessment of the Alternative 2A effects on trace metals in the SWP/CVP Export Service Areas is based on assessment of changes in trace metal concentrations at Banks and Jones pumping plants. As just discussed regarding similarities in Delta source water trace metal concentrations, the Alternative 2A is not expected to result in substantial changes in trace metal concentrations in Delta waters, including Banks and Jones pumping plants, therefore effects on trace metal concentrations in the SWP/CVP Export Service Area are expected to be negligible.

Based on the above, there would be no substantial long-term increase in trace metal concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the SWP/CVP export service area waters under Alternative 2A relative to Existing Conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because trace metal concentrations are not expected to increase substantially, no long-term water quality degradation for trace metals is expected to occur and, thus, no adverse effects to beneficial uses would occur. Furthermore, any negligible changes in long-term trace metal concentrations that may occur in water bodies of the affected environment would not be expected to make any existing beneficial use impairments measurably worse. The trace metals discussed in this assessment are not considered bioaccumulative, and thus would not directly cause bioaccumulative problems in aquatic life or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-28: Effects on Trace Metal Concentrations Resulting from Implementation of CM2–CM22

***NEPA Effects*:** Conservation Measures 2–22 proposed under Alternative 2A would be the same as those proposed under Alternative 1A. As such, effects on trace metals resulting from the implementation of CM2–CM22 would be similar to that previously discussed for Alternative 1A. As they pertain to trace metals, implementation of CM2–CM22 would not be expected to adversely affect beneficial uses of the affected environment or substantially degrade water quality with respect to trace metals.

In summary, implementation of CM2–CM22 under Alternative 2A, relative to the No Action Alternative, would have negligible, if any, effect on trace metals concentrations. The effect on trace metals from implementing CM2–CM22 is determined not to be adverse.

CEQA Conclusion**:** Implementation of CM2–CM22 under Alternative 2A would not cause substantial long-term increase in trace metal concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the SWP/CVP export service area. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because trace metal concentrations are not expected to increase substantially, no long-term water quality degradation for trace metals is expected to occur and, thus, no adverse effects to beneficial uses would occur. Furthermore, any negligible changes in long-term trace metal concentrations that may occur throughout the affected environment would not be expected to make any existing beneficial use impairments measurably worse. The trace metals discussed in this assessment are not considered bioaccumulative, and thus would not directly cause bioaccumulative problems in aquatic life or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-29: Effects on TSS and Turbidity Resulting from Facilities Operations and Maintenance (CM1)

NEPA Effects**:** Effects of CM1 on TSS and turbidity under Alternative 2A are the same as those discussed for Alternative 1A. The effects on TSS and turbidity from implementing CM1 is determined to not be adverse.

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

Changes river flow rate and reservoir storage that would occur under Alternative 2A, relative to Existing Conditions, would not be expected to result in a substantial adverse change in TSS concentrations and turbidity levels in the reservoirs and rivers upstream of the Delta, given that suspended sediment concentrations are more affected by season than flow. Site-specific and temporal exceptions may occur due to localized temporary construction activities, dredging activities, development, or other land use changes would be site-specific and temporal, which would be regulated to limit both their short-term and long-term effects on TSS and turbidity levels to less than substantial levels.

Within the Delta, geomorphic changes associated with sediment transport and deposition are usually gradual, occurring over years, and high storm event inflows would not be substantially affected. Thus, it is expected that the TSS concentrations and turbidity levels in the affected channels would not be substantially different from the levels under Existing Conditions. Consequently, this alternative is expected to have minimal effect on TSS concentrations and turbidity levels in the Delta region, relative to Existing Conditions.

There is not expected to be substantial, if even measurable, changes in TSS concentrations and turbidity levels in the SWP/CVP Export Service Areas waters under Alternative 2A, relative to Existing Conditions, because this alternative is not expected to result in substantial changes in TSS concentrations and turbidity levels at the south Delta export pumps, relative to Existing Conditions.

Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives where such objectives are not exceeded under Existing Conditions. Because TSS concentrations and turbidity levels are not expected to be substantially different, long-term water quality degradation is not expected, and, thus, beneficial uses are not expected to be adversely affected. Finally, TSS and turbidity are neither bioaccumulative nor Clean Water Act section 303(d) listed constituents. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-30: Effects on TSS and Turbidity Resulting from Implementation of CM2–CM22

***NEPA Effects*: **Effects of CM2–CM22 on TSS and turbidity under Alternative 2A are the same as those discussed for Alternative 1A. The effects on TSS and turbidity from implementing CM2–CM22 is determined to not be adverse.

***CEQA Conclusion*: **Conservation Measures 2–22 proposed under Alternative 2A would be similar to those proposed under Alternative 1A. As such, effects on TSS and turbidity resulting from the implementation of CM2–CM22 would be similar to that previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-31: Water Quality Effects Resulting from Construction-Related Activities (CM1–CM22)

The conveyance features for CM1 under Alternative 2A would be very similar to those discussed for Alternative 1A. The primary difference between Alternative 2A and Alternative 1A is that under Alternative 2A, the locations of two intakes and two intermediate pumping plant locations would differ. As such, construction techniques and locations of major features of the conveyance system within the Delta would be similar. The remainder of the facilities constructed under Alternative 2A, including CM2–CM22, would be very similar to, or the same as, those to be constructed for Alternative 1A.

***NEPA Effects*: **The types and magnitude of potential construction-related water quality effects associated with implementation of CM1 under Alternative 2A would be very similar to the effects discussed for Alternative 1A, and the effects anticipated with implementation of CM2–CM22 would be essentially identical. Nevertheless, the construction of CM1, and any individual components necessitated by CM2, and CM4–CM10, with the implementation of the BMPs specified in Appendix 3B, *Environmental Commitments*. The specific environmental commitments that would be implemented under Alternative 2A would be similar to those described for Alternative 1A. Consequently, relative to the No Action Alternative, Alternative 2A would not be expected to cause exceedance of applicable water quality objectives/criteria or substantial water quality degradation with respect to constituents of concern, and thus would not adversely affect any beneficial uses upstream of the Delta, in the Delta, or in the SWP and CVP service area.

In summary, with implementation of environmental commitments in Appendix 3B, the potential construction-related water quality effects are considered to be not adverse.

***CEQA Conclusion*: **Because environmental commitments would be implemented under Alternative 2A for construction-related activities along with agency-issued permits that also contain construction requirements to protect water quality, the construction-related effects, relative to Existing Conditions, would not be expected to cause or contribute to substantial alteration of existing drainage patterns which would result in substantial erosion or siltation on- or off-site, substantial increased frequency of exceedances of water quality objectives/criteria, or substantially degrade water quality with respect to the constituents of concern on a long-term average basis, and thus would not adversely affect any beneficial uses in water bodies upstream of the Delta, within the Delta, or in the SWP and CVP service area. Moreover, because the construction-related activities would be temporary and intermittent in nature, the construction would involve negligible discharges, if any, of bioaccumulative or 303(d) listed constituents to water bodies of the affected environment. As such, construction activities would not contribute measurably to bioaccumulation of contaminants in organisms or humans or cause 303(d) impairments to be discernibly worse. Based on these findings, this impact is determined to be less than significant. No mitigation is required.

8.4.3.6 Alternative 2B—Dual Conveyance with East Alignment and Five Intakes

Alternative 2B would include the same physical/structural water conveyance components and eastern alignment as Alternative 1B, but, like Alternative 2A, could entail two different intake and intake pumping plant locations downstream of Steamboat and Sutter Slough (i.e., Intakes 6 and 7). Alternative 2B would also include an operable barrier at the head of Old River. Intakes would be located on the west bank of the Sacramento River and diverted water would be carried by canal to a new 600 acre forebay at Byron Tract. An intermediate pumping plant would be constructed, but there would be no intermediate forebay. Water supply and conveyance operations would follow the guidelines described as Scenario B, which includes fall X2. CM2–CM22 would be implemented under this alternative, and these conservation measures would be the same as those under Alternative 1A. See Chapter 3, *Description of Alternatives*, Section 3.5.6, for additional details on Alternative 2B.

Water Quality Effects Resulting from Facilities Operations and Maintenance (CM1)

Alternative 2B has the same diversion and conveyance operations and conservation measures as Alternative 2A. The primary difference between the two alternatives is that conveyance under Alternative 2B would be in a lined or unlined canal, instead of pipeline. Because there would be no difference in conveyance capacity or operations, there would be no differences between these two alternatives in upstream of the Delta river flows or reservoir operations, Delta inflow, source fractions to various Delta locations, and hydrodynamics in the Delta. Conveyance of water in an open channel instead of a pipeline may result in differing physical properties (e.g., DO, pH, temperature) of the water upon reaching the south Delta export pumps than if the water was conveyed in a pipeline. However, the physical properties of water arriving at the south Delta export pumps would continue to change and would equilibrate to similar levels as Alternative 2A as it is conveyed throughout the SWP/CVP Export Service Areas. Because no substantial differences in water quality effects are anticipated anywhere in the affected environment under Alternative 2B compared to those described in detail for Alternative 2A, the water quality effects described for Alternative 2A also appropriately characterize effects under Alternative 2B.

Water Quality Effects Resulting from Implementation of CM2–CM22

Alternative 2B has the same conservation measures as Alternative 2A Because no substantial differences in water quality effects are anticipated anywhere in the affected environment under Alternative 2B compared to those described in detail for Alternative 2A, the water quality effects described for Alternative 2A also appropriately characterize effects under Alternative 2B.

Impact WQ-31: Water Quality Effects Resulting from Construction-Related Activities (CM1–CM22)

The primary difference between Alternative 2B and Alternative 1A is that under Alternative 2B, a canal would be constructed for CM1 along the eastern side of the Delta to convey the Sacramento River water south, rather than the tunnel/pipeline features. As such, construction techniques and locations of major features of the conveyance system within the Delta would be different (see Chapter 3, *Description of Alternatives,* Section 3.5.6). The remainder of the facilities constructed under Alternative 2B, including CM2–CM22, would be very similar to, or the same as, those to be constructed for Alternative 1A.

NEPA Effects: The types of potential construction-related water quality effects associated with implementation of CM1 under Alternative 2B would be very similar to the effects discussed for Alternative 1A, and the effects anticipated with implementation of CM2–CM22 would be essentially identical. However, given the substantial differences in the conveyance features under CM1 with construction of a canal, there could be differences in the location, magnitude, duration, and frequency of construction activities and related water quality effects. In particular, relative to the No Action Alternative conditions, construction of the major canal features for CM1 under Alternative 2B would involve extensive general construction activities, material handling/storage/placement activities, surface soil grading/excavation/disposal and associated exposure of disturbed sites to erosion and runoff, and construction site dewatering operations. Nevertheless, the construction of CM1, and any individual components necessitated by CM2, and CM4–CM10, with the implementation of the BMPs specified in Appendix 3B, *Environmental Commitments*, and other agency permitted construction requirements would result in the potential water quality effects being largely avoided and minimized. The specific environmental commitments that would be implemented under Alternative 2B would be similar to those described for Alternative 1A with the exception that Category "B" BMPs for tunnel muck dewatering basin construction and operations, if necessary at all, would be much reduced. Consequently, relative to the No Action Alternative, Alternative 2B would not be expected to cause exceedance of applicable water quality objectives/criteria or substantial water quality degradation with respect to constituents of concern, and thus would not adversely affect any beneficial uses upstream of the Delta, in the Delta, or in the SWP and CVP service area.

In summary, with implementation of environmental commitments in Appendix 3B, the potential construction-related water quality effects are considered to be not adverse.

CEQA Conclusion**:** Construction-related contaminant discharges would be temporary and intermittent in nature and would involve negligible, if any, discharges of bioaccumulative or 303(d) listed constituents to water bodies of the affected environment. As such, construction activities would not contribute measurably to bioaccumulation of contaminants in organisms or humans or cause 303(d) impairments to be discernibly worse. Because environmental commitments would be implemented under Alternative 2B for construction-related activities along with agency-issued permits that also contain construction related mitigation requirements to protect water quality, the construction-related effects, relative to Existing Conditions, would not be expected to cause or contribute to substantial alteration of existing drainage patterns which would result in substantial erosion or siltation on- or off-site, substantial increased frequency of exceedances of water quality objectives/criteria, or substantially degrade water quality with respect to the constituents of concern on a long-term average basis, and thus would not adversely affect any beneficial uses in water bodies upstream of the Delta, within the Delta, or in the SWP and CVP service area. Based on these findings, this impact is determined to be less than significant. No mitigation is required.

8.4.3.7 Alternative 2C—Dual Conveyance with West Canal and Intakes W1-W5 (15,000 cfs; Operational Scenario B)

Alternative 2C would include the same physical/structural water conveyance components and western alignment as Alternative 1C, but would also include an operable barrier at the head of Old River. Intake 1 through 5 would be located on the west bank of the Sacramento River and diverted water would be carried by canals and tunnels to a new 600 acre forebay at Byron Tract. An intermediate pumping plant would be constructed, but there would be no intermediate forebay. Water supply and conveyance operations would follow the guidelines described as Scenario B, which includes fall X2. CM2–CM22 would be implemented under this alternative, and these conservation measures would be the same as those under Alternative 1A. See Chapter 3, *Description of Alternatives*, Section 3.5.7, for additional details on Alternative 2C.

Water Quality Effects Resulting from Facilities Operations and Maintenance (CM1)

Alternative 2C has the same diversion and conveyance operations and conservation measures as Alternative 2A. The primary differences between the two alternatives is that conveyance under Alternative 2C would be in a lined or unlined canal, instead of pipeline, and the alignment of the canal would be along the western side of the Delta, rather than the eastern side. Because there would be no difference in conveyance capacity or operations, there would be no differences between these two alternatives in upstream of the Delta river flows or reservoir operations, Delta inflow, source fractions to various Delta locations, and hydrodynamics in the Delta. Conveyance of water in an open channel instead of a pipeline may result in differing physical properties (e.g., DO, pH, temperature) of the water upon reaching the south Delta export pumps than if the water was conveyed in a pipeline. However, the physical properties of water arriving at the south Delta export pumps would continue to change and would equilibrate to similar levels as Alternative 2A as it is conveyed throughout the SWP/CVP Export Service Areas. Because no substantial differences in water quality effects are anticipated anywhere in the affected environment under Alternative 2C compared to those described in detail for Alternative 2A, the water quality effects described for Alternative 2A also appropriately characterize effects under Alternative 2C.

Water Quality Effects Resulting from Implementation of CM2–CM22

Alternative 2C has the same conservation measures as Alternative 2A. Because no substantial differences in water quality effects are anticipated anywhere in the affected environment under Alternative 2C compared to those described in detail for Alternative 2A, the water quality effects described for Alternative 2A also appropriately characterize effects under Alternative 2C.

Impact WQ-31: Water Quality Effects Resulting from Construction-Related Activities (CM1–CM22)

The primary difference between Alternative 2C and Alternative 1A is that under Alternative 2C, a canal would be constructed for CM1 along the western side of the Delta to convey the Sacramento River water south, in addition to the tunnel/pipeline features. As such, construction techniques and locations of major features of the conveyance system within the Delta would be different (see Chapter 3, *Description of Alternatives,* Section 3.5.7). The remainder of the facilities constructed under Alternative 2C, including CM2–CM22, would be very similar to, or the same as, those to be constructed for Alternative 1A.

NEPA Effects: The types of potential construction-related water quality effects associated with implementation of CM1 under Alternative 2C would be very similar to the effects discussed for Alternative 1A, and the effects anticipated with implementation of CM2–CM22 would be essentially identical. Given the substantial differences in the conveyance features under CM1 with construction of a canal in addition to the tunnel/pipeline features, there could be differences in the location, magnitude, duration, and frequency of construction activities and related water quality effects. In particular, relative to the No Action Alternative conditions, construction of the major canal features for CM1 under Alternative 2C would involve extensive general construction activities, material handling/storage/placement activities, surface soil grading/excavation/disposal and associated exposure of disturbed sites to erosion and runoff, and construction site dewatering operations. Nevertheless, the construction of CM1, and any individual components necessitated by CM2, and CM4–CM10, with the implementation of the BMPs specified in Appendix 3B, *Environmental Commitments*, and other agency permitted construction requirements would result in the potential water quality effects being largely avoided and minimized. The specific environmental commitments that would be implemented under Alternative 2C would be similar to those described for Alternative 1A. However, this alternative would involve environmental commitments associated with both tunnel/pipeline and canal construction activities. Consequently, relative to the No Action Alternative, Alternative 2C would not be expected to cause exceedance of applicable water quality objectives/criteria or substantial water quality degradation with respect to constituents of concern, and thus would not adversely affect any beneficial uses upstream of the Delta, in the Delta, or in the SWP and CVP service area.

In summary, with implementation of environmental commitments in Appendix 3B, the potential construction-related water quality effects are considered to be not adverse.

CEQA Conclusion: Construction-related contaminant discharges would be temporary and intermittent in nature and would involve negligible, if any, discharges of bioaccumulative or 303(d) listed constituents to water bodies of the affected environment. As such, construction activities would not contribute measurably to bioaccumulation of contaminants in organisms or humans or cause 303(d) impairments to be discernibly worse. Because environmental commitments would be implemented under Alternative 2C for construction-related activities along with agency-issued permits that also contain construction related mitigation requirements to protect water quality, the construction-related effects, relative to Existing Conditions, would not be expected to cause or contribute to substantial alteration of existing drainage patterns which would result in substantial erosion or siltation on- or off-site, substantial increased frequency of exceedances of water quality objectives/criteria, or substantially degrade water quality with respect to the constituents of concern on a long-term average basis, and thus would not adversely affect any beneficial uses in water bodies upstream of the Delta, within the Delta, or in the SWP and CVP service area. Based on these findings, this impact is determined to be less than significant. No mitigation is required.

8.4.3.8 Alternative 3—Dual Conveyance with Tunnel and Intakes 1 and 2 (6,000 cfs; Operational Scenario A)

Alternative 3 would comprise physical/structural components similar to those under Alternative 1A with the principal exception that Alternative 3 would convey up to 6,000 cfs of water from the north Delta to the south Delta. Diverted water would be conveyed through pipelines/tunnels from two screened intakes (i.e., Intakes 1 and 2) located on the east bank of the Sacramento River between Clarksburg and Walnut Grove. Alternative 3 would include a 750 acre intermediate forebay and pumping plant. A new 600 acre Byron Tract Forebay, adjacent to and south of Clifton Court Forebay, would be constructed which would provide water to the south Delta pumping plants. Water supply and conveyance operations would follow the guidelines described as Scenario A, which does not include fall X2. Conservation Measures 2–22 (CM2–CM22) would be implemented under this alternative, and would be the same as those under Alternative 1A. See Chapter 3, *Description of Alternatives,* Section 3.5.8, for additional details on Alternative 3.

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.

Since the only difference between Alternative 3 and Alternative 1A is that the north Delta diversion capacity under Alternative 3 is 6,000 cfs instead of 15,000 cfs under Alternative 1A, effects on Delta hydrodynamics under Alternative 3 are very similar to Alternative 1A, but are generally of a lesser extent.

Under Alternative 3, over the long term, average annual delta exports are anticipated to increase by 227 TAF relative to Existing Conditions, and decrease by 930 TAF relative to the No Action Alternative. Since, over the long-term, approximately 35% 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 3–Old River at Rock Slough for ALL years (1976–1991), which shows increased San Joaquin River (SJR) percentage and decreased Sacramento River (SAC) percentage under the alternative, relative to Existing Conditions and the No Action Alternative.

Under Alternative 3, long-term average annual Delta outflow is anticipated to decrease 227 TAF relative to Existing Conditions, due to both changes in operations (including north Delta intake capacity of 6,000 cfs and numerous other operational components of Scenario A) and climate change/sea level rise (see Chapter 5, *Water Supply*, for more information). The result of this is increased sea water intrusion in the west Delta. The increase of sea water intrusion in the west Delta under Alternative 1A is greater relative to the No Action alternative because the No Action alternative includes operations to meet Fall X2, whereas Existing Conditions and Alternative 3 do not. Long-term average annual Delta outflow is anticipated to decrease under Alternative 3 by 977 TAF relative to the No Action Alternative, due only to changes in operations. The increases in sea water intrusion (represented by an increase in San Francisco Bay (BAY) percentage) can be seen, for example, in Appendix 8D, ALT 3–Sacramento River at Mallard Island for ALL years (1976–1991).

Impact WQ-1: Effects on Ammonia Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative, Alternative 3 would have negligible, if any, effect on ammonia concentrations in the rivers and reservoirs upstream of the Delta relative to Existing Conditions and the No Action Alternative. Any negligible increases in ammonia-N concentrations that could occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regard to ammonia.

Delta

Assessment of effects of ammonia under Alternative 3 is the same as discussed under Alternative 1A, except that because flows in the Sacramento River at Freeport are different between the two alternatives, estimated monthly average and long term annual average predicted ammonia-N concentrations in the Sacramento River downstream of Freeport are different.

As Table 8-66 shows, estimated ammonia-N concentrations in the Sacramento River downstream of Freeport (upon full mixing of the SRWTP discharge with river water) under Alternative 3 and the No Action Alternative are expected to be similar. Minor increases in ammonia-N concentrations would occur during February, August, September, and November, and remaining months would be unchanged or have a minor decrease. A minor increase in the annual average concentration would occur under Alternative 3, compared to the No Action Alternative. Moreover, the estimated concentrations downstream of Freeport under Alternative 3 would be similar to existing source water concentrations for the San Francisco Bay and San Joaquin River. Consequently, changes in source water fraction anticipated under Alternative 3, relative to the No Action Alternative, are not expected to substantially increase ammonia concentrations at any Delta locations.

Any negligible increases in ammonia-N concentrations that could occur at certain locations in the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to ammonia.

Table 8-66. Estimated Ammonia-N (mg-L as N) Concentrations in the Sacramento River Downstream of the Sacramento Regional Wastewater Treatment Plant for the No Action Alternative and Alternative 3

	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
Alternative 3	0.068	0.089	0.068	0.060	0.058	0.060	0.058	0.062	0.064	0.064	0.073	0.076	0.067

SWP/CVP Export Service Areas

The assessment of effects on ammonia in the SWP/CVP Export Service Area is based on assessment of ammonia-N concentrations at Banks and Jones pumping plants. Similar to the discussion for Alternative 1A, under Alternative 3 for areas of the Delta that are influenced by Sacramento River water, including Banks and Jones pumping plants, ammonia-N concentrations are expected to decrease, relative to Existing Conditions (in association with less diversion of water influenced by the SRWTP). This decrease in ammonia-N concentrations for water exported via the south Delta pumps is not expected to result in adverse effects on beneficial uses or substantially degrade water quality of exported water, with regards to ammonia.

Furthermore, as discussed above for the Plan Area, for all areas of the Delta, including Banks and Jones pumping plants, ammonia-N concentrations are not expected to be substantially different under Alternative 3, relative to No Action Alternative. Any negligible increases in ammonia-N concentrations that could occur at Banks and Jones pumping plants would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to ammonia.

NEPA Effects: In summary, based on the discussion above, effects on ammonia from implementation of CM1 are considered to be not adverse.

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

Ammonia-N concentrations are generally low in the reservoirs and rivers of the watersheds, owing to the lack of substantial point and nonpoint sources of ammonia-N upstream of the SRWTP in the Sacramento River watershed, in the watersheds of the eastern tributaries (Cosumnes, Mokelumne, and Calaveras Rivers), or upstream of the Delta in the San Joaquin River watershed. Consequently, any modified reservoir operations and subsequent changes in river flows under Alternative 3, relative to Existing Conditions, are expected to have negligible, if any, effects on reservoir and river ammonia-N concentrations upstream of Freeport in the Sacramento River watershed and upstream of the Delta in the San Joaquin River watershed.

Ammonia-N concentrations in the Sacramento River downstream of the SRWTP would be substantially lower under Alternative 3, relative to Existing Conditions, due to upgrades to the SRWTP that are assumed to be in place, and thus, ammonia concentrations for all areas of the Delta that are influenced by Sacramento River water are expected to decrease. At locations which are not influenced notably by Sacramento River water, concentrations are expected to remain relatively unchanged, due to the similarity in SJR and BAY concentrations and the lack of expected changes in either of these concentrations.

The assessment of effects on ammonia in the SWP/CVP Export Service Areas is based on assessment of ammonia-N concentrations at Banks and Jones pumping plants. As discussed above for the Plan Area, for areas of the Delta that are influenced by Sacramento River water, including Banks and Jones pumping plants, ammonia-N concentrations are expected to decrease under Alternative 3, relative to Existing Conditions.

Based on the above, there would be no substantial, long-term increase in ammonia-N concentrations in the rivers and reservoirs upstream of the Delta, in the Plan Area, or the waters exported to the CVP and SWP service areas under Alternative 3 relative to Existing Conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because ammonia concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects on beneficial uses would occur. Ammonia is not 303(d) listed within the affected environment and thus any minor increases that could occur in some areas would not make any existing ammonia-related impairment measurably worse because no such impairments currently exist. Because ammonia-N is not bioaccumulative, minor increases that could occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-2: Effects on Ammonia Concentrations Resulting from Implementation of CM2–CM22

NEPA Effects: Effects of CM2–CM22 on ammonia under Alternative 3 are the same as those discussed for Alternative 1A and are considered to be not adverse.

CEQA Conclusion: Conservation Measures 2–22 proposed under Alternative 3 would be similar to those proposed under Alternative 1A. As such, effects on ammonia resulting from the implementation of CM2–CM22 would be similar to that previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-3: Effects on Boron Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Effects of CM1 on boron under Alternative 3 in areas upstream of the Delta would be very similar to the effects discussed for Alternative 1A. There would be no expected change to the sources of boron in the Sacramento and east-side tributary watersheds, and resultant changes in flows from altered system-wide operations would have negligible, if any, effects on the concentration of boron in the rivers and reservoirs of these watersheds. The modeled long-term annual average lower San Joaquin River flow at Vernalis would decrease slightly compared to Existing Conditions (in association with project operations, climate change, and increased water demands) and would be similar compared to the No Action Alternative considering only changes due to Alternative 3 operations. The reduced flow would result in possible increases in long-term average boron concentrations of up to about

3% relative to the Existing Conditions (Appendix 8F, Table 24). The increased boron concentrations would not increase the frequency of exceedances of any applicable objectives or criteria and would not be expected to cause further degradation at measurable levels in the lower San Joaquin River, and thus would not cause the existing impairment there to be discernibly worse. Consequently, Alternative 3 would not be expected to cause exceedance of boron objectives/criteria or substantially degrade water quality with respect to boron, and thus would not adversely affect any beneficial uses of the Sacramento River, the east-side tributaries, associated reservoirs upstream of the Delta, or the San Joaquin River.

Delta

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

Effects of CM1 on boron under Alternative 3 in the Delta would be similar to the effects discussed for Alternative 1A. Relative to the Existing Conditions and No Action Alternative, Alternative 3 would result in unchanged or reduced long-term average boron concentrations for the 16-year period modeled at northern and eastern Delta locations, and would increase at interior and western Delta locations (by as much as 8% at the SF Mokelumne River at Staten Island, 9% at Franks Tract, 6% at Old River at Rock Slough, and 4% at the Sacramento River at Emmaton) (Appendix 8F, Table Bo-10). This comparison to Existing Conditions reflects changes 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. This comparison to the No Action Alternative reflects changes due only to operations.

Implementation of tidal habitat restoration under CM4 also may contribute to increased boron concentrations at western Delta assessment locations (more discussion of this phenomenon is included in Section 8.3.1.3), and thus would not be anticipated to substantially affect agricultural diversions which occur primarily at interior Delta locations. The long-term annual average and monthly average boron concentrations, for either the 16-year period or drought period modeled, would never exceed the 2,000 μg/L human health advisory objective (i.e., for children) or 500 μg/L agricultural objective at any of the eleven Delta assessment locations, which represents no change from the Existing Conditions and No Action Alternative conditions (Appendix 8F, Table Bo-3A). Reductions in long-term average assimilative capacity of up to 4% at interior Delta locations (i.e., Franks Tract and Old River at Rock Slough) would be small with respect to the 500 μg/L agricultural objective (Appendix 8F, Table Bo-11). However, because the absolute boron concentrations would still be well below the lowest 500 μg/L objective for the protection of the agricultural beneficial use under Alternative 3, the levels of boron degradation would not be of sufficient magnitude to substantially increase the risk of exceeding objectives or cause adverse effects to municipal and agricultural water supply beneficial uses, or any other beneficial uses, in the Delta (Appendix 8F, Figure Bo-2).

SWP/CVP Export Service Areas

Effects of CM1 on boron under Alternative 3 in the Delta would be very similar to the effects discussed for Alternative 1A. Under Alternative 3, long-term average boron concentrations would decrease by as much as 15% at the Banks Pumping Plant and by as much as 14% at Jones Pumping Plant relative to Existing Conditions and No Action Alternative (Appendix 8F, Table Bo-10) as a result of export of a greater proportion of low-boron Sacramento River water. Commensurate with the decrease in exported boron concentrations, boron concentrations in the lower San Joaquin River may be reduced and would likely alleviate or lessen any expected increase in boron concentrations at Vernalis associated with flow reductions (see discussion of Upstream of the Delta), as well as locations in the Delta receiving a large fraction of San Joaquin River water. Reduced export boron concentrations also may contribute to reducing the existing 303(d) impairment in the lower San Joaquin River and associated TMDL actions for reducing boron loading.

Maintenance of SWP and CVP facilities under Alternative 3 would not be expected to create new sources of boron or contribute towards a substantial change in existing sources of boron in the affected environment. Maintenance activities would not be expected to cause any substantial increases in boron concentrations or degradation with respect to boron such that objectives would be exceeded more frequently, or any beneficial uses would be adversely affected anywhere in the affected environment.

***NEPA Effects*:** In summary, relative to the No Action Alternative conditions, Alternative 3 would result in relatively small increases in long-term average boron concentrations in the Delta and not appreciably change boron levels in the lower San Joaquin River. However, the predicted changes would not be expected to cause exceedances of applicable objectives or further measurable water quality degradation, and thus would not constitute an adverse effect on water quality.

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

Boron is not a constituent of concern in the Sacramento River watershed upstream of the Delta, thus river flow rate and reservoir storage reductions that would occur under the Alternative 3, relative to Existing Conditions, would not be expected to result in a substantial adverse change in boron levels. Additionally, relative to Existing Conditions, Alternative 3 would not result in reductions in river flow rates (i.e., less dilution) or increased boron loading such that there would be any substantial increases in boron concentration upstream of the Delta in the San Joaquin River watershed.

Small increased boron levels predicted for interior and western Delta locations (i.e., up to 9% increase) in response to a shift in the Delta source water percentages and tidal habitat restoration under this alternative would not be expected to cause exceedances of objectives, or substantial degradation of these water bodies. Alternative 3 maintenance also would not result in any substantial increases in boron concentrations in the affected environment. Boron concentrations would be reduced in water exported from the Delta to the CVP/SWP Export Service Areas, thus reflecting a potential improvement to boron loading in the lower San Joaquin River.

Boron is not a bioaccumulative constituent, thus any increased concentrations under Alternative 3 would not result in adverse boron bioaccumulation effects to aquatic life or humans. Relative to Existing Conditions, Alternative 3 would not result in substantially increased boron concentrations such that frequency of exceedances of municipal and agricultural water supply objectives would increase. The levels of boron degradation that may occur under Alternative 3 would not be of sufficient magnitude to cause substantially increased risk for adverse effects to municipal or agricultural beneficial uses within the affected environment. Long-term average boron concentrations would decrease in Delta water exports to the SWP and CVP service area, which may contribute to reducing the existing 303(d) impairment of agricultural beneficial uses in the lower San Joaquin River. Based on these findings, this impact is determined to be less than significant. No mitigation is required.

Impact WQ-4: Effects on Boron Concentrations Resulting from Implementation of CM2–CM22

NEPA Effects**:** Effects of CM2–CM22 on boron under Alternative 3 are the same as those discussed for Alternative 1A and are determined to be not adverse.

CEQA Conclusion**:** Conservation Measures 2–22 proposed under Alternative 3 would be similar to those proposed under Alternative 1A. As such, effects on boron resulting from the implementation of CM2–CM22 would be similar to that previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

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

Upstream of the Delta

Under Alternative 3 there would be no expected change to the sources of bromide in the Sacramento and eastside tributary watersheds. Bromide loading in these watersheds would remain unchanged and resultant changes in flows from altered system-wide operations under Alternative 3 would have negligible, if any, effects on the concentration of bromide in the rivers and reservoirs of these watersheds. Consequently, Alternative 3 would not be expected to adversely affect the MUN beneficial use, or any other beneficial uses, of the Sacramento River, the eastside tributaries, or their associated reservoirs upstream of the Delta.

Under Alternative 3, modeling indicates that long-term annual average flows on the San Joaquin River would decrease by 6%, relative to Existing Conditions and would remain virtually the same relative to the No Action Alternative (Appendix 5A). These decreases in flow would result in possible increases in long-term average bromide concentrations of about 3% relative to Existing Conditions and less than <1% relative to No Action Alternative (Appendix 8E, Bromide Table 22). The small increases in lower San Joaquin River bromide levels that could occur under Alternative 3, relative to existing and No Action Alternative conditions would not be expected to adversely affect the MUN beneficial use, or any other beneficial uses, of the lower San Joaquin River.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2-22 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for CM2-22. 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, Alternative 3 relative to the No Action Alternative would result in predicted increases in long-term average bromide concentrations at all locations with the exception of the Banks and Jones pumping plants (Appendix 8E, *Bromide*, Table 8). These increases would continue to be greatest at Barker Slough, where long-term average concentrations are predicted to increase by about 38% (about 85% in drought years) relative to the No Action Alternative. Increases in long-term average bromide concentrations would be less than 29% at the remaining assessment locations. Due to the relatively small differences between modeled Existing Conditions and No Action baselines, changes in the frequency with which concentration thresholds of 50 µg/L and 100 µg/L are exceeded are of similar magnitude to the previously described existing condition comparison. Unlike the comparison to Existing Conditions, this comparison to the No Action Alternative reflects changes in bromide due only to Alternative 3 operations.

At Barker Slough, modeled long-term average bromide concentrations for the two baseline conditions are very similar (Appendix 8E, Bromide Table 8). Such similarity demonstrates that the modeled Alternative 3 change in bromide is almost entirely due to Alternative 3 operations, and not climate change/sea level rise. Therefore, operations are the primary driver of effects on bromide at Barker Slough, regardless whether Alternative 3 is compared to Existing Conditions, or compared to the No Action Alternative.

Results of the modeling approach which used relationships between EC and chloride and between chloride and bromide (see Section 8.3.1.3) differed somewhat from what is presented above for the mass-balance approach (see Appendix 8E, Table 9). For most locations, the frequency of exceedance of the 50 µg/L and 100 µg/L were similar. The greatest difference between the methods was predicted for Barker Slough. The increases in frequency of exceedance of the 100 µg/L threshold, relative to Existing Conditions and the No Action Alternative, were not as great using this alternative

EC to chloride and chloride to bromide relationship modeling approach as compared to that presented above from the mass-balance modeling approach. However, there were still substantial increases, resulting in 9% exceedance over the modeled period under Alternative 3, as compared to 1% under Existing Conditions and 2% under the No Action Alternative. For the drought period, exceedance frequency increased from 0% under Existing Conditions and the No Action Alternative, to 18% under Alternative 3. Because the mass-balance approach predicts a greater level of impact at Barker Slough, determination of impacts was based on the mass-balance results.

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

The seasonal intakes at Mallard Slough and City of Antioch are infrequently used due to water quality constraints related to sea water intrusion. On a long-term average basis, bromide at these locations is in excess of 3,000 μg/L, but during seasonal periods of high Delta outflow can be <300 μg/L. Based on modeling using the mass-balance approach, use of the seasonal intakes at Mallard Slough and City of Antioch under Alternative 3 would experience a period average increase in bromide during the months when these intakes would most likely be utilized. For those wet and above normal water year types where mass balance modeling would predict water quality typically suitable for diversion, predicted long-term average bromide would increase from 103 μg/L to 149 μg/L (45% increase) at City of Antioch and would increase from 150 μg/L to 201 μg/L (34% increase) at Mallard Slough relative to Existing Conditions (Appendix 8E, Bromide Table 23). Increases would be similar for the No Action Alternative comparison. Modeling results using the EC to chloride and chloride to bromide relationships show increases during these months, but the relative magnitude of the increases is much lower (Appendix 8E, Bromide Table 24). Regardless of the differences in the data between the two modeling approaches, the decisions surrounding the use of these seasonal intakes is largely driven by acceptable water quality, and thus have historically been opportunistic. Opportunity to use these intakes would remain, and the predicted increases in bromide concentrations at the City of Antioch and Mallard Slough intake would not be expected to adversely affect MUN beneficial uses, or any other beneficial use, at these locations.

SWP/CVP Export Service Areas

Under Alternative 3, improvement in long-term average bromide concentrations would occur at the Banks and Jones pumping plants. Long-term average bromide concentrations for the modeled 16-year hydrologic period at these locations would decrease by as much as 31% relative to Existing Conditions and 21% relative to the No Action Alternative. Relative change in long-term average bromide concentration would generally be less for the drought period (≤31%), but would still represent considerable improvement (Appendix 8E, Bromide Table 8). As a result, less frequent bromide concentration exceedances of the 50 µg/L and 100 µg/L assessment thresholds would be predicted and an overall improvement in Export Service Areas water quality would be experienced respective to bromide. Commensurate with the decrease in exported bromide, an improvement in lower San Joaquin River bromide would also be observed since bromide in the lower San Joaquin River is principally related to irrigation water deliveries from the Delta. While the magnitude of this expected lower San Joaquin River improvement in bromide is difficult to predict, the relative decrease in overall loading of bromide to the Export Service Areas would likely alleviate or lessen any expected increase in bromide concentrations at Vernalis (see discussion of Upstream of the Delta) as well as locations in the Delta receiving a large fraction of San Joaquin River water, such as much of the south Delta.

NEPA Effects: 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, *Bromide*, Table 9).

Similar to the discussion pertaining to the No Action Alternative, maintenance of SWP and CVP facilities under Alternative 3 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.

In summary, Alternative 3 operations and maintenance, relative to the No Action Alternative, would result in small increases (i.e., <1%) in long-term average bromide concentrations at Vernalis related to relatively small declines in long-term average flow on the San Joaquin River. However, Alternative 3 operation and maintenance activities would cause substantial degradation to water quality with respect to bromide at Barker Slough, source of the North Bay Aqueduct. Resultant substantial change in long-term average bromide at Barker Slough could necessitate changes in water treatment plant operations or require treatment plant upgrades in order to maintain DBP compliance, and thus would constitute an adverse effect on water quality. Mitigation Measure WQ-5 is available to reduce these effects (implementation of this measure along with a separate, non-environmental commitment as set forth in EIR/EIS Appendix 3B, *Environmental Commitments*, relating to the potential increased treatment costs associated with bromide-related changes would reduce these effects).

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

Under Alternative 3 there would be no expected change to the sources of bromide in the Sacramento and eastside tributary watersheds. Bromide loading in these watersheds would remain unchanged and resultant changes in flows from altered system-wide operations under Alternative 3 would have negligible, if any, effects on the concentration of bromide in the rivers and reservoirs of these watersheds. However, south of the Delta, the San Joaquin River is a substantial source of bromide, primarily due to the use of irrigation water imported from the southern Delta. Concentrations of bromide at Vernalis are inversely correlated to net river flow. Under Alternative 3, long-term average flows at Vernalis would decrease only slightly, resulting in less than substantial predicted increases in long-term average bromide of about 3% relative to Existing Conditions.

Relative to Existing Conditions, Alternative 3 would result in small decreases in long-term average bromide concentration at most Delta assessment locations, with principal exceptions being the North Bay Aqueduct at Barker Slough, Staten Island, and Emmaton on the Sacramento River. Overall effects would be greatest at Barker Slough, where substantial increases in long-term average bromide concentrations would be predicted. The increase in long-term average bromide concentrations predicted for Barker Slough would result in a substantial change in source water quality to existing drinking water treatment plants drawing water from the North Bay Aqueduct. These modeled increases in bromide at Barker Slough could lead to adverse changes in the formation of disinfection byproducts at drinking water treatment plants such that considerable water treatment plant upgrades would be necessary in order to achieve equivalent levels of drinking water health protection.

The assessment of effects on bromide in the SWP/CVP Export Service Areas is based on assessment of changes in bromide concentrations at Banks and Jones pumping plants. Under Alternative 3, substantial improvement would occur at the Banks and Jones pumping plants, where predicted long-term average bromide concentrations are predicted to decrease by as much as 31% relative to Existing Conditions. An overall improvement in bromide-related water quality would be predicted in the SWP/CVP Export Service Areas.

Based on the above, Alternative 3 operation and maintenance would not result in any substantial change in long-term average bromide concentration upstream of the Delta. Furthermore, under Alternative 3, water exported from the Delta to the SWP/CVP service area would be substantially improved relative to bromide. Bromide is not bioaccumulative, therefore change in long-term average bromide concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Additionally, bromide is not a constituent related to any 303(d) listings. Alternative 3 operation and maintenance activities would not cause substantial long-term degradation to water quality respective to bromide with the exception of water quality at Barker Slough, source of the North Bay Aqueduct. At Barker Slough, modeled long-term annual average concentrations of bromide would increase by 34%, and 85% during the modeled drought period. For the modeled 16-year hydrologic period the frequency of predicted bromide concentrations exceeding 100 μg/L would increase from 0% under Existing Conditions to 22% under Alternative 3, while for the modeled drought period, the frequency would increase from 0% to 47%. Substantial changes in long-term average bromide could necessitate changes in treatment plant operation or require treatment plant upgrades in order to maintain DBP compliance. The model predicted change at Barker Slough is substantial and, therefore, would represent a substantially increased risk for adverse effects on existing MUN beneficial uses should treatment upgrades not be undertaken. The impact is considered significant.

Implementation of Mitigation Measure WQ-5 along with a separate, non-environmental commitment relating to the potential increased treatment costs associated with bromide-related changes would reduce these effects. While mitigation measures to reduce these water quality effects in affected water bodies to less than significant levels are not available, implementation of Mitigation Measure WQ-5 is recommended to attempt to reduce the effect that increased bromide concentrations may have on Delta beneficial uses. However, because the effectiveness of this mitigation measure to result in feasible measures for reducing water quality effects is uncertain, this impact is considered to remain significant and unavoidable. Please see Mitigation Measure WQ-5 under Impact WQ-5 in the discussion of Alternative 1A.

In addition to and to supplement Mitigation Measure WQ-5, the BDCP proponents have incorporated into the BDCP, as set forth in EIR/EIS Appendix 3B, *Environmental Commitments*, a separate, non-environmental commitment to address the potential increased water treatment costs that could result from bromide-related concentration effects on municipal water purveyor operations. Potential options for making use of this financial commitment include funding or providing other assistance towards implementation of the North Bay Aqueduct AIP, acquiring alternative water supplies, or other actions to indirectly reduce the effects of elevated bromide and DOC in existing water supply diversion facilities. Please refer to Appendix 3B, *Environmental Commitments*, for the full list of potential actions that could be taken pursuant to this commitment in order to reduce the water quality treatment costs associated with water quality effects relating to chloride, electrical conductivity, and bromide.

Mitigation Measure WQ-5: Avoid, Minimize, or Offset, as Feasible, Adverse Water Quality Conditions

Please see Mitigation Measure WQ-5 under Impact WQ-5 in the discussion of Alternative 1A.

Impact WQ-6: Effects on Bromide Concentrations Resulting from Implementation of CM2–CM22

***NEPA Effects*:** Conservation Measures 2–22 proposed under Alternative 3 would be the same as those proposed under Alternative 1A. As discussed for Alternative 1A, implementation of the CM2–CM22 would not present new or substantially changed sources of bromide to the study area. Some conservation measures may replace or substitute for existing irrigated agriculture in the Delta. This replacement or substitution is not expected to substantially increase or present new sources of bromide. CM2–CM22 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.

In summary, implementation of CM2–CM22 under Alternative 3, relative to the No Action Alternative, would have negligible, if any, effects on bromide concentrations. The effects on bromide from implementing CM2–CM22 are determined to not be adverse.

***CEQA Conclusion*:** Conservation Measures 2–22 proposed under Alternative 3 would be similar to those proposed under Alternative 1A. As such, effects on bromide resulting from the implementation of CM2–CM22 would be similar to that previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

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

Upstream of the Delta

Under Alternative 3 there would be no expected change to the sources of chloride in the Sacramento and eastside tributary watersheds. Chloride loading in these watersheds would remain unchanged and resultant changes in flows from altered system-wide operations would have negligible, if any, effects on the concentration of chloride in the rivers and reservoirs of these watersheds. The modeled long-term annual average flows on the lower San Joaquin River at Vernalis would decrease slightly compared to Existing Conditions and be similar compared to the No Action Alternative (as a result of climate change). The reduced flow would result in possible increases in long-term average chloride concentrations of about 2%, relative to the Existing Conditions and no change relative to No Action Alternative (Appendix 8G, Table Cl-62). Consequently, Alternative 3 would not be expected to cause exceedance of chloride objectives/criteria or substantially degrade water quality with respect to chloride, and thus would not adversely affect any beneficial uses of the Sacramento River, the eastside tributaries, associated reservoirs upstream of the Delta, or the San Joaquin River.

Delta

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

Relative to Existing Conditions, modeling predicts that Alternative 3 would result in similar or reduced long-term average chloride concentrations for the 16-year period modeled at most of the assessment locations, and, depending on modeling approach (see Section 8.3.1.3), would result in increased concentrations at the North Bay Aqueduct at Barker Slough (i.e., ≤28%), San Joaquin River at Staten Island (i.e., ≤19%), Sacramento River at Emmaton (i.e., ≤16%), and Sacramento River at Mallard Island (i.e., ≤5%) (Appendix 8G, *Chloride*, Table Cl-19 and Table Cl-20). Additionally, implementation of tidal habitat restoration under CM4 would increase the tidal exchange volume in the Delta, and thus may contribute to increased chloride concentrations in the Bay source water as a result of increased salinity intrusion. More discussion of this phenomenon is included in Section 8.3.1.3. Consequently, while uncertain, the magnitude of chloride increases may be greater than indicated herein and would affect the western Delta assessment locations the most which are influenced to the greatest extent by the Bay source water. This comparison to Existing Conditions reflects changes in chloride due to both Alternative 3 operations (including north Delta intake capacity of 6,000 cfs and numerous other operational components of Scenario A) and climate change/sea level rise.

Relative to the No Action Alternative conditions, the mass balance analysis of modeling results indicated that Alternative 3A would result in increased long-term average chloride concentrations for the 16-year period modeled at nine of the assessment locations (Appendix 8G, Table Cl-19). The increases in long-term average chloride concentrations would generally be largest compared to the No Action Alternative condition, ranging from 2% at the San Joaquin River at Buckley Cove to 32% at the North Bay Aqueduct at Barker Slough. Long-term average chloride concentrations would decrease at the Banks pumping plant and Jones pumping plant locations. The comparison to the No Action Alternative reflects chloride changes due only to operations.

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

Municipal Beneficial Uses–Relative to Existing Conditions

Estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3) were used to evaluate the 150 mg/L Bay-Delta WQCP objective for municipal and industrial beneficial uses on a basis of the percent of years the chloride objective is exceeded for the modeled 16-year period. The objective is exceeded if chloride concentrations exceed 150 mg/L for a specified number of days in a given water year at both the Antioch and Contra Costa Pumping Plant #1 locations. For Alternative 3, the modeled frequency of objective exceedance would approximately double from 6% of years under Existing Conditions, to 13% of years under Alternative 3 (Appendix 8G, Table Cl-64).

Similarly, estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3) were also used to evaluate the 250 mg/L Bay-Delta WQCP objective for chloride at Contra Costa Pumping Plant #1 where daily average objectives apply. The basis for the evaluation was the predicted number of days the objective was exceeded for the modeled 16-year period. For Alternative 3, the modeled frequency of objective exceedance would decrease slightly, from 6% of modeled days under Existing Conditions, to 4% of modeled days under Alternative 3 (Appendix 8G, Table Cl-63).

Given the limitations inherent to estimating future chloride concentrations (see Section 8.3.1.3), estimation of chloride concentrations through both a mass balance approach and an EC-chloride relationship approach was used to evaluate the 250 mg/L Bay-Delta WQCP objectives in terms of both frequency of exceedance and use of assimilative capacity. When utilizing the mass balance approach to model monthly average chloride concentrations for the 16-year period, the predicted frequency of exceeding the 250 mg/L objective would occur for the 16-year period modeled at the San Joaquin River at Antioch (i.e., from 66% under Existing Conditions to 74%) and Sacramento River at Mallard Island (i.e., from 85% under Existing Conditions to 87%) (Appendix 8G, Table Cl-21), and would cause further degradation at Antioch in March and April (Appendix 8G, Table Cl-23). The frequency of exceedances at the Contra Costa Canal at Pumping Plant #1 would not increase (Appendix 8G, Table Cl-21); however, available assimilative capacity would be reduced by up to 100% (i.e., eliminated) in October and November compared to Existing Conditions (Appendix 8G, Table Cl-23), reflecting substantial degradation during these months when average concentrations would be near, or exceed, the objective.

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

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

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

With respect to the 303(d) listing for chloride in Tom Paine Slough, the monthly average chloride concentrations for the 16-year period modeled at Old River at Tracy Road would generally be similar compared to Existing Conditions, and thus, would not be further degraded on a long-term basis (Appendix 8G, Figure Cl-2). With respect to Suisun Marsh, the monthly average chloride concentrations for the 16-year period modeled would increase compared to Existing Conditions in some months during October through May at the Sacramento River at Collinsville (Appendix 8G, Figure Cl-3), Mallard Island (Appendix 8G, Figure Cl-1), and increase substantially at Montezuma Slough at Beldon's Landing (i.e., up to a tripling of concentration in December through February) (Appendix 8G, Figure Cl-4), thereby contributing to additional, measureable long-term degradation that potentially would adversely affect the necessary actions to reduce chloride loading for any TMDL that is developed.

Municipal Beneficial Uses–Relative to No Action Alternative

Similar to the assessment conducted for Existing Conditions, estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3) were used to evaluate the 150 mg/L Bay-Delta WQCP objective for municipal and industrial beneficial uses. For Alternative 3, the modeled frequency of objective exceedance would increase from 6% under the No Action Alternative to 13% of years under Alternative 3 (Appendix 8G, Table Cl-64).

Similarly, estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3) were also used to evaluate the 250 mg/L Bay-Delta WQCP objective for chloride at Contra Costa Pumping Plant #1 where daily average objectives apply. For Alternative 3, the modeled frequency of objective exceedance would decrease slightly from 5% of modeled days under the No Action Alternative to 4% of modeled days under Alternative 3 (Appendix 8G, Table Cl-63).

Similar to Existing Conditions, a comparative assessment of modeling approaches was utilized to evaluate the 250 mg/L Bay-Delta WQCP objectives in terms of both frequency of exceedance and use of assimilative capacity on a monthly average basis. When utilizing the mass balance approach to model monthly average chloride concentrations for the 16-year period, a small increase in exceedance frequency would be predicted relative to the No Action Alternative at the Contra Costa Canal at Pumping Plant #1 (i.e., from 14% for the No Action Alternative to 20%), San Joaquin River at Antioch (i.e., from 73% to 74%), and Sacramento River at Mallard Island (i.e., from 86% to 87%) (Appendix 8G, Table Cl-21). Additionally, the available assimilative capacity would be reduced at the Contra Costa Canal at Pumping Plant #1 in September through November (i.e., ranging from 29% to 100% [i.e., elimination]) and at the Antioch location in April (i.e., up to 46%) (Appendix 8G, Table Cl-23), reflecting substantial degradation during these months when average concentrations would be near, or exceed, the objective.

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

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

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

With respect to the 303(d) listing for chloride, Alternative 3 would generally result in similar changes to those discussed for the comparison to Existing Conditions. Monthly average chloride concentrations at Tom Paine Slough would not be further degraded on a long-term basis (Appendix 8G, Figure Cl-2). Monthly average chloride concentrations at source water channel locations for the Suisun Marsh (Appendix 8G, Figures Cl-1, Cl-3 and Cl-4) would increase substantially in some months during October through May compared to the No Action Alternative conditions. Therefore, additional, measureable long-term degradation would occur in Suisun Marsh that potentially would adversely affect the necessary actions to reduce chloride loading for any TMDL that is developed.

SWP/CVP Export Service Areas

Under Alternative 3, long-term average chloride concentrations based on the mass balance analysis of modeling results for the 16-year period modeled at the Banks and Jones pumping plants would decrease by as much as 30% relative to Existing Conditions and 21% compared to No Action Alternative (Appendix 8G, *Chloride*, Table Cl-19). The modeled frequency of exceedances of applicable water quality objectives/criteria would decrease relative to Existing Conditions and No Action Alternative, for both the 16-year period and the drought period modeled (Appendix 8G, *Chloride*, Table Cl-21). Consequently, water exported into the SWP/CVP service area would generally be of similar or better quality with regards to chloride relative to Existing Conditions and the No Action Alternative conditions.

Results of the modeling approach which used relationships between EC and chloride (see Section 8.3.1.3) were consistent with the discussion above, and assessment of chloride using these data results in the same conclusions as are presented above for the mass-balance approach (Appendix 8G, Table Cl-20 and Table Cl-22).

Commensurate with the reduced chloride concentrations in water exported to the service area, reduced chloride loading in the lower San Joaquin River would be anticipated which would likely alleviate or lessen any expected increase in chloride at Vernalis related to decreased annual average San Joaquin River flows (see discussion of Upstream of the Delta).

Maintenance of SWP and CVP facilities would not be expected to create new sources of chloride or contribute towards a substantial change in existing sources of chloride in the affected environment. Maintenance activities would not be expected to cause any substantial change in chloride such that any long-term water quality degradation would occur, thus, beneficial uses would not be adversely affected anywhere in the affected environment.

NEPA Effects: In summary, relative to the No Action Alternative conditions, Alternative 3 would result in increased water quality degradation and frequency of exceedance of the 150 mg/L objective at Contra Costa Pumping Plant #1 and Antioch, the 250 mg/L municipal and industrial objective at interior and western Delta locations on a monthly average chloride basis, and measureable water quality degradation relative to the 303(d) impairment in Suisun Marsh. The predicted chloride increases constitute an adverse effect on water quality (see Mitigation Measure WQ-7 below; implementation of this measure along with a separate, non-environmental commitment relating to the potential increased chloride treatment costs would reduce these effects). Additionally, the predicted changes relative to the No Action Alternative conditions indicate that in addition to the effects of climate change/sea level rise, implementation of CM1 and CM4 under Alternative 3 would contribute substantially to the adverse water quality effects.

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

Chloride is not a constituent of concern in the Sacramento River watershed upstream of the Delta, thus river flow rate and reservoir storage reductions that would occur under the Alternative 3, relative to Existing Conditions, would not be expected to result in a substantial adverse change in chloride levels. Additionally, relative to Existing Conditions, the Alternative 3 would not result in reductions in river flow rates (i.e., less dilution) or increased chloride loading such that there would be any substantial increase in chloride concentrations upstream of the Delta in the San Joaquin River watershed.

Relative to Existing Conditions, the Alternative 3 would result in substantially increased chloride concentrations in the Delta such that frequency of exceeding the 150 mg/L Bay-Delta WQCP objective would approximately double. Moreover, the frequency of exceedance of the 250 mg/L Bay-Delta WQCP objective would increase at the San Joaquin River at Antioch (by 8%) and at Mallard Slough (by 2%), and long-term degradation may occur at Antioch, Mallard Slough, and Contra Costa Canal at Pumping Plant #1, that may result in adverse effects on the municipal and industrial water supply beneficial use (see Mitigation Measure WQ-7 below; implementation of this measure along with a separate, non-environmental commitment relating to the potential increased chloride treatment costs would reduce these effects). Relative to the Existing Conditions, the modeled increased chloride concentrations and degradation in the western Delta could further contribute, at measurable levels (i.e., over a tripling of concentration), to the existing 303(d) listed impairment due to chloride in Suisun Marsh for the protection of fish and wildlife.

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

Chloride is not a bioaccumulative constituent, thus any increased concentrations under Alternative 3 would not result in substantial chloride bioaccumulation impacts on aquatic life or humans. Alternative 3 maintenance would not result in any substantial changes in chloride concentration upstream of the Delta or in the SWP/CVP Export Service Areas. However, based on these findings, this impact is determined to be significant due to increased chloride concentrations and degradation at western Delta locations and its effects on municipal and industrial water supply, and fish and wildlife beneficial uses.

While mitigation measures to reduce these water quality effects in affected water bodies to less than significant levels are not available, implementation of Mitigation Measure WQ-7 is recommended to attempt to reduce the effect that increased chloride concentrations may have on Delta beneficial uses. However, because the effectiveness of this mitigation measure to result in feasible measures for reducing water quality effects is uncertain, this impact is considered to remain significant and unavoidable. Please see Mitigation Measure WQ-7 under Impact WQ-7 in the discussion of Alternative 1A.

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

Impact WQ-8: Effects on Chloride Concentrations Resulting from Implementation of CM2–CM22

NEPA Effects**:** Under Alternative 3, the types and geographic extent of effects on chloride concentrations in the Delta as a result of implementation of the other conservation measures (i.e., CM2–CM22) would be similar to, and undistinguishable from, those effects previously described for Alternative 1A. The conservation measures would present no new direct sources of chloride to the affected environment. Moreover, some habitat restoration conservation measures (CM4–CM10) would occur on lands within the Delta currently used for irrigated agriculture, thus replacing agricultural land uses with restored tidal wetlands, floodplain, and related channel margin and off-channel habitats. The potential reduction in irrigated lands within the Delta may result in reduced discharges of agricultural field drainage with elevated chloride concentrations, which would be considered an improvement compared to No Action Alternative conditions.

In summary, based on the discussion above, the effects on chloride from implementing CM2-CM22 are considered to be not adverse.

CEQA Conclusion**:** Implementation of the CM2–CM22 for Alternative 3 would not present new or substantially changed sources of chloride to the affected environment upstream of the Delta, within Delta, or in the SWP/CVP service area. Replacement of irrigated agricultural land uses in the Delta with habitat restoration conservation measures may result in some reduction in discharge of agricultural field drainage with elevated chloride concentrations, thus resulting in improved water quality conditions. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

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

NEPA Effects**:** Effects of CM1 on DO under Alternative 3 are the same as those discussed for Alternative 1A and are considered to not be adverse.

CEQA Conclusion**:** Effects of CM1 on DO under Alternative 3 would be similar to those discussed for Alternative 1A, and are summarized here, then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion under Alternative 1A.

River flow rate and reservoir storage reductions that would occur under Alternative 3, relative to Existing Conditions, would not be expected to result in a substantial adverse change in DO levels in the reservoirs and rivers upstream of the Delta, given that mean monthly flows would remain within the ranges historically seen under Existing Conditions and the affected river are large and turbulent. Any reduced DO saturation level that may be caused by increased water temperature would not be expected to cause DO levels to be outside of the range seen historically. Finally, amounts of oxygen demanding substances and salinity would not be expected to change sufficiently to affect DO levels.

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

There is not expected to be substantial, if even measurable, changes in DO levels in the SWP/CVP Export Service Areas waters under Alternative 3, relative to Existing Conditions, because the biochemical oxygen demand of the exported water would not be expected to substantially differ from that under Existing Conditions (due to ever increasing water quality regulations), canal turbulence and exposure of the water to the atmosphere and the algal communities that exist within the canals would establish an equilibrium for DO levels within the canals. The same would occur in downstream reservoirs.

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

Impact WQ-10: Effects on Dissolved Oxygen Resulting from Implementation of CM2–CM22

***NEPA Effects*:** Effects of CM2–CM22 on DO under Alternative 3 are the same as those discussed for Alternative 1A and are considered to not be adverse.

***CEQA Conclusion*:** Conservation Measures 2–22 proposed under Alternative 3 would be similar to those proposed under Alternative 1A. As such, effects on DO resulting from the implementation of CM2–CM22 would be similar to that previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

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

Upstream of the Delta

For the same reasons stated for the No Action Alternative, EC levels (highs, lows, typical conditions) in the Sacramento River and its tributaries, the eastside tributaries, their associated reservoirs, and the San Joaquin River upstream of the Delta under Alternative 3 are not expected to be outside the ranges occurring under Existing Conditions or would occur under the No Action Alternative. Any minor changes in EC levels that could occur under Alternative 3 in water bodies upstream of the Delta would not be of sufficient magnitude, frequency and geographic extent that would cause adverse effects on beneficial uses or substantially degrade water quality with regard to EC.

Delta

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

Relative to Existing Conditions, Alternative 3 would result in a fewer number of days when Bay-Delta WQCP compliance locations in the western, interior, and southern Delta would exceed EC objectives or be out of compliance with the EC objectives, with the exception of the Sacramento River at Emmaton in the western Delta and San Joaquin River at San Andreas Landing in the interior Delta (Appendix 8H, Table EC-3). The percent of days the Emmaton EC objective would be exceeded for the entire period modeled (1976–1991) would increase from 6% under Existing Conditions to 27% under Alternative 3, and the days out of compliance with the EC objective would increase from 11% under Existing Conditions to 39% under Alternative 3. The percent of days the San Andreas Landing EC objective would be exceeded would increase from 1% under Existing Conditions to 2% under Alternative 3. Further, the percent of days out of compliance with the EC objective would increase from 1% under Existing Conditions to 4% under Alternative 3. Average EC levels at the western and southern Delta compliance locations, except at Emmaton in the western Delta, would decrease from 1–28% for the entire period modeled and 2–30% during the drought period modeled (1987–1991) (Appendix 8H, Table EC-14). At Emmaton, average EC would increase by 14% for the entire period modeled and 12% for the drought period modeled. At the two interior Delta locations, there would be increases in average EC: the S. Fork Mokelumne River at Terminous average EC would increase 4% for the entire period modeled and 3% during the drought period modeled; and San Joaquin River at San Andreas Landing average EC would increase 12% for the entire period modeled and 13% during the drought period modeled. On average, EC would increase at Emmaton during December and March through September. Average EC would increase at San Andreas Landing during all months except November. Average EC in the S. Fork Mokelumne River at Terminous would increase during all months (Appendix 8H, Table EC-14). Of the Clean Water Act section 303(d) listed sections of the Delta–western, northwestern, and southern–the western portion of the Delta at Emmaton would have an increased frequency of exceedance of EC objectives (Appendix 8H, Table EC-1) and increased average EC. Thus, Alternative 3 could contribute to additional impairment and adversely affect beneficial uses for section 303(d) listed Delta waterways, relative to Existing Conditions. These EC changes are similar to that described for

Alternative 1A. The comparison to Existing Conditions reflects changes in EC due to both Alternative 3 operations (including north Delta intake capacity of 6,000 cfs and numerous other operational components of Scenario A) and climate change/sea level rise.

Relative to the No Action Alternative, the percent of days exceeding EC objectives and percent of days out of compliance would increase at: Sacramento River at Emmaton, San Joaquin River at Jersey Point, San Andreas Landing, and Prisoners Point; and Old River near Middle River; and Old River at Tracy Bridge (Appendix 8H, Table EC-3). The increase in percent of days exceeding the EC objective would be 1% or less and the increase in percent of days out of compliance would be 3% or less, with the exception of Emmaton, which would have a 15% increase in days exceeding the EC objective and a 17% increase in days out of compliance. Average EC would increase at some compliance locations for the entire period modeled: Sacramento River at Emmaton (13%), San Joaquin River at Jersey Point (2%), S. Fork Mokelumne River at Terminous (4%),San Joaquin River at San Andreas Landing (18%), and San Joaquin River at Prisoners Point (9%) (Appendix 8H, Table EC-14). For the drought period modeled, the locations with an average EC increase, relative to the No Action Alternative, would be: Sacramento River at Emmaton (1%), S. Fork Mokelumne River at Terminous (4%), San Joaquin River at San Andreas Landing (13%), San Joaquin River at Brandt Bridge (1%), Old River at Tracy Bridge (1%), and San Joaquin River at Prisoners Point (5%) (Appendix 8H, Table EC-14). Given that the western and southern Delta are Clean Water Act section 303(d) listed as impaired due to elevated EC, the increase in the incidence of exceedance of EC objectives and increases in long-term and drought period average EC at the western and southern Delta locations under Alternative 3, relative to the No Action Alternative, has the potential to contribute to additional impairment and potentially adversely affect beneficial uses. These EC changes are similar to that described for Alternative 1A. The comparison to the No Action Alternative reflects changes in EC due only to Alternative 3 operations (including north Delta intake capacity of 6,000 cfs and numerous other operational components of Scenario A).

For Suisun Marsh, October–May is the period when Bay-Delta WQCP EC objectives for protection of fish and wildlife apply. Long-term average EC would increase under Alternative 3, relative to Existing Conditions, during the months of March through May by 0.3–0.9 mS/cm in the Sacramento River at Collinsville (Appendix 8H, Table EC-21). Long-term average EC would decrease relative to Existing Conditions in Montezuma Slough at National Steel during October–May (Appendix 8H, Table EC-22). The most substantial increase would occur near Beldon Landing, with long-term average EC levels increasing by 1.8–6.1 mS/cm, depending on the month, which would be a doubling or tripling of long-term average EC relative to Existing Conditions (Appendix 8H, Table EC-23). Sunrise Duck Club and Volanti Slough also would have long-term average EC increases during all months of 1.7–4.0 mS/cm (Appendix 8H, Tables EC-24 and EC-25). The degree to which the long-term average EC increases would cause exceedance of Bay-Delta WQCP objectives is unknown, because objectives are expressed as a monthly average of daily high tide EC, which does not have to be met if it can be demonstrated “equivalent or better protection will be provided at the location” (State Water Resources Control Board 2006:14). 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 be substantial and it is uncertain the degree to which current management plans for the Suisun Marsh would be able to address these substantially higher EC levels and protect beneficial uses. Thus, these increased EC levels in Suisun Marsh are considered to have a potentially adverse effect on marsh beneficial uses. Long-term average EC increases in Suisun Marsh under Alternative 3 relative to the

No Action Alternative would be similar to the increases relative to Existing Conditions. Suisun Marsh is section 303(d) listed as impaired due to elevated EC, and the potential increases in long-term average EC concentrations could contribute to additional impairment, because the increases would be double or triple that relative to Existing Conditions and the No Action Alternative. These EC changes are similar to that described for Alternative 1A.

SWP/CVP Export Service Areas

At the Banks and Jones pumping plants, Alternative 3 would result in no exceedances of the Bay-Delta WQCP's 1,000 μmhos/cm EC objective for the entire period modeled (Appendix 8H, Table EC-10). Thus, there would be no adverse effect on the beneficial uses in the SWP/CVP Export Service Areas using water pumped at this location under Alternative 3.

At the Banks pumping plant, relative to Existing Conditions, average EC levels under Alternative 3 would decrease 18% for the entire period modeled and 18% during the drought period modeled. Relative to the No Action Alternative, average EC levels would decrease by 12% for the entire period modeled and drought period modeled. (Appendix 8H, Table EC-14)

At the Jones pumping plant, relative to Existing Conditions, average EC levels under Alternative 3 would decrease 17% for the entire period modeled and 20% during the drought period modeled. Relative to the No Action Alternative, average EC levels would decrease by 13% for the entire period modeled and 16% during the drought period modeled. (Appendix 8H, Table EC-14)

Based on the decreases in long-term average EC levels that would occur at the Banks and Jones pumping plants, Alternative 3 would not cause degradation of water quality with respect to EC in the SWP/CVP Export Service Areas; rather, Alternative 3 would improve long-term average EC conditions in the SWP/CVP Export Service Areas.

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

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

NEPA Effects: In summary, the increased frequency of exceedance of EC objectives and increased long-term and drought period average EC levels that would occur at western and southern Delta compliance locations under Alternative 3, relative to the No Action Alternative, would contribute to adverse effects on the agricultural beneficial uses. Given that the western and southern Delta are Clean Water Act section 303(d) listed as impaired due to elevated EC, the increase in the incidence of exceedance of EC objectives and increases in long-term and drought period average EC in the southern Delta under Alternative 3 has the potential to contribute to additional beneficial use impairment. The increases in long-term average EC levels that would occur in Suisun Marsh would further degrade existing EC levels and could contribute additionally to adverse effects on the fish and wildlife beneficial uses. Suisun Marsh is section 303(d) listed as impaired due to elevated EC, and the potential increases in long-term average EC levels could contribute to additional beneficial use impairment. These increases in EC constitute an adverse effect on water quality. Mitigation Measure WQ-11 would be available to reduce these effects (implementation of this measure along with a separate, non-environmental commitment as set forth in EIR/EIS Appendix 3B, *Environmental Commitments*, relating to the potential EC-related changes would reduce these effects).

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

River flow rate and reservoir storage reductions that would occur under Alternative 3, relative to Existing Conditions, would not be expected to result in a substantial adverse change in EC levels in the reservoirs and rivers upstream of the Delta, given that: changes in the quality of watershed runoff and reservoir inflows would not be expected to occur in the future; the state's aggressive regulation of point-source discharge effects on Delta salinity-elevating parameters and the expected further regulation as salt management plans are developed; the salt-related TMDLs adopted and being developed for the San Joaquin River; and the expected improvement in lower San Joaquin River average EC levels commensurate with the lower EC of the irrigation water deliveries from the Delta.

Relative to Existing Conditions, Alternative 3 would not result in any substantial increases in long-term average EC levels in the SWP/CVP Export Service Areas. There would be no exceedance of the EC objective at the Jones and Banks pumping plants. Average EC levels for the entire period modeled would decrease at both plants and, thus, this alternative would not contribute to additional beneficial use impairment related to elevated EC in the SWP/CVP Export Service Areas waters. Rather, this alternative would improve long-term EC levels in the SWP/CVP Export Service Areas, relative to Existing Conditions.

In the Plan Area, Alternative 3 would result in an increase in the frequency with which Bay-Delta WQCP EC objectives for agricultural beneficial use protection are exceeded in the Sacramento River at Emmaton (21%; western Delta) and San Joaquin River at San Andreas Landing (1%; interior Delta) for the entire period modeled (1976–1991). Further, average EC levels at Emmaton would increase by 14% for the entire period modeled and 12% during the drought period modeled. Average EC levels at San Andreas Landing would increase by 12% for the entire period modeled and 13% during the drought period modeled. Because EC is not bioaccumulative, the increases in long-term average EC levels would not directly cause bioaccumulative problems in aquatic life or humans. The interior Delta is not Clean Water Act section 303(d) listed for elevated EC; however, the western Delta is. The increases in long-term and drought period average EC levels and increased frequency of exceedance of EC objectives that would occur in the Sacramento River at Emmaton and San Joaquin River at San Andreas Landing would potentially contribute to adverse effects on the agricultural beneficial uses in the interior Delta. This impact is considered to be significant.

Further, relative to Existing Conditions, Alternative 3 would 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.

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

Please see Mitigation Measure WQ-11 under Impact WQ-11 in the discussion of Alternative 1A.

Impact WQ-12: Effects on Electrical Conductivity Resulting from Implementation of CM2–CM22

***NEPA Effects*:** Effects of CM2–CM22 on EC under Alternative 3 are the same as those discussed for Alternative 1A and are considered not to be adverse.

***CEQA Conclusion*:** Conservation Measures 2–22 proposed under Alternative 3 would be similar to those proposed under Alternative 1A. As such, effects on EC resulting from the implementation of CM2–CM22 would be similar to that previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

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

Upstream of the Delta

Under Alternative 3, the magnitude and timing of reservoir releases and river flows upstream of the Delta in the Sacramento River watershed and east-side tributaries would be altered, relative to Existing Conditions and the No Action Alternative.

The Sacramento River at Freeport and San Joaquin River at Vernalis (as summarized for water quality average concentrations in Tables 8-48 and 8-49) were examined for flow/concentration relationships for mercury and methylmercury. No significant, predictive regression relationships were discovered for mercury or methylmercury, except for total mercury with flow at Freeport (monthly or annual)(Figures 8I-10 through 8I-13, Appendix 8I). Such a positive relationship between total mercury and flow is to be expected based on the association of mercury with suspended sediment and the mobilization of sediments during storm flows. However, the changes in flow in the Sacramento River under Alternative 3 relative to Existing Conditions and the No Action Alternative are not of the magnitude of storm flows, in which substantial sediment-associated mercury is mobilized. Therefore mercury loading should not be substantially different due to changes in flow. In addition, even though it may be flow-affected, total mercury concentrations remain well below criteria at upstream locations. Any negligible changes in mercury concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies as related to mercury. Both waterborne methylmercury concentrations and largemouth bass fillet mercury concentrations are expected to remain above guidance levels at upstream of Delta locations, but will not change substantially relative to Existing Conditions or the No Action Alternative due to changes in flows under Alternative 3.

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

Delta

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

The water quality impacts of waterborne concentrations of mercury and methylmercury and fish tissue mercury concentrations were evaluated for 9 Delta locations. The analysis of percentage change in assimilative capacity of waterborne total mercury of Alternative 3 relative to the 25 ng/L ecological risk benchmark as compared to Existing Conditions showed the greatest decrease to be 0.7% for Franks Tract, Old River at Rock Slough, and Contra Costa Pumping Plant, and 0.8% for the

Mokelumne River (South Fork) at Staten Island and Franks Tract relative to the No Action Alternative (Figures 8-53 and 8-54). These changes are not expected to result in adverse effects to beneficial uses. Similarly, changes in methylmercury concentration are expected to be very small. The greatest annual average methylmercury concentration for drought conditions was 0.167 ng/L for the San Joaquin River at Buckley Cove which was slightly higher than Existing Conditions (0.161 ng/L), and the same as the No Action Alternative (Appendix 8I, Table I-6) (Appendix 8I, Figure I-3). All modeled input concentrations exceeded the methylmercury TMDL guidance objective of 0.06 ng/L, therefore percentage change in assimilative capacity was not evaluated for methylmercury.

Fish tissue showed small increases in exceedance quotients based on long-term annual average concentrations for mercury at the Delta locations. There was a 6% increase at the Mokelumne River (South Fork) at Staten Island, the San Joaquin River at Buckley Cove, Franks Tract, and Old River at Rock Slough relative to Existing Conditions, and a 8% increase at the Mokelumne River (South Fork) at Staten Island relative to the No Action Alternative (Figure 8-55, Appendix 8I, Table I-10b). All water export locations except Contra Costa Pumping Plant #1 showed improved bass tissue mercury estimates (Figure 8-55, Appendix 8I, Table I-10a,b).

SWP/CVP Export Service Areas

The analysis of mercury and methylmercury in the SWP/CVP Export Service Areas was based on concentrations estimated at the Banks and Jones pumping plants. Both waterborne total and methylmercury concentrations for Alternative 3 are projected to be lower than Existing Conditions, and the No Action Alternative at the Jones and Banks pumping plants (Appendix 8I, Figures 8I-2 and 8I-3). Therefore, mercury shows an increased assimilative capacity at these locations (Figures 8-53 and 8-54). Bass tissue mercury concentrations are also improved under Alternative 3, relative to Existing Conditions and the No Action Alternative (Figure 8-55; Appendix 8I, Table I-10a,b).

NEPA Effects: In summary, based on the above discussion, the effects of mercury and methylmercury in comparison of Alternative 3 to the No Action Alternative (as waterborne and bioaccumulated forms) are not considered to be adverse.

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

Under Alternative 3, greater water demands and climate change would alter the magnitude and timing of reservoir releases and river flows upstream of the Delta in the Sacramento River watershed and east-side tributaries, relative to Existing Conditions. Concentrations of mercury and methylmercury upstream of the Delta will not be substantially different relative to Existing Conditions due to the lack of important relationships between mercury/methylmercury concentrations and flow for the major rivers.

Methylmercury concentrations exceed criteria at all locations in the Delta and no assimilative capacity exists. However, monthly average waterborne concentrations of total and methylmercury, over the period of record, are very similar to Existing Conditions. Similarly, estimates of fish tissue mercury concentrations show almost no differences would occur among sites for Alternative 3 as compared to Existing Conditions for Delta sites.

Assessment of effects of mercury in the SWP and CVP Export Service Areas were based on effects on mercury concentrations and fish tissue mercury concentrations at the Banks and Jones pumping plants. The Banks and Jones pumping plants are expected to show increased assimilative capacity for waterborne mercury and decreased fish tissue concentrations of mercury for Alternative 3 as compared to Existing Conditions.

As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because mercury concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Because any increases in mercury or methylmercury concentrations are not likely to be measurable, changes in mercury concentrations or fish tissue mercury concentrations would not make any existing mercury-related impairment measurably worse. In comparison to Existing Conditions, Alternative 3 would not increase levels of mercury by frequency, magnitude, and geographic extent such that the affected environment would be expected to have measurably higher body burdens of mercury in aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish) or humans consuming those organisms. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-14: Effects on Mercury Concentrations Resulting from Implementation of CM2–22

NEPA Effects: Some habitat restoration activities under Alternative 3 would occur on lands in the Delta formerly used for irrigated agriculture. Tidal and other restoration proposed under Alternative 3 have the potential to increase water residence times and increase accumulation of organic sediments that are known to enhance methylmercury bioaccumulation in biota in the restored habitat. Therefore, increases in mercury methylation in the habitat restoration areas is possible but uncertain depending on the specific restoration design implemented at a particular Delta location. Models to estimate the potential for methylmercury formation in restored areas are not currently available. However, DSM2 modeling for Alternative 3 operations does incorporate assumptions for certain habitat restoration activities proposed under CM2 and CM4 (see Section 8.3.1.3) that result in changes to Delta hydrodynamics compared to the No Action Alternative. These modeled restoration assumptions provide some insight into potential hydrodynamic changes that could be expected related to implementing CM2 and CM4 and are considered in the evaluation of the potential for increased mercury and methylmercury concentrations under Alternative 3.

BDCP Conservation Measure 12 (CM12) addresses the potential for methylmercury bioaccumulation associated with restoration activities and acknowledges the uncertainties associated with mitigating or minimizing this potential effect. CM12 proposes project-specific mercury management plans for restoration actions that will incorporate relevant approaches recommended in Phase 1 Methylmercury TMDL control studies. Specific approaches recommended under CM12 that are intended to minimize or mitigate for potential increases in methylmercury bioaccumulation at future restoration sites include:

- Characterizing mercury, methylmercury, organic carbon, iron, and sulfate concentrations to better inform restoration design,
- Sequestering methylmercury at restoration sites using low intensity chemical dosing techniques,

- Minimizing microbial methylation associated with anoxic conditions by reducing the amount of organic material at a restoration site,
- Designing restoration sites to enhance photo degeneration that converts methylmercury into a biologically unavailable, inorganic form of mercury,
- Remediating restoration site soils with iron to reduce methylation in sulfide rich soils, and
- Considering capping mercury laden sediments, where possible to reduce methylation potential at a site.

Because of the uncertainties associated with site-specific estimates of methylmercury concentrations and the uncertainties in source modeling and tissue modeling, the effectiveness of methylmercury management proposed under CM12 to reduce methylmercury concentrations would need to be evaluated separately for each restoration effort, as part of design and implementation.

In summary, because of this uncertainty and the known potential for methylmercury creation in the Delta this potential effect of implementing CM2–CM22 is considered adverse.

CEQA Conclusion**:** There would be no substantial, long-term increase in mercury or methylmercury concentrations or loads in the rivers and reservoirs upstream of the Delta or the waters exported to the CVP and SWP service areas due to implementation of CM2–CM22 relative to Existing Conditions. However, uptake of mercury from water and/or methylation of inorganic mercury may increase to an unquantified degree as part of the creation of new, marshy, shallow, or organic-rich restoration areas. Methylmercury is 303(d)-listed within the affected environment, and therefore any potential measurable increase in methylmercury concentrations would make existing mercury-related impairment measurably worse. Because mercury is bioaccumulative, increases in water-borne mercury or methylmercury that could occur in some areas could bioaccumulate to somewhat greater levels in aquatic organisms and would, in turn, pose health risks to fish, wildlife, or humans. Design of restoration sites under Alternative 3 would be guided by CM12 which requires development of site specific mercury management plans as restoration actions are implemented. The effectiveness of minimization and mitigation actions implemented according to the mercury management plans is not known at this time although the potential to reduce methylmercury concentrations exists based on current research. Although the BDCP will implement CM12 with the goal to reduce this potential effect the uncertainties related to site specific restoration conditions and the potential for increases in methylmercury concentrations in the Delta result in this potential impact being considered significant. No mitigation measures would be available until specific restoration actions are proposed. Therefore this programmatic impact is considered significant and unavoidable.

Impact WQ-15: Effects on Nitrate Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative, Alternative 3 would have negligible, if any, impact on nitrate concentrations in the rivers and reservoirs upstream of the Delta in the Sacramento River watershed relative to Existing Conditions and the No Action Alternative.

Under Alternative 3, modeling indicates that long-term annual average flows on the San Joaquin River would decrease by an estimated 6%, relative to Existing Conditions, and would remain virtually the same relative to the No Action Alternative (Appendix 5A). Given these relatively small decreases in flows and the weak correlation between nitrate and flows in the San Joaquin River (see Nitrate Appendix 8J, Figure 2), it is expected that nitrate concentrations in the San Joaquin River would be minimally affected, if at all, by changes in flow rates under Alternative 3.

Any negligible changes in nitrate-N concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regards to nitrate.

Delta

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

Results of the mixing calculations indicate that under Alternative 3, relative to Existing Conditions, and the No Action Alternative, nitrate concentrations throughout the Delta are anticipated to remain low (<1.4 mg/L-N) relative to adopted objectives (Nitrate Appendix 8J, Table 13 and 14). Although changes at specific Delta locations and for specific months may be substantial on a relative basis, the absolute concentration of nitrate in Delta waters would remain low (<1.4 mg/L-N) in relation to the drinking water MCL of 10 mg/L-N, as well as all other thresholds identified in Table 8-50. Long-term average nitrate concentrations are anticipated to remain below 1 mg/L-N at all 11 assessment locations except the San Joaquin River at Buckley Cove, where long-term average concentrations would be somewhat above 1 mg/L-N. Nevertheless, at this location, long-term average nitrate concentration would be somewhat reduced under Alternative 3, relative to Existing Conditions and would be nearly the same (i.e., any increase would be negligible) as that under the No Action Alternative. No additional exceedances of the MCL are anticipated at any location (Nitrate Appendix 8J, Table 13). On a monthly average basis and on a long term annual average basis, for all modeled years and for the drought period (1987–1991) only, use of assimilative capacity available under Existing Conditions and the No Action Alternative, relative to the drinking water MCL of 10 mg/L-N, was low or negligible (i.e., <5%) for all locations and months, except for Jones PP in November, where use of assimilative capacity available under Existing Conditions was 6.5% in the drought period (1987–1991) (Nitrate Appendix 8J, Table 15).

Nitrate concentrations will likely be higher than the modeling results indicate in certain locations. This includes in the Sacramento River between Freeport and Mallard Island and other areas in the Delta downstream of Freeport that are influenced by Sacramento River water. These increases are associated with ammonia and nitrate that are discharged from the SRWTP, which are not included in the modeling.

- Under Existing Conditions, most of the ammonia discharged from the SRWTP is converted to nitrate downstream of the facility's discharge at Freeport, and thus, nitrate concentrations under Existing Conditions in these areas are expected to be higher than the modeling predicts, the increase becoming greater with increasing distance downstream. However, the increase in nitrate concentrations downstream of the SRWTP is expected to be small—the existing increase appears to be from approximately 0.1 mg/L-N to approximately 0.4–0.5

mg/L-N over this reach, due to approximately a 1:1 conversion of ammonia-N to nitrate-N (Central Valley Water Board 2010a:32).

- Under Alternative 3, the planned upgrades to the SRWTP, which include nitrification/partial denitrification, would substantially decrease ammonia concentrations in the discharge, but would increase nitrate concentrations in the discharge up to 10 mg/L-N, which is substantially higher than under Existing Conditions.

- Overall, under Alternative 3, the nitrogen load from the SRWTP discharge is expected to decrease (by up to 50%), relative to Existing Conditions, due to nitrification/partial dentrification ugrades at the SRWTP facility. Thus, while concentrations of nitrate downstream of the facility are expected to be higher than modeling results indicate for both Existing Conditions and Alternative 3, the increase is expected to be greater under Existing Conditions than for Alternative 3 due to the upgrades that are assumed under Alternative 3.

The other areas in which nitrate concentrations will be higher than the modeling results indicate are immediately downstream of other wastewater treatment plants that practice nitrification, but not denitrification (e.g., City of Rio Vista Beach WWTF, Town of Discovery Bay WWTF, City of Stockton RWCF). For all such facilities in the Delta, the Regional Water Boards have issued NPDES permits that allow discharge of wastewater containing nitrate into the Delta, and under these permits, the State has determined that no beneficial uses are adversely affected by the discharge, and that the discharger's use of available assimilative capacity of the water body is acceptable. When dilution is necessary in order for the discharge to be in compliance with the Basin Plans (which incorporate the 10 mg/L-N MCL by reference), not all of the assimilative capacity of the receiving water is granted to the discharger. Thus, limited decreases in flows are not anticipated to result in systemic exceedances of the MCLs by these POTWs. Furthermore, NPDES permits are renewed on a 5-year basis, and thus, if under changes in flows, dilution was no longer sufficient to maintain nitrate below the MCL in the receiving water, the NPDES permit renewal process would address such cases.

Therefore, any increases in nitrate-N concentrations that may occur at certain locations within the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to nitrate.

SWP/CVP Export Service Areas

Assessment of effects of nitrate in the SWP and CVP Export Service Areas is based on effects on nitrate-N at the Banks and Jones pumping plants.

Results of the mixing calculations indicate that under Alternative 3, relative to Existing Conditions and the No Action Alternative, nitrate concentrations at Banks and Jones pumping plants are anticipated to decrease on a long-term average annual basis (Nitrate Appendix 8J, Table 13 and 14). During the late summer, particularly in the drought period assessed, concentrations are expected to increase substantially on a relative basis (i.e., >50%), but the absolute value of these changes (i.e., in mg/L-N) is small. Additionally, given the many factors that contribute to potential algal blooms in the SWP and CVP canals within the Export Service Area, and the lack of studies that have shown a direct relationship between nutrient concentrations in the canals and reservoirs and problematic algal blooms in these water bodies, there is no basis to conclude that these small (i.e., generally <0.3 mg/L-N), seasonal increases in nitrate concentrations would increase the potential for problem algal blooms in the SWP and CVP Export Service Area. No additional exceedances of the MCL are anticipated (Nitrate Appendix 8J, Table 13). On a monthly average basis and on a long term annual average basis, for all modeled years and for the drought period (1987–1991) only, use of assimilative capacity available under Existing Conditions and the No Action Alternative, relative to the 10 mg/L-N MCL, was negligible (<4%) for both Banks and Jones pumping plants (Nitrate Appendix 8J, Table 15).

Any increases in nitrate-N concentrations that may occur in water exported via Banks and Jones pumping plants are not expected to result in adverse effects to beneficial uses or substantially degrade the quality of exported water, with regards to nitrate.

NEPA Effects: In summary, based on the discussion above, the effects on nitrate from implementing CM1 are considered to be not adverse.

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

Nitrate-N concentrations are generally low in the reservoirs and rivers of the watersheds, owing to substantial dilution available for point sources and the lack of substantial nonpoint sources of nitrate-N upstream of the SRWTP in the Sacramento River watershed, and in the watersheds of the eastern tributaries (Cosumnes, Mokelumne, and Calaveras Rivers). Although higher in the San Joaquin River watershed, nitrate-N concentrations are not well-correlated with flow rates. Consequently, any modified reservoir operations and subsequent changes in river flows under Alternative 3, relative to Existing Conditions, are expected to have negligible, if any, effects on reservoir and river nitrate-N concentrations upstream of Freeport in the Sacramento River watershed and upstream of the Delta in the San Joaquin River watershed.

In the Delta, results of the mixing calculations indicate that under Alternative 3, relative to Existing Conditions, nitrate concentrations throughout the Delta are anticipated to remain low (<1.4 mg/L-N) relative to adopted objectives. No additional exceedances of the MCL are anticipated at any location, and use of assimilative capacity available under Existing Conditions, relative to the drinking water MCL of 10 mg/L-N, was low or negligible (i.e., <5%) for virtually all locations and months.

Assessment of effects of nitrate in the SWP and CVP Export Service Areas is based on effects on nitrate-N concentrations at the Banks and Jones pumping plants. Results of the mixing calculations indicate that under Alternative 3, relative to Existing Conditions, long-term average nitrate concentrations at Banks and Jones pumping plants are anticipated to change negligibly. No additional exceedances of the MCL are anticipated, and use of assimilative capacity available under Existing Conditions, relative to the MCL was negligible (i.e., <4%) for both Banks and Jones pumping plants for all months.

Based on the above, there would be no substantial, long-term increase in nitrate-N concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the waters exported to the CVP and SWP service areas under Alternative 3 relative to Existing Conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/ criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because nitrate concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Nitrate is not 303(d) listed within the affected environment and thus any increases that may occur in some areas and months would not make any existing nitrate-related impairment measurably worse because no such impairments currently exist. Because nitrate is not bioaccumulative, increases that may occur in some areas and months would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-16: Effects on Nitrate Concentrations Resulting from Implementation of CM2–CM22

***NEPA Effects*:** Effects of CM2–CM22 on nitrate under Alternative 3 are the same as those discussed for Alternative 1A and are considered not to be adverse.

***CEQA Conclusion*:** Conservation Measures 2–22 proposed under Alternative 3 would be similar to those proposed under Alternative 1A. As such, effects on nitrate resulting from the implementation of CM2–CM22 would be similar to that previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-17: Effects on Dissolved Organic Carbon Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Under Alternative 3, there would be no substantial change to the sources of DOC within the watersheds upstream of the Delta. Moreover, long-term average flow and DOC levels in the Sacramento River at Hood and San Joaquin River at Vernalis are poorly correlated. Thus changes in system operations and resulting reservoir storage levels and river flows would not be expected to cause a substantial long-term change in DOC concentrations in the water bodies upstream of the Delta. Any negligible changes in DOC levels in water bodies upstream of the Delta under Alternative 3, relative to Existing Conditions and the No Action Alternative, would not be of sufficient frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regards to DOC.

Delta

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

Under Alternative 3, the geographic extent of effects pertaining to long-term average DOC concentrations in the Delta would be similar to that previously described for Alternative 1A, although the magnitude of predicted long-term change and relative frequency of concentration threshold exceedances would be less. Modeled effects would be greatest at Franks Tract, Rock Slough, and Contra Costa PP No. 1., where for the 16-year hydrologic period and the modeled drought period, long-term average concentration increases ranging from 0.2–0.3 mg/L would be predicted (≤8% net increase) (Appendix 8K, DOC Table 4). Increases in long-term average concentrations would correspond to more frequent concentration threshold exceedances, with the greatest change occurring at Rock Slough and Contra Costa PP No. 1 locations. For Rock Slough, long-term average DOC concentrations exceeding 3 mg/L would increase from 52% under Existing Conditions to 65% under the Alternative 3 (an increase from 47% to 63% for the drought period), and concentrations exceeding 4 mg/L would increase from 30% to 33% (32% to 38% for the drought period). For Contra Costa PP No. 1, long-term average DOC concentrations exceeding 3 mg/L would increase from 52% under Existing Conditions to 65% under Alternative 3 45% to 67% for the drought period), and concentrations exceeding 4 mg/L would increase from 32% to 37% (35% to 42% for the drought period). Relative change in frequency of threshold exceedance for other assessment locations would be similar or less. While Alternative 3 would generally lead to slightly higher long-term average DOC concentrations (≤0.3 mg/L) at some municipal water intakes and Delta interior locations, the predicted change would not be expected to adversely affect MUN beneficial uses, or any other beneficial use. This comparison to Existing Conditions reflects changes in DOC due to both Alternative 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, Alternative 3 relative to the No Action Alternative would generally result in a similar magnitude of change to that discussed for the comparison to Existing Conditions. Maximum increases of 0.1–0.2 mg/L DOC (i.e., ≤7%) would be predicted at Franks Tract, Rock Slough, and Contra Costa PP No. 1 relative to No Action Alternative (Appendix 8K, DOC Table 4). Threshold concentration exceedance frequency trends would also be similar to that discussed for the existing condition comparison, with exception to the predicted 4 mg/L exceedance frequency at Buckley Cove. In comparison to the No Action Alternative, the frequency which long-term average DOC concentrations exceeded 4 mg/L at Buckley Cove would increase from 27% to 33% (42% to 63% for the modeled drought period). While the Alternative 3 would generally lead to slightly higher long-term average DOC concentrations at some Delta assessment locations when compared to No Action Alternative conditions, the predicted change would not be expected to adversely affect MUN beneficial uses, or any other beneficial use, particularly when considering the relatively small change in long-term annual average concentration. Unlike the comparison to Existing Conditions, this comparison to the No Action Alternative reflects changes in DOC due to only Alternative 3 operations.

As discussed for Alternative 1A, substantial change in ambient DOC concentrations would need to occur before significant changes in drinking water treatment plant design or operations are triggered. The increases in long-term average DOC concentrations estimated to occur at various Delta locations under Alternative 3 are of sufficiently small magnitude that they would not require existing drinking water treatment plants to substantially upgrade treatment for DOC removal above levels currently employed.

Relative to existing and No Action Alternative conditions, Alternative 3 would lead to predicted improvements in long-term average DOC concentrations at Barker Slough, as well as Banks and Jones pumping plants (discussed below). At Barker Slough, long-term average DOC concentrations would be predicted to decrease by as much as 0.1–0.2 mg/L, depending on baseline conditions comparison and modeling period.

SWP/CVP Export Service Areas

Under Alternative 3, modeled long-term average DOC concentrations would decrease at Banks and Jones pumping plants for both the modeled 16-year hydrologic period and the modeled drought period, relative to Existing Conditions and the No Action Alternative. Relative to Existing Conditions, long-term average DOC concentrations at Banks would be predicted to decrease by 0.3 mg/L (0.1 mg/L during drought period) (Appendix 8K, DOC Tables 4). At Jones, long-term average DOC concentrations would be predicted to decrease by 0.2 mg/L (<0.1 mg/L during drought period). Such decreases in long-term average DOC, however, would not necessarily translate into lower exceedance frequencies for concentration thresholds. To the contrary, long-term average DOC concentrations at Banks exceeding 3 mg/L would increase from 64% under Existing Conditions to 69% under Alternative 3 (57% to 92% for the drought period), and at Jones would increase from 71% to 77% (72% to 88% for the drought period). In contrast, however, the frequency of concentrations exceeding 4 mg/L at Banks and Jones would decrease or remain relatively unchanged. Comparisons to the No Action Alternative yield similar trends, but with slightly smaller 16-year hydrologic period and drought period changes. Overall, modeling results for the SWP/CVP Export Service Areas predict an overall long-term improvement in Export Service Areas water quality, primarily through a reduction in exports of water exceeding 4 mg/L.

Similar to the discussion pertaining to the No Action Alternative, maintenance of SWP and CVP facilities under Alternative 3 would not be expected to create new sources of DOC or contribute towards a substantial change in existing sources of DOC in the affected area. Maintenance activities would not be expected to cause any substantial change in long-term average DOC concentrations such that MUN beneficial uses, or any other beneficial use, would be adversely affected.

NEPA Effects: In summary, Alternative 3, relative to the No Action Alternative, would not cause a substantial long-term change in DOC concentrations in the water bodies upstream of the Delta. Long-term average DOC concentrations at Banks and Jones pumping plants are predicted to decrease by as much as 0.4 mg/L, while long-term average DOC concentrations for some Delta interior locations, including Contra Costa PP #1, are predicted to increase by as much as 0.2 mg/L. The increase in long-term average DOC concentration that could occur within the Delta interior would not be of sufficient magnitude to adversely affect the MUN beneficial use, or any other beneficial uses, of Delta waters. The effect of Alternative 1A operations and maintenance (CM1) on DOC is determined not to be adverse.

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

While greater water demands under the Alternative 3 would alter the magnitude and timing of reservoir releases north, south and east of the Delta, these activities would have no substantial effect on the various watershed sources of DOC. Moreover, long-term average flow and DOC at Sacramento River at Hood and San Joaquin River at Vernalis are poorly correlated; therefore, changes in river flows would not be expected to cause a substantial long-term change in DOC concentrations upstream of the Delta.

Relative to Existing Conditions, Alternative 3 would result in relatively small increases (i.e., ≤8%) in long-term average DOC concentrations at some Delta interior locations, including Franks Tract, Rock Slough, and Contra Costa PP No. 1. However, these increases would not substantially increase the frequency with which long-term average DOC concentrations exceeds 2, 3, or 4 mg/L. While Alternative 3 would generally lead to slightly higher long-term average DOC concentrations (≤0.3

mg/L) within the Delta interior and some municipal water intakes, the predicted change would not be expected to adversely affect MUN beneficial uses, or any other beneficial use.

The assessment of Alternative 3 effects on DOC in the SWP/CVP Export Service Areas is based on assessment of changes in DOC concentrations at Banks and Jones pumping plants. Relative to the existing condition, long-term average DOC concentrations would decrease by as much as 0.3 mg/L at Banks and Jones pumping plants, although slightly more frequent export of >3 mg/L DOC water is predicted. Nevertheless, an overall improvement in DOC-related water quality would be predicted in the SWP/CVP Export Service Areas.

Based on the above, Alternative 3 operation and maintenance would not result in any substantial change in long-term average DOC concentration upstream of the Delta or result in substantial increase in the frequency with which long-term average DOC concentrations exceeds 2, 3, or 4 mg/L levels at the 11 assessment locations analyzed for the Delta. Modeled long-term average DOC concentrations would increase by no more than 0.3 mg/L at any single Delta assessment location (i.e., ≤8% relative increase), with long-term average concentrations estimated to remain at or below 4.0 mg/L at all Delta locations assessed, with the exception of Buckley Cove on the San Joaquin River during the drought period modeled. Nevertheless, long-term average concentrations at Buckley Cove are predicted to remain the same during the drought period, relative to Existing Conditions. The increases in long-term average DOC concentration that could occur within the Delta would not be of sufficient magnitude to adversely affect the MUN beneficial use, or any other beneficial uses, of Delta waters or waters of the SWP/CVP Service Area. Because DOC is not bioaccumulative, the increases in long-term average DOC concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Finally, DOC is not causing beneficial use impairments and thus is not 303(d) listed for any water body within the affected environment. Thus, the increases in long-term average DOC that could occur at various locations would not make any beneficial use impairment measurably worse. Because long-term average DOC concentrations are not expected to increase substantially, no long-term water quality degradation with respect to DOC is expected to occur and, thus, no adverse effects on beneficial uses would occur. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-18: Effects on Dissolved Organic Carbon Concentrations Resulting from Implementation of CM2–CM22

NEPA Effects: Conservation Measures 2–22 proposed under Alternative 3 would be the same as those proposed under Alternative 1A. As such, effects on DOC resulting from the implementation of CM2–CM22 would be similar to that previously discussed for Alternative 1A. In summary, CM4–CM7 and CM10 could contribute substantial amounts of DOC to raw drinking water supplies, largely depending on final design and operational criteria for the related wetland and riparian habitat restoration activities. Substantially increased long-term average DOC in raw water supplies could lead to a need for treatment plant upgrades in order to appropriately manage DBP formation in treated drinking water. This potential for future DOC increases would lead to substantially greater associated risk of long-term adverse effects on the MUN beneficial use.

In addition to and to supplement Mitigation Measure WQ-18, the BDCP proponents have incorporated into the BDCP, as set forth in EIR/EIS Appendix 3B, *Environmental Commitments*, a separate, non-environmental commitment to address the potential increased water treatment costs that could result from DOC concentration effects on municipal and industrial water purveyor operations. Potential options for making use of this financial commitment include funding or providing other assistance towards implementing treatment for DOC and/or DBPs or DOC source control strategies. Please refer to Appendix 3B, *Environmental Commitments*, for the full list of potential actions that could be taken pursuant to this commitment in order to reduce the water quality treatment costs associated with water quality effects relating to DOC.

In summary, the habitat restoration elements of CM4–CM7 and CM10 under Alternative 3 would present new localized sources of DOC to the study area, and in some circumstances would substitute for existing sources related to replaced agriculture. Depending on localized hydrodynamics and proximity to municipal drinking water intakes, such restoration activities could contribute substantial amounts of DOC to municipal raw water. Substantial increases in municipal raw water DOC could necessitate changes in water treatment plant operations or require treatment plant upgrades in order to maintain DBP compliance, and thus would constitute an adverse effect on water quality. Mitigation Measure WQ-18 is available to reduce these effects.

CEQA Conclusion**:** Effects of CM4–CM7 and CM10 on DOC under Alternative 3 would be similar to those discussed for Alternative 1A. Similar to the discussion for Alternative 1A, this impact is considered to be significant and mitigation is required. It is uncertain whether implementation of Mitigation Measure WQ-18 would reduce identified impacts to a less-than-significant level. Hence, this impact remains significant and unavoidable.

Mitigation Measure WQ-18: Design Wetland and Riparian Habitat Features to Minimize Effects on Municipal Intakes

Please see Mitigation Measure WQ-18 under Impact WQ-18 in the discussion of Alternative 1A.

Impact WQ-19: Effects on Pathogens Resulting from Facilities Operations and Maintenance (CM1)

NEPA Effects**:** Effects of CM1 on pathogens under Alternative 3 are the same as those discussed for Alternative 1A and are considered to not be adverse.

CEQA Conclusion**:** Effects of CM1 on pathogens under Alternative 3 are the same as those discussed for Alternative 1A, and are summarized here, then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion under Alternative 1A.

River flow rate and reservoir storage reductions that would occur due to implementation of CM1 (water facilities and operations) under Alternative 3, relative to Existing Conditions, would not be expected to result in a substantial adverse change in pathogen concentrations in the reservoirs and rivers upstream of the Delta, given the small magnitude of urban runoff contributions relative to the magnitude of river flows, that pathogen concentrations in the rivers have a minimal relationship to river flow rate, and the expected reduced pollutant loadings in response to NPDES stormwater-related regulations.

It is expected there would be no substantial change in Delta pathogen concentrations in response to a shift in the Delta source water percentages under this alternative or substantial degradation of these water bodies, with regard to pathogens. This conclusion is based on the Pathogens Conceptual Model, which found that pathogen sources in close proximity to a Delta site appear to have the greatest influence on pathogen levels at the site, rather than the primary source(s) of water to the site. In-Delta potential pathogen sources, including water-based recreation, tidal habitat, wildlife, and livestock-related uses, would continue under this alternative.

In the SWP/CVP Export Service Areas waters, relative to Existing Conditions, an increased proportion of water coming from the Sacramento River would not adversely affect beneficial uses in the SWP/CVP Export Service Areas. The pathogen levels in the Sacramento River are similar to or lower than the water diverted at the Delta export pumps. Further, it is localized sources of pathogens that appear to have the greatest influence on concentrations. Thus, an increased proportion of Sacramento River water diverted to the SWP/CVP Export Service Areas would result in minimal changes in pathogen levels in the SWP/CVP Export Service Areas waters.

Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because pathogen concentrations are not expected to increase substantially, no long-term water quality degradation for pathogens is expected to occur and, thus, no adverse effects on beneficial uses would occur. The San Joaquin River in the Stockton Deep Water Ship Channel is Clean Water Act section 303(d) listed for pathogens. Because no measurable increase in Deep Water Ship Channel pathogen concentrations are expected to occur on a long-term basis, further degradation and impairment of this area is not expected to occur. Finally, pathogens are not bioaccumulative constituents. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-20: Effects on Pathogens Resulting from Implementation of CM2–CM22

***NEPA Effects*:** Effects of CM2–CM22 on pathogens under Alternative 3 are the same as those discussed for Alternative 1A and are considered to not be adverse.

***CEQA Conclusion*:** Conservation Measures 2–22 proposed under Alternative 3 would be similar to those proposed under Alternative 1A. As such, effects on pathogens resulting from the implementation of CM2–CM22 would be similar to that previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-21: Effects on Pesticide Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative, under Alternative 3, no specific operations or maintenance activity of the SWP or CVP would substantially drive a change in pesticide use, and thus pesticide sources would remain unaffected upstream of the Delta. Nevertheless, changes in the timing and magnitude of reservoir releases could have an effect on available dilution capacity along river segments such as the Sacramento, Feather, American, and San Joaquin Rivers.

Under Alternative 3, winter (November–March) and summer (April–October) season average flow rates on the Sacramento River at Freeport, American River at Nimbus, Feather River at Thermalito and the San Joaquin River at Vernalis would change. Relative to existing condition and No Action Alternative, seasonal average flow rates on the Sacramento would decrease no more than 7% during the summer and 2% during the winter (Appendix 8L, Seasonal average flows Table 1-4). On the Feather River, average flow rates would decrease no more than 14% during the summer, but would increase by as much as 18% in the winter. Similarly, American River average flow rates would decrease by as much as 16% in the summer but would increase by as much as 6% in the winter. Seasonal average flow rates on the San Joaquin River would decrease by as much as 12% in the summer, but increase by as much as 1% in the winter. For the same reasons stated for the No Action Alternative, decreased seasonal average flow of ≤16% is not considered to be of sufficient magnitude to substantially increase pesticide concentrations or alter the long-term risk of pesticide-related toxicity to aquatic life, nor adversely affect other beneficial uses of water bodies upstream of the Delta.

Delta

Sources of diuron, OP and pyrethroid insecticides to the Plan Area include direct input of surface runoff from in-Delta agriculture and Delta urbanized areas as well as inputs from rivers upstream of the Delta. Similar to Upstream of the Delta, CVP/SWP operations would not affect these sources.

Under Alternative 3, the distribution and mixing of Delta source waters would change. Percent change in monthly average source water fraction were evaluated for the modeled 16-year (1976–1991) hydrologic period and a representative drought period (1987–1991), with special attention given to changes in San Joaquin River, Sacramento River and Delta Agriculture sources water fractions. Relative to Existing Conditions, under Alternative 3 modeled San Joaquin River fractions would increase greater than 10% at (not including Banks and Jones, discussed below) Rock Slough and Contra Costa PP No. 1 (Appendix 8D, Source Water Fingerprinting). At Rock Slough, San Joaquin River source water fractions when modeled for the 16-year hydrologic period would increase 11% during March, while at Contra Costa PP No. 1 San Joaquin River source water fractions when modeled for the 16-year hydrologic period would increase 14% during March. Corresponding increases for the modeled drought period would not be greater than 7% at Rock Slough or Contra Costa PP No. 1. Relative to Existing Conditions, there would be no modeled increases in Sacramento River fractions greater than 10% (with exception to Banks and Jones which are discussed below) and Delta agricultural fractions greater than 7%. These modeled changes in the source water fractions of Sacramento, San Joaquin and Delta agriculture water are not of sufficient magnitude to substantially alter the long-term risk of pesticide-related toxicity to aquatic life, nor adversely affect other beneficial uses of the Delta.

When compared to the No Action Alternative, changes in source water fractions would be similar in season, geographic extent, and magnitude to those discussed for Existing Conditions with exception to Buckley Cove during the modeled drought period. At Buckley Cove, modeled drought period San Joaquin River fractions would increase 13% in July and 24% in August when compared to No Action Alternative (Appendix 8D, Source Water Fingerprinting). These increases would primarily balance through decreases in Sacramento River water and eastside tributary waters. Nevertheless, the San Joaquin River would only account for 37% of the total source water volume at Buckley Cove in July and August during the modeled drought period. As such, these modeled changes in the source water fractions of Sacramento, San Joaquin and Delta agriculture water are not of sufficient magnitude to substantially alter the long-term risk of pesticide-related toxicity to aquatic life, nor adversely affect other beneficial uses of the Delta.

SWP/CVP Export Service Areas

Assessment of effects in SWP/CVP Export Service Areas is based on effects seen in the Plan Area at the Banks and Jones pumping plants. Under Alternative 3, Sacramento River source water fractions would increase substantially at both Banks and Jones pumping plants relative to Existing Conditions and the No Action Alternative (Appendix 8D, Source Water Fingerprinting). At Banks pumping plant, Sacramento source water fractions would generally increase from 12–34% for the period of January through June (12–22% for March through May of the modeled drought period) and at Jones pumping plant Sacramento source water fractions would generally increase from 18–39% for the period of January through June (12–36% for February through June of the modeled drought period). These increases in Sacramento source water fraction would primarily balance through equivalent decreases in San Joaquin River water. Based on the general observation that San Joaquin River, in comparison to the Sacramento River, is a greater contributor of OP insecticides in terms of greater frequency of incidence and presence at concentrations exceeding water quality benchmarks, modeled increases in Sacramento River fraction at Banks and Jones would generally represent an improvement in export water quality respective to pesticides.

***NEPA Effects*:** In summary, the changes in long-term average flows on the Sacramento, Feather, American, and San Joaquin Rivers, under Alternative 3 relative to the No Action Alternative, are of insufficient magnitude to substantially increase the long-term risk of pesticide-related water quality degradation and related toxicity to aquatic life in these water bodies upstream of the Delta. Similarly, modeled changes in source water fractions to the Delta are of insufficient magnitude to substantially alter the long-term risk of pesticide-related water quality degradation and related toxicity to aquatic life in the Delta or CVP/SWP export service areas. The effects on pesticides from operations and maintenance (CM1) are determined not to be adverse.

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

Sources of pesticides upstream of the Delta include direct input of pesticide containing surface runoff from agriculture and urbanized areas. Flows in rivers receiving these discharges dilute these pesticide inputs. Relative to Existing Conditions, however, modeled changes in long-term average flows on the Sacramento, Feather, American, and San Joaquin Rivers are of insufficient magnitude to substantially increase the long-term risk of pesticide-related water quality degradation and related toxicity to aquatic life in these water bodies upstream of the Delta.

In the Delta, sources of pesticides include direct input of surface runoff from Delta agriculture and Delta urbanized areas as well as inputs from rivers upstream of the Delta. While facilities operations and maintenance activities would not affect these sources, changes in Delta source water fraction could change the relative risk associated with pesticide related toxicity to aquatic life. Under Alternative 3, however, modeled changes in source water fractions relative to Existing Conditions are of insufficient magnitude to substantially alter the long-term risk of pesticide-related toxicity to aquatic life within the Delta, nor would such changes result in adverse pesticide-related effects on any other beneficial uses of Delta waters.

The assessment of Alternative 3 effects on pesticides in the SWP/CVP Export Service Areas is based on assessment of changes predicted at Banks and Jones pumping plants. As just discussed regarding effects to pesticides in the Delta, modeled changes in source water fractions at the Banks and Jones pumping plants are of insufficient magnitude to substantially alter the long-term risk of pesticide-related toxicity to aquatic life beneficial uses, or any other beneficial uses, in water bodies of the SWP and CVP export service area.

Based on the above, Alternative 3 would not result in any substantial change in long-term average pesticide concentration or result in substantial increase in the anticipated frequency with which long-term average pesticide concentrations would exceed aquatic life toxicity thresholds or other beneficial use effect thresholds upstream of the Delta, at the 11 assessment locations analyzed for the Delta, or the SWP/CVP service area. Numerous pesticides are currently used throughout the affected environment, and while some of these pesticides may be bioaccumulative, those present-use pesticides for which there is sufficient evidence for their presence in waters affected by SWP and CVP operations (i.e., diazinon, chlorpyrifos, diuron, and pyrethroids) are not considered bioaccumulative, and thus changes in their concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Furthermore, while there are numerous 303(d) listings throughout the affected environment that name pesticides as the cause for beneficial use impairment, the modeled changes in upstream river flows and Delta source water fractions would not be expected to make any of these beneficial use impairments measurably worse. Because long-term average pesticide concentrations are not expected to increase substantially, no long-term water quality degradation with respect to pesticides is expected to occur and, thus, no adverse effects on beneficial uses would occur. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-22: Effects on Pesticide Concentrations Resulting from Implementation of CM2–CM22

***NEPA Effects*: **Conservation Measures 2–22 proposed under Alternative 3 would be the same as those proposed under Alternative 1A. As such, effects on pesticides resulting from the implementation of CM2–CM22 would be similar to that previously discussed for Alternative 1A. In summary, CM13 proposes the use of herbicides to control invasive aquatic vegetation around habitat restoration sites. Herbicides directly applied to water could include adverse effects on non-target aquatic life, such as aquatic invertebrates and beneficial aquatic plants. As such, aquatic life toxicity objectives could be exceeded with sufficient frequency and magnitude such that beneficial uses would be impacted, thus constituting an adverse effect on water quality.

In summary, based on the discussion above, the effects on pesticides from implementing CM2-CM22 are considered to be adverse. Mitigation Measure WQ-22 would be available to reduce this adverse effect.

***CEQA Conclusion*: **Effects of CM2–CM22 on pesticides under Alternative 3 are similar to those discussed for Alternative 1A. Potential environmental effects related only to CM13 are considered to be significant. Mitigation is required. While Mitigation Measure WQ-22 is available to partially reduce this impact of pesticides, no feasible mitigation is available that would reduce it to a level that would be less than significant.

Mitigation Measure WQ-22: Implement Least Toxic Integrated Pest Management Strategies

Please see Mitigation Measure WQ-22 under Impact WQ-22 in the discussion of Alternative 1A.

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

***NEPA Effects*: **Effects of water facilities and operations (CM1) on phosphorus levels in water bodies of the affected environment under Alternative 3 would be very similar (i.e., nearly the same) to those discussed for Alternative 1A. Consequently, the environmental consequences to phosphorus levels discussed in detail for Alternative 1A also adequately represent the effects under Alternative 3, which are considered to be not adverse.

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

Because phosphorus loading to waters upstream of the Delta is not anticipated to change, and because changes in flows do not necessarily result in changes in concentrations or loading of phosphorus to these water bodies, substantial changes in phosphorus concentration upstream of the Delta are not anticipated for Alternative 3, relative to Existing Conditions.

Because phosphorus concentrations in the major source waters to the Delta are similar for much of the year, phosphorus concentrations in the Delta are not anticipated to change substantially on a long term-average basis under Alternative 3, relative to Existing Conditions. Algal growth rates are limited by availability of light in the Delta, and therefore any minor increases in phosphorus levels that may occur at some locations and times within the Delta would be expected to have little effect on primary productivity in the Delta.

The assessment of effects of phosphorus under Alternative 3 in the SWP and CVP Export Service Areas is based on effects on phosphorus at the Banks and Jones pumping plants. As noted above, phosphorus concentrations in the Delta (including Banks and Jones pumping plants) are not anticipated to change substantially on a long term-average basis.

Based on the above, there would be no substantial, long-term increase in phosphorus concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the waters exported to the CVP and SWP service areas under Alternative 3 relative to Existing Conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because phosphorus concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Phosphorus is not 303(d) listed within the affected environment and thus any minor increases that may occur in some areas would not make any existing phosphorus-related impairment measurably worse because no such impairments currently exist. Because phosphorus is not bioaccumulative, minor increases that may occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-24: Effects on Phosphorus Concentrations Resulting from Implementation of CM2–CM22

NEPA Effects**:** Effects of CM2–CM22 on phosphorus levels in water bodies of the affected environment under Alternative 3 would be very similar (i.e., nearly the same) to those discussed for Alternative 1A. Consequently, the environmental consequences to phosphorus levels from implementing CM2–CM22 discussed in detail for Alternative 1A also adequately represent the effects of these same actions under Alternative 3, which are considered to be not adverse.

CEQA Conclusion: Conservation Measures 2–22 proposed under Alternative 3 would be similar to those proposed under Alternative 1A. As such, effects on phosphorus resulting from the implementation of CM2–CM22 would be similar to that previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

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

Upstream of the Delta

For the same reasons stated for the No Action Alternative, Alternative 3 would have negligible, if any, effect on selenium concentrations in the rivers and reservoirs upstream of the Delta relative to Existing Conditions and the No Action Alternative. Any negligible increases in selenium concentrations that could occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regard to selenium.

Delta

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

Alternative 3 would result in small changes in average selenium concentrations in water at all modeled Delta assessment locations relative to Existing Conditions and the No Action Alternative (Appendix 8M, Table M-10A). These changes are reflected in small percent changes (10% or less) in available assimilative capacity for selenium for all years. Relative to Existing Conditions, Alternative 3 would result in the largest modeled increase in available assimilative capacity at Buckley Cove (5%), and relative to the No Action Alternative, the largest increase would be at Staten Island (1%) (Figures 8-59 and 8-60). Relative to Existing Conditions and the No Action Alternative, the largest decrease in available assimilative capacity would be at North Bay Aqueduct at Barker Slough Pumping Plant (Barker Slough PP [1%]). Although some small negative changes in selenium concentrations in water are expected, the effect of Alternative 3 would generally be minimal for the Delta locations. The modeled selenium concentrations in water (Appendix 8M, Table M-10A) for Alternative 3 (range 0.21–0.70 μg/L) are very similar to Existing Conditions (range 0.21–0.76 μg/L) and the No Action Alternative (range 0.21–0.69 μg/L), and all would be below the ecological risk benchmark (2 μg/L).

Relative to Existing Conditions and the No Action Alternative, Alternative 3 would result in minimal changes in estimated selenium concentrations in biota (whole-body fish, bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets) (Appendix 8M, Table M-14 and Addendum M.A to Appendix 8M, Table M.A-2). Relative to Existing Conditions, the largest increase of selenium concentrations in biota would be at Barker Slough PP for drought years (except for bird eggs [assuming a fish diet] at Barker Slough for all years) and for sturgeon at the San Joaquin River at Antioch in all years, and the largest decrease would be at Buckley Cove for drought years. Relative to the No Action Alternative, the largest increase also would be at Barker Slough PP for drought years (except for bird eggs [assuming a fish diet] at Barker Slough for all years) and the largest decrease would be at Staten Island for drought years (except for bird eggs [assuming a fish diet] at Buckley Cove for drought years). Except for sturgeon in the western Delta, concentrations of selenium in whole-body fish and bird eggs (invertebrate and fish diets) would exceed only the lower benchmarks (4 and 6 mg/kg dry weight, respectively, indicating a low potential for effects), under drought conditions, at Buckley Cove for Alternative 3 (as it would for Existing Conditions and the No Action Alternative) (Figures 8-61 through 8-63). Exceedance Quotients for all these exceedances of the lower benchmarks are between 1.0 and 1.5, indicating a low risk to biota in the Delta and no substantial difference from Existing Conditions and the No Action Alternative. Selenium concentrations in fish fillets would not exceed the screening value for protection of human health (Figure 8-64). For sturgeon in the western Delta, whole-body selenium concentrations would increase from 12.3 mg/kg under Existing Conditions and the No Action Alternative to 12.7 mg/kg under Alternative 3, a 3% increase (Table M.A-2). Although all of these values exceed both the low and high toxicity benchmarks, it is unlikely that the modeled increases in whole-body selenium for sturgeon would be measurable in the environment (see also the discussion of results provided in Addendum M.A to Appendix 8M).

Relative to Existing Conditions and the No Action Alternative, Alternative 3 would result in essentially no change in selenium concentrations throughout the Delta. Alternative 3 would not be expected to substantially increase the frequency with which applicable benchmarks would be exceeded in the Delta or substantially degrade the quality of water, with regard to selenium.

SWP/CVP Export Service Areas

Alternative 3 would result in small changes in average selenium concentrations in water at both modeled Export Service Area assessment locations relative to Existing Conditions and the No Action Alternative (Appendix 8M, Table M-10A). These small changes are reflected in small percent changes (10% or less) in available assimilative capacity for selenium for all years. Relative to Existing Conditions and the No Action Alternative, Alternative 3 would result in modeled increases in assimilative capacity at Jones PP (4% and 5%, respectively) and at Banks PP (4% and 3%) (Figures 8-59 and 8-60) and generally have a small positive effect on the Export Service Area locations. The modeled selenium concentrations in water (Appendix 8M, Table M-10A) for Alternative 3 (range 0.37–0.52 µg/L) would generally be similar to those for Existing Conditions (range 0.37–0.58 µg/L) and the No Action Alternative (range 0.37–0.59 µg/L), and all would be below the ecological risk benchmark (2 µg/L).

Relative to Existing Conditions and the No Action Alternative, Alternative 3 would result in small changes in estimated selenium concentrations in biota (Appendix 8M, Table M-14). Relative to Existing Conditions the largest increase of selenium concentrations in biota would be at Banks PP for drought years (except for bird eggs (assuming a fish diet) at Banks PP for all years), and the largest decrease would be at Jones PP for all years (except for bird eggs [assuming a fish diet] at Jones PP for drought years). Relative to the No Action Alternative, the largest increase of selenium in biota would be at Banks PP for drought years (except for bird eggs (assuming a fish diet) at Banks PP for all years), and the largest decrease would be at Jones PP for drought years. Furthermore, concentrations in biota would not exceed any benchmarks for Alternative 3 (Figures 8-61 through 8-64).

Thus, relative to Existing Conditions and the No Action Alternative, Alternative 3 would result in minimal changes in selenium concentrations throughout at Export Service Area locations. Selenium concentrations in water and biota generally would decrease for Alternative 3 and would not exceed ecological benchmarks at any location, whereas the lower benchmark for bird eggs (fish diet) would be exceeded under Existing Conditions and the No Action Alternative at Jones PP under drought conditions. This small positive change in selenium concentrations under Alternative 3 would be expected to slightly decrease the frequency with which applicable benchmarks would be exceeded or slightly improve the quality of water in at Export Service Area locations, with regard to selenium.

***NEPA Effects*:** Based on the discussion above, the effects on selenium (both as waterborne and as bioaccumulated in biota) from Alternative 3 are not considered to be adverse.

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

There are no substantial point sources of selenium in watersheds upstream of the Delta, and no substantial nonpoint sources of selenium in the watersheds of the Sacramento River and the eastern tributaries. Nonpoint sources in the San Joaquin Valley that contribute selenium to the Delta will be controlled through a TMDL developed by the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the Grassland Bypass Project, and Basin Plan objectives (Central Valley Water Board 2010c) and State Water Board (2010d, 2010e) that are expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta. Consequently, any modified reservoir operations and subsequent changes in river flows under Alternative 3, relative to Existing Conditions, are expected to cause negligible changes in selenium concentrations in water. Any negligible changes in selenium concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies as related to selenium.

Relative to Existing Conditions, modeling estimates indicate that Alternative 3 would result in essentially no change in selenium concentrations throughout the Delta.

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 3 would slightly decrease the frequency with which applicable benchmarks would be exceeded or slightly improve the quality of water in selenium concentrations at the Banks and Jones pumping plants locations.

Based on the above, selenium concentrations that would occur in water under Alternative 3 would not cause additional exceedances of applicable state or federal numeric or narrative water quality objectives/criteria, or other relevant water quality effects thresholds identified for this assessment (Table 8-54), by frequency, magnitude, and geographic extent that would result in adverse effects to one or more beneficial uses within affected water bodies. In comparison to Existing Conditions, water quality conditions under this alternative would not increase levels of selenium by frequency, magnitude, and geographic extent such that the affected environment would be expected to have measurably higher body burdens of selenium in aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish) or humans consuming those organisms. Water quality conditions under this alternative with respect to selenium would not cause long-term degradation of water quality in the affected environment, and therefore would not result in use of available assimilative capacity such that exceedances of water quality objectives/criteria would be likely and would result in substantially increased risk for adverse effects to one or more beneficial uses. This alternative would not further degrade water quality by measurable levels, on a long-term basis, for selenium and, thus, cause the 303(d)-listed impairment of beneficial use to be made discernibly worse. This impact is considered to be less than significant. No mitigation is required.

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

NEPA Effects: In general, with the possible exception of changes in Delta hydrodynamics resulting from habitat restoration, CM2–CM11 would not substantially increase selenium concentrations in the water bodies of the affected environment. Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, and thus such effects of these restoration measures were included in the assessment of CM1 facilities operations and maintenance (see Impact WQ-25).

However, implementation of these conservation measures may increase water residence time within the restoration areas. Increased restoration area water residence times could potentially increase the bioaccumulation of selenium in biota, thereby potentially increasing fish tissue and bird egg concentrations of selenium, but models are not available to quantitatively estimate the level of changes in residence time and the associated selenium bioavailability. If increases in fish tissue or bird egg selenium were to occur, the increases would likely be of concern only where fish tissues or bird eggs are already elevated in selenium to near or above thresholds of concern. That is, where biota concentrations are currently low and not approaching thresholds of concern, changes in residence time alone would not be expected to cause them to then approach or exceed thresholds of concern. In consideration of this factor, although the Delta as a whole is a 303(d)-listed water body for selenium, and although monitoring data of fish tissue or bird eggs in the Delta are sparse, the most likely areas in which biota tissues would be at levels high enough that additional bioaccumulation due to increased residence time from restoration areas would be a concern are the western Delta and Suisun Bay, and the South Delta in areas that receive San Joaquin River water.

The western Delta and Suisun Bay receive elevated selenium loads from North San Francisco Bay (including San Pablo Bay, Carquinez Strait, and Suisun Bay) and from the San Joaquin River. Point sources of selenium in North San Francisco Bay (i.e., refineries) that contribute selenium to Suisun Bay are expected to be reduced through a TMDL under development by the San Francisco Bay Water Board (San Francisco Bay Water Board 2012) that is expected to result in decreasing discharges of selenium. Nonpoint sources of selenium in the San Joaquin Valley that contribute selenium to the San Joaquin River, and thus the Delta and Suisun Bay, will be controlled through a TMDL developed by the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the Grassland Bypass Project, and Basin Plan objectives (Central Valley Water Board 2010c, d) that are expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta. If selenium levels are not sufficiently reduced via these efforts, it is expected that the State Water Board and the San Francisco Bay and Central Valley Water Boards would initiate additional actions to further control sources of selenium.

The South Delta receives elevated selenium loads from the San Joaquin River. In contrast to Suisun Bay and possibly the western Delta in the future, the South Delta lacks the overbite clam (*Corbula* [*Potamocorbula*] *amurensis*), which is considered a key driver of selenium bioaccumulation in Suisun Bay, due to its high bioaccumulation of selenium and its role in the benthic food web that includes long-lived sturgeon. The South Delta does have *Corbicula fluminea*, another bivalve that bioaccumulates selenium, but it is not as invasive as the overbite clam and thus likely makes up a smaller fraction of sturgeon diet. Also, as mentioned above, nonpoint sources of selenium in the San Joaquin Valley that contribute selenium to the Delta will be controlled through a TMDL developed by the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the Grassland Bypass Project, and Basin Plan objectives (Central Valley Water Board 2010c, d) that are expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta. Further, if selenium levels in the San Joaquin River are not sufficiently reduced via these efforts, it is expected that the State Water Board and Central Valley Water Board would initiate additional TMDLs to further control nonpoint sources of selenium.

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

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

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

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

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

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

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

Impact WQ-27: Effects on Trace Metal Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative, Alternative 3 would result in negligible, and likely immeasurable, increases in trace metal concentrations in the rivers and reservoirs upstream of the Delta, relative to Existing Conditions and the No Action Alternative. Effects due to the operation and maintenance of the conveyance facilities are expected to be immeasurable, on an annual and long-term average basis. As such, Alternative 3 would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or CTR criteria would be exceeded in water bodies of the affected environment located upstream of the Delta or substantially degrade the quality of these water bodies, with regard to trace metals.

Delta

For the same reasons stated for the No Action Alternative, Alternative 3 would not result in substantial increases in trace metal concentrations in the Delta relative to Existing Conditions and the No Action Alternative. Effects due to the operation and maintenance of the conveyance facilities are expected to be negligible, on a long-term average basis. As such, Alternative 3 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 Delta waters, with regard to trace metals.

SWP/CVP Export Service Areas

For the same reasons stated for the No Action Alternative, Alternative 3 would not result in substantial increases in trace metal concentrations in the water exported from the Delta or diverted from the Sacramento River through the proposed conveyance facilities. As such, there is not expected to be substantial changes in trace metal concentrations in the SWP/CVP export service area waters under Alternative 3, relative to Existing Conditions and the No Action Alternative. As such, Alternative 3 would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or CTR criteria would be exceeded in the water bodies of the affected environment in the SWP and CVP Service Area or substantially degrade the quality of these water bodies, with regard to trace metals.

NEPA Effects: In summary, Alternative 3, relative to the No Action Alternative, would not cause a substantial increase in long-term average trace metals concentrations within the affected environment, nor would it cause an increased frequency of water quality objective/criteria exceedances within the affected environment. The effect on trace metals is determined not to be adverse.

CEQA Conclusion: Effects of CM1 on trace metals under Alternative 3 would be similar to those discussed for Alternative 1A, and are summarized here, then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion under Alternative 1A.

While greater water demands under the Alternative 3 would alter the magnitude and timing of reservoir releases north, south and east of the Delta, these activities would have no substantial effect on the various watershed sources of trace metals. Moreover, long-term average flow and trace metals at Sacramento River at Hood and San Joaquin River at Vernalis are poorly correlated; therefore, changes in river flows would not be expected to cause a substantial long-term change in trace metal concentrations upstream of the Delta.

Average and 95th percentile trace metal concentrations are very similar across the primary source waters to the Delta. Given this similarity, very large changes in source water fraction would be necessary to effect a relatively small change in trace metal concentration at a particular Delta location. Moreover, average and 95th percentile trace metal concentrations for these primary source waters are all below their respective water quality criteria, including those that are hardness-based without a WER adjustment. No mixing of these three source waters could result in a metal concentration greater than the highest source water concentration, and given that trace metals do not already exceed water quality criteria, more frequent exceedances of criteria in the Delta would not be expected to occur under the Alternative 3.

The assessment of the Alternative 3 effects on trace metals in the SWP/CVP Export Service Areas is based on assessment of changes in trace metal concentrations at Banks and Jones pumping plants. As just discussed regarding similarities in Delta source water trace metal concentrations, the Alternative 3 is not expected to result in substantial changes in trace metal concentrations in Delta waters, including Banks and Jones pumping plants, therefore effects on trace metal concentrations in the SWP/CVP Export Service Area are expected to be negligible.

Based on the above, there would be no substantial long-term increase in trace metal concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the SWP/CVP export service area waters under Alternative 3 relative to Existing Conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because trace metal concentrations are not expected to increase substantially, no long-term water quality degradation for trace metals is expected to occur and, thus, no adverse effects to beneficial uses would occur. Furthermore, any negligible changes in long-term trace metal concentrations that may occur in water bodies of the affected environment would not be expected to make any existing beneficial use impairments measurably worse. The trace metals discussed in this assessment are not considered bioaccumulative, and thus would not directly cause bioaccumulative problems in aquatic life or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-28: Effects on Trace Metal Concentrations Resulting from Implementation of CM2–CM22

***NEPA Effects*:** Conservation Measures 2–22 proposed under Alternative 3 would be the same as those proposed under Alternative 1A. As such, effects on trace metals resulting from the implementation of CM2–CM22 would be similar to that previously discussed for Alternative 1A. As they pertain to trace metals, implementation of CM2–CM22 would not be expected to adversely affect beneficial uses of the affected environment or substantially degrade water quality with respect to trace metals.

In summary, implementation of CM2–CM22 under Alternative 3, relative to the No Action Alternative, would have negligible, if any, effect on trace metals concentrations. The effect on trace metals from implementing CM2–CM22 is determined not to be adverse.

***CEQA Conclusion*:** Implementation of CM2–CM22 under Alternative 3 would not cause substantial long-term increase in trace metal concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the SWP/CVP export service area. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because trace metal concentrations are not expected to increase substantially, no long-term water quality degradation for trace metals is expected to occur and, thus, no adverse effects to beneficial uses would occur. Furthermore, any negligible changes in long-term trace metal concentrations that may occur throughout the affected environment would not be expected to make any existing beneficial use impairments measurably worse. The trace metals discussed in this assessment are not considered bioaccumulative, and thus would not directly cause bioaccumulative problems in aquatic life or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-29: Effects on TSS and Turbidity Resulting from Facilities Operations and Maintenance (CM1)

***NEPA Effects*:** Effects of CM1 on TSS and turbidity under Alternative 3 are the same as those discussed for Alternative 1A. The effects on TSS and turbidity from implementing CM1 is determined to not be adverse.

***CEQA Conclusion*:** Effects of CM1 on TSS and turbidity under Alternative 3 would be similar to those discussed for Alternative 1A, and are summarized here, then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion under Alternative 1A.

Changes river flow rate and reservoir storage that would occur under Alternative 3, relative to Existing Conditions, would not be expected to result in a substantial adverse change in TSS concentrations and turbidity levels in the reservoirs and rivers upstream of the Delta, given that suspended sediment concentrations are more affected by season than flow. Site-specific and temporal exceptions may occur due to localized temporary construction activities, dredging activities, development, or other land use changes would be site-specific and temporal, which would be regulated to limit both their short-term and long-term effects on TSS and turbidity levels to less than substantial levels.

Within the Delta, geomorphic changes associated with sediment transport and deposition are usually gradual, occurring over years, and high storm event inflows would not be substantially affected. Thus, it is expected that the TSS concentrations and turbidity levels in the affected channels would not be substantially different from the levels under Existing Conditions. Consequently, this alternative is expected to have minimal effect on TSS concentrations and turbidity levels in the Delta region, relative to Existing Conditions.

There is not expected to be substantial, if even measurable, changes in TSS concentrations and turbidity levels in the SWP/CVP Export Service Areas waters under Alternative 3, relative to Existing Conditions, because this alternative is not expected to result in substantial changes in TSS concentrations and turbidity levels at the south Delta export pumps, relative to Existing Conditions.

Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives where such objectives are not exceeded under Existing Conditions. Because TSS concentrations and turbidity levels are not expected to be substantially different, long-term water quality degradation is not expected, and, thus, beneficial uses are not expected to be adversely affected. Finally, TSS and turbidity are neither bioaccumulative nor Clean Water Act section 303(d) listed constituents. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-30: Effects on TSS and Turbidity Resulting from Implementation of CM2–CM22

***NEPA Effects*:** Effects of CM2–CM22 on TSS and turbidity under Alternative 3 are the same as those discussed for Alternative 1A. The effects on TSS and turbidity from implementing CM2–CM22 is determined to not be adverse.

***CEQA Conclusion*:** Conservation Measures 2–22 proposed under Alternative 3 would be similar to those proposed under Alternative 1A. As such, effects on TSS and turbidity resulting from the implementation of CM2–CM22 would be similar to that previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-31: Water Quality Effects Resulting from Construction-Related Activities (CM1–CM22)

***NEPA Effects*:** The conveyance features for CM1 under Alternative 3 would be very similar to those discussed for Alternative 1A. The primary difference between Alternative 3 and Alternative 1A is that under Alternative 3, there would be three fewer intakes and three fewer pumping plants constructed, which would result reduce the level of construction activity. However, construction techniques and locations of major features of the conveyance system within the Delta would be similar. The remainder of the facilities constructed under Alternative 3, including CM2–CM22, would be very similar to, or the same as, those to be constructed for Alternative 1A.

The types and magnitude of potential construction-related water quality effects associated with implementation of CM1 under Alternative 3 would be very similar to the effects discussed for Alternative 1A, and the effects anticipated with implementation of CM2–CM22 would be essentially identical. Nevertheless, the construction of CM1, and any individual components necessitated by CM2, and CM4–CM10, with the implementation of the BMPs specified in Appendix 3B, *Environmental Commitments* and other agency permitted construction requirements would result in the potential water quality effects being largely avoided and minimized. The specific environmental commitments that would be implemented under Alternative 3 would be similar to those described for Alternative 1A. Consequently, relative to the No Action Alternative, Alternative 3 would not be expected to cause exceedance of applicable water quality objectives/criteria or substantial water quality degradation with respect to constituents of concern, and thus would not adversely affect any beneficial uses upstream of the Delta, in the Delta, or in the SWP and CVP service area.

In summary, with implementation of environmental commitments in Appendix 3B, the potential construction-related water quality effects are considered to be not adverse.

CEQA Conclusion**:** Because environmental commitments would be implemented under Alternative 3 for construction-related activities along with agency-issued permits that also contain construction requirements to protect water quality, the construction-related effects, relative to Existing Conditions, would not be expected to cause or contribute to substantial alteration of existing drainage patterns which would result in substantial erosion or siltation on- or off-site, substantial increased frequency of exceedances of water quality objectives/criteria, or substantially degrade water quality with respect to the constituents of concern on a long-term average basis, and thus would not adversely affect any beneficial uses in water bodies upstream of the Delta, within the Delta, or in the SWP and CVP service area. Moreover, because the construction-related activities would be temporary and intermittent in nature, the construction would involve negligible discharges, if any, of bioaccumulative or 303(d) listed constituents to water bodies of the affected environment. As such, construction activities would not contribute measurably to bioaccumulation of contaminants in organisms or humans or cause 303(d) impairments to be discernibly worse. Based on these findings, this impact is determined to be less than significant. No mitigation is required.

8.4.3.9 Alternative 4—Dual Conveyance with Modified Pipeline/Tunnel and Intakes 2, 3, and 5 (9,000 cfs; Operational Scenario H)

Alternative 4 would comprise physical/structural components similar to those under Alternative 1A, however, there are notable differences. Alternative 4 would convey up to 9,000 cfs of water from the north Delta to the south Delta and that Alternative 4 would include an operable barrier at the head of Old River. Diverted water would be conveyed through pipelines/tunnels from three screened intakes (i.e., Intakes 2, 3 and 5) located on the east bank of the Sacramento River between Clarksburg and Courtland. Alternative 4 would include a 245 acre intermediate forebay at Glannvale Tract. Clifton Court Forebay would be dredged and expanded by approximately 690 acres to the southeast of the existing forebay. Water supply and conveyance operations would follow the guidelines described as Scenario H1, H2, H3, or H4, which variously include or exclude implementation of fall X2 and/or enhanced spring outflow. Conservation Measures 2–22 would be implemented under this alternative, and would be the same as those under Alternative 1A. See Chapter 3, *Description of Alternatives,* Section 3.5.9, for additional details on Alternative 4.

Effects of the Alternative on Delta Hydrodynamics

Under the No Action Alternative and Alternatives 1–9, the following two primary factors can substantially affect water quality within the Delta:

- Within the south, west, and interior Delta, a decrease in the percentage of Sacramento River-sourced water and a concurrent increase in San Joaquin River-sourced water can increase the concentrations of numerous constituents (e.g., boron, bromide, chloride, electrical conductivity, nitrate, organic carbon, some pesticides, selenium). This source water replacement is caused by decreased exports of San Joaquin River water (due to increased Sacramento River water exports), or effects of climate change on timing of flows in the rivers. Changes in channel flows also can affect water residence time and many related physical, chemical, and biological variables.
- Particularly in the west Delta, sea water intrusion as a result of sea level rise or decreased Delta outflow can increase the concentration of salts (bromide, chloride) and levels of electrical conductivity. Conversely, increased Delta outflow (e.g., as a result of Fall X2 operations in wet and above normal water years) will decrease levels of these constituents, particularly in the west Delta.

Under Alternative 4, over the long term, average annual delta exports are anticipated to range from an increase of 112 TAF under scenario H1 to a decrease by 730 TAF under scenario H4 relative to Existing Conditions, and an increase by 815 TAF under scenario H1 to a decrease of 27 TAF under scenario H4 relative to the No Action Alternative. Since, over the long-term, between 47 (scenario H1) and 49% (scenario H4) of the exported water will be from the new north Delta intakes, average monthly diversions at the south Delta intakes would be decreased because of the shift in diversions to the north Delta intakes (see Chapter 5, *Water Supply*, for more information). The result of this is increased San Joaquin River water influence throughout the south, west, and interior Delta, and a corresponding decrease in Sacramento River water influence. This can be seen, for example, in Appendix 8D, ALT 4, H3–Old River at Rock Slough for ALL years (1976–1991), which shows increased San Joaquin River (SJR) percentage and decreased Sacramento River (SAC) percentage under the alternative, relative to Existing Conditions and the No Action Alternative.

Under Alternative 4, long-term average annual Delta outflow is anticipated to range from a decrease of 114 TAF under scenario H1 to an increase 744 TAF under scenario H4 relative to Existing Conditions, due to both changes in operations (including north Delta intake capacity of 9,000 cfs, Fall X2, and numerous other operational components of scenarios H1 through H4) and climate change/sea level rise (see Chapter 5, *Water Supply*, for more information). Long-term average annual Delta outflow is anticipated to decrease under Alternative 4 by between 864 (scenario H1) and 5 TAF (scenario H4) relative to the No Action Alternative, due only to changes in operations. The result of this is increased sea water intrusion in the west Delta. The increase in sea water intrusion (represented by an increase in San Francisco Bay (BAY) percentage) can be seen, for example, in Appendix 8D, ALT 4, H3–Sacramento River at Mallard Island for ALL years (1976–1991).

Impact WQ-1: Effects on Ammonia Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Substantial point sources of ammonia-N do not exist upstream of the SRWTP in the Sacramento River watershed, in the watersheds of the eastern tributaries (Cosumnes, Mokelumne, and Calaveras Rivers), or upstream of the Delta in the San Joaquin River watershed. Nonpoint sources of ammonia-N within the watersheds are also relatively low, thus resulting in generally low ammonia-N concentrations in the reservoirs and rivers of the watersheds. Consequently, any modified reservoir operations and subsequent changes in river flows under Alternative 4 (including the different operational components of Scenarios H1–H4) would have negligible, if any, effect on ammonia concentrations in the rivers and reservoirs upstream of the Delta relative to Existing Conditions and the No Action Alternative. Any negligible increases in ammonia-N concentrations that could occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regard to ammonia.

Delta

As summarized in Table 8-40, it is assumed that SRWTP effluent ammonia concentrations would be substantially lower under Alternative 4 than under Existing Conditions, and would be the same as would occur under the No Action Alternative. Relative to Existing Conditions, ammonia-N concentrations downstream of the SRWTP would be substantially lower under Alternative 4 (including the different operational components of Scenarios H1–H4) because it is assumed that SRWTP upgrades would be in place, and thus that the average monthly effluent ammonia-N concentration would not exceed 1.5 mg/L-N in April through October or 2.4 mg/L-N in November through March. Consequently, a substantial decrease in Sacramento River ammonia-N concentrations is expected to decrease ammonia concentrations for all areas of the Delta that are influenced by Sacramento River water. Concentrations of ammonia-N at locations not influenced notably by Sacramento River water will change little relative to Existing Conditions, due to the similarity in SJR and BAY concentrations and the lack of expected changes in either of these concentrations. Thus, Alternative 4 would not result in substantial increases in ammonia concentrations in the Plan Area, relative to Existing Conditions.

Because the SRWTP discharge ammonia concentrations are assumed to be the same under Alternative 4 as would occur under the No Action Alternative, the primary mechanism that could potentially increase ammonia concentrations in the Delta under Alternative 4, relative to the No Action Alternative, is decreased flows in the Sacramento River, which would lower dilution available to the SRWTP discharge. This change would be attributable only to operations of Alternative 4, since the same assumptions regarding water demands, climate change, and sea level rise are included in both Alternative 1A and the No Action Alternative.

To address this possibility, a simple mixing calculation was performed to assess concentrations of ammonia downstream of the SRWTP discharge (i.e., downstream of Freeport) under Alternative 4 and the No Action Alternative. Monthly average CALSIM II flows at Freeport and the upstream ammonia concentration (0.04 mg/L-N; Central Valley Water Board 2010a:5) were used, together with the SRWTP permitted average dry weather flow (181 mgd) and seasonal ammonia concentration (1.5 mg/L-N in Apr-Oct, 2.4 mg/L-N in Nov-Mar), to estimate the average change in ammonia concentrations downstream of the SRWTP. Table 8-67 shows monthly average and long term annual average predicted concentrations under the two scenarios.

As Table 8-67 shows, average monthly ammonia-N concentrations in the Sacramento River downstream of Freeport (upon full mixing of the SRWTP discharge with river water) under the four different operational scenarios of Alternative 4 and under the No Action Alternative are expected to be similar (Table 8-67). In comparison to the No Action Alternative, minor increases in monthly average ammonia-N concentrations would occur during February, July through September, and during November for all operational scenarios (H1 through H4). Under operational scenario H2 and H4, minor increases in ammonia-N concentrations also would occur in the months of January and March. In the month of December, average ammonia-N concentrations would increase slightly for scenario H4. Minor decreases in ammonia-N concentrations are expected for all scenarios (H1 through H4) in May and June, while minor decreases would also occur in October under scenario H1.

A minor increase in the annual average concentration would occur under the different operational components of scenarios H1 through H4 of Alternative 4, compared to the No Action Alternative. Moreover, the estimated concentrations downstream of Freeport under Alternative 4 would be similar to existing source water concentrations for the San Francisco Bay and San Joaquin River. Consequently, changes in source water fraction anticipated under Alternative 4, relative to the No Action Alternative, are not expected to substantially increase ammonia concentrations at any Delta locations.

Any negligible increases in ammonia-N concentrations that could occur at certain locations in the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to ammonia.

Table 8-67. Estimated Ammonia-N (mg-L as N) Concentrations in the Sacramento River Downstream of the Sacramento Regional Wastewater Treatment Plant for the No Action Alternative and Alternative 4 Operational Scenarios H1, H2, H3, and H4.

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual Average
No Action Alternative	0.074	0.084	0.069	0.060	0.057	0.060	0.058	0.064	0.067	0.060	0.067	0.064	0.065
Scenario H1	0.073	0.090	0.068	0.060	0.058	0.060	0.058	0.063	0.062	0.062	0.070	0.076	0.067
Scenario H2	0.074	0.088	0.069	0.061	0.058	0.061	0.058	0.063	0.062	0.062	0.070	0.065	0.066
Scenario H3	0.074	0.090	0.069	0.060	0.058	0.060	0.057	0.062	0.066	0.064	0.071	0.075	0.067
Scenario H4	0.074	0.088	0.070	0.061	0.058	0.061	0.057	0.062	0.066	0.064	0.071	0.065	0.066

SWP/CVP Export Service Areas

The assessment of effects on ammonia in the SWP and CVP Export Service Area is based on assessment of ammonia-N concentrations at Banks and Jones pumping plants. The dominant source waters influencing the Banks and Jones pumping plants are the Sacramento and San Joaquin Rivers (see Appendix 8D). As discussed above for the Plan Area, for areas of the Delta that are influenced by Sacramento River water, including Banks and Jones pumping plants, ammonia-N concentrations are expected to decrease under Alternative 4, relative to Existing Conditions (in association with less diversion of water influenced by the SRWTP). This decrease in ammonia-N concentrations for water exported via the south Delta pumps is not expected to result in an adverse effect on beneficial uses or substantially degrade water quality of exported water, with regards to ammonia.

Furthermore, as discussed above for the Plan Area, for all areas of the Delta, including Banks and Jones pumping plants, ammonia-N concentrations are not expected to be substantially different under the four different operational scenarios of Alternative 4, relative to No Action Alternative. Any negligible increases in ammonia-N concentrations that could occur at Banks and Jones pumping plants would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to ammonia.

NEPA Effects: In summary, based on the discussion above, effects on ammonia from implementation of CM1 are considered to be not adverse.

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

Ammonia-N concentrations are generally low in the reservoirs and rivers of the watersheds, owing to the lack of substantial point and nonpoint sources of ammonia-N upstream of the SRWTP in the Sacramento River watershed, in the watersheds of the eastern tributaries (Cosumnes, Mokelumne, and Calaveras Rivers), or upstream of the Delta in the San Joaquin River watershed. Consequently, any modified reservoir operations and subsequent changes in river flows under Alternative 4, relative to Existing Conditions, are expected to have negligible, if any, effects on reservoir and river ammonia-N concentrations upstream of Freeport in the Sacramento River watershed and upstream of the Delta in the San Joaquin River watershed.

Ammonia-N concentrations in the Sacramento River downstream of the SRWTP would be substantially lower under Alternative 4 (regardless of operational scenario), relative to Existing Conditions, due to upgrades to the SRWTP that are assumed to be in place, and thus, ammonia concentrations for all areas of the Delta that are influenced by Sacramento River water are expected to decrease. At locations which are not influenced notably by Sacramento River water, concentrations are expected to remain relatively unchanged compared to Existing Conditions, due to the similarity in SJR and BAY concentrations and the lack of expected changes in either of these concentrations.

The assessment of effects on ammonia in the SWP/CVP Export Service Areas is based on assessment of ammonia-N concentrations at Banks and Jones pumping plants. As discussed above for the Plan Area, for areas of the Delta that are influenced by Sacramento River water, including Banks and Jones pumping plants, ammonia-N concentrations are expected to decrease under Alternative 4, relative to Existing Conditions.

Based on the above, there would be no substantial, long-term increase in ammonia-N concentrations in the rivers and reservoirs upstream of the Delta, in the Plan Area, or the waters exported to the CVP and SWP service areas under Alternative 4 relative to Existing Conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because ammonia concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects on beneficial uses would occur. Ammonia is not 303(d) listed within the affected environment and thus any minor increases that could occur in some areas would not make any existing ammonia-related impairment measurably worse because no such impairments currently exist. Because ammonia-N is not bioaccumulative, minor increases that could occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-2: Effects on Ammonia Concentrations Resulting from Implementation of CM2–CM22

NEPA Effects: Some habitat restoration activities would occur on lands in the Delta formerly used for irrigated agriculture. Although this may decrease ammonia loading to the Delta from agriculture, increased biota in those areas as a result of restored habitat may increase ammonia loading originating from flora and fauna. Ammonia loaded from organisms is expected to be converted rapidly to nitrate by established microbial communities. Thus, these land use changes would not be expected to substantially increase ammonia concentrations in the Delta. In general, with the exception of changes in Delta hydrodynamics resulting from habitat restoration, CM2–CM11 would not substantially increase ammonia concentrations in the water bodies of the affected environment. Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, and thus such effects of these restoration measures were included in the assessment of CM1 facilities operations and maintenance (see Impact WQ-1). Additionally, implementation of CM12–CM22 would not be expected to substantially alter ammonia concentrations in the affected environment.

The effects of ammonia from implementation of CM2–22 are considered to be not adverse.

CEQA Conclusion: There would be no substantial, long-term increase in ammonia-N concentrations in the rivers and reservoirs upstream of the Delta, in the Plan Area, or the waters exported to the CVP and SWP service areas due to implementation of CM2–CM22 relative to Existing Conditions. As such, implementation of these conservations measures would not be expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause significant impacts on any beneficial uses of waters in the affected environment. Because ammonia concentrations would not be expected to increase substantially from implementation of these conservation measures, no long-term water quality degradation would be expected to occur and, thus, no significant impact on beneficial uses would occur. Ammonia is not 303(d) listed within the affected environment and thus any minor increases that could occur in some areas would not make any existing ammonia-related impairment measurably worse because no such impairments currently exist. Because ammonia-N is not bioaccumulative, minor increases that could occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered less than significant. No mitigation is required.

Impact WQ-3: Effects on Boron Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Under Alternative 4 Scenarios H1–H4, there would be no expected change to the sources of boron in the Sacramento and east-side tributary watersheds, and resultant changes in flows from altered system-wide operations would have negligible, if any, effects on the concentration of boron in the rivers and reservoirs of these watersheds. The modeled long-term annual average lower San Joaquin River flow at Vernalis would decrease by an estimated 6%, relative to Existing Conditions (in association with the different operational components of Scenarios H1–H4 for Alternative 4, climate change, and increased water demands) and would remain virtually the same relative to the No Action Alternative considering only changes due only to the different operational components of Scenarios H1–H4 under Alternative 4. The reduced flow would result in possible increases in long-term average boron concentrations of up to about 3% relative to the Existing Conditions, which would be nearly identical under each of the H1–H4 scenarios (Appendix 8F, Table Bo-24). The increased boron concentrations would not increase the frequency of exceedances of any applicable objectives or criteria and would not be expected to cause further degradation at measurable levels in the lower San Joaquin River, and thus would not cause the existing impairment there to be discernibly worse. Consequently, Alternative 4 would not be expected to cause exceedance of boron objectives/criteria or substantially degrade water quality with respect to boron, and thus would not adversely affect any beneficial uses of the Sacramento River, the east-side tributaries, associated reservoirs upstream of the Delta, or the San Joaquin River.

Delta

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

The effects relative to Existing Conditions and the No Action Alternative are discussed together because the direction and magnitude of predicted change are so similar. Relative to Existing Conditions, the following changes reflect the range of effects that would result from the four potential outcomes under the Alternative 4 H1–H4 Scenarios. There would be generally similar increased long-term average boron concentrations for the 16-year period modeled at interior Delta locations (by as much as 8% at the SF Mokelumne River at Staten Island for all H1–H4 Scenarios, from 12% for H1 to 15% for H4 at Franks Tract, and from 11% for H1 to 18% for H4 at Old River at Rock Slough) (Appendix 8F, Tables Bo-12A/12D). The comparisons to Existing Conditions reflects changes due to the different operational components of Scenarios H1–H4 for Alternative 4 and climate change/sea level rise. Comparison to the No Action Alternative reflects changes due only to the different operational components of Scenarios H1–H4 for Alternative 4.

Implementation of tidal habitat restoration under CM4 also may contribute to increased boron concentrations at western Delta assessment locations (more discussion of this phenomenon is included in Section 8.3.1.3), and thus would not be anticipated to substantially affect agricultural diversions which occur primarily at interior Delta locations. The long-term annual average and monthly average boron concentrations, for either the 16-year period or drought period modeled, would never exceed the 2,000 μg/L human health advisory objective (i.e., for children) or 500 μg/L agricultural objective at any of the eleven Delta assessment locations, which represents no change from the Existing Conditions and No Action Alternative (Appendix 8F, Table Bo-3B). Additionally, relative to the Existing Conditions, reductions in long-term average assimilative capacity would be small with respect to the 500 μg/L agricultural objective at interior Delta locations and reductions would be similar for all of the Alternative 4 H1–H4 Scenarios (i.e., range of maximum monthly reductions of 12% (H1) to 13% (H4) at Franks Tract and up to 13% (H1) to 18% (H4) at Old River at Rock Slough (Appendix 8F, Tables Bo-13A/13D), and the reductions in assimilative capacity relative to the No Action Alternative also would be comparable. However, because the absolute boron concentrations would still be well below the lowest 500 μg/L objective for the protection of the agricultural beneficial use under Alternative 4, the levels of boron degradation would not be of sufficient magnitude to substantially increase the risk of exceeding objectives or cause adverse effects to municipal and agricultural water supply beneficial uses, or any other beneficial uses, in the Delta (Appendix 8F, Figure Bo-3).

SWP/CVP Export Service Areas

Under all of the Alternative 4 H1–H4 Scenarios, long-term average boron concentrations would decrease at the Banks Pumping Plant (ranging from as much as 21% [H1]) to a 9% [H2]) and at Jones Pumping Plant (ranging from 23% [H4] to 19% [H1]) relative to Existing Conditions and the reductions would be similar compared to No Action Alternative (Appendix 8F, Table Bo-12A/12D) as a result of export of a greater proportion of low-boron Sacramento River water. Commensurate with the decrease in exported boron concentrations, boron concentrations in the lower San Joaquin River may be reduced and would likely alleviate or lessen any expected increase in boron concentrations at Vernalis associated with flow reductions (see discussion of Upstream of the Delta), as well as locations in the Delta receiving a large fraction of San Joaquin River water. Reduced export boron concentrations also may contribute to reducing the existing 303(d) impairment in the lower San Joaquin River and associated TMDL actions for reducing boron loading.

Maintenance of SWP and CVP facilities under Alternative 4 would not be expected to create new sources of boron or contribute towards a substantial change in existing sources of boron in the affected environment. Maintenance activities would not be expected to cause any substantial increases in boron concentrations or degradation with respect to boron such that objectives would be exceeded more frequently, or any beneficial uses would be adversely affected anywhere in the affected environment.

NEPA Effects: In summary, relative to the No Action Alternative conditions, Alternative 4 would result in relatively small increases in long-term average boron concentrations in the Delta and not appreciably change boron levels in the lower San Joaquin River. However, the predicted changes would not be expected to cause exceedances of applicable objectives or further measurable water quality degradation, and thus would not constitute an adverse effect on water quality.

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

Boron is not a constituent of concern in the Sacramento River watershed upstream of the Delta, thus river flow rate and reservoir storage reductions that would occur under the Alternative 4, relative to

Existing Conditions, would not be expected to result in a substantial adverse change in boron levels. Additionally, relative to Existing Conditions, Alternative 4 would not result in reductions in river flow rates (i.e., less dilution) or increased boron loading such that there would be any substantial increases in boron concentration upstream of the Delta in the San Joaquin River watershed.

Small increased boron levels predicted for interior and western Delta locations in response (i.e., up to 15% increase) to a shift in the Delta source water percentages and tidal habitat restoration under this alternative would not be expected to cause exceedances of objectives, or substantial degradation of these water bodies. Alternative 4 maintenance also would not result in any substantial increases in boron concentrations in the affected environment. Boron concentrations would be reduced in water exported from the Delta to the CVP/SWP Export Service Areas, thus reflecting a potential improvement to boron loading in the lower San Joaquin River.

Boron is not a bioaccumulative constituent, thus any increased concentrations under Alternative 4 would not result in adverse boron bioaccumulation effects to aquatic life or humans. Relative to Existing Conditions, Alternative 4 would not result in substantially increased boron concentrations such that frequency of exceedances of municipal and agricultural water supply objectives would increase. The levels of boron degradation that may occur under Alternative 4 would not be of sufficient magnitude to cause substantially increased risk for adverse effects to municipal or agricultural beneficial uses within the affected environment. Long-term average boron concentrations would decrease in Delta water exports to the SWP and CVP service area, which may contribute to reducing the existing 303(d) impairment of agricultural beneficial uses in the lower San Joaquin River. Based on these findings, this impact is determined to be less than significant. No mitigation is required.

Impact WQ-4: Effects on Boron Concentrations Resulting from Implementation of CM2–CM22

***NEPA Effects*:** The implementation of the other conservation measures (i.e., CM2–CM22), of which most do not involve land disturbance, present no new direct sources of boron to the affected environment, including areas Upstream of the Delta, within the Plan Area, and the SWP/CVP Export Service Area, nor would they affect channel flows or Delta hydrodynamic conditions. As noted above, the potential effects of implementation of tidal habitat restoration (i.e., CM4) on Delta hydrodynamic conditions is addressed above in the discussion of Impact WQ-3. The potential channel flow effects of CM2 for actions in the Yolo Bypass also were accounted for in the CALSIM II and DSM2 modeling, and thus were addressed in the discussion for Impact WQ-3. Habitat restoration activities in the Delta (i.e., CM4-10), including restored tidal wetlands, floodplain, and related channel margin and off-channel habitats, while involving increased land and water interaction within these habitats, would not be anticipated to contribute boron which is primarily associated with source water inflows to the Delta (i.e., San Joaquin River, agricultural drainage, and Bay source water). Moreover, some habitat restoration conservation measures (CM4–CM10) would occur on lands within the Delta currently used for irrigated agriculture, thus replacing agricultural land uses with restored habitats. The potential reduction in irrigated lands within the Delta may result in reduced discharges of agricultural field drainage with elevated boron concentrations, which would be considered an improvement compared to the No Action Alternative. CM3 and CM11 provide the mechanism, guidance, and planning for the land acquisition and thus would not, themselves, affect boron levels in the Delta. CM12–CM22 involve actions that target reduction in other stressors at the species level involving actions such as methylmercury reduction management (CM12), improving DO in the Stockton Deep Water Ship Channel (CM14), and urban stormwater treatment (CM19). None of the CM12–CM22 actions would contribute to substantially increasing boron levels in the Delta. Consequently, as they pertain to boron, implementation of CM2–CM22 would not be expected to adversely affect any of the beneficial uses of the affected environment.

The impact on boron of implementing CM2–CM22 is determined to be not adverse.

CEQA Conclusion: Implementation of the CM2–CM22 for Alternative 4 would not present new or substantially changed sources of boron to the affected environment upstream of the Delta, within Delta, or in the SWP and CVP service area. As such, the their implementation would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or other criteria would be exceeded in water bodies of the affected environment located upstream of the Delta, within the Delta, or in the SWP and CVP Service Area or substantially degrade the quality of these water bodies, with regard to boron. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

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

Upstream of the Delta

Under Alternative 4, regardless of operational scenario (i.e., Scenarios H1–H4), there would be no expected change to the sources of bromide in the Sacramento and eastside tributary watersheds. Bromide loading in these watersheds would remain unchanged and resultant changes in flows from altered system-wide operations under Alternative 4 would have negligible, if any, effects on the concentration of bromide in the rivers and reservoirs of these watersheds. Consequently, no individual operational scenario of Alternative 4 would be expected to adversely affect the MUN beneficial use, or any other beneficial uses, of the Sacramento River, the eastside tributaries, or their associated reservoirs upstream of the Delta.

Under the four operational scenarios of Alternative 4, modeling indicates that long-term annual average flows on the San Joaquin River would decrease by 6% relative to Existing Conditions and would remain virtually the same relative to the No Action Alternative (Appendix 5A). These similar decreases in flow, regardless of operational scenario, would result in possible increases in long-term average bromide concentrations of about 3%, relative to Existing Conditions and less than <1% relative to the No Action Alternative (Appendix 8E, Bromide Table 22). The small predicted increases in lower San Joaquin River bromide levels that could occur under Scenarios H1–H4 of Alternative 4, relative to existing and No Action Alternative conditions, would not be expected to adversely affect the MUN beneficial use, or any other beneficial uses, of the lower San Joaquin River.

Delta

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

Under operational scenarios H1–H4 of Alternative 4, the geographic extent of effects pertaining to long-term average bromide concentrations in the Delta would be similar to that previously described for Alternative 1A, although the magnitude of predicted long-term change and relative frequency of concentration threshold exceedances would be different. Using the mass-balance modeling approach for bromide (see Section 8.3.1.3), relative to Existing Conditions, Scenario H1–H4 modeled long-term average bromide concentrations would increase at Staten Island, Emmaton, and Barker Slough, while Scenario H1–H4 modeled long-term average bromide concentrations would decrease at the other assessment locations (Appendix 8E, *Bromide*, Table 10). Overall effects would be greatest at Barker Slough, with the smallest model predicted increases occurring under Scenario H3, and the largest model predicted increases occurring under Scenario H2. Under Scenario H3, predicted long-term average bromide concentrations would increase from 51 μg/L to 62 μg/L (21% relative increase) for the modeled 16-year hydrologic period and would increase from 54 μg/L to 92 μg/L (72% relative increase) for the modeled drought period. Under Scenario H2, predicted long-term average bromide concentrations would increase from 51 μg/L to 72 μg/L (40% relative increase) for the modeled 16-year hydrologic period and would increase from 54 μg/L to 106 μg/L (98% relative increase) for the modeled drought period. At Barker Slough, changes in exceedance frequency would follow a similar pattern, with the greatest increase in exceedance frequency occurring under Scenario H2. Under Scenario H2, the predicted 50 μg/L exceedance frequency would increase from 49% under Existing Conditions to 56% under Alternative 4, and would increase from 55% to 83% during the drought period. Similarly at Barker Slough, the predicted 100 μg/L exceedance frequency would increase from 0% under Existing Conditions to 20% under Scenario H2, and would increase from 0% to 47% during the drought period. In contrast, increases in bromide at Staten Island would result in a 50 μg/L bromide threshold exceedance increase from 47% under Existing Conditions to 76% under Scenario H2 (52% to 83% during the modeled drought period). However, unlike Barker Slough, modeling shows that long-term average bromide concentration at Staten Island would exceed the 100 μg/L assessment threshold concentration 1% under Existing Conditions and 3% under all operational scenarios (0% to 2% during the modeled drought period for all operational scenarios). The highest long-term average bromide concentrations would occur under Scenario H2, and would be 76 μg/L (83 μg/L for the modeled drought period) at Staten Island. Changes in exceedance frequency of the 50 μg/L and 100 μg/L concentration thresholds, as well as relative change in long-term average concentration, at other assessment locations would be less substantial for all operational scenarios. This comparison to Existing Conditions reflects changes in bromide due to both Alternative 4 operations (including north Delta intake capacity of 9,000 cfs and the different operational components of Scenarios H1–H4) and climate change/sea level rise.

Due to the relatively small differences between modeled Existing Conditions and No Action baseline, changes in long-term average bromide concentrations and changes in exceedance frequencies relative to the No Action Alternative are generally of similar magnitude to those previously described for the existing condition comparison (Appendix 8E, Bromide Table 10). Relative to the No Action Alternative, modeled long-term average bromide concentration increases would similarly be greatest at Barker Slough under Scenario H2, where long-term average concentrations are predicted to increase by 44% (97% for the modeled drought period). However, unlike the Existing Conditions comparison, under the No Action Alternative long-term average bromide concentrations at Buckley Cove would increase for all operational scenarios, although the increases would be relatively small (≤4%). Unlike the comparison to Existing Conditions, this comparison to the No Action Alternative reflects changes in bromide due only to the different operational components of Scenarios H1–H4 of Alternative 4.

At Barker Slough, modeled long-term average bromide concentrations for the two baseline conditions are very similar (Appendix 8E, Bromide Table 10-11). Such similarity demonstrates that the modeled Alternative 4 change in bromide is almost entirely due to Alternative 4 operations, and not climate change/sea level rise, regardless of the specific different operational components of Scenarios H1–H4. Therefore, operations are the primary driver of effects on bromide at Barker Slough, regardless of whether and particular operational scenario of Alternative 4 is compared to Existing Conditions, or compared to the No Action Alternative.

Results of the modeling approach which used relationships between EC and chloride and between chloride and bromide (see Section 8.3.1.3) differed somewhat from what is presented above for the mass-balance approach (see Appendix 8E, Table 11). For most locations, the frequency of exceedance of the 50 µg/L and 100 µg/L were similar. The greatest difference between the methods was predicted for Barker Slough. Under all of the operational scenarios, the increases in frequency of exceedance of the 100 µg/L threshold, relative to Existing Conditions and the No Action Alternative, were not as great using this alternative EC to chloride and chloride to bromide relationship modeling approach as compared to that presented above from the mass-balance modeling approach. Model predicted increases under Scenario H2 were still the greatest, and increases under the other operational scenarios were still substantial. At Barker Slough, the predicted 100 µg/L exceedance frequency for the 16-year hydrologic period would increase from 1% under Existing Conditions and 2% under the No Action Alternative to as much as 11% under the Scenario H2. For the modeled drought period, the predicted 100 µg/L exceedance frequency would increase from 0% under Existing Conditions and the No Action Alternative to as much as 25% under Scenario H2. Because the mass-balance approach predicts a greater level of impact at Barker Slough, determination of impacts was based on the mass-balance results.

Although Scenario H2 would result in the greatest relative increase in long-term average bromide concentrations and greatest relative increase in exceedance frequency at Barker Slough, the difference between operational scenarios is very small. Regardless of particular Alternative 4 operational scenario, the increase in long-term average bromide concentrations predicted at Barker Slough, principally the relative increase in 100 µg/L exceedance frequency, would result in a substantial change in source water quality for existing drinking water treatment plants drawing water from the North Bay Aqueduct. As discussed for Alternative 1A, drinking water treatment plants obtaining water via the North Bay Aqueduct utilize a variety of conventional and enhanced treatment technologies in order to achieve DBP drinking water criteria. While the implications of such a modeled change in bromide at Barker Slough are difficult to predict, the substantial modeled increases could lead to adverse changes in the formation of disinfection byproducts such that considerable treatment plant upgrades may be necessary in order to achieve equivalent levels of health protection. Because many of the other modeled locations already frequently exceed the 100 µg/L threshold under Existing Conditions and the No Action Alternative, these locations likely already require treatment plant technologies to achieve equivalent levels of health protection, and thus no additional treatment technologies would be triggered by the small increases in the frequency of exceeding the 100 µg/L threshold. Hence, no further impact on the drinking water beneficial use would be expected at these locations.

The seasonal intakes at Mallard Slough and City of Antioch are infrequently used due to water quality constraints related to sea water intrusion. On a long-term average basis, bromide at these locations is in excess of 3,000 µg/L, but during seasonal periods of high Delta outflow can be <300 µg/L. Based on modeling using the mass-balance approach, use of the seasonal intakes at Mallard Slough and City of Antioch under Scenarios H1–H4 of Alternative 4 would experience a period average increase in bromide during the months when these intakes would most likely be utilized. For those wet and above normal water year types where mass balance modeling would predict water quality typically suitable for diversion, change would be greatest for Scenario H1 and H3, where predicted long-term average bromide concentrations would increase from 103 µg/L to 155 µg/L (51% increase) at City of Antioch and would increase from 150 µg/L to 201 µg/L (41% increase) at Mallard Slough relative to Existing Conditions (Appendix 8E, *Bromide*, Table 23). Under Scenarios H2 and H4, predicted increases would also occur, but would be somewhat less, with approximate 40% increases at the City of Antioch and approximate 34% increases at Mallard Slough. Increases would be similar for the No Action Alternative comparison, with slightly lower relative increases at City of Antioch (i.e., 33–44% depending on operational scenario), and slightly higher relative increases at Mallard Slough (i.e., 36–47% depending on operational scenario). Modeling results using the EC to chloride and chloride to bromide relationships show increases during these months, but the relative magnitude of the increases is much lower (Appendix 8E, *Bromide*, Table 24). Regardless of the differences in the data between the two modeling approaches, the decisions surrounding the use of these seasonal intakes is largely driven by acceptable water quality, and thus have historically been opportunistic. Opportunity to use these intakes would remain, and the predicted increases in bromide concentrations at the City of Antioch and Mallard Slough intake would not be expected to adversely affect MUN beneficial uses, or any other beneficial use, at these locations.

SWP/CVP Export Service Areas

Under the various operational scenarios of Alternative 4, improvement in long-term average bromide concentrations would occur at the Banks and Jones pumping plants, with the largest improvement predicted to occur under Scenario H4 and the smallest improvement predicted to occur under Scenario H1. Under Scenario H4, long-term average bromide concentrations for the modeled 16-year hydrologic period at Banks and Jones pumping plants would decrease by as much as 46% relative to Existing Conditions and 38% relative to the No Action Alternative. Relative change in long-term average bromide concentration under Scenario H4 would be less during drought conditions (≤36%), but would still represent considerable improvement (Appendix 8E, *Bromide*, Table 10). Decreased long-term average bromide concentrations under the other operational scenarios would also be predicted, but would be slightly less. Under Scenario H1, long-term average bromide concentrations for the modeled 16-year hydrologic period at Banks and Jones pumping plants would decrease by as much as 37% relative to Existing Conditions and 28% relative to the No Action Alternative. Relative change in long-term average bromide concentration under Scenario H1 would be less during drought conditions (≤28%) (Appendix 8E, *Bromide*, Table 10). As a result, and regardless of operational scenario, less frequent bromide concentration exceedances of the 50 µg/L and 100 µg/L assessment thresholds would be predicted and an overall improvement in Export Service Areas water quality would be experienced respective to bromide. Commensurate with the decrease in exported bromide, an improvement in lower San Joaquin River bromide would also be observed since bromide in the lower San Joaquin River is principally related to irrigation water deliveries from the Delta. While the magnitude of this expected lower San Joaquin River improvement in bromide is difficult to predict, the relative decrease in overall loading of bromide to the Export Service Areas would likely alleviate or lessen any expected increase in bromide concentrations at Vernalis (see discussion of Upstream of the Delta) as well as locations in the Delta receiving a large fraction of San Joaquin River water, such as much of the south Delta.

The discussion above is based on results of the mass-balance modeling approach. Results of the modeling approach which used relationships between EC and chloride and between chloride and bromide (see Section 8.3.1.3) were consistent with the discussion above, and assessment of bromide using these data results in the same conclusions as are presented above for the mass-balance approach (see Appendix 8E, Table 11).

Similar to the discussion pertaining to the No Action Alternative, maintenance of SWP and CVP facilities under Scenarios H1–H4 of Alternative 4 would not be expected to create new sources of bromide or contribute towards a substantial change in existing sources of bromide in the affected environment. Maintenance activities would not be expected to cause any substantial change in bromide such that MUN beneficial uses, or any other beneficial use, would be adversely affected anywhere in the affected environment.

NEPA Effects: In summary, the operations and maintenance activities under Scenarios H1–H4 of Alternative 4, relative to the No Action Alternative, would result in small increases (i.e., <1%) in long-term average bromide concentrations at Vernalis related to relatively small declines in long-term average flow on the San Joaquin River. However, the operations and maintenance activities under Scenarios H1–H4 of Alternative 4 would cause substantial degradation to water quality with respect to bromide at Barker Slough, source of the North Bay Aqueduct. This substantial degradation would be predicted to occur regardless of operational scenario, but would be greatest under Scenario H2. Resultant substantial change in long-term average bromide at Barker Slough could necessitate changes in water treatment plant operations or require treatment plant upgrades in order to maintain DBP compliance, and thus would constitute an adverse effect on water quality. Mitigation Measure WQ-5 is available to reduce these effects (implementation of this measure along with a separate, non-environmental commitment as set forth in EIR/EIS Appendix 3B, *Environmental Commitments*, relating to the potential increased treatment costs associated with bromide-related changes would reduce these effects).

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

Under operational Scenarios H1–H4 of Alternative 4 there would be no expected change to the sources of bromide in the Sacramento and eastside tributary watersheds. Bromide loading in these watersheds would remain unchanged and resultant changes in flows from altered system-wide operations under any operational scenario of Alternative 4 would have negligible, if any, effects on the concentration of bromide in the rivers and reservoirs of these watersheds. However, south of the Delta, the San Joaquin River is a substantial source of bromide, primarily due to the use of irrigation water imported from the southern Delta. Concentrations of bromide at Vernalis are inversely correlated to net river flow. Under all operational scenarios of Alternative 4, long-term average flows at Vernalis would decrease only slightly, resulting in less than substantial predicted increases in long-term average bromide of about 3% relative to Existing Conditions.

Relative to Existing Conditions, all operational scenarios of Alternative 4 would result in small decreases in long-term average bromide concentration at most Delta assessment locations, with principal exceptions being the North Bay Aqueduct at Barker Slough, Staten Island, and Emmaton on the Sacramento River. Overall effects would be greatest at Barker Slough, where substantial increases in long-term average bromide concentrations under all operational scenarios would be predicted, but would be greatest for Scenario H2. While the predicted increase in long-term average bromide concentrations at Barker Slough would be greatest for Scenario H2, the relative increases regardless of particular operational scenario would result in a substantial change in source water quality to existing drinking water treatment plants drawing water from the North Bay Aqueduct. These modeled increases in bromide at Barker Slough could lead to adverse changes in the formation of disinfection byproducts at drinking water treatment plants such that considerable water treatment plant upgrades could be necessary in order to achieve equivalent levels of drinking water health protection.

The assessment of effects on bromide in the SWP/CVP Export Service Areas is based on assessment of changes in bromide concentrations at Banks and Jones pumping plants. Under all of the operational scenarios of Alternative 4, substantial improvement would occur at the Banks and Jones pumping plants, where long-term average bromide concentrations are predicted to decrease by as much as 44% relative to Existing Conditions. As a result, an overall improvement in bromide-related water quality would be predicted in the SWP/CVP Export Service Areas.

Based on the above, the operations and maintenance activities under Scenarios H1–H4 of Alternative 4 would not result in any substantial change in long-term average bromide concentration upstream of the Delta. Furthermore, under all of the operational scenarios of Alternative 4, water exported from the Delta to the SWP/CVP service area would be substantially improved relative to bromide. Bromide is not bioaccumulative, therefore change in long-term average bromide concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Additionally, bromide is not a constituent related to any 303(d) listings. The operations and maintenance activities under Scenarios H1–H4 of Alternative 4 would not cause substantial long-term degradation to water quality respective to bromide with the exception of water quality at Barker Slough, source of the North Bay Aqueduct. At Barker Slough, modeled long-term annual average concentrations of bromide would increase by as much as 40%, and 98% during the modeled drought period. For the modeled 16-year hydrologic period the frequency of predicted bromide concentrations exceeding 100 μg/L would increase from 0% under Existing Conditions to as much as 20% under Alternative 4, while for the modeled drought period, the frequency would increase from 0% to as much as 47%. The substantial changes in long-term average bromide predicted for Barker Slough under all operational scenarios of Alternative 4 could necessitate changes in treatment plant operation or require treatment plant upgrades in order to maintain DBP compliance. The model predicted change at Barker Slough is substantial and, therefore, would represent a substantially increased risk for adverse effects on existing MUN beneficial uses should treatment upgrades not be undertaken. The impact is considered significant.

Implementation of Mitigation Measure WQ-5 along with a separate, non-environmental commitment relating to the potential increased treatment costs associated with bromide-related changes would reduce these effects. While mitigation measures to reduce these water quality effects in affected water bodies to less than significant levels are not available, implementation of Mitigation Measure WQ-5 is recommended to attempt to reduce the effect that increased bromide concentrations may have on Delta beneficial uses. However, because the effectiveness of this mitigation measure to result in feasible measures for reducing water quality effects is uncertain, this impact is considered to remain significant and unavoidable.

In addition to and to supplement Mitigation Measure WQ-5, the BDCP proponents have incorporated into the BDCP, as set forth in EIR/EIS Appendix 3B, *Environmental Commitments*, a separate, non-environmental commitment to address the potential increased water treatment costs that could result from bromide-related concentration effects on municipal water purveyor operations. Potential options for making use of this financial commitment include funding or providing other assistance towards implementation of the North Bay Aqueduct AIP, acquiring alternative water supplies, or other actions to indirectly reduce the effects of elevated bromide and DOC in existing water supply diversion facilities. Please refer to Appendix 3B, *Environmental Commitments*, for the full list of potential actions that could be taken pursuant to this commitment in order to reduce the water quality treatment costs associated with water quality effects relating to chloride, electrical conductivity, and bromide.

Mitigation Measure WQ-5: Avoid, Minimize, or Offset, as Feasible, Adverse Water Quality Conditions

It remains to be determined whether, or to what degree, the available and existing salinity response and countermeasure actions of SWP and CVP facilities or municipal water purveyors would be capable of offsetting the actual level of changes in bromide that may occur from implementation of Alternative 4. Therefore, in order to determine the feasibility of reducing the effects of increased bromide levels, and potential adverse effects on beneficial uses associated with CM1 operations (and hydrodynamic effects of tidal restoration under CM4), the proposed mitigation requires a series of phased actions to identify and evaluate existing and possible feasible actions, followed by development and implementation of the actions, if determined to be necessary. The development and implementation of any mitigation actions shall be focused on those incremental effects attributable to implementation of Alternative 4 operations only. Development of mitigation actions for the incremental bromide effects attributable to climate change/sea level rise are not required because these changed conditions would occur with or without implementation of Alternative 4. The goal of specific actions would be to reduce/avoid additional degradation of Barker Slough water quality conditions with respect to the CALFED bromide goal.

Following commencement of initial operations of CM1, the BDCP proponents will conduct additional evaluations described herein, and develop additional modeling (as necessary), to define the extent to which modified operations could reduce or eliminate the increased bromide concentrations currently modeled to occur under Alternative 4. The additional evaluations should also consider specifically the changes in Delta hydrodynamic conditions associated with tidal habitat restoration under CM4 (in particular the potential for increased bromide concentrations that could result from increased tidal exchange) once the specific restoration locations are identified and designed. If sufficient operational flexibility to offset bromide increases is not practicable/feasible under Alternative 4 operations, achieving bromide reduction pursuant to this mitigation measure would not be feasible under this alternative.

Impact WQ-6: Effects on Bromide Concentrations Resulting from Implementation of CM2–CM22

NEPA Effects: CM12–CM22 would present no new sources of bromide to the affected environment, including areas Upstream of the Delta, within the Plan Area, and the SWP/CVP Export Service Areas. As they pertain to bromide, implementation of these conservation measures would not be expected to adversely affect MUN beneficial use, or any other beneficial uses, of the affected environment.

With exception to habitat restoration areas that would effectively alter Delta hydrodynamics, habitat restoration and the various land-disturbing conservation measures proposed for Alternative 4 would not present new or substantially changed sources of bromide to the study area. Modeling scenarios included assumptions regarding how certain habitat restoration activities would affect Delta hydrodynamics (CM2 and CM4), and thus such hydrodynamic effects of these restoration measures were included in the assessment of CM1 facilities operations and maintenance (see Impact WQ-1).

Some habitat restoration activities would occur on lands in the Delta formerly used for irrigated agriculture. Such replacement or substitution of land use activity would not be expected to result in new or increased sources of bromide to the Delta. Implementation of CM2–CM11 would not be expected to adversely affect MUN beneficial use, or any other beneficial uses, within the affected environment.

In summary, implementation of CM2–CM22 under Alternative 4, relative to the No Action Alternative, would have negligible, if any, effects on bromide concentrations. The effects on bromide from implementing CM2–CM22 are determined to not be adverse.

CEQA Conclusion**:** Implementation of CM2–CM22 under Alternative 4 would not present new or substantially changed sources of bromide to the study area. Some conservation measures may replace or substitute for existing irrigated agriculture in the Delta. This replacement or substitution would not be expected to substantially increase or present new sources of bromide. Implementation of CM2–CM22 would have negligible, if any, effects on bromide concentrations throughout the affected environment, would not cause exceedance of applicable state or federal numeric or narrative water quality objectives/criteria because none exist for bromide, and would not cause changes in bromide concentrations that would result in significant impacts on any beneficial uses within affected water bodies. Implementation of CM2–CM22 would not cause significant long-term water quality degradation such that there would be greater risk of significant impacts on beneficial uses, would not cause greater bioaccumulation of bromide, and would not further impair any beneficial uses due to bromide concentrations because no uses are currently impaired due to bromide levels. This impact is therefore considered less than significant. No mitigation is required.

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

Upstream of the Delta

Under Alternative 4, Scenarios H1–H4, there would be no expected change to the sources of chloride in the Sacramento and eastside tributary watersheds. Chloride loading in these watersheds would remain unchanged and resultant changes in flows from altered system-wide operations would have negligible, if any, effects on the concentration of chloride in the rivers and reservoirs of these watersheds. The modeled long-term annual average flows on the lower San Joaquin River at Vernalis would decrease slightly compared to Existing Conditions (in association with the different operational components of Scenarios H1–H4 for Alternative 4, climate change, and increased water demands) and be similar compared to the No Action Alternative (considering only changes due only to the different operational components of Scenarios H1–H4 under Alternative 4). The reduced flow would result in possible increases in long-term average chloride concentrations of about 2%, relative to the Existing Conditions, which would be nearly identical under each of the H1–H4 scenarios, and no change relative to No Action Alternative (Appendix 8G, Table Cl-62). Consequently, the Alternative 4 H1–H4 Scenarios would not be expected to cause exceedances of chloride objectives/criteria or substantially degrade water quality with respect to chloride, and thus would not adversely affect any beneficial uses of the Sacramento River, the eastside tributaries, associated reservoirs upstream of the Delta, or the San Joaquin River.

Delta

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

Relative to Existing Conditions, modeling predicts that the Alternative 4 H1–H4 Scenarios would result in similar or reduced long-term average chloride concentrations for the 16-year period modeled at most of the assessment locations. The mass-balance modeling results indicate similar, but slightly larger increases in chloride concentrations compared to estimates generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3). Increased long-term average chloride concentrations would occur at the North Bay Aqueduct at Barker Slough (i.e., range from up to 33% [H2] to 16% [H3]) and San Joaquin River at Staten Island (i.e., similar increase of 22–23% for all H1–H4 Scenarios) (Appendix 8G, *Chloride*, Tables Cl-25A/25D [mass balance model results] and Tables Cl-26A/26D [EC-chloride relationship results]). Changes in long-term average concentrations in the western Sacramento River at Emmaton would range from an increase for Scenarios H1 and H2 (14 to 16%) to no measureable change for Scenarios H3 and H4 (i.e., -1%). Long-term average chloride concentration would decrease at other assessment locations, with the largest reductions occurring under Scenarios H3 and H4 (i.e., up to -24% at Franks Tract) and less reduction under Scenarios H1 and H2 (i.e., up to -12% at Franks Tract). Additionally, implementation of tidal habitat restoration under CM4 would increase the tidal exchange volume in the Delta, and thus may contribute to increased chloride concentrations in the Bay source water as a result of increased salinity intrusion. More discussion of this phenomenon is included in Section 8.3.1.3. Consequently, while uncertain, the magnitude of chloride increases may be greater than indicated herein and would affect the western Delta assessment locations the most which are influenced to the greatest extent by the Bay source water. This comparison to Existing Conditions reflects changes in chloride due to both the different operational components of Scenarios H1–H4 for Alternative 4 and climate change/sea level rise.

Relative to the No Action Alternative conditions, the mass balance analysis of modeling results indicated that the Alternative 4 Scenarios H1–H4 would result in similar increases in long-term average chloride concentrations for the 16-year period as described above compared to Existing Conditions: SF Mokelumne River at Staten Island (i.e., up to 25 to 27% for all H1–H4 Scenarios), North Bay Aqueduct at Barker Slough (i.e., range of 20% [H3] up to 37% [H2]), and for the Sacramento River at Emmaton (i.e., ranging from an increase for Scenarios H1-H2 of up to 17% to reduction under Scenarios H3-H4 [-1%]) (Appendix 8G, Table Cl-25A/25D [mass balance model results] and Tables Cl-26A/26D [EC-chloride relationship results]). Relative to the No Action Alternative, the long-term average chloride concentrations based on EC to chloride relationships indicate that most of the other interior and western Delta assessment locations under Scenarios H1 and H2 would exhibit similar increases ranging from up to 3% at San Joaquin River at Buckley Cove to 9% at the Sacramento River at Mallard Island. The comparison to the No Action Alternative reflects chloride changes due only to the different operational components of Scenarios H1–H4 for Alternative 4.

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

Municipal Beneficial Uses–Relative to Existing Conditions

Estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3) were used to evaluate the 150 mg/L Bay-Delta WQCP objective for municipal and industrial beneficial uses on a basis of the percent of years the chloride objective is exceeded for the modeled 16-year period. The objective is exceeded if chloride concentrations exceed 150 mg/L for a specified number of days in a given water year at both the Antioch and Contra Costa Pumping Plant #1 locations. For the Alternative 4 Scenarios H1–H4, the modeled frequency of objective exceedance would approximately double at the Contra Costa Pumping Plant #1 from 6% of years under Existing Conditions, to 13% of years under all of the Alternative 4 scenarios (Appendix 8G, Table Cl-64).

Similarly, estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3) were also used to evaluate the 250 mg/L Bay-Delta WQCP objective for chloride at Contra Costa Pumping Plant #1 where daily average objectives apply. The basis for the evaluation was the predicted number of days the objective was exceeded for the modeled 16-year period. For Alternative 4, the modeled frequency of objective exceedance would decrease similarly for the H1–H4 Scenarios by approximately one half, from 6% of modeled days under Existing Conditions, to 3–4% of modeled days under the Alternative 4 operational scenarios (Appendix 8G, Table Cl-63).

Given the limitations inherent to estimating future chloride concentrations (see Section 8.3.1.3), estimation of chloride concentrations through both a mass balance approach and an EC-chloride relationship approach was used to evaluate the 250 mg/L Bay-Delta WQCP objectives in terms of both frequency of exceedance and use of assimilative capacity. When utilizing the mass balance approach to model monthly average chloride concentrations for the 16-year period, the predicted frequency of exceeding the 250 mg/L objective would decrease at the Contra Costa Canal at Pumping Plant #1 from an exceedance frequency of 24% under Existing Conditions to a range of 18% (for H1) to 12–13% (for H3 and H4) (Appendix 8G, Table Cl-27 and Figure Cl-5). However, the frequency of exceedances would increase slightly for the 16-year period modeled at the San Joaquin River at Antioch (i.e., from 66% under Existing Conditions to 68% to 70% for the H1–H4 Scenarios) and Sacramento River at Mallard Island (i.e., from 85% under Existing Conditions to 86% to 88% for the H1–H4 Scenarios) (Appendix 8G, Table Cl-27). The mass balance results also indicate that the increased concentrations would reduce assimilative capacity with respect to the 250 mg/L objective, thus causing further degradation at Antioch in March and April, with similar maximum reductions under H1 and H3 of up to 54% to maximum reductions of up to 42% for H3 and H4 for the 16-year period modeled, and 100% reduction, or elimination of assimilative capacity, for all of the H1–H4 Scenarios during the drought period modeled) (Appendix 8G, Tables Cl-29A/29D and Figure Cl-5). Assimilative capacity at the Contra Costa Canal at Pumping Plant #1 also would be similarly reduced in September and October under the H1 and H2 scenarios (i.e., up to 100%, or elimination) when chloride concentrations would be near, or exceed, the objectives, thus increasing the risk of exceeding objectives (Appendix 8G, Figure Cl-5), but would not be substantially reduced under the H3 or H4 scenarios.

In comparison, when utilizing the chloride-EC relationship to model monthly average chloride concentrations for the 16-year period, trends in frequency of exceedance and use of assimilative capacity would be similar to that discussed when utilizing the mass balance modeling approach (Appendix 8G, Table Cl-28 and Tables Cl-30A/30D). However, as with Alternative 1A the modeling approach utilizing the chloride-EC relationships predicted changes of lesser magnitude, where predictions of change utilizing the mass balance approach were generally of greater magnitude, and thus more conservative. As discussed in Section 8.3.1.3, in cases of such disagreement, the approach that yielded the more conservative predictions was used as the basis for determining adverse impacts.

Based on the additional predicted annual and seasonal exceedances of one or both Bay Delta WQCP objectives for chloride, and the associated long-term average water quality degradation in the western Delta, the potential exists for substantial adverse effects under all of the Alternative 4 H1–H4 Scenarios on the municipal and industrial beneficial uses through reduced opportunity for diversion of water with acceptable chloride levels.

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

With respect to the 303(d) listing for chloride in Tom Paine Slough, the monthly average chloride concentrations for the 16-year period modeled at Old River at Tracy Road would generally be similar under all of the Alternative 4 H1–H4 Scenarios compared to Existing Conditions, and thus, would not be further degraded on a long-term basis (Appendix 8G, Figure Cl-6). With respect to Suisun Marsh, the monthly average chloride concentrations for the 16-year period modeled would generally increase under all of the Alternative 4 H1–H4 Scenarios compared to Existing Conditions in the months of March through May at the Sacramento River at Collinsville (Appendix 8G, Figure Cl-7), Mallard Island (Appendix 8G, Figure Cl-5), and increase substantially at Montezuma Slough at Beldon's Landing (i.e., over a doubling of concentration in December through February) (Appendix 8G, Figure Cl-8), thereby contributing to additional, measureable long-term degradation that potentially would adversely affect the necessary actions to reduce chloride loading for any TMDL that is developed.

Municipal Beneficial Uses–Relative to No Action Alternative

Similar to the assessment conducted for Existing Conditions, estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3) were used to evaluate the 150 mg/L Bay-Delta WQCP objective for municipal and industrial beneficial uses. For Alternative 4, the modeled frequency of objective exceedance would increase at the Contra Costa Pumping Plant #1 from 6% under the No Action Alternative to 13% of years under all of the Alternative 4 H1–H4 Scenarios (Appendix 8G, Table Cl-64).

Similarly, estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3) were also used to evaluate the 250 mg/L Bay-Delta WQCP objective for chloride at Contra Costa Pumping Plant #1 where daily average objectives apply. For Alternative 4, the modeled frequency of objective exceedance would decrease minimally under all the H1–H4 Scenarios, from 5% of modeled days under the No Action Alternative to 4–3% of modeled days under the Alternative 4 scenarios (Appendix 8G, Table Cl-64).

Similar to Existing Conditions, a comparative assessment of modeling approaches was utilized to evaluate the 250 mg/L Bay-Delta WQCP objectives in terms of both frequency of exceedance and use of assimilative capacity on a monthly average basis. When utilizing the mass balance approach to model monthly average chloride concentrations for the 16-year period, a small increase in exceedance frequency would be predicted at the Sacramento River at Mallard Island (i.e., from 86% for the No Action Alternative to a slight 2% increase [up to 88%] for H1 and H3), with no change in exceedances under H2 or H4 (Appendix 8G, Table Cl-27). The frequency of exceedances would decrease slightly at the San Joaquin River at Antioch (i.e., from 73% for the No Action Alternative to a range of 68% [H2 and H4] to 70% [H1]), and the frequency of exceedances at the Contra Costa Canal at Pumping Plant #1 would depend on the scenario from 14% under the No Action Alternative increasing by 2–4% for H1 and H2 (i.e., up to 18%) and decreasing at H3 and H4 [to 12%])(Appendix 8G, Table Cl-27). Substantial reductions in available assimilative capacity compared to the No Action Alternative condition would occur at Antioch under H1 and H3 (i.e., 24% in April) and no substantial reduction under H2/H4 for the 16-year period modeled, and up to 100% in April [i.e., eliminated] for the drought period for all H1–H4 scenarios). Assimilative capacity also would be reduced substantially at the Contra Costa Canal at Pumping Plant #1 at similar levels for H1 and H2 in August through November (i.e., up to 100% elimination in October) to only in August and September under H3 and H4 (i.e., up to 29%) for the 16-year period modeled, with 100% elimination in at least one month under all of the H1–H4 scenarios for the drought period) (Appendix 8G, Tables Cl-29A/29D), reflecting substantial degradation during months when average concentrations would be near, or exceed, the objective.

In comparison, when utilizing the chloride-EC relationship to model monthly average chloride concentrations for the 16-year period, trends in frequency of exceedance and use of assimilative capacity would be similar to that discussed when utilizing the mass balance modeling approach (Appendix 8G, Tables Cl-30A/30D). However, as with Alternative 1A the modeling approach utilizing the chloride-EC relationships predicted changes of lesser magnitude, where predictions of change utilizing the mass balance approach were generally of greater magnitude, and thus more conservative. As discussed in Section 8.3.1.3, in cases of such disagreement, the approach that yielded the more conservative predictions was used as the basis for determining adverse impacts.

Based on the additional predicted annual and seasonal exceedances of one or both Bay Delta WQCP objectives for chloride, and the associated long-term average water quality degradation in the western Delta, the potential exists for substantial adverse effects under all of the Alternative 4 H1–H4 Scenarios on the municipal and industrial beneficial uses through reduced opportunity for diversion of water with acceptable chloride levels.

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

With respect to the 303(d) listing for chloride, Alternative 4 would generally result in similar changes for all of the Alternative 4 H1–H4 Scenarios to those discussed for the comparison to Existing Conditions. Monthly average chloride concentrations at Tom Paine Slough would not be further degraded on a long-term basis (Appendix 8G, Figure Cl-6). Monthly average chloride concentrations at source water channel locations for the Suisun Marsh (Appendix 8G, Figures Cl-5, Cl-7 and Cl-8) would increase substantially in some months during October through May compared to the No Action Alternative conditions. Therefore, additional, measureable long-term degradation would occur in Suisun Marsh that potentially would adversely affect the necessary actions to reduce chloride loading for any TMDL that is developed.

SWP/CVP Export Service Areas

Under the Alternative 4 H1–H4 Scenarios, long-term average chloride concentrations based on the mass balance analysis of modeling results for the 16-year period modeled at the Banks and Jones pumping plants would decrease compared to Existing Conditions. Reductions at Banks would be slightly larger than at Jones, ranging from 37% (H1) to 45% (H4) (Appendix 8G, *Chloride*, Table Cl-25A/25D). Compared to No Action Alternative, the pattern of reductions would be similar with Banks ranging from 32% (H1) to 38% (H4). The modeled frequency of exceedances of applicable water quality objectives/criteria would decrease relative to Existing Conditions and No Action

Alternative, for both the 16-year period and the drought period modeled (Appendix 8G, *Chloride*, Table Cl-27). Consequently, water exported into the SWP/CVP service area would generally be of similar or better quality with regards to chloride relative to Existing Conditions and the No Action Alternative conditions.

Results of the modeling approach which used relationships between EC and chloride (see Section 8.3.1.3) were consistent with the discussion above, and assessment of chloride using these data results in the same conclusions as are presented above for the mass-balance approach (Appendix 8G, Tables Cl-26A/26D [for concentration changes] and Table Cl-28 [for frequency of exceedances]).

Commensurate with the reduced chloride concentrations in water exported to the service area, reduced chloride loading in the lower San Joaquin River would be anticipated which would likely alleviate or lessen any expected increase in chloride at Vernalis related to decreased annual average San Joaquin River flows (see discussion of Upstream of the Delta).

Maintenance of SWP and CVP facilities would not be expected to create new sources of chloride or contribute towards a substantial change in existing sources of chloride in the affected environment. Maintenance activities would not be expected to cause any substantial change in chloride such that any long-term water quality degradation would occur, thus, beneficial uses would not be adversely affected anywhere in the affected environment.

***NEPA Effects*:** In summary, relative to the No Action Alternative conditions, all of the Alternative 4 H1–H4 Scenarios would result in increased water quality degradation and frequency of exceedance of the 150 mg/L objective at Contra Costa Pumping Plant #1 and Antioch, increased water quality degradation with respect to the 250 mg/L municipal and industrial objective at interior and western Delta locations on a monthly average basis, and measureable water quality degradation relative to the 303(d) impairment in Suisun Marsh (see Mitigation Measure WQ-7 below; implementation of this measure along with a separate, non-environmental commitment relating to the potential increased chloride treatment costs would reduce these effects). The predicted chloride increases constitute an adverse effect on water quality. Additionally, the predicted changes relative to the No Action Alternative conditions indicate that in addition to the effects of climate change/sea level rise, implementation of CM1 and CM4 under the Alternative 4 H1–H4 Scenarios would contribute substantially to the adverse water quality effects.

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

Chloride is not a constituent of concern in the Sacramento River watershed upstream of the Delta, thus river flow rate and reservoir storage reductions that would occur under any of the Alternative 4 H1–H4 Scenarios, relative to Existing Conditions, would not be expected to result in a substantial adverse change in chloride levels. Additionally, relative to Existing Conditions, the Alternative 4 H1–H4 Scenarios would not result in reductions in river flow rates (i.e., less dilution) or increased chloride loading such that there would be any substantial increase in chloride concentrations upstream of the Delta in the San Joaquin River watershed.

Relative to Existing Conditions, all of the Alternative 4 H1–H4 Scenarios would result in substantially increased chloride concentrations in the Delta such that frequency of exceeding the

150 mg/L Bay-Delta WQCP objective would approximately double. Moreover, the frequency of exceedance of the 250 mg/L Bay-Delta WQCP objective would increase at the San Joaquin River at Antioch and at Mallard Slough (ranging by up to 2 to 4% for the H1–H4 Scenarios). Substantial long-term degradation also may occur at Antioch under all of the H1–H4 Scenarios, and at the Contra Costa Canal at Pumping Plant #1 under the H1-H2 Scenarios, that may result in adverse effects on the municipal and industrial water supply beneficial use (see Mitigation Measure WQ-7 below; implementation of this measure along with a separate, non-environmental commitment relating to the potential increased chloride treatment costs would reduce these effects). Relative to the Existing Conditions, the modeled increased chloride concentrations and degradation in the western Delta under all of the H1–H4 Scenarios could further contribute, at measurable levels (i.e., over a doubling of concentration), to the existing 303(d) listed impairment due to chloride in Suisun Marsh for the protection of fish and wildlife.

Chloride concentrations would be reduced under all of the H1–H4 Scenarios in water exported from the Delta to the CVP/SWP Export Service Areas, thus reflecting a potential improvement to chloride loading in the lower San Joaquin River.

Chloride is not a bioaccumulative constituent, thus any increased concentrations under the Alternative 4 H1–H4 Scenarios would not result in substantial chloride bioaccumulation impacts on aquatic life or humans. Alternative 4 maintenance would not result in any substantial changes in chloride concentration upstream of the Delta or in the SWP/CVP Export Service Areas. However, based on these findings, this impact is determined to be significant due to increased chloride concentrations and degradation at western Delta locations and its potential effects on municipal and industrial water supply and fish and wildlife beneficial uses.

While mitigation measures to reduce these water quality effects in affected water bodies to less than significant levels are not available, implementation of Mitigation Measure WQ-7 is recommended to attempt to reduce the effect that increased chloride concentrations may have on Delta beneficial uses. However, because the effectiveness of this mitigation measure to result in feasible measures for reducing water quality effects is uncertain, this impact is considered to remain significant and unavoidable.

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

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

It is currently unknown whether the effects of increased chloride levels, and potential adverse effects on municipal and industrial water supply and fish and wildlife beneficial uses associated with CM1 operations (and hydrodynamic effects of tidal restoration under CM4), can be mitigated through modifications to initial operations. Specifically, it remains to be determined whether, or to what degree, the available and existing salinity response and countermeasure actions of SWP and CVP facilities, municipal water purveyors, or Suisun Marsh salinity control facilities would be capable of offsetting the actual level of changes in chloride that may occur from implementation of Alternative 4. Therefore, the proposed mitigation measures require a series of actions to identify and evaluate potentially feasible actions, to achieve reduced chloride levels in order to reduce or avoid impacts to beneficial uses.

The development and implementation of any mitigation actions shall be focused on those incremental effects attributable to implementation of Alternative 4 operations only. Development of mitigation actions for the incremental chloride effects attributable to climate change/sea level rise are not required because these changed conditions would occur with or without implementation of Alternative 4.

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

Following commencement of initial operations of CM1, the BDCP proponents will conduct additional evaluations described herein, and develop additional modeling (as necessary), to define the extent to which modified operations could reduce or eliminate the additional exceedances of the 250 mg/L Bay-Delta WQCP objective for chloride currently modeled to occur under Alternative 4. The additional evaluations should also consider specifically the changes in Delta hydrodynamic conditions associated with tidal habitat restoration under CM4 (in particular the potential for increased chloride concentrations that could result from increased tidal exchange) once the specific restoration locations are identified and designed. If sufficient operational flexibility to offset chloride increases is not feasible under Alternative 4 operations, achieving chloride reduction pursuant to this mitigation measure would not be feasible under this alternative.

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

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

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

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

Impact WQ-8: Effects on Chloride Concentrations Resulting from Implementation of CM2–CM22

NEPA Effects: The implementation of the other conservation measures (i.e., CM2–CM22), of which most do not involve land disturbance, present no new direct sources of chloride to the affected environment, including areas Upstream of the Delta, within the Plan Area, and the SWP/CVP Export Service Area, nor would they affect channel flows or Delta hydrodynamic conditions. As noted above, the potential effects of implementation of tidal habitat restoration (i.e., CM4) on Delta hydrodynamic conditions is addressed above in the discussion of Impact WQ-8. The potential channel flow effects of CM2 for actions in the Yolo Bypass also were accounted for in the CALSIM II and DSM2 modeling, and thus were addressed in the discussion for Impact WQ-8. CM3 and CM11 provide the mechanism, guidance, and planning for the land acquisition and thus would not, themselves, affect chloride levels in the Delta. CM12–CM22 involve actions that target reduction in other stressors at the species level involving actions such as methylmercury reduction management (CM12), improving DO in the Stockton Deep Water Ship Channel (CM14), and urban stormwater treatment (CM19). None of CM12–CM22 would contribute to substantially increasing chloride levels in the Delta. Consequently, as they pertain to chloride, implementation of CM2–CM22 would not be expected to adversely affect any of the beneficial uses of the affected environment. Moreover, some habitat restoration conservation measures (CM4–CM10) would occur on lands within the Delta currently used for irrigated agriculture, thus replacing agricultural land uses with restored tidal wetlands, floodplain, and related channel margin and off-channel habitats. The potential reduction in irrigated lands within the Delta may result in reduced discharges of agricultural field drainage with elevated chloride concentrations, which would be considered an improvement compared to the No Action Alternative.

In summary, based on the discussion above, the effects on chloride from implementing CM2-CM22 are considered to be not adverse.

CEQA Conclusion: Implementation of the CM2–CM22 for Alternative 4 would not present new or substantially changed sources of chloride to the affected environment upstream of the Delta, within Delta, or in the SWP/CVP service area. Replacement of irrigated agricultural land uses in the Delta with habitat restoration conservation measures may result in some reduction in discharge of agricultural field drainage with elevated chloride concentrations, thus resulting in improved water quality conditions. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

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

Upstream of the Delta

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

The four operational scenarios of Alternative 4 would alter the magnitude and timing of water releases from reservoirs upstream of the Delta relative to Existing Conditions and the No Action Alternative, which would consequently alter downstream river flows. There would be some increases and decreases in the mean monthly river flows, depending on month and year. Mean monthly flows would remain within the range historically seen under Existing Conditions and the No Action Alternative. Moreover, these are large, turbulent rivers with flow velocities typically in the range of 0.5 fps to 2.0 fps or higher. Consequently, flow changes that would occur under any operational scenario of Alternative 4 would not be expected to have substantial effects on river DO levels; likely, the changes would be immeasurable. This is because sufficient turbulence and interaction of river water with the atmosphere would continue to occur under this alternative to maintain water saturation levels (due to these factors) at levels similar to that of Existing Conditions and the No Action Alternative.

The changes in the magnitude and timing of water releases from reservoirs upstream of the Delta, relative to Existing Conditions and the No Action Alternative, could affect downstream river temperatures, depending on month and year. Water temperature affects the maximum DO saturation level; as temperature increases, the DO saturation level decreases. When holding constant for barometric pressure (e.g., 760 mm mercury), the DO saturation level ranges from 7.5 mg/L at 30°C (86°F) to 11 mg/L at 10°C (50°F) (Tchobanoglous and Schroeder 1987:735). As described in the affected environment section, DO in the Sacramento River at Keswick, Feather River at Oroville, and lower American River ranged from 7.3 to 15.6 mg/L, 7.4 to 12.5 mg/L, and 6.5 to 13.0 mg/L, respectively. Thus, these rivers are well oxygenated and experience periods of supersaturation (i.e., when DO level exceeds the saturation concentration). Because these are large, turbulent rivers, any reduced DO saturation level that would be caused by an increase in temperature under any operational scenario of Alternative 4 would not be expected to cause DO levels to be outside of the range seen historically. This is because sufficient turbulence and interaction of river water with the atmosphere would continue to occur under this alternative to maintain saturation levels.

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

An effect on salinity (expressed as EC) would not be expected in the rivers and reservoirs upstream of the Delta. Thus, these parameters would not be expected to measurably change DO levels under any of the operational scenarios of Alternative 4, relative to Existing Conditions or the No Action Alternative.

Delta

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

Under all operational scenarios of Alternative 4, minor DO level changes could occur due to nutrient loading to the Delta relative to Existing Conditions and the No Action Alternative (see WQ-1, WQ-15, WQ-23). The state has begun to aggressively regulate point-source discharge effects on Delta nutrients, and is expected to further regulate nutrients upstream of and in the Delta in the future. Although population increased in the affected environment between 1983 and 2001, average monthly DO levels during this period of record show no trend in decline in the presence of presumed increases in anthropogenic sources of nutrients (see Table 4.4-15 in the ES/AE section). Based on these considerations, excessive nutrients that would cause low DO levels would not be expected to occur under any operational scenario of Alternative 4.

Various areas of the Delta could experience salinity increases due to change in quantity of Delta inflows (see WQ-11) For a 5 ppt salinity increase at 68° Fahrenheit, the saturation level of oxygen dissolved in the water is reduced by only about 0.25 mg/L. Thus, increased salinity under Alternative 4 would generally have relatively minor effects on Delta DO levels where salinity is increased on the order of 5 ppt or less.

The relative degree of tidal exchange of flows and turbulence, which contributes to exposure of Delta waters to the atmosphere for reaeration, would not be expected to substantially change relative to Existing Conditions or the No Action Alternative, such that these factors would reduce Delta DO levels below objectives or levels that protect beneficial uses.

As discussed in the section on DO in section 8.3.1.7 Effects of climate change on air and Delta water temperatures are discussed in Appendix 29C. In general, waters of the Delta would be expected to warm less than 5 degrees F under Alternative 4, relative to Existing Conditions, due to climate change, which translates into a < 0.5 mg/L decrease in DO saturation. Thus, increased temperature under Alternative 4 would generally have relatively minor effects on Delta DO levels, relative to Existing Conditions.

Some waterways in the eastern, southern, and western Delta are listed on the state's Clean Water Act section 303(d) list as impaired due to low oxygen levels. A TMDL for the Deep Water Ship channel in the eastern Delta has been approved and identifies the factors contributing to low DO in the Deep Water Ship Channel as oxygen demanding substances from upstream sources, Deep Water Ship Channel geometry, and reduced flow through the Deep Water Ship Channel (Central Valley Water Board 2005:28). The TMDL takes a phased approach to allow more time to gather additional informational on sources and linkages to the DO impairment, while at the same time moving forward on making improvements to DO conditions. One component of the TMDL implementation activities is an aeration device demonstration project. It is expected that under Alternative 4 that DO levels in the Deep Water Ship Channel would remain similar to those under Existing Conditions and the No Action Alternative or improve as the TMDL-required studies are completed and actions are implemented to improve DO levels. DO levels in other Clean Water Act section 303(d)-listed waterways would not be expected to change relative to Existing Conditions or the No Action Alternative, as the circulation of flows, tidal flow exchange, and re-aeration would continue to occur.

SWP/CVP Export Service Areas

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

NEPA Effects: The effects on dissolved oxygen from implementing any operational scenario of Alternative 4 is determined to not be adverse.

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

River flow rate and reservoir storage reductions that would occur under any operational scenario of Alternative 4, relative to Existing Conditions, would not be expected to result in a substantial adverse change in DO levels in the reservoirs and rivers upstream of the Delta, given that mean monthly flows would remain within the ranges historically seen under Existing Conditions and the affected river are large and turbulent. Any reduced DO saturation level that may be caused by increased water temperature would not be expected to cause DO levels to be outside of the range seen historically. Finally, amounts of oxygen demanding substances and salinity would not be expected to change sufficiently to affect DO levels.

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

There is not expected to be substantial, if even measurable, changes in DO levels in the SWP/CVP Export Service Areas waters under any operational scenario of Alternative 4, relative to Existing Conditions, because the biochemical oxygen demand of the exported water would not be expected to substantially differ from that under Existing Conditions (due to ever increasing water quality regulations), canal turbulence and exposure of the water to the atmosphere and the algal communities that exist within the canals would establish an equilibrium for DO levels within the canals. The same would occur in downstream reservoirs.

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

Impact WQ-10: Effects on Dissolved Oxygen Resulting from Implementation of CM2–CM22

***NEPA Effects*:** CM2–CM22 would not be expected to contribute to adverse DO levels in the Delta. The increased habitat provided by CM2–CM11 could contribute to an increased biochemical or sediment demand, through contribution of organic carbon and plants decaying. However, similar habitat exists currently in the Delta and is not identified as contributing to adverse DO conditions. Although additional DOC loading to the Delta may occur (see impact WQ-18), only a fraction of the DOC is available to microorganisms that would consume oxygen as part of the decay and mineralization process. Since decreases in dissolved organic carbon are not typically observed in Delta waterways due to these processes, any increase in DOC is unlikely to contribute to adverse DO levels in the Delta. CM14, an oxygen aeration facility in the Stockton Deep Water Ship Channel to meet TMDL objectives established by the Central Valley Water Board, would maintain DO levels above those that impair fish species when covered species are present. CM19, which would fund projects to contribute to reducing pollutant discharges in stormwater, would be expected to reduce biochemical oxygen demand load and, thus, would not adversely affect DO levels. The remaining conservation measures would not be expected to affect DO levels because they are actions that do not affect the presence of oxygen-demanding substances.

The effects on dissolved oxygen from implementing CM2–CM22 is determined to not be adverse.

***CEQA Conclusion*:** It is expected that DO levels in the Upstream of the Delta Region, in the Plan Area, or in the SWP/CVP Export Service Areas following implementation of CM2–CM22 under Alternative 4 would not be substantially different from existing DO conditions. Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would result in significant impacts on any beneficial uses within affected water bodies. Because no substantial changes in DO levels would be expected, long-term water quality degradation would not be expected, and, thus, beneficial uses would not be adversely affected. Various Delta waterways are 303(d)-listed for low DO, but because no substantial decreases in DO levels would be expected, greater degradation and impairment of these areas would not be expected. Implementation of CM14 would have a net beneficial effect on DO conditions in the Stockton Deep Water Ship Channel. This impact would be less than significant. No mitigation is required.

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

Upstream of the Delta

Alternative 4, Scenarios H1–H4, would alter the magnitude and timing of water releases from reservoirs upstream of the Delta relative to Existing Conditions and the No Action Alternative. With respect to EC, an increase or decrease in river flow alone is not of concern. Measureable changes in the quality of the watershed runoff and reservoir inflows would not be expected to occur in the future; therefore, the EC levels in these reservoirs would not be expected to change relative to Existing Conditions or the No Action Alternative. There could be increased discharges of EC-elevating parameters in the future in water bodies upstream of the Delta as a result of urban growth and increased runoff and wastewater discharges. The state has begun to aggressively regulate point-source discharge effects on Delta salinity-elevating parameters, capping dischargers at existing levels, and is expected to further regulate EC and related parameters upstream of and within the Delta in the future as salt management plans are developed. Based on these considerations, EC levels (highs, lows, typical conditions) in the Sacramento River and its tributaries, the eastside tributaries, or their associated reservoirs upstream of the Delta would not be expected to be outside the ranges occurring under Existing Conditions or the No Action Alternative.

The effects on lower San Joaquin River EC would be somewhat different. Elevated EC in the San Joaquin River can be sourced to agricultural use of irrigation water imported from the southern Delta and applied on soils high in salts. This accumulation of salts is a primary contributor of elevated EC on the lower San Joaquin River. Tributary flows generally provide dilution of the high EC agricultural drainage waters. Depending on operational scenario, long-term average flows at Vernalis would decrease about 6% (as a result of climate change and increased water demands) relative to Existing Conditions, and would increase about 0.1% relative to the No Action Alternative (Appendix 5A). These decreases in flow, alone, would correspond to a possible increase in long-term average EC levels. The level of EC increase cannot be readily quantified but, based on estimated increase in bromide and chloride concentrations, to which EC is correlated, would be relatively small and on the order of about 3% relative to Existing Conditions, and less than 0.1% relative to the No Action Alternative. However, with the implementation of the adopted TMDL for the San Joaquin River at Vernalis and the ongoing development of the TMDL for the San Joaquin River upstream of Vernalis and its implementation, it is expected that long-term EC levels will improve. Based on these considerations, substantial changes in EC levels in the San Joaquin River relative to Existing Conditions or the No Action Alternative would not be expected of sufficient magnitude and geographic extent that would result in adverse effects on any beneficial uses, or substantially degrade the quality of these water bodies, with regard to EC.

Delta

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

Relative to Existing Conditions, Alternative 4, Scenarios H1–H4, would result in an increase in the number of days the Bay-Delta WQCP EC objectives would be exceeded in the Sacramento River at

Emmaton, San Joaquin River at San Andreas Landing and Prisoners Point, and Old River near Middle River and at Tracy Bridge (Appendix 8H, Table EC-4). The percent of days the Emmaton EC objective would be exceeded for the entire period modeled (1976–1991) would increase from 6% under Existing Conditions to 23–25%, depending on the operations scenario, and the percent of days out of compliance would increase from 11% under Existing Conditions to 35–38%, depending on the operations scenario. The percent of days the San Andreas Landing EC objective would be exceeded would increase from 1% to 3–4%, depending on the operations scenario. The percent of days out of compliance with the EC objective for San Andreas Landing would increase from 1% to 5–7%, depending on the operations scenario. The percent of days the Prisoners Point EC objective would be exceeded for the entire period modeled would increase from 6% to 20–31% and the percent of days out of compliance with the EC objective would increase from 10% to 22–31%, depending on the operations scenario. The increase in percent of days exceeding the EC objectives and days out of compliance at the Old River locations would be 1–2% at Tracy Bridge and less than 1% at Middle River for all operations scenarios. Average EC levels at the western and southern Delta compliance locations would decrease, except at Emmaton, from 1–36% for the entire period modeled and 2–33% during the drought period modeled (1987–1991) (Appendix 8H, Tables EC-15A through EC-15D). At Emmaton, there would be an increase in average EC under all operational scenarios, though the increase would be less for scenarios H3 and H4 (0% for entire period; 8% for drought period) than for scenarios H1 and H2 (13–14% for entire period; 12–13% for drought period). There would be increases in average EC at two interior Delta locations under all operational scenarios: the S. Fork Mokelumne River at Terminous average EC would increase 5% for the entire period modeled and 4% during the drought period modeled; and San Joaquin River at San Andreas Landing average EC would increase 0–9% for the entire period modeled and 7–13% during the drought period modeled. In addition, under Scenarios H1 and H2, there would be slight increase (<1–2%) in drought period average EC in the San Joaquin River at Prisoners Point. On average, EC would increase at San Andreas Landing from March through September under all operations scenarios; Scenarios H1, H2, and H4 also would increase EC at this location in February and Scenarios H1 and H2 would increase EC in October. Average EC in the S. Fork Mokelumne River at Terminous would increase during all months (Appendix 8H, Tables EC-15A through EC-15D). The comparison to Existing Conditions reflects changes in EC due to both Alternative 4 operations (including north Delta intake capacity of 9,000 cfs and numerous other operational components of Scenarios H1–H4) and climate change/sea level rise.

Relative to the No Action Alternative, the percent of days exceeding EC objectives and percent of days out of compliance would increase at: Sacramento River at Emmaton, San Joaquin River at Jersey Point, San Andreas Landing, and Prisoners Point; and Old River near Middle River and at Tracy Bridge (Appendix 8H, Table EC-4). The increase in percent of days exceeding the EC objective would be 19–30% at Prisoners Point, depending on the operations scenario, and 13% or less at the remaining locations. The increase in percent of days out of compliance would be 21–30% at Prisoners Point, depending on the operations scenario, and 16% or less at the remaining locations. For the entire period modeled, average EC levels would increase at western (scenarios H1 and H2 only), interior, and southern Delta locations; the average EC increase would be 12–13% at Emmaton (western Delta; for scenarios H1 and H2 only), 5–15% at interior Delta locations and 2% or less at southern Delta locations, depending on the operations scenario (Appendix 8H, Tables EC-15A through EC-15D). During the drought period modeled, average EC would increase at western (scenarios H1 and H2 only), interior, and southern Delta locations. The greatest average EC increase during the drought period modeled would occur in the interior Delta in the San Joaquin River at San Andreas Landing (7–13% depending on the operations scenario); the increase at the other locations would be <1–9% (Appendix 8H, Tables EC-15A through EC-15D). The comparison to the No Action Alternative reflects changes in EC due only to the different operational components of Scenarios H1–H4 of Alternative 4.

For Suisun Marsh, October–May is the period when Bay-Delta WQCP EC objectives for protection of fish and wildlife apply. Average EC for the entire period modeled would increase in the Sacramento River at Collinsville during the months of March through May under all operations scenarios of Alternative 4, relative to Existing Conditions, by 0.3–0.9 mS/cm (Appendix 8H, Table EC-21). Long-term average EC would decrease under all operations scenarios, relative to Existing Conditions, in Montezuma Slough at National Steel during October–May (Appendix 8H, Table EC-22). The most substantial EC increase would occur near Beldon Landing, with long-term average EC levels increasing by 1.3–6.0 mS/cm, depending on the month and operations scenario, at least doubling during some months the long-term average EC relative to Existing Conditions (Appendix 8H, Table EC-23). Sunrise Duck Club and Volanti Slough also would have long-term average EC increases during all months ranging 0.5–3.9 mS/cm (Appendix 8H, Tables EC-24 and EC-25). The degree to which the long-term average EC increases would cause exceedance of Bay-Delta WQCP objectives is unknown, because objectives are expressed as a monthly average of daily high tide EC, which does not have to be met if it can be demonstrated "equivalent or better protection will be provided at the location" (State Water Resources Control Board 2006:14). 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 be substantial and it is uncertain the degree to which current management plans for the Suisun Marsh would be able to address these substantially higher EC levels and protect beneficial uses. Thus, these increased EC levels in Suisun Marsh are considered to have a potentially adverse effect on marsh beneficial uses. Long-term average EC increases in Suisun Marsh under Alternative 4, Scenarios H1–H4, relative to the No Action Alternative would be similar to the increases relative to Existing Conditions.

SWP/CVP Export Service Area

At the Banks and Jones pumping plants, Alternative 4, Scenarios H1–H4, would result in no exceedances of the Bay-Delta WQCP's 1,000 μmhos/cm EC objective for the entire period modeled (Appendix 8H, Table EC-10). Thus, there would be no adverse effect on the beneficial uses in the SWP/CVP Export Service Areas using water pumped at this location under the Alternative 4.

At the Banks pumping plant, relative to Existing Conditions, average EC levels under Alternative 4, Scenarios H1–H4, would decrease 23–27% for the entire period modeled and 21–27% during the drought period modeled, depending on the operations scenario. Relative to the No Action Alternative, average EC levels would similarly decrease, by 17–22% for the entire period modeled and 16–22% during the drought period modeled. (Appendix 8H, Tables EC-15A through EC-15D)

At the Jones pumping plant, relative to Existing Conditions, average EC levels under Alternative 4, Scenarios H1–H4, would decrease 21–26% for the entire period modeled and 17–23% during the drought period modeled, depending on the operations scenario. Relative to the No Action Alternative, average EC levels would similarly decrease by 17–22% for the entire period modeled and 14–20% during the drought period modeled. (Appendix 8H, Table EC-13)

Based on the decreases in long-term average EC levels that would occur at the Banks and Jones pumping plants, Alternative 4, Scenarios H1–H4, would not cause degradation of water quality with respect to EC in the SWP/CVP Export Service Areas; rather, Alternative 4, Scenarios H1–H4, would improve long-term average EC conditions in the SWP/CVP Export Service Areas.

Commensurate with the EC decrease in exported waters, an improvement in lower San Joaquin River average EC levels would be expected since EC in the lower San Joaquin River is, in part, related to irrigation water deliveries from the Delta. While the magnitude of this expected lower San Joaquin River improvement in EC is difficult to predict, the relative decrease in overall loading of EC-elevating constituents to the Export Service Areas would likely alleviate or lessen any expected increase in EC at Vernalis related to decreased annual average San Joaquin River flows.

The export area of the Delta is listed on the state's CWA Section 303(d) list as impaired due to elevated EC. Alternative 4, Scenarios H1–H4, would result in lower average EC levels relative to Existing Conditions and the No Action Alternative and, thus, would not contribute to additional beneficial use impairment related to elevated EC in the SWP/CVP Export Service Areas waters.

NEPA Effects: In summary, the increased frequency of exceedance of EC objectives and increased long-term and drought period average EC levels that would occur at western, interior, and southern Delta compliance locations under Alternative 4, Scenarios H1–H4, relative to the No Action Alternative, would contribute to adverse effects on the agricultural beneficial uses. In addition, the increased frequency of exceedance of the San Joaquin River at Prisoners Point EC objective and long-term and drought period average EC could contribute to adverse effects on fish and wildlife beneficial uses. Given that the western and southern Delta are CWA section 303(d) listed as impaired due to elevated EC, the increase in the incidence of exceedance of EC objectives and long-term average and drought period average EC in this portion of the Delta has the potential to contribute to additional beneficial use impairment. The increases in long-term average EC levels that would occur in Suisun Marsh would further degrade existing EC levels and could contribute additional to adverse effects on the fish and wildlife beneficial uses. Suisun Marsh is CWA section 303(d) listed as impaired due to elevated EC, and the potential increases in long-term average EC levels could contribute to additional beneficial use impairment. These increases in EC constitute an adverse effect on water quality. Mitigation Measure WQ-11 would be available to reduce these effects (implementation of this measure along with a separate, non-environmental commitment as set forth in EIR/EIS Appendix 3B, *Environmental Commitments*, relating to the potential EC-related changes would reduce these effects).

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

River flow rate and reservoir storage reductions that would occur under Alternative 4, Scenarios H1–H4, relative to Existing Conditions, would not be expected to result in a substantial adverse change in EC levels in the reservoirs and rivers upstream of the Delta, given that: changes in the quality of watershed runoff and reservoir inflows would not be expected to occur in the future; the state's aggressive regulation of point-source discharge effects on Delta salinity-elevating parameters and the expected further regulation as salt management plans are developed; the salt-related TMDLs adopted and being developed for the San Joaquin River; and the expected improvement in lower San Joaquin River average EC levels commensurate with the lower EC of the irrigation water deliveries from the Delta.

Relative to Existing Conditions, Alternative 4, Scenarios H1–H4, would not result in any substantial increases in long-term average EC levels in the SWP/CVP Export Service Areas. There would be no exceedance of the EC objective at the Jones and Banks pumping plants. Average EC levels for the entire period modeled would decrease at both plants and, thus, this alternative would not contribute to additional beneficial use impairment related to elevated EC in the SWP/CVP Export Service Areas waters. Rather, this alternative would improve long-term EC levels in the SWP/CVP Export Service Areas, relative to Existing Conditions.

In the Plan Area, Alternative 4, Scenarios H1–H4, would result in an increase in the frequency with which Bay-Delta WQCP EC objectives are exceeded for the entire period modeled (1976–1991): in the Sacramento River at Emmaton (agricultural objective; 17–19% increase) in the western Delta, and in the San Joaquin River at San Andreas Landing (agricultural objective; 2–3% increase) and Prisoners Point (fish and wildlife objective; 14–25% increase), both in the interior Delta; and in Old River near Middle River and at Tracy Bridge (agricultural objectives; up to 2% increase), both in the southern Delta. Average EC levels at Emmaton would increase by <1–14% for the entire period modeled and 8–13% during the drought period modeled. Average EC levels at San Andreas Landing would increase by 0–9% during for the entire period modeled and 7–13% during the drought period modeled. The increases in long-term and drought period average EC levels and increased frequency of exceedance of EC objectives that would occur in the Sacramento River at Emmaton and San Joaquin River at San Andreas Landing would potentially contribute to adverse effects on the agricultural beneficial uses in the western and interior Delta. Further, the increased frequency of exceedance of the fish and wildlife objective at Prisoners Point could contribute to adverse effects on aquatic life. Because EC is not bioaccumulative, the increases in long-term average EC levels would not directly cause bioaccumulative problems in aquatic life or humans. The western and southern Delta are CWA section 303(d) listed for elevated EC and the increased frequency of exceedance of EC objectives that would occur in these portions of the Delta could make beneficial use impairment measurably worse. This impact is considered to be significant.

Further, relative to Existing Conditions, Alternative 4, Scenarios H1–H4, would result in substantial increases in long-term average EC during the months of October through May in Suisun Marsh, such that EC levels would be double that relative to Existing Conditions. The increases in long-term average EC levels that would occur in Suisun Marsh could further degrade existing EC levels and thus contribute additionally to adverse effects on the fish and wildlife beneficial uses. Because EC is not bioaccumulative, the increases in long-term average EC levels would not directly cause bioaccumulative problems in fish and wildlife. Suisun Marsh is CWA section 303(d) listed for elevated EC and the increases in long-term average EC that would occur in the marsh could make beneficial use impairment measurably worse. This impact is considered to be significant.

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

In addition to and to supplement Mitigation Measure WQ-11, the BDCP proponents have incorporated into the BDCP, as set forth in EIR/EIS Appendix 3B, *Environmental Commitments*, a

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

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

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

Mitigation Measure WQ-11a: Conduct Additional Evaluation and Modeling of Increased EC Levels Following Initial Operations of CM1

Following commencement of initial operations of CM1, the BDCP proponents will conduct additional evaluations described herein, and develop additional modeling (as necessary), to define the extent to which modified operations could reduce or eliminate the additional exceedances of the Bay-Delta WQCP objectives for EC currently modeled to occur under Alternative 4. The additional evaluations should also consider specifically the changes in Delta hydrodynamic conditions associated with tidal habitat restoration under CM4 (in particular the potential for increased EC concentrations that could result from increased tidal exchange) once the specific restoration locations are identified and designed. If sufficient operational flexibility to offset EC increases is not feasible under Alternative 4 operations, achieving EC reduction pursuant to this mitigation measure would not be feasible under this Alternative.

Mitigation Measure WQ-11b: Consult with CDFW/USFWS, and Suisun Marsh Stakeholders, to Identify Potential Actions to Avoid or Minimize EC Level Increases in the Marsh

In order to determine the feasibility of reducing the effects of CM1/CM4 operations on increased EC concentrations as shown in modeling estimates to occur in the Suisun Marsh, the BDCP proponents will 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-12: Effects on Electrical Conductivity Resulting from Implementation of CM2–CM22

NEPA Effects: The implementation of the other conservation measures (i.e., CM2–CM22) present no new direct sources of EC to the affected environment, including areas upstream of the Delta, within the Delta region, and in the SWP/CVP Export Service Areas. As they pertain to EC, implementation of these conservation measures would not be expected to adversely affect any of the beneficial uses of the affected environment. Moreover, some habitat restoration conservation measures would occur on lands within the Delta currently used for irrigated agriculture. Such replacement or substitution of land use activity is not expected to result in new or increased sources of EC to the Delta and, in fact, could decrease EC through elimination of high EC agricultural runoff.

CM4 would result in substantial tidal habitat restoration that would increase the magnitude of daily tidal water exchange at the restoration areas, and alter other hydrodynamic conditions in adjacent Delta channels. The DSM2 modeling included assumptions regarding possible locations of tidal habitat restoration areas, and how restoration would affect Delta hydrodynamic conditions, and thus the effects of this restoration measure on Delta EC were included in the assessment of CM1 facilities operations and maintenance.

Implementation of CM2–CM22 would not be expected to adversely affect EC levels in the affected environment and thus would not adversely affect beneficial uses or substantially degrade water quality with regard to EC within the affected environment.

The effects on EC from implementing CM2–CM22 is determined to not be adverse.

CEQA Conclusion: Implementation of CM2–CM22 under Alternative 4 would not present new or substantially changed sources of EC to the affected environment. Some conservation measures may replace or substitute for existing irrigated agriculture in the Delta. This replacement or substitution is not expected to substantially increase or present new sources of EC, and could actually decrease EC loads to Delta waters. Thus, implementation of CM2–CM22 would have negligible, if any, adverse effects on EC levels throughout the affected environment and would not cause exceedance of applicable state or federal numeric or narrative water quality objectives/criteria that would result in adverse effects on any beneficial uses within affected water bodies. Further, implementation of CM2–CM22 would not cause significant long-term water quality degradation such that there would be greater risk of adverse effects on beneficial uses. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

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

Upstream of the Delta

Under the various Alternative 4 scenarios (H1–H4), greater water demands and climate change would alter the magnitude and timing of reservoir releases and river flows upstream of the Delta in the Sacramento River watershed and east-side tributaries, relative to Existing Conditions.

The Sacramento River at Freeport and San Joaquin River at Vernalis (as summarized for water quality average concentrations in Tables 8-48 and 8-49) were examined for flow/concentration relationships for mercury and methylmercury. No significant, predictive regression relationships were discovered for mercury or methylmercury, except for total mercury with flow at Freeport (monthly or annual) (Appendix 8I, Figure 8I-10 through 8I-13). Such a positive relationship between total mercury and flow is to be expected based on the association of mercury with suspended sediment and the mobilization of sediments during storm flows. However, the changes in flow in the Sacramento River under the operational scenarios of Alternative 4 relative to Existing Conditions and No Action Alternative are not of the magnitude of storm flows, in which substantial sediment-associated mercury is mobilized. Therefore mercury loading should not be substantially different due to changes in flow. In addition, even though it may be flow-affected, total mercury concentrations remain well below criteria at upstream locations. Any negligible changes in mercury concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies as related to mercury. Both waterborne methylmercury concentrations and largemouth bass fillet mercury concentrations are expected to remain above guidance levels at upstream of Delta locations, but will not change substantially relative to Existing Conditions or No Action Alternative due to changes in flows under the operational scenarios of Alternative 4.

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

Delta

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

The water quality impacts of waterborne concentrations of mercury (Appendix 8I, Table I-5) and methylmercury (Appendix 8I, Table I-6) and fish tissue mercury concentrations (Appendix 8I, Tables I-11A through I-11D) were evaluated for 9 Delta locations.

The analysis of percentage change in assimilative capacity of waterborne total mercury of Alternative 4 scenarios as compared to Existing Conditions showed the greatest decrease to be of -2.4% in the Old River at Rock Slough and the Contra Costa Pumping Plant for scenario. These are bounded by Alternative 4 H1 estimates of -1.4% and -1.5% at these two locations, respectively. In contrast the greatest increase in assimilative capacity relative to Existing Conditions was 4.4% for H4 at the Jones Pumping Plant (Figures 8-53 through 8-54). Scenarios H2 and H3 range in changes in assimilative capacity in relation to Existing Conditions from -2.1% (H3 at Contra Costa Pumping Plant to 4.1 (H2 at Banks). These small changes in assimilative capacity are not expected to result in adverse (or positive) effects to beneficial uses.

As compared to the No Action Alternative, Alternative 4 H4 showed the greatest range in changes in assimilative capacity for total mercury; ranging from 5.0% at the Jones Pumping Plant to -2.3% at the Old River site. These same sites show the smallest range of effects for Alternative 4 H1; with 4.3% and -1.4% for these same two stations, respectively. Scenarios H2 and H3 fall between these extremes. However, these small ranges of changes are not expected to result in adverse effects to beneficial uses.

All methylmercury concentrations in water were estimated to exceed TMDL guidelines and no assimilative capacity exists. Changes in methylmercury concentration are expected to be very small. The greatest annual average methylmercury concentration for drought conditions was 0.163 ng/L for the San Joaquin River at Buckley Cove (all scenarios) which was slightly higher than Existing Conditions (0.161 ng/L) and slightly lower than the No Action Alternative (0.167 ng/L)(Appendix 8I Table I-6). In general, the Alternative 4 H4 conditions were highest in concentration and Alternative 4 H1 was lowest, as compared among scenarios for modeled methylmercury concentrations in water. All modeled concentrations exceeded the methylmercury TMDL guidance objective of 0.06 ng/L, therefore percentage change in assimilative capacity was not evaluated for methylmercury.

Similar to waterborne methylmercury, fish tissue mercury concentration estimates all exceed TMDL guidelines. Percentage changes were somewhat larger than for waterborne concentrations, but not expected to result in changes to beneficial use. Fish tissue estimates show only small or no increases in EQs based on long-term annual average concentrations for mercury at the Delta locations (Appendix 8I, Table I-11Aa through I-11Db). The greatest increase over Existing Conditions was for scenario H4 and was 15% at Old River at Rock Slough and 13% for Franks Tract as compared to H1 estimates for both of those locations of 9% (Table 1-11 Ab – Db). In comparison to the No Action Alternative, the greatest increases in concentrations mirrored the Existing Condition comparisons and were estimated to be 12% for Old River at Rock Slough, and 12% for Franks Tract. Scenario H1 provided the lowest set of percent changes in bass mercury for those locations (Figure 8-55, Appendix 8I Tables I-11Aa through I-11Db).

SWP/CVP Export Service Areas

The analysis of mercury and methylmercury in the SWP/CVP Export Service Areas was based on concentrations estimated at the Banks and Jones pumping plants. Both waterborne total and methylmercury concentrations for Alternative 4, all scenarios, at the Jones and Banks pumping plants, were lower than Existing Conditions and the No Action Alternative (Appendix 8I, Figures 8I-4 and 8I-5). Therefore, mercury shows an increased assimilative capacity at these locations (Figures

8-53 and 8-54). The greatest increase was 5% for scenario H4 for Jones Plant (compared to No Action); the least was H2 at Banks of 2.9% (compared to Existing Conditions).

The largest improvements in bass tissue mercury concentrations and EQs for Alternative 4, relative to Existing Conditions and the No Action Alternative at any location within the Delta are expected for the export pump locations. The greatest improvement in bass tissue mercury concentration are expected for scenario H4 at the Banks and Jones pumping plants (-14% and -16%, respectively) (Figure 8-55, Appendix 8I Table I-11Aa through I-11Db).

***NEPA Effects*:** Based on the above discussion, the effects of mercury and methylmercury in comparison of Scenarios H1–H4 of Alternative 4 to the No Action Alternative (as waterborne and bioaccumulated forms) are not considered to be adverse.

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

Under Alternative 4, greater water demands and climate change would alter the magnitude and timing of reservoir releases and river flows upstream of the Delta in the Sacramento River watershed and east-side tributaries, relative to Existing Conditions. Concentrations of mercury and methylmercury upstream of the Delta will not be substantially different relative to Existing Conditions due to the lack of important relationships between mercury/methylmercury concentrations and flow for the major rivers.

Methylmercury concentrations exceed criteria at all locations in the Delta and no assimilative capacity exists. However, monthly average waterborne concentrations of total and methylmercury, over the period of record, are very similar to Existing Conditions. Similarly, estimates of fish tissue mercury concentrations show almost no differences would occur among sites for Alternative 4 scenarios as compared to Existing Conditions for Delta sites. The greatest changes in assimilative capacity and tissue mercury estimates were for scenario H4; these least for scenario H1.

Assessment of effects of mercury in the SWP and CVP Export Service Areas were based on effects on mercury concentrations and fish tissue mercury concentrations at the Banks and Jones pumping plants. The Banks and Jones pumping plants are expected to show increased assimilative capacity for waterborne mercury and decreased fish tissue concentrations of mercury for Alternative 4, all scenarios, as compared to Existing Conditions.

As such, none of the H1–H4 scenarios for this alternative are expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because mercury concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Because any increases in mercury or methylmercury concentrations are not likely to be measurable, changes in mercury concentrations or fish tissue mercury concentrations would not make any existing mercury-related impairment measurably worse. In comparison to Existing Conditions, Alternative 4 would not increase levels of mercury by frequency, magnitude, and geographic extent such that the affected environment would be expected to have measurably higher body burdens of mercury in aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish) or humans consuming those organisms. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-14: Effects on Mercury Concentrations Resulting from Implementation of CM2–22

***NEPA Effects*:** Some habitat restoration activities under Alternative 4 would occur on lands in the Delta formerly used for irrigated agriculture. Tidal and other restoration proposed under Alternative 4 have the potential to increase water residence times and increase accumulation of organic sediments that are known to enhance methylmercury bioaccumulation in biota in the restored habitat. Therefore, increases in mercury methylation in the habitat restoration areas is possible but uncertain depending on the specific restoration design implemented at a particular Delta location. Models to estimate the potential for methylmercury formation in restored areas are not currently available. However, DSM2 modeling for Alternative 4 operations does incorporate assumptions for certain habitat restoration activities proposed under CM2 and CM4 (see Section 8.3.1.3) that result in changes to Delta hydrodynamics compared to the No Action Alternative. These modeled restoration assumptions provide some insight into potential hydrodynamic changes that could be expected related to implementing CM2 and CM4 and are considered in the evaluation of the potential for increased mercury and methylmercury concentrations under Alternative 4.

BDCP Conservation Measure 12 (CM12) addresses the potential for methylmercury bioaccumulation associated with restoration activities and acknowledges the uncertainties associated with mitigating or minimizing this potential effect. CM12 proposes project-specific mercury management plans for restoration actions that will incorporate relevant approaches recommended in Phase 1 Methylmercury TMDL control studies. Specific approaches recommended under CM12 that are intended to minimize or mitigate for potential increases in methylmercury bioaccumulation at future restoration sites include:

- Characterizing mercury, methylmercury, organic carbon, iron, and sulfate concentrations to better inform restoration design,
- Sequestering methylmercury at restoration sites using low intensity chemical dosing techniques,
- Minimizing microbial methylation associated with anoxic conditions by reducing the amount of organic material at a restoration site (this approach could limit the benefit of restoration areas by limiting the amount of carbon supplied by these areas to the Delta as a whole. In some cases, this would run directly counter to the goals and objectives of the BDCP. This approach should not be implemented in such a way that it reduces the benefits to the Delta ecosystem provided by restoration areas),
- Designing restoration sites to enhance photo degeneration that converts methylmercury into a biologically unavailable, inorganic form of mercury,
- Remediating restoration site soils with iron to reduce methylation in sulfide rich soils, and
- Considering capping mercury laden sediments, where feasible, to reduce methylation potential at a site.

Because of the uncertainties associated with site-specific estimates of methylmercury concentrations and the uncertainties in source modeling and tissue modeling, the effectiveness of methylmercury management proposed under CM12 to reduce methylmercury concentrations would need to be evaluated separately for each restoration effort, as part of design and implementation.

Because of this uncertainty and the known potential for methylmercury creation in the Delta this potential effect of implementing CM2–CM22 is considered adverse.

***CEQA Conclusion*:** There would be no substantial, long-term increase in mercury or methylmercury concentrations or loads in the rivers and reservoirs upstream of the Delta or the waters exported to the CVP and SWP service areas due to implementation of CM2–CM22 relative to Existing Conditions. However, in the Delta, uptake of mercury from water and/or methylation of inorganic mercury may increase to an unquantified degree as part of the creation of new, marshy, shallow, or organic-rich restoration areas. Methylmercury is 303(d)-listed within the affected environment, and therefore any potential measurable increase in methylmercury concentrations would make existing mercury-related impairment measurably worse. Because mercury is bioaccumulative, increases in water-borne mercury or methylmercury that could occur in some areas could bioaccumulate to somewhat greater levels in aquatic organisms and would, in turn, pose health risks to fish, wildlife, or humans. Design of restoration sites under Alternative 4 would be guided by CM12 which requires development of site specific mercury management plans as restoration actions are implemented. The effectiveness of minimization and mitigation actions implemented according to the mercury management plans is not known at this time, although the potential to reduce methylmercury concentrations exists based on current research. Although the BDCP will implement CM12 with the goal to reduce this potential effect, the uncertainties related to site specific restoration conditions and the potential for increases in methylmercury concentrations in the Delta result in this potential impact being considered significant. No mitigation measures would be available until specific restoration actions are proposed. Therefore this programmatic impact is considered significant and unavoidable.

Impact WQ-15: Effects on Nitrate Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Although point sources of nitrate do exist upstream of the Delta in the Sacramento River watershed, nitrate levels in the major rivers (Sacramento, Feather, American) are low, generally due to ample dilution available in the rivers relative to the magnitude of the discharges. Furthermore, while many dischargers have already improved facilities to remove more nitrate, many others are likely to do so over the next few decades. Non-point sources of nitrate within the Sacramento watersheds are also relatively low, thus resulting in generally low nitrate-N concentrations in the reservoirs and rivers of the watershed. Furthermore, there is no correlation between historical water year average nitrate concentrations and water year average flow in the Sacramento River at Freeport (Nitrate Appendix 8J, Figure 1). Consequently, any modified reservoir operations and subsequent changes in river flows under various operational scenarios of Alternative 4, relative to Existing Conditions or the No Action Alternative, are expected to have negligible, if any, effects on average reservoir and river nitrate-N concentrations in the Sacramento River watershed upstream of the Delta.

In the San Joaquin River watershed, nitrate concentrations are higher than in the Sacramento watershed, owing to use of nitrate based fertilizers throughout the lower watershed. The correlation between historical water year average nitrate concentrations and water year average flow in the San Joaquin River at Vernalis is a weak inverse relationship—that is, generally higher flows result in lower nitrate concentrations, while low flows result in higher nitrate concentrations (linear regression r^2=0.49, Nitrate Appendix 8J, Figure 2). Under Alternative 4, Scenarios H1–H4, modeling indicates that long-term annual average flows on the San Joaquin River would decrease by an estimated 6% relative to Existing Conditions, and would remain virtually the same relative to the No Action Alternative (Appendix 5A). Given these relatively small decreases in flows and the weak correlation between nitrate and flows in the San Joaquin River (see Nitrate Appendix 8J, Figure 2), it is expected that nitrate concentrations in the San Joaquin River would be minimally affected, if at all, by changes in flow rates under any operational scenario of Alternative 4.

Any negligible changes in nitrate-N concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regards to nitrate.

Delta

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

Mixing calculations indicate that under Alternative 4 (including the different operational components of Scenarios H1–H4), relative to Existing Conditions and the No Action Alternative, nitrate concentrations throughout the Delta are anticipated to remain low (<1.4 mg/L-N) relative to adopted objectives (Nitrate Appendix 8J, Table 16, 17A/17D). Although changes at specific Delta locations and for specific months may be substantial on a relative basis, the absolute concentration of nitrate in Delta waters would remain low (<1.4 mg/L-N) in relation to the drinking water MCL of 10 mg/L-N, as well as all other thresholds identified in Table 8-50. Long-term average nitrate concentrations are anticipated to remain below 1 mg/L-N at all 11 assessment locations except the San Joaquin River at Buckley Cove, where long-term average concentrations would be somewhat above 1 mg/L-N. Nevertheless, at this location, long-term average nitrate concentration would be somewhat reduced under Alternative 4 relative to Existing Conditions, and slightly increased relative to the No Action Alternative. Regardless of operational scenario, no additional exceedances of the MCL are anticipated at any location under Alternative 4 (Nitrate Appendix 8J, Table 16).

Use of assimilative capacity relative to the drinking water MCL of 10 mg/L-N under the four operational scenarios of Alternative 4 is low or negligible (i.e., <5%) in comparison to both Existing Conditions and the No Action Alternative, for all locations and months, for all modeled years, and for the drought period (Nitrate Appendix 8J, Table 18A/18D). One exception is for Buckley Cove on the San Joaquin River in August, where use of assimilative capacity available during the drought period (1987–1991) relative to the No Action Alternative for the four operational scenarios of Alternative 4 ranged from 6.3% to 6.5%.

Nitrate concentrations will likely be higher than the modeling results indicate in certain locations. This includes in the Sacramento River between Freeport and Mallard Island and other areas in the Delta downstream of Freeport that are influenced by Sacramento River water. These increases are associated with ammonia and nitrate that are discharged from the SRWTP, which are not included in the modeling.

- Under Existing Conditions, most of the ammonia discharged from the SRWTP is converted to nitrate downstream of the facility's discharge at Freeport, and thus, nitrate concentrations under Existing Conditions in these areas are expected to be higher than the modeling predicts, the increase becoming greater with increasing distance downstream. However, the increase in nitrate concentrations downstream of the SRWTP is expected to be small—the existing increase appears to be from approximately 0.1 mg/L-N to approximately 0.4–0.5 mg/L-N over this reach, due to approximately a 1:1 conversion of ammonia-N to nitrate-N (Central Valley Water Board 2010a:32).

- Under the four operational scenarios of Alternative 4, the planned upgrades to the SRWTP, which include nitrification/partial denitrification, would substantially decrease ammonia concentrations in the discharge, but would increase nitrate concentrations in the discharge up to 10 mg/L-N, which is substantially higher than under Existing Conditions.
- Overall, under the four operational scenarios of Alternative 4, the nitrogen load from the SRWTP discharge is expected to decrease (by up to 50%), relative to Existing Conditions, due to nitrification/partial dentrification ugrades at the SRWTP facility. Thus, while concentrations of nitrate downstream of the facility are expected to be higher than modeling results indicate for both Existing Conditions and the four operational scenarios of Alternative 4, the increase is expected to be greater under Existing Conditions than for the four operational scenarios of Alternative 4 due to the upgrades that are assumed under the four operational scenarios of Alternative 4.

The other areas in which nitrate concentrations will be higher than the modeling results indicate are immediately downstream of other wastewater treatment plants that practice nitrification, but not denitrification (e.g., City of Rio Vista Beach WWTF, Town of Discovery Bay WWTF, City of Stockton RWCF). For all such facilities in the Delta, the Regional Water Boards have issued NPDES permits that allow discharge of wastewater containing nitrate into the Delta, and under these permits, the State has determined that no beneficial uses are adversely affected by the discharge, and that the discharger's use of available assimilative capacity of the water body is acceptable. When dilution is necessary in order for the discharge to be in compliance with the Basin Plans (which incorporate the 10 mg/L-N MCL by reference), not all of the assimilative capacity of the receiving water is granted to the discharger. Thus, limited decreases in flows are not anticipated to result in systemic exceedances of the MCLs by these POTWs. Furthermore, NPDES permits are renewed on a 5-year basis, and thus, if under changes in flows, dilution was no longer sufficient to maintain nitrate below the MCL in the receiving water, the NPDES permit renewal process would address such cases.

In summary, any increases in nitrate-N concentrations that may occur at certain locations within the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to nitrate.

SWP/CVP Export Service Areas

Assessment of effects of nitrate in the SWP and CVP Export Service Areas is based on effects on nitrate-N at the Banks and Jones pumping plants.

Results of the mixing calculations indicate that the change in nitrate concentrations and use of assimilative capacity are similar for the four operational scenarios of Alternative 4 (Nitrate Appendix 8J, Tables 16, 17A/17D, 18A/18D). Relative to Existing Conditions and the No Action Alternative, nitrate concentrations at Banks and Jones pumping plants under Alternative 4 are anticipated to decrease on a long-term average annual basis (Nitrate Appendix 8J, Table 17A/17D). During the late summer, particularly in the drought period assessed, concentrations are expected to increase substantially on a relative basis (i.e., >50%), but the absolute value of these changes (i.e., in mg/L-N) is small. Additionally, given the many factors that contribute to potential algal blooms in the SWP and CVP canals within the Export Service Area, and the lack of studies that have shown a direct relationship between nutrient concentrations in the canals and reservoirs and problematic algal blooms in these water bodies, there is no basis to conclude that these small (i.e., generally <0.3 mg/L-N), seasonal increases in nitrate concentrations would increase the potential for problem algal blooms in the SWP and CVP Export Service Area. No additional exceedances of the MCL are anticipated (Nitrate Appendix 8J, Table 16). On a monthly average basis and on a long term annual average basis, for all modeled years and for the drought period (1987–1991) only, use of assimilative capacity available under Existing Conditions and the No Action Alternative, relative to the 10 mg/L-N MCL, was negligible (<5%) for both Banks and Jones pumping plants (Nitrate Appendix 8J, Table 18A/18D).

Any increases in nitrate-N concentrations that may occur in water exported via Banks and Jones pumping plants are not expected to result in adverse effects to beneficial uses or substantially degrade the quality of exported water, with regards to nitrate.

NEPA Effects: In summary, based on the discussion above, the effects on nitrate from implementing CM1 are considered to be not adverse.

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

Nitrate-N concentrations are generally low in the reservoirs and rivers of the watersheds, owing to substantial dilution available for point sources and the lack of substantial nonpoint sources of nitrate-N upstream of the SRWTP in the Sacramento River watershed, and in the watersheds of the eastern tributaries (Cosumnes, Mokelumne, and Calaveras Rivers). Although higher in the San Joaquin River watershed, nitrate-N concentrations are not well-correlated with flow rates. Consequently, any modified reservoir operations and subsequent changes in river flows under Alternative 4, relative to Existing Conditions, are expected to have negligible, if any, effects on reservoir and river nitrate-N concentrations upstream of Freeport in the Sacramento River watershed and upstream of the Delta in the San Joaquin River watershed.

In the Delta, results of the mixing calculations indicate that under the four operational scenarios of Alternative 4 (H1 through H4), relative to Existing Conditions, nitrate concentrations throughout the Delta are anticipated to remain low (<1.4 mg/L-N) relative to adopted objectives. No additional exceedances of the MCL are anticipated at any location, and use of assimilative capacity available under Existing Conditions, relative to the drinking water MCL of 10 mg/L-N, was low or negligible (i.e., <5%) for all operational scenarios for virtually all locations and months.

Assessment of effects of nitrate in the SWP and CVP Export Service Areas is based on effects on nitrate-N concentrations at the Banks and Jones pumping plants. Results of the mixing calculations indicate that under Alternative 4 (including the different operational components of Scenarios H1–H4), relative to Existing Conditions, long-term average nitrate concentrations at Banks and Jones pumping plants are anticipated to change negligibly. No additional exceedances of the MCL are anticipated, and use of assimilative capacity available under Existing Conditions, relative to the MCL was negligible (i.e., <5%) for both Banks and Jones pumping plants for all months.

Based on the above, there would be no substantial, long-term increase in nitrate-N concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the waters exported to the CVP and SWP service areas under Alternative 4 relative to Existing Conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because nitrate concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Nitrate is not 303(d) listed within the affected environment and thus any increases that may occur in some areas and months would not make any existing nitrate-related impairment measurably worse because no such impairments currently exist. Because nitrate is not bioaccumulative, increases that may occur in some areas and months would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-16: Effects on Nitrate Concentrations Resulting from Implementation of CM2–CM22

NEPA Effects**:** Some habitat restoration activities included in CM2–CM11 would occur on lands within the Delta formerly used for agriculture. It is expected that this will decrease nitrate concentrations in the Delta, due to less use of nitrate-based fertilizers, relative to the No Action Alternative. Modeling scenarios included assumptions regarding how certain habitat restoration activities (i.e., CM2 and CM4) would affect Delta hydrodynamics, and thus such effects of these restoration measures were included in the assessment of CM1 facilities operations and maintenance (see Impact WQ-1). In general, aside from changes in Delta hydrodynamics resulting from habitat restoration discussed in Impact WQ-1, CM2–CM11 proposed for Alternative 4 are not expected to increase nitrate concentrations in water bodies of the affected environment, relative to the No Action Alternative.

Because urban stormwater is a source of nitrate in the affected environment, CM19, Urban Stormwater Treatment, is expected to slightly reduce nitrate loading to the Delta, thus slightly decreasing nitrate-N concentrations relative to the No Action Alternative. Implementation of CM12–CM18 and CM20–CM22 is not expected to substantially alter nitrate concentrations in any of the water bodies of the affected environment.

The effects on nitrate from implementing CM2–22 are considered to be not adverse.

CEQA Conclusion**:** There would be no substantial, long-term increase in nitrate-N concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the waters exported to the CVP and SWP service areas due to implementation of CM2–CM22 under Alternative 4, Scenarios H1–H4, relative to Existing Conditions. Because urban stormwater is a source of nitrate in the affected environment, CM19, Urban Stormwater Treatment, is expected to slightly reduce nitrate loading to the Delta. As such, implementation of these conservation measures is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because nitrate concentrations are not expected to increase substantially due to these conservation measures, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Nitrate is not 303(d) listed within the affected environment and thus any minor increases that may occur in some areas would not make any existing nitrate-related impairment measurably worse because no such impairments currently exist. Because nitrate is not bioaccumulative, minor increases that may occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-17: Effects on Dissolved Organic Carbon Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Under Alternative 4, Scenarios H1–H4, there would be no substantial change to the sources of DOC within the watersheds upstream of the Delta. Moreover, long-term average flow and DOC levels in the Sacramento River at Hood and San Joaquin River at Vernalis are poorly correlated. Thus changes in system operations and resulting reservoir storage levels and river flows under the various operational scenarios of Alternative 4 would not be expected to cause a substantial long-term change in DOC concentrations in the water bodies upstream of the Delta. Any negligible changes in DOC levels in water bodies upstream of the Delta under Scenarios H1–H4 of Alternative 4, relative to Existing Conditions and the No Action Alternative, would not be of sufficient frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regards to DOC.

Delta

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

Under the four operational scenarios of Alternative 4, the geographic extent of effects pertaining to long-term average DOC concentrations in the Delta would be similar to that previously described for Alternative 1A, although the magnitude of predicted long-term change and relative frequency of concentration threshold exceedances would be slightly greater. For all the operational scenarios relative to Existing Conditions, the modeled effects would be greatest at Franks Tract, Rock Slough, and Contra Costa PP No. 1. Increased long-term average DOC concentrations at these locations would be greatest under Scenario H4 and would be least under Scenario H1, although differences would be generally small between operational scenarios (i.e., ≤0.2 mg/L). Under Scenario H4, long-term average DOC concentrations for the modeled 16-year hydrologic period and the modeled drought period would be predicted to increase between 0.4–0.5 mg/L at Franks Tract, Rock Slough, and Contra Costa PP No. 1 (≤14% net increase) (Appendix 8K, DOC Table 5). Under Scenario H4, increases in long-term average concentrations of between 0.4–0.5 mg/L at Franks Tract, Rock Slough, and Contra Costa PP No. 1 would correspond to more frequent concentration threshold exceedances, with the greatest change occurring at Rock Slough and Contra Costa PP No. 1 locations. For Rock Slough, long-term average DOC concentrations exceeding 3 mg/L would increase from 52% under Existing Conditions to 76% under Scenario H4 of Alternative 4 (an increase from 47% to 67% for the drought period), and concentrations exceeding 4 mg/L would increase from 30% to 38% (32% to 38% for the drought period). For Contra Costa PP No. 1, long-term average DOC concentrations exceeding 3 mg/L would increase from 52% under Existing Conditions to 81% under Scenario H4 of Alternative 4 (45% to 78% for the drought period), and concentrations exceeding 4 mg/L would increase from 32% to 45% (35% to 47% for the drought period). Relative change in frequency of threshold exceedance for the other operational scenarios and at other assessment locations would be similar or less. While all of the operational scenarios of Alternative 4 would generally lead to slightly higher long-term average DOC concentrations (≤0.5 mg/L) at some municipal water intakes and Delta interior locations, the predicted change would not be expected to adversely affect MUN beneficial uses, or any other beneficial use. This comparison to Existing Conditions reflects changes in DOC due to both Alternative 4 operations (including north Delta intake capacity of 9,000 cfs and the different operational components of Scenarios H1–H4) and climate change/sea level rise.

In comparison, relative to the No Action Alternative, the operational scenarios of Alternative 4 would generally result in a similar magnitude of change to that discussed for the Alternative 4 operational scenario comparison to Existing Conditions. Scenario H4 would generally lead to the largest model predicted long-term average DOC concentration increases, and Scenario H1 would generally lead to the smallest model predicted increases, although the relative difference between operational scenarios would be small (i.e., ≤0.2 mg/L). Under Scenario H4, maximum increases of 0.3–0.4 mg/L DOC (i.e., ≤12%) would be predicted at Franks Tract, Rock Slough, and Contra Costa PP No. 1 relative to No Action Alternative (Appendix 8K, DOC Table 5). For the operational scenarios, threshold concentration exceedance frequency trends would also be similar to that discussed for the existing condition comparison, with exception to the drought period predicted 4 mg/L exceedance frequency at Buckley Cove. In comparison to the No Action Alternative, and regardless of operational scenario, the frequency which long-term average DOC concentrations exceeded 4 mg/L during the modeled drought period at Buckley Cove would increase from 42% to 50%. While the operational scenarios of Alternative 4 would generally lead to slightly higher long-term average DOC concentrations at some Delta assessment locations when compared to No Action Alternative conditions, the predicted change would not be expected to adversely affect MUN beneficial uses, or any other beneficial use, particularly when considering the relatively small change in long-term annual average concentration. Unlike the comparison to Existing Conditions, this comparison to the No Action Alternative reflects changes in DOC due only to the different operational components of Scenarios H1–H4 of Alternative 4.

As discussed for Alternative 1A, substantial change in ambient DOC concentrations would need to occur before significant changes in drinking water treatment plant design or operations are triggered. The increases in long-term average DOC concentrations estimated to occur at various Delta locations under the four alternative operational scenarios of Alternative 4 are of sufficiently small magnitude that they would not require existing drinking water treatment plants to substantially upgrade treatment for DOC removal above levels currently employed.

Relative to existing and No Action Alternative conditions, Alternative 4 would lead to predicted improvements in long-term average DOC concentrations at Barker Slough, as well as Banks and Jones pumping plants (discussed below). At Barker Slough, long-term average DOC concentrations would be predicted to decrease by as much as 0.1–0.2 mg/L, depending on operational scenario, baseline conditions comparison and modeling period.

SWP/CVP Export Service Areas

Under all operational scenarios of Alternative 4, relative to Existing Conditions and the No Action Alternative, modeled long-term average DOC concentrations would decrease at Banks and Jones pumping plants. Modeled decreases would be greatest under Scenarios H2 and H4. Relative to Existing Conditions, long-term average DOC concentrations at Banks under Scenarios H2 and H4 would be predicted to decrease by 0.4 mg/L (0.4 mg/L during drought period) (Appendix 8K, DOC Table 5). At Jones, long-term average DOC concentrations would be predicted to decrease by 0.4 mg/L (<0.1 mg/L during drought period). Under all the operational scenarios, decreases in long-term average DOC would result in generally lower exceedance frequencies for concentration thresholds, although the frequency of exceedance during the modeled drought period (i.e., 1987–1991) in particular would be predicted to increase. For the Banks pumping plant during the drought period, exceedance of the 3 mg/L threshold would increase from 57% under Existing Conditions to as much as 83% under Scenario H3, and exceedance of the 4 mg/L concentration threshold would increase slightly for only Scenarios H1 and H3 from 42% to as much as 45%. At the Jones pumping plant, exceedance of the 3 mg/L concentration threshold during the drought period would increase from 72% under Existing Conditions to as much as 93% under Scenario H1, and exceedance of the 4 mg/L threshold would increase slightly for all operational scenarios, from 35% to as much as 41% for Scenario H4. Comparisons to the No Action Alternative yield similar trends, but with slightly smaller magnitude drought period changes. Overall, modeling results for the SWP/CVP Export Service Areas predict an overall improvement in Export Service Areas water quality, although more frequent exports of >3 mg/L DOC water would likely occur for drought periods.

Similar to the discussion pertaining to the No Action Alternative, maintenance of SWP and CVP facilities under Scenarios H1–H4 of Alternative 4 would not be expected to create new sources of DOC or contribute towards a substantial change in existing sources of DOC in the affected area. Maintenance activities would not be expected to cause any substantial change in long-term average DOC concentrations such that MUN beneficial uses, or any other beneficial use, would be adversely affected.

NEPA Effects: In summary, the operations and maintenance activities under Scenarios H1–H4 of Alternative 4, relative to the No Action Alternative, would not cause a substantial long-term change in DOC concentrations in the water bodies upstream of the Delta. Depending on operational scenario, long-term average DOC concentrations at Banks and Jones pumping plants are predicted to decrease by as much as 0.5 mg/L, while long-term average DOC concentrations for some Delta interior locations, including Contra Costa PP #1, are predicted to increase by as much as 0.4 mg/L. Regardless of operational scenario, the increase in long-term average DOC concentration that could occur within the Delta interior would not be of sufficient magnitude to adversely affect the MUN beneficial use, or any other beneficial uses, of Delta waters. The effect of operations and maintenance activities on DOC under Scenarios H1–H4 of Alternative 4 is determined not to be adverse.

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

While greater water demands under the operational scenarios of Alternative 4 would alter the magnitude and timing of reservoir releases north, south and east of the Delta, these activities would have no substantial effect on the various watershed sources of DOC. Moreover, long-term average flow and DOC at Sacramento River at Hood and San Joaquin River at Vernalis are poorly correlated; therefore, changes in river flows would not be expected to cause a substantial long-term change in DOC concentrations upstream of the Delta.

Relative to Existing Conditions, the operational scenarios of Alternative 4 would result in relatively small increases (i.e., ≤14%) in long-term average DOC concentrations at some Delta interior locations, including Franks Tract, Rock Slough, and Contra Costa PP No. 1. These increases would be greatest for Scenario H4, and least for Scenarios H1, although the difference in change would be relatively small. The predicted increases under the operational scenarios modeled would not substantially increase the frequency with which long-term average DOC concentrations exceeds 2, 3, or 4 mg/L. While Scenarios H1–H4 would generally lead to slightly higher long-term average DOC concentrations (≤0.2–0.5 mg/L) within the Delta interior and some municipal water intakes, the predicted change would not be expected to adversely affect MUN beneficial uses, or any other beneficial use.

The assessment of Alternative 4 Scenario H1–H4 effects on DOC in the SWP/CVP Export Service Areas is based on assessment of changes in DOC concentrations at Banks and Jones pumping plants. Relative decreases in long-term average DOC concentrations would be greatest under Scenarios H2 and H4, where long-predicted concentrations would decrease as much as 0.4 mg/L at Banks and Jones pumping plants. Regardless of operational scenario, however, slightly more frequent export of >3 mg/L DOC water is predicted during the drought period. Nevertheless, under any operational scenario, an overall improvement in DOC-related water quality would be predicted in the SWP/CVP Export Service Areas.

Based on the above, the operations and maintenance activities of Scenarios H1–H4 of Alternative 4 would not result in any substantial change in long-term average DOC concentration upstream of the Delta or result in substantial increase in the frequency with which long-term average DOC concentrations exceeds 2, 3, or 4 mg/L levels at the 11 assessment locations analyzed for the Delta. Increases in long-term average DOC concentrations at some Delta interior locations, including Franks Tract, Rock Slough, and Contra Costa PP No. 1 would be predicted, with the greatest increases occurring under Scenario H4 and the smallest increase occurring under Scenario H1. Under Scenario H4, modeled long-term average DOC concentrations would increase by no more than 0.5 mg/L at any single Delta assessment location (i.e., ≤14% relative increase) while under Scenario H1, modeled long-term DOC concentrations would increase by no more than 0.3 mg/L at any single Delta assessment location (i.e., ≤9% relative increase). For all operational scenarios considered, the increases in long-term average DOC concentration that could occur within the Delta would not be of sufficient magnitude to adversely affect the MUN beneficial use, or any other beneficial uses, of Delta waters or waters of the SWP/CVP Service Area. Because DOC is not bioaccumulative, the increases in long-term average DOC concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Finally, DOC is not causing beneficial use impairments and thus is not 303(d) listed for any water body within the affected environment. Thus, the increases in long-term average DOC that could occur at various locations would not make any beneficial use impairment measurably worse. Because long-term average DOC concentrations are not expected to increase substantially, no long-term water quality degradation with respect to DOC is expected to occur and, thus, no adverse effects on beneficial uses would occur This impact is considered to be less than significant. No mitigation is required.

Impact WQ-18: Effects on Dissolved Organic Carbon Concentrations Resulting from Implementation of CM2–CM22

***NEPA Effects*:** The mostly non-land disturbing CM12–CM22 present no new sources of DOC to the affected environment, including areas Upstream of the Delta, within the Plan Area, and the SWP/CVP Export Service Area. Implementation of methylmercury control measures (CM12) and urban stormwater treatment measures (CM19) may result in beneficial effects, to the extent that control measures treat or reduce organic carbon loading from tidal wetlands and urban land uses. Control of nonnative aquatic vegetation (CM13) may include killing mature aquatic vegetation in place, leading to their decay and contribution to DOC in Delta channels. However, this measure is not expected to be a significant source of long-term DOC loading as vegetation control would be sporadic and on an as needed basis, with decreasing need for treatments in the long-term as nonnative vegetation is eventually controlled and managed. Implementation of CM12–CM22 would not be expected to have substantial, if even measurable, effect on DOC concentrations upstream of the Delta, within the Delta, and in the SWP/CVP service areas. Consequently, any negligible increases in DOC levels in these areas of the affected environment are not expected to be of sufficient frequency, magnitude and geographic extent that they would adversely affect the MUN beneficial use, or any other beneficial uses, of the affected environment, nor would potential increases substantially degrade water quality with regards to DOC.

For CM2–CM11, effects on DOC concentrations can generally be considered in terms of: (1) alternative-caused change in Delta hydrodynamics, and (2) alternative-caused change in Delta DOC sources. Change in Delta hydrodynamics involves a two part process, including the conveyance facilities and operational scenarios of CM1, as well as the change in Delta channel geometry and open water areas that would occur as a consequence of implementing tidal wetland restoration measures such as that described for CM4. Modeling scenarios included assumptions regarding how these habitat restoration activities would affect Delta hydrodynamics, and thus the effects of these restoration measures, via their effects on delta hydrodynamics, were included in the assessment of CM1 facilities operations and maintenance (see Impact WQ-17). The potential for these same conservation measures to change Delta DOC sources are addressed below.

CM2, CM3, CM8, CM9, and CM11 could include activities that would target increasing primary production (i.e., algae growth) within the Delta. Algae currently are not estimated to be a major source of DOC in the Delta (CALFED Bay-Delta Program 2008a: 4, 6), and comprise mostly the particulate fraction of TOC. Conventional drinking water treatment removes much of the POC from raw source water; therefore, conservation measure activities targeted at increased algae production are not expected to contribute substantial amounts of new DOC, or adversely affect MUN beneficial use, or any other beneficial uses, of the affected environment.

CM4–CM7 and CM10 include land disturbing restoration activities known to be sources of DOC. Research within the Delta has focused primarily on non-tidal wetlands and flooding of Delta island peat soils. The dynamics of DOC production and export from wetlands and seasonally flooded soils is complex, as well as highly site and circumstance specific. Age and configuration of a wetland significantly affects the amount of DOC that may be generated in a wetland. In a study of a permanently flooded non-tidal constructed wetland on Twitchell Island, initial DOC loading was determined to be much greater (i.e., approximately 10 times greater) than equivalent area of agricultural land, but trends in annual loading led researchers to estimate that loading from the wetland would be equivalent to that of agriculture within about 15 years (Fleck et. al. 2007: 18). It was observed that the majority of the wetland load originated from seepage through peat soils.

Trends in declining load were principally associated with flushing of mobile DOC from submerged soils, the origins of which were related to previous agricultural activity prior to restoration to wetland. Peaks in annual loading, however, would be different, where peaks in agricultural drainage occur in winter months while peaks in wetland loading occur in spring and summer months. As such, age, configuration, location, operation, and season all factor into DOC loading, and long-term average DOC concentrations in the Delta.

Available evidence suggests that restoration activities establishing new tidal and non-tidal wetlands, new riparian and new seasonal floodplain habitat could potentially lead to new substantial sources of localized DOC loading within the Delta. If established in areas presently used for agriculture, these restoration activities could result in a substitution and temporary increase in localized DOC loading for years. Presently, the specific design, operational criteria, and location of these activities are not well established. Depending on localized hydrodynamics, such restoration activities could contribute substantial amounts of DOC to municipal raw water if established near municipal intakes. Substantially increased DOC concentrations in municipal source water may create a need for existing drinking water treatment plants to upgrade treatment systems in order to achieve EPA Stage 1 Disinfectants and Disinfection Byproduct Rule action thresholds. While treatment technologies sufficient to achieve the necessary DOC removals exist, implementation of such technologies would likely require substantial investment in new or modified infrastructure.

In summary, the habitat restoration elements of CM4–CM7 and CM10 under Alternative 4 would present new localized sources of DOC to the study area, and in some circumstances would substitute for existing sources related to replaced agriculture. Depending on localized hydrodynamics and proximity to municipal drinking water intakes, such restoration activities could contribute substantial amounts of DOC to municipal raw water. Substantial increases in municipal raw water DOC could necessitate changes in water treatment plant operations or require treatment plant upgrades in order to maintain DBP compliance, and thus would constitute an adverse effect on water quality. Mitigation Measure WQ-18 is available to reduce these effects.

CEQA Conclusion: Implementation of CM2, CM3, CM8, CM9, and CM11–CM22 would not present new or substantially changed sources of organic carbon to the affected environment of the Delta, and thus would not contribute substantially to changes in long-term average DOC concentrations in the Delta. Therefore, related long-term water quality degradation would not be expected to occur and, thus, no adverse effects on beneficial uses would occur through implementation of CM2, CM3, CM8, CM9, and CM11–CM22. Furthermore, DOC is not bioaccumulative, therefore changes in DOC concentrations would not cause bioaccumulative problems in aquatic life or humans. Nevertheless, implementation of CM4–CM7 and 10 would present new localized sources of DOC to the study area, and in some circumstances would substitute for existing sources related to replaced agriculture. Depending on localized hydrodynamics and proximity to municipal drinking water intakes, such restoration activities could contribute substantial amounts of DOC to municipal raw water. The potential for substantial increases in long-term average DOC concentrations related to the habitat restoration elements of CM4–CM7 and 10 could contribute to long-term water quality degradation with respect to DOC and, thus, adversely affect MUN beneficial uses. The impact is considered to be significant and mitigation is required. It is uncertain whether implementation of Mitigation Measure WQ-18 would reduce identified impacts to a less-than-significant level. Hence, this impact remains significant and unavoidable.

In addition to and to supplement Mitigation Measure WQ-18, the BDCP proponents have incorporated into the BDCP, as set forth in EIR/EIS Appendix 3B, *Environmental Commitments*, a

separate, non-environmental commitment to address the potential increased water treatment costs that could result from DOC concentration effects on municipal and industrial water purveyor operations. Potential options for making use of this financial commitment include funding or providing other assistance towards implementing treatment for DOC and/or DBPs or DOC source control strategies. Please refer to Appendix 3B, *Environmental Commitments*, for the full list of potential actions that could be taken pursuant to this commitment in order to reduce the water quality treatment costs associated with water quality effects relating to DOC.

Mitigation Measure WQ-18: Design Wetland and Riparian Habitat Features to Minimize Effects on Municipal Intakes

The BDCP proponents will design wetland and riparian habitat features taking into consideration effects on Delta hydrodynamics and impacts on municipal intakes. Locate restoration features such that impacts on municipal intakes are minimized and habitat benefits are maximized. Incorporate design features to control the load and/or timing of DOC exports from habitat restoration features. This could include design elements to control seepage from non-tidal wetlands (e.g., incorporation of slurry walls into levees), and features to increase retention time and decrease tidal exchange in tidal wetlands and riparian and channel margin habitat designs. For restoration features directly connected to open channel waters, design wetlands with only channel margin exchanges to decrease DOC loading. Stagger construction of wetlands and channel margin/riparian sites both spatially and temporally so as to allow aging of the restoration features and associated decreased creation of localized "hot spots" and net Delta loading.

The BDCP proponents will also establish measures to help guide the design and creation of the target wetland habitats. At a minimum, the measures should limit potential increases in long-term average DOC concentrations, and thus guide efforts to site, design, and maintain wetland and riparian habitat features, consistent with the biological goals and objectives of the BDCP. For example, restoration activities could be designed and located with the goal of preventing, consistent with the biological goals and objectives of the BDCP, net long-term average DOC concentration increases of greater than 0.5 mg/L at any municipal intake location within the Delta.

However, it must be noted that some of these measures could limit the benefit of restoration areas by limiting the amount of carbon supplied by these areas to the Delta as a whole. In some cases, these measures would run directly counter to the goals and objectives of the BDCP. This mitigation measure should not be implemented in such a way that it reduces the benefits to the Delta ecosystem provided by restoration areas. As mentioned above, the BDCP proponents have incorporated into the BDCP, as set forth in EIR/EIS Appendix 3B, *Environmental Commitments*, a separate, non-environmental commitment to address the potential increased water treatment costs that could result from DOC concentration effects on municipal and industrial water purveyor operations.

Impact WQ-19: Effects on Pathogens Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Under Alternative 4, Scenarios H1–H4, the only pathogen sources expected to change in the watersheds upstream of the Delta relative to Existing Conditions or the No Action Alternative would be associated with population growth, i.e., increased municipal wastewater discharges and development contributing to increased urban runoff.

Increased municipal wastewater discharges resulting from future population growth would not be expected to measurably increase pathogen concentrations in receiving waters due to state and federal water quality regulations requiring disinfection of effluent discharges and the state's implementation of Title 22 filtration requirements for many wastewater dischargers in the Sacramento River and San Joaquin River watersheds.

Pathogen loading from urban areas would generally occur in association with both dry and wet weather runoff from urban landscapes. Municipal stormwater regulations and permits have become increasingly stringent in recent years, and such further regulation of urban stormwater runoff is expected to continue in the future. Municipalities may implement BMPs for reducing pollutant loadings from urban runoff, particularly in response to NPDES stormwater-related regulations requiring reduction of pollutant loading in urban runoff. The ability of these BMPs to consistently reduce pathogen loadings and the extent of future implementation is uncertain, but would be expected to improve as new technologies are continually tested and implemented. Also, some of the urbanization may occur on lands used by other pathogens sources, such as grazing lands, resulting in a change in pathogen source, but not necessarily an increase (and possibly a decrease) in pathogen loading.

Pathogen concentrations in the Sacramento and San Joaquin Rivers have a minimal relationship to flow rate in these rivers, although most of the high concentrations observed have been during the wet months (Tetra Tech 2007). Further, urban runoff contributions during the dry season would be expected to be a relatively small fraction of the rivers' total flow rates. During wet weather events, when urban runoff contributions would be higher, the flows in the rivers also would be higher. Given the small magnitude of urban runoff contributions relative to the magnitude of river flows, that pathogen concentrations in the rivers have a minimal relationship to river flow rate, and the expected reduced pollutant loadings in response to NPDES stormwater-related regulations, river flow rate and reservoir storage reductions that would occur under Alternative 4, Scenarios H1–H4, relative to Existing Conditions and the No Action Alternative, would not be expected to result in a substantial adverse change in pathogen concentrations in the reservoirs and rivers upstream of the Delta. As such, none of the operational scenarios of Alternative 4 would be expected to substantially increase the frequency with which applicable Basin Plan objectives or U.S. EPA-recommended pathogen criteria would be exceeded in water bodies of the affected environment located upstream of the Delta or substantially degrade the quality of these water bodies, with regard to pathogens.

Delta

The *Conceptual Model for Pathogens and Pathogen Indicators in the Central Valley and Sacramento-San Joaquin Delta* (Pathogens Conceptual Model; Tetra Tech 2007) provides a comprehensive evaluation of factors affecting pathogen levels in the Delta. The Pathogens Conceptual Model characterizes relative pathogen contributions to the Delta from the Sacramento and San Joaquin Rivers and various pathogen sources, including wastewater discharges and urban runoff. Contributions from the San Francisco Bay to the Delta are not addressed. The Pathogens Conceptual Model is based on a database compiled by the Central Valley Drinking Water Policy Group in 2004–2005, supplemented with data from Natomas East Main Drainage Canal Studies, North Bay Aqueduct sampling, and the USGS. Data for multiple sites in the Sacramento River and San Joaquin River watersheds, and in the Delta were compiled. Indicator species evaluated include fecal coliforms, total coliforms, and *E. coli*. Because of its availability, *Cryptosporidium* and *Giardia* data for the Sacramento River also were evaluated. Key results of the data evaluation are:

Total Coliform

- In the Sacramento Valley, the highest total coliform concentrations (>10,0000 MPN/100 ml) were located near urban areas.
- Similarly high total coliform concentrations were not observed in the San Joaquin Valley, because reported results were capped at about 2,400 MPN/100 ml, though a large number of results were reported as being greater than this value.
- The data should not to be interpreted to conclude that Sacramento River has higher total coliform concentrations; rather, the "appearance" of the lower total coliform concentrations in the San Joaquin Valley is attributed to a lower upper limit of reporting (2,400 MPN/100 ml versus 10,000 MPN/100 ml).

E. coli

- Comparably high concentrations observed in the Sacramento River and San Joaquin River watersheds for waters affected by urban environments and intensive agriculture.
- The highest concentrations in the San Joaquin River were not at the most downstream location monitored, but rather at an intermediate location near Hills Ferry.
- *E. coli* concentrations in the Delta were somewhat higher than in the San Joaquin River and Sacramento River, indicating the importance of in-Delta sources and influence of distance of pathogen source on concentrations at a particular location in the receiving waters.
- Temporal (seasonal) trends were weak, however, the highest concentrations in the Sacramento River were observed during the wet months and the lowest concentrations were observed in July and August.

Fecal Coliform

- There was limited data from which to make comparisons/observations.

Cryptosporidium and Giardia

- Data were available only for the Sacramento River, limiting the ability to make comparisons between sources.
- Often not detected and when detected, concentrations typically less than 1 organism per liter.
- There may be natural/artificial barriers/processes that limit transport to water. Significant die off of those that reach the water contribute to the low frequency of detection.

The Pathogens Conceptual Model found that coliform indicators vary by orders of magnitudes over small distances and short time-scales. Concentrations appear to be more closely related to what happens in the proximity of a sampling station, rather than what happens in the larger watershed where significant travel time and concomitant pathogen die-off can occur. Sites in the Delta close to urban discharges had elevated concentrations of coliform organisms. The highest total coliform and *E. coli* concentrations were observed in the discharge from the Natomas East Main Drainage Canal and several stations near sloughs, indicating the relative influence of urban and wildlife pathogen sources on receiving water concentrations.

The effects of the operational scenarios of Alternative 4 relative to Existing Conditions and the No Action Alternative would be changes in the relative percentage of water throughout the Delta being comprised of various source waters (i.e., water from the Sacramento River, San Joaquin River, Bay water, eastside tributaries, and agricultural return flow), due to potential changes in inflows particularly from the Sacramento River watershed due to increased water demands (see Table 8-55) and somewhat modified SWP and CVP operations. However, it is expected there would be no substantial change in Delta pathogen concentrations in response to a shift in the Delta source water percentages under this alternative or substantial degradation of these water bodies, with regard to pathogens. This conclusion is based on the Pathogens Conceptual Model, which found that pathogen sources in close proximity to a Delta site appear to have the greatest influence on pathogen levels at the site, rather than the primary source(s) of water to the site. In-Delta potential pathogen sources, including water-based recreation, tidal habitat, wildlife, and livestock-related uses, would continue under this alternative.

SWP/CVP Export Service Areas

None of the operational scenarios of Alternative 4 are expected to result in substantial changes in pathogen levels in Delta waters, relative to Existing Conditions or the No Action Alternative. As such, there is not expected to be substantial, if even measurable, changes in pathogen concentrations in the SWP/CVP Export Service Area waters.

***NEPA Effects*: The effects on pathogens from implementing Alternative 4, Scenarios H1–H4, is determined to not be adverse.

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

River flow rate and reservoir storage reductions that would occur due to implementation of CM1 (water facilities and operations) under Alternative 4, relative to Existing Conditions, would not be expected to result in a substantial adverse change in pathogen concentrations in the reservoirs and rivers upstream of the Delta, given the small magnitude of urban runoff contributions relative to the magnitude of river flows, that pathogen concentrations in the rivers have a minimal relationship to river flow rate, and the expected reduced pollutant loadings in response to NPDES stormwater-related regulations.

It is expected there would be no substantial change in Delta pathogen concentrations in response to a shift in the Delta source water percentages under this alternative or substantial degradation of these water bodies, with regard to pathogens. This conclusion is based on the Pathogens Conceptual Model, which found that pathogen sources in close proximity to a Delta site appear to have the greatest influence on pathogen levels at the site, rather than the primary source(s) of water to the site. In-Delta potential pathogen sources, including water-based recreation, tidal habitat, wildlife, and livestock-related uses, would continue under this alternative.

In the SWP/CVP Export Service Areas waters, relative to Existing Conditions, an increased proportion of water coming from the Sacramento River would not adversely affect beneficial uses in the SWP/CVP Export Service Areas. The pathogen levels in the Sacramento River are similar to or lower than the water diverted at the Delta export pumps. Further, it is localized sources of pathogens that appear to have the greatest influence on concentrations. Thus, an increased proportion of Sacramento River water diverted to the SWP/CVP Export Service Areas would result in minimal changes in pathogen levels in the SWP/CVP Export Service Areas waters.

Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because pathogen concentrations are not expected to increase substantially, no long-term water quality degradation for pathogens is expected to occur and, thus, no adverse effects on beneficial uses would occur. The San Joaquin River in the Stockton Deep Water Ship Channel is Clean Water Act section 303(d) listed for pathogens. Because no measurable increase in Deep Water Ship Channel pathogen concentrations are expected to occur on a long-term basis, further degradation and impairment of this area is not expected to occur. Finally, pathogens are not bioaccumulative constituents. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-20: Effects on Pathogens Resulting from Implementation of CM2–CM22

***NEPA Effects*:** CM2–CM11 would involve habitat restoration actions, and CM22 involves waterfowl and shorebird areas. Tidal wetlands are known to be sources of coliforms originating from aquatic, terrestrial, and avian wildlife that inhabit these areas (Desmarais et al. 2001, Grant et al. 2001, Evanson and Ambrose 2006, Tetra Tech 2007). Specific locations of restoration areas for this alternative have not yet been established. However, most low-lying land suitable for restoration is unsuitable for livestock. Therefore, it is likely that the majority of land to be converted to wetlands would be crop-based agriculture or fallow/idle land. Because of a great deal of scientific uncertainty in the loading of coliforms from these various sources, the resulting change in coliform loading is uncertain, but it is anticipated that coliform loading to Delta waters would increase. Based on findings from the Pathogens Conceptual Model that pathogen concentrations are greatly influenced by the proximity to the source, this could result in localized increases in wildlife-related coliforms relative to the No Action Alternative. The Delta currently supports similar habitat types and, with the exception of the Clean Water Act section 303(d) listing for the Stockton Deep Water Ship Channel, is not recognized as exhibiting pathogen concentrations that rise to the level of adversely affecting beneficial uses. As such, the potential increase in wildlife-related coliform concentrations due to tidal habitat creation is not expected to adversely affect beneficial uses.

CM19, which would fund projects to contribute to reducing pollutant discharges in stormwater, would be expected to reduce pathogen load relative to the No Action Alternative. The remaining conservation measures would not be expected to affect pathogen levels, because they are actions that do not affect the presence of pathogen sources.

The effects on pathogens from implementing CM2–CM22 is determined to not be adverse.

***CEQA Conclusion*:** Based on findings from the Pathogens Conceptual Model that pathogen concentrations are greatly influenced by the proximity to the source, implementation of CM2–CM11 and CM22 could result in localized increases in wildlife-related coliforms relative to Existing Conditions. The Delta currently supports similar habitat types and, with the exception of the Clean Water Act section 303(d) listing for the Stockton Deep Water Ship Channel, is not recognized as exhibiting pathogen concentrations that rise to the level of adversely affecting beneficial uses. As such, the potential increase in wildlife-related coliform concentrations due to tidal habitat creation is not expected to adversely affect beneficial uses. Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because pathogen concentrations are not expected to increase substantially, no long-term water quality degradation for pathogens is expected to occur and, thus, no adverse effects on beneficial uses would occur. The San Joaquin River in the Stockton Deep Water Ship Channel is Clean Water Act section 303(d) listed for pathogens. Because no measurable increase in Deep Water Ship Channel pathogen concentrations are expected to occur on a long-term basis, further degradation and impairment of this area is not expected to occur. Finally, pathogens are not bioaccumulative constituents. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-21: Effects on Pesticide Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Residues of "legacy" OC pesticides enter rivers primarily through surface runoff and erosion of terrestrial soils during storm events, and through resuspension of riverine bottom sediments, the combination of which to this day may contribute to excursions above water quality objectives (Central Valley Water Board 2010c). Operation of the CVP/SWP does not affect terrestrial sources, but may result in geomorphic changes to the affected environment that ultimately could result in changes to sediment suspension and deposition. However, as discussed in greater detail for Turbidity/TSS, operations under any alternative would not be expected to change TSS or turbidity levels (highs, lows, typical conditions) to any substantial degree. Changes in the magnitude, frequency, and geographic distribution of legacy pesticides in water bodies of the affected environment that would result in new or more severe adverse effects on aquatic life or other beneficial uses, relative to Existing Conditions or the No Action Alternative, would not be expected to occur. Therefore, the pesticide assessment focuses on the present use pesticides for which substantial information is available, namely diazinon, chlorpyrifos, pyrethroids, and diuron.

Upstream of the Delta

Pyrethroid and OP insecticides are applied to agricultural fields, orchards, row crops, and confined animal facilities on an annual basis, with peaks in agricultural application during the winter dormant season (January–February) and during field cropping in the spring and summer. Applications of diuron occur year-round, but the majority of diuron is applied to road rights-of-way as a pre-emergent and early post emergent weed treatment during the late fall and early winter (Green and Young 2006). Pyrethroid insecticides and urban use herbicides are additionally applied around urban and residential structures and landscapes on an annual basis. These applications throughout the upstream watershed represent the source and potential pool of these pesticides that may enter the rivers upstream of the Delta by way of surface runoff and/or drift. Principal factors contributing to pesticide loading in the Sacramento River watershed include the amount of pesticide used and amount of precipitation (Guo et al. 2004). Although urban dry weather runoff occurs, this is generally believed to be less significant source of pesticides to main stem receiving waters, but for pyrethroids a recent study concluded that municipal wastewater treatment plants in Sacramento and Stockton represent a continuous year-round source of pyrethroids to the lower Sacramento and San Joaquin River's (Weston and Lydy 2010).

Pesticide-related toxicity has historically been observed throughout the affected environment regardless of season or water year type; however, toxicity is generally observed with increased incidence during spring and summer months of April to June, coincident with the peak in irrigated agriculture in the Sacramento and San Joaquin Valleys, as well as the winter rainy season, particularly December through February, coincident with urban and agricultural storm-water runoff and the orchard dormant spraying season (Fox and Archibald 1997). Although OP insecticide incidence and related toxicity can be observed throughout the year, diazinon is most frequently observed during the winter months and chlorpyrifos is most frequently observed in the summer irrigation months (Central Valley Water Board 2007). These seasonal trends coincide with their use, where diazinon is principally used as an orchard dormant season spray, and chlorpyrifos is primarily used on crops during the summer.

Application of diuron peaks in the late fall and early winter. Coincidently, diuron is found most frequently in surface waters during the winter precipitation and runoff months of January through March (Green and Young 2006), although diruon can be found much less frequently in surface waters throughout the year (Johnson et al. 2010).

Monitoring for pyrethroid insecticides in main-stem rivers is limited and detections are rather few. With the replacement of many traditionally OP related uses, however, it is conservatively assumed that pyrethroid incidence and associated toxicity could ultimately take a pattern of seasonality similar to that of the chlorpyrifos or diazinon.

In comparison to the Valley floor, relatively small amounts of pesticides are used in watersheds upstream of project reservoirs. Water released from reservoirs flow through urban and agricultural areas at which point these waters may acquire a burden of pesticide from agricultural or urban sourced discharges. These discharges with their potential burden of pesticides are effectively diluted by reservoir water. Under the operational scenarios of Alternative 4, no activity of the SWP or CVP would substantially drive a change in pesticide use, and thus pesticide sources would remain unaffected. Nevertheless, changes in the timing and magnitude of reservoir releases could have an effect on available dilution capacity along river segments such as the Sacramento, Feather, American, and San Joaquin Rivers.

Under the operational scenarios of Alternative 4, winter (November–March) and summer (April–October) season average flow rates on the Sacramento River at Freeport, American River at Nimbus, Feather River at Thermalito and the San Joaquin River at Vernalis would change. Relative to Existing Conditions and the No Action Alternative, seasonal average flow rates on the Sacramento for Scenarios H1–H4 would decrease no more than 7% during the summer and 4% during the winter (Appendix 8L, Seasonal average flows Tables 1-4). On the Feather River, average flow rates for Scenarios H1–H4 would decrease no more than 9% during the summer and 2% during the winter, while on the American River average flow rates would decrease by as much as 19% in the summer but would increase by as much as 8% in the winter. Seasonal average flow rates for Scenarios H1–H4 on the San Joaquin River would decrease by as much as 12% in the summer, but increase by as much as 1% in the winter.

As previously stated, historically chlorpyrifos is used in greater amounts in agriculture in the summer, and consequently observed in surface waters with greater frequency in the summer, while diazinon and diuron are used and observed in surface water with greater frequency in the winter. While flow reductions in the summer on the American River would not coincide with urban stormwater discharges, summer flow reductions on the San Joaquin River would correspond to the agricultural irrigation season. However, summer average flow reductions of up to 19% are not considered of sufficient magnitude to substantially increase in-river concentrations or alter the long-term risk of pesticide-related effects on aquatic life beneficial uses. Greater long-term average flow reductions, and corresponding reductions in dilution/assimilative capacity, would be necessary before long-term risk of pesticide related effects on aquatic life beneficial uses would be adversely altered.

Delta

Sources of diuron, OP and pyrethroid insecticides to the Plan Area include direct input of surface runoff from in-Delta agriculture and Delta urbanized areas as well as inputs from rivers upstream of the Delta. Similar to Upstream of the Delta, CVP/SWP operations under Scenarios H1–H4 of Alternative 4 would not affect these sources.

Under Scenarios H1–H4, the distribution and mixing of Delta source waters would change. Percent change in monthly average source water fraction were evaluated for the modeled 16-year (1976–1991) hydrologic period and a representative drought period (1987–1991), with special attention given to changes in San Joaquin River, Sacramento River and Delta Agriculture sources water fractions. Changes in source water fractions at the modeled Delta assessment locations would vary depending on operational scenario, but relative differences between the operational scenarios would be small. Relative to Existing Conditions, under Scenarios H1–H4 of Alternative 4 modeled San Joaquin River fractions would increase greater than 10% at Buckley Cove (drought period only), Franks Tract, Rock Slough, and Contra Costa PP No. 1, with the largest changes occurring under Scenario H4 (Appendix 8D, Source Water Fingerprinting). At Buckley Cove under Scenario H4, change in drought period San Joaquin River source water fractions would increase 11% in July and 16% in August. At Franks Tract under Scenario H4, change in San Joaquin River source water fractions when modeled for the 16-year hydrologic period, would increase 11–16% during October through November and February through June. At Rock Slough, modeled San Joaquin River source water fractions under Scenario H4 would increase 15–22% during September through March (11–15% during October and November of the modeled drought period). Similarly, under Scenario H4 modeled San Joaquin River fractions at Contra Costa Pumping Plant No. 1 would increase 15–23% during October through April (12% during October and November of the modeled drought period). While the modeled 22–23% increases of San Joaquin River Fraction at Rock Slough and Contra Costa PP No. 1 in November are considerable, the resultant net fraction would be ≤29%. For all operational scenarios, relative to Existing Conditions, there would be no modeled increases in Sacramento River fractions greater than 14% (with exception to Banks and Jones, discussed below) and Delta agricultural fractions greater than 8%. These modeled changes in the source water fractions of Sacramento, San Joaquin and Delta agriculture water are not of sufficient magnitude to substantially alter the long-term risk of pesticide-related toxicity to aquatic life, nor adversely affect other beneficial uses of the Delta.

When compared to the No Action Alternative, changes in source water fractions resulting from Scenarios H1–H4 would be similar in season, geographic extent, and magnitude to those discussed for Existing Conditions, with exception to Buckley Cove. Relative to the No Action Alternative, on a source water basis Buckley Cove is comprised predominantly of water of San Joaquin River origin (i.e., typically >80% San Joaquin River) for all months of the year but July and August. In July and August, the combined operational effects on Delta hydrodynamics of the Delta Cross Channel being open, the absence of a barrier at Head of Old River, and seasonally high exports from south Delta pumps results in substantially lower San Joaquin River source water fraction at Buckley Cove relative to all other months of the year. Under the operational scenarios of Alternative 4, however, modeled July and August San Joaquin River fractions at Buckley Cove would increase relative to the No Action Alternative, with increases between 16–17% in July (31–34% for the modeled drought period) and 24–25% in August (47–49% for the modeled drought period) (Appendix 8D, Source

Water Fingerprinting). Despite these San Joaquin River increases, the resulting net San Joaquin River source water fraction for July and August would remain less than all other months. As a result, these modeled changes in the source water fractions are not of sufficient magnitude to substantially alter the long-term risk of pesticide-related toxicity to aquatic life, nor adversely affect other beneficial uses of the Delta.

SWP/CVP Export Service Areas

Assessment of effects in SWP/CVP Export Service Areas is based on effects seen in the Plan Area at the Banks and Jones pumping plants. Under all operational scenarios of Alternative 4, Sacramento River source water fractions would increase substantially at both Banks and Jones pumping plants relative to Existing Conditions and the No Action Alternative (Appendix 8D, Source Water Fingerprinting). Sacramento River source water fractions would increase similarly by both season and magnitude extent under all operational scenarios at both Banks and Jones pumping plant. At Banks pumping plant, Sacramento source water fractions would generally increase from 16–48% for the period of January through June (12–35% for March through April of the modeled drought period) and at Jones pumping plant Sacramento source water fractions would generally increase from 21–56% for the period of January through June (15–48% for February through May of the modeled drought period). These increases in Sacramento source water fraction would primarily balance through equivalent decreases in San Joaquin River water. Based on the general observation that San Joaquin River, in comparison to the Sacramento River, is a greater contributor of OP insecticides in terms of greater frequency of incidence and presence at concentrations exceeding water quality benchmarks, modeled increases in Sacramento River fraction at Banks and Jones would generally represent an improvement in export water quality respective to pesticides.

NEPA Effects: In summary, the changes in long-term average flows on the Sacramento, Feather, American, and San Joaquin Rivers, under Scenarios H1–H4 of Alternative 4 relative to the No Action Alternative, are of insufficient magnitude to substantially increase the long-term risk of pesticide-related water quality degradation and related toxicity to aquatic life in these water bodies upstream of the Delta. Similarly, modeled changes in source water fractions to the Delta are of insufficient magnitude to substantially alter the long-term risk of pesticide-related water quality degradation and related toxicity to aquatic life in the Delta or CVP/SWP export service areas. The effects on pesticides from operations and maintenance (CM1) are determined not to be adverse.

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

Sources of pesticides upstream of the Delta include direct input of pesticide containing surface runoff from agriculture and urbanized areas. Flows in rivers receiving these discharges dilute these pesticide inputs. For all operational scenarios relative to Existing Conditions, however, modeled changes in long-term average flows on the Sacramento, Feather, American, and San Joaquin Rivers are of insufficient magnitude to substantially increase the long-term risk of pesticide-related water quality degradation and related toxicity to aquatic life in these water bodies upstream of the Delta.

In the Delta, sources of pesticides include direct input of surface runoff from Delta agriculture and Delta urbanized areas as well as inputs from rivers upstream of the Delta. While facilities operations and maintenance activities under Scenarios H1–H4 would not affect these sources, changes in Delta source water fraction could change the relative risk associated with pesticide related toxicity to aquatic life. Under Scenarios H1–H4 of Alternative 4, however, modeled changes in source water fractions relative to Existing Conditions are of insufficient magnitude to substantially alter the long-term risk of pesticide-related toxicity to aquatic life within the Delta, nor would such changes result in adverse pesticide-related effects on any other beneficial uses of Delta waters.

The assessment of Alternative 4 effects on pesticides in the SWP/CVP Export Service Areas is based on assessment of changes predicted at Banks and Jones pumping plants. As just discussed regarding Scenario H1–H4 effects to pesticides in the Delta, modeled changes in source water fractions at the Banks and Jones pumping plants are of insufficient magnitude to substantially alter the long-term risk of pesticide-related toxicity to aquatic life beneficial uses, or any other beneficial uses, in water bodies of the SWP and CVP export service area.

Based on the above, the considered operational scenarios of Alternative 4 would not result in any substantial change in long-term average pesticide concentration or result in substantial increase in the anticipated frequency with which long-term average pesticide concentrations would exceed aquatic life toxicity thresholds or other beneficial use effect thresholds upstream of the Delta, at the 11 assessment locations analyzed for the Delta, or the SWP/CVP service area. Numerous pesticides are currently used throughout the affected environment, and while some of these pesticides may be bioaccumulative, those present-use pesticides for which there is sufficient evidence for their presence in waters affected by SWP and CVP operations (i.e., diazinon, chlorpyrifos, diuron, and pyrethroids) are not considered bioaccumulative, and thus changes in their concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Furthermore, while there are numerous 303(d) listings throughout the affected environment that name pesticides as the cause for beneficial use impairment, the modeled changes in upstream river flows and Delta source water fractions under Scenarios H1–H4 would not be expected to make any of these beneficial use impairments measurably worse. Because long-term average pesticide concentrations are not expected to increase substantially, no long-term water quality degradation with respect to pesticides is expected to occur and, thus, no adverse effects on beneficial uses would occur. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-22: Effects on Pesticide Concentrations Resulting from Implementation of CM2–CM22

***NEPA Effects*:** With the exception of CM13, the mostly non-land disturbing CM12–CM22 present no new sources of pesticides to the affected environment, including areas Upstream of the Delta, within the Plan Area, and the SWP/CVP Export Service Area. Implementation of urban stormwater treatment measures (CM19) may result in beneficial effects, to the extent that control measures treat or reduce pesticide loading from urban land uses. However, control of nonnative aquatic vegetation (CM13) associated with tidal habitat restoration efforts would include killing invasive and nuisance aquatic vegetation through direct application of herbicides or through alternative mechanical means. Use and selection of type of herbicides would largely be circumstance specific, but would follow existing control methods used by the CDBW. The CDBW's use of herbicides is regulated by permits and regulatory agreements with the Central Valley Water Board, US Fish and Wildlife Service, and National Marine Fisheries Service and is guided by research conducted on the efficacy of vegetation control in the Delta through herbicide use. Through a program of adaptive management and assessment, the CDBW has employed a program of herbicide use that reduces potential environmental impacts, nevertheless, the CDBW found that impacts on water quality and associated aquatic beneficial uses would continue to occur and could not be avoided, including non-target impacts on aquatic invertebrates and beneficial aquatic plants (California Department of Boating and Waterways 2006).

In addition to the potential beneficial and adverse effects of CM19 and CM13, respectively, the various restoration efforts of CM2–CM11 could involve the conversion of active or fallow agricultural lands to natural landscapes, such as wetlands, grasslands, floodplains, and vernal pools. In the long-term, conversion of agricultural land to natural landscapes could possibly result in a limited reduction in pesticide use throughout the Delta. In the short-term, tidal and non-tidal wetland restoration, as well as seasonal floodplain restoration (i.e., CM4, CM5, and CM10) over former agricultural lands may include the contamination of water with pesticide residues contained in the soils. Present use pesticides typically degrade fairly rapidly, and in such cases where pesticide containing soils are flooded, dissipation of those pesticides would be expected to occur rapidly. Moreover, seasonal floodplain restoration (CM5) and Yolo Bypass enhancements (CM2) may be managed alongside continuing agriculture, where pesticides may be used on a seasonal basis and where water during flood events may come in contact with residues of these pesticides. Similarly, however, rapid dissipation would be expected, particularly in the large volumes of water involved in flooding. During these flooding events, pesticides potentially suspended in water would not be expected to cause toxicity to aquatic life or cause substantial adverse effects on any other beneficial uses of these water bodies.

In summary, CM13 of Alternative 4 proposes the use of herbicides to control invasive aquatic vegetation around habitat restoration sites. Herbicides directly applied to water could adversely affect non-target aquatic life, such as aquatic invertebrates and beneficial aquatic plants. Use of herbicides could potentially exceed aquatic life toxicity objectives with sufficient frequency and magnitude such that beneficial uses would be adversely affected, thus constituting an adverse effect on water quality. Mitigation Measure WQ-22 would be available to reduce this effect.

CEQA Conclusion: With the exception of CM13, implementation of CM2–CM22 would not present new or substantially increased sources of pesticides in the Plan Area. In the long-term, implementation of conservation measures could possibly result in a limited reduction in pesticide use throughout the Delta through the potential repurposing of active or fallow agricultural land for natural habitat purposes. In the short-term, the repurposing of agricultural land associated with CM4, CM5, and CM10 may expose water used for habitat restoration to pesticide residues. Moreover, CM2 and CM5 may be managed alongside continuing agriculture, where pesticides may be used on a seasonal basis and where water during flood events may come in contact with residues of these pesticides. However, rapid dissipation would be expected, particularly in the large volumes of water involved in flooding, such that aquatic life toxicity objectives would not be exceeded by frequency, magnitude, and geographic extent whereby adverse effects on beneficial uses would be expected. Conservation Measures 2–22 do not include the use of pesticides known to be bioaccumulative in animals or humans, nor do the conservation measures propose the use of any pesticide currently named in a Section 303(d) listing of the affected environment. CM13 proposes the use of herbicides to control invasive aquatic vegetation around habitat restoration sites. Herbicides directly applied to water could include adverse effects on non-target aquatic life, such as aquatic invertebrates and beneficial aquatic plants. As such, aquatic life toxicity objectives could be exceeded with sufficient frequency and magnitude such that beneficial uses would be impacted. Potential environmental effects related only to CM13 are considered significant. Mitigation Measure WQ-22 is available to partially reduce this impact of pesticides on water quality; however, because of the uncertainty about successful implementation of this measure at specific restoration sites programmatic impact is considered significant and unavoidable.

Mitigation Measure WQ-22: Implement Least Toxic Integrated Pest Management Strategies

Implement the principals of IPM in the management of invasive aquatic vegetation under CM13, including the selective use of pesticides applied in a manner that minimizes risks to human health, nontarget organisms and the aquatic ecosystem. In doing so, the BDCP proponents will consult with the Central Valley Water Board, USFWS, NMFS, and CDBW to obtain effective IPM strategies such as selective application of pesticides, timing of applications in order to minimize tidal dispersion, and timing to target the invasive plant species at the most vulnerable times such that less herbicide can be used or the need for repeat applications can be reduced.

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

Upstream of the Delta

A conceptual model of nutrients in the Delta stated that: "previous attempts to relate concentration data to flow data in the Central Valley and Delta showed little correlation between the two variables (Tetra Tech 2006b, Conceptual Model for Organic Carbon in the Central Valley). One possible reason is that the Central Valley and Delta system is a highly managed system with flows controlled by major reservoirs on most rivers" (Tetra Tech 2006b:4-1 to 4-2). Attempts made in the Nitrate section of this chapter also showed weak correlation between nitrate and flows for major source waters to the Delta. The linear regressions between average dissolved ortho-phosphate concentrations and average flows in the San Joaquin and Sacramento Rivers were derived for this analysis (Figure 8-58 and Figure 8-59). As expected, neither relationship is very strong, although over the large range in flows for the Sacramento River, the relationship is stronger than for the San Joaquin River. However, over smaller changes in flows, neither relationship can function as a predictor of phosphorus concentrations because the variability in the data over small to medium ranges of flows (i.e., < 10,000 CFS) is large.

Because phosphorus loading to waters upstream of the Delta is not anticipated to change, and because changes in flows do not necessarily result in changes in concentrations or loading of phosphorus to these water bodies, substantial changes in phosphorus concentration are not anticipated under the operational scenarios of Alternative 4, relative to Existing Conditions or the No Action Alternative. Any negligible changes in phosphorus concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regards to phosphorus.

Delta

Because phosphorus concentrations in the major source waters to the Delta are similar for much of the year, phosphorus concentrations in the Delta are not anticipated to change substantially on a long term-average basis. Phosphorus concentrations may increase during January through March at locations where the source fraction of San Joaquin River water increases, due to the higher concentration of phosphorus in the San Joaquin River during these months compared to Sacramento River water or San Francisco Bay water. Based on the DSM2 fingerprinting results (see Appendix 8D), together with source water concentrations shown in Figure 8-56, the magnitude of increases during these months may range from negligible up to approximately 0.05 mg/L. However, there are no state or federal objectives/criteria for phosphorus and thus any increases would not cause exceedances of objectives/criteria. Because algal growth rates are limited by availability of light in the Delta, increases in phosphorus levels that may occur at some locations and times within the Delta under Alternative 4, Scenarios H1–H4, would be expected to have little effect on primary productivity in the Delta. Moreover, such increases in concentrations would not be anticipated to be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to phosphorus.

SWP/CVP Export Service Areas

The assessment of effects of phosphorus under Alternative 4, Scenarios H1–H4, in the SWP and CVP Export Service Areas is based on effects on phosphorus at the Banks and Jones pumping plants.

As noted in the Delta Region section above, phosphorus concentrations in the Delta (including Banks and Jones pumping plants) are not anticipated to change substantially on a long term-average basis. During January through March, phosphorus concentrations may increase as a result of more San Joaquin River water reaching Banks and Jones pumping plants and the higher concentration of phosphorus in the San Joaquin River. However, based on the DSM2 fingerprinting results (see Appendix 8D), together with source water concentrations show in Figure 8-56, the magnitude of this increase is expected to be negligible (<0.01 mg/L-P). Additionally, there are no state or federal objectives for phosphorus. Moreover, given the many factors that contribute to potential algal blooms in the SWP and CVP canals within the Export Service Area, and the lack of studies that have shown a direct relationship between nutrient concentrations in the canals and reservoirs and problematic algal blooms in these water bodies, there is no basis to conclude that any seasonal increases in phosphorus concentrations at the levels expected under this alternative, should they occur, would increase the potential for problem algal blooms in the SWP and CVP Export Service Area.

Any increases in phosphorus concentrations that may occur in water exported via Banks and Jones pumping plants are not expected to result in adverse effects to beneficial uses of exported water or substantially degrade the quality of exported water, with regards to phosphorus.

NEPA Effects: In summary, based on the discussion above, effects on phosphorus of CM1 are considered to be not adverse.

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

Because phosphorus loading to waters upstream of the Delta is not anticipated to change, and because changes in flows do not necessarily result in changes in concentrations or loading of phosphorus to these water bodies, substantial changes in phosphorus concentration upstream of the Delta are not anticipated for any operational scenario of Alternative 4, relative to Existing Conditions.

Because phosphorus concentrations in the major source waters to the Delta are similar for much of the year, phosphorus concentrations in the Delta are not anticipated to change substantially on a long term-average basis under the operational scenarios of Alternative 4, relative to Existing Conditions. Algal growth rates are limited by availability of light in the Delta, and therefore any minor increases in phosphorus levels that may occur at some locations and times within the Delta would be expected to have little effect on primary productivity in the Delta.

The assessment of effects of phosphorus under the various operational scenarios of Alternative 4 in the SWP and CVP Export Service Areas is based on effects on phosphorus at the Banks and Jones pumping plants. As noted above, phosphorus concentrations in the Delta (including Banks and Jones pumping plants) are not anticipated to change substantially on a long term-average basis.

Based on the above, there would be no substantial, long-term increase in phosphorus concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the waters exported to the CVP and SWP service areas under any operational scenario of Alternative 4 relative to Existing Conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because phosphorus concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Phosphorus is not 303(d) listed within the affected environment and thus any minor increases that may occur in some areas would not make any existing phosphorus-related impairment measurably worse because no such impairments currently exist. Because phosphorus is not bioaccumulative, minor increases that may occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-24: Effects on Phosphorus Concentrations Resulting from Implementation of CM2–CM22

NEPA Effects: CM2–CM11 include activities that create additional aquatic habitat within the affected environment, and therefore may increase the total amount of algae and plant-life within the Delta. These activities would not affect phosphorus loading to the affected environment, but may affect phosphorus dynamics and speciation. For example, water column concentrations of total phosphorus may increase or decrease in localized areas as a result of increased or decreased suspended solids, while ortho-phosphate concentrations may be locally altered as a result of changing planktonic and macroinvertebrate species contributing to the cycling of phosphorus within the affected environment. Additionally, depending on age, configuration, location, operation, and season, some of the restoration measures included under these conservation measures may function to remove or sequester phosphorus, but since presently, the specific design, operational criteria, and location of these activities are not well established, the degree to which this would occur is unknown. Overall, phosphorus concentrations are not expected to change substantially in the affected environment as a result of CM2–CM22. Because increases or decreases in phosphorus levels are, in general, expected to have little effect on productivity, any changes in phosphorus concentrations that may occur at certain locations within the affected environment are not anticipated to be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to phosphorus.

Because urban stormwater is a source of phosphorus in the affected environment, CM19, Urban Stormwater Treatment, is expected to slightly reduce phosphorus loading to the Delta, thus slightly decreasing phosphorus concentrations relative to the No Action Alternative. Implementation of

CM12–CM18 and CM20–CM22 is not expected to substantially alter phosphorus concentrations in the affected environment.

The effects on phosphorus from implementing CM2–22 are considered to be not adverse.

***CEQA Conclusion*:** There would be no substantial, long-term increase in phosphorus concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the waters exported to the CVP and SWP service areas due to implementation of CM2–CM22 under Alternative 4 relative to Existing Conditions. Because urban stormwater is a source of phosphorus in the affected environment, CM19, Urban Stormwater Treatment, is expected to slightly reduce phosphorus loading to the Delta. As such, implementation of these conservation measures is not expected to cause adverse effects on any beneficial uses of waters in the affected environment. Because phosphorus concentrations are not expected to increase substantially due to these conservation measures, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Phosphorus is not 303(d) listed within the affected environment and thus any minor increases that may occur in some areas would not make any existing phosphorus-related impairment measurably worse because no such impairments currently exist. Because phosphorus is not bioaccumulative, minor increases that may occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant. No mitigation is required.

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

Upstream of the Delta

Substantial point sources of selenium do not exist upstream in the Sacramento River watershed, in the watersheds of the eastern tributaries (Cosumnes, Mokelumne, and Calaveras Rivers), or upstream of the Delta in the San Joaquin River watershed. Nonpoint sources of selenium within the watersheds of the Sacramento River and the eastern tributaries also are relatively low, resulting in generally low selenium concentrations in the reservoirs and rivers of those watersheds. Consequently, any modified reservoir operations and subsequent changes in river flows under Alternative 4, Scenarios H1–H4, relative to Existing Conditions or the No Action Alternative, are expected to have negligible, if any, effects on reservoir and river selenium concentrations upstream of Freeport in the Sacramento River watershed or in the eastern tributaries upstream of the Delta.

Non-point sources of selenium in the San Joaquin River watershed are associated with discharges of subsurface agricultural drainage to the river and its tributaries. Selenium concentrations at Vernalis are generally higher during lower San Joaquin River flows, with considerable variability in concentrations below about 3,000 cfs, as shown in Appendix 8M (Table 31 and Figures 4 through 17). The only monthly average selenium concentrations greater than 2 μg/L were in March 2002 (2.3 μg/L) and February and March 2003 (2.1 and 2.3 μg/L), when monthly average flows were 1,879 to 2,193 cfs. Under the four operational scenarios of Alternative 4, modeling indicates that long-term annual average flows on the San Joaquin River would decrease by 6% relative to Existing Conditions and would remain virtually the same relative to the No Action Alternative (Appendix 5A). Given these relatively small decreases in flows and the considerable variability in the relationship between selenium concentrations and flows in the San Joaquin River, it is expected that selenium concentrations in the San Joaquin River would be minimally affected, if at all, by anticipated changes in flow rates under the operational scenarios of Alternative 4. Thus, available information indicates selenium concentrations are well below the Basin Plan objective and are likely to remain so. Any negligible changes in selenium concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies as related to selenium.

Delta

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

All scenarios (H1, H2, H3, and H4) under Alternative 4 would result in small changes in average selenium concentrations in water relative to Existing Conditions and No Action Alternative at almost all modeled Delta assessment locations (Appendix 8M, Table M-10B). These small changes in selenium concentrations in water are reflected in small percent changes (10% or less) in available assimilative capacity for selenium (based on 2 µg/L ecological risk benchmark) for all years (Figures 8-59 and 8-60). Relative to Existing Conditions, Scenario H1 would result in the largest modeled increase in assimilative capacity (range of +1% at Buckley Cove to -3% at Contra Costa PP), and the largest decrease would be under Scenario H4 (range of -4% at Contra Costa PP to +1% at Buckley Cove). Relative to the No Action Alternative, the largest modeled increase in assimilative capacity would be under Scenario H1 (range of <+1% at Staten Island to-4% at Buckley Cove) and the largest decrease would be under Scenario H4 (range of -4% at Buckley Cove to + 1% at Staten Island) (Figure 8-60). Although some small negative changes in selenium concentrations in water are expected, the effect of any of the scenarios under Alternative 4 would generally be minimal for the Delta locations. Furthermore, the modeled selenium concentrations in water (Appendix 8M, Table M-10B) for Existing Conditions (range 0.21–0.76 µg/L), No Action Alternative (range 0.21–0.69 µg/L), Alternative 4 Scenarios H1 (range 0.21–0.74 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 generally similar, and would all be below the ecological risk benchmark (2 µg/L).

Relative to Existing Conditions and the No Action Alternative, all scenarios under Alternative 4 would result in small changes in estimated selenium concentrations in biota (whole-body fish, bird eggs [invertebrate diet or fish diet], and fish fillets) (Appendix 8M, Tables M-15A through M-15D and Addendum M.A to Appendix 8M, Table M.A-2). Relative to Existing Conditions for all scenarios under Alternative 4, the largest increase of selenium concentrations in all biota would be at Contra Costa PP for all years and in sturgeon at the San Joaquin River at Antioch in all years, and the largest decrease of selenium in all biota would be at Buckley Cove for drought years. Relative to the No Action Alternative, the largest increases and decreases in estimated selenium concentrations in biota for each scenario are provided below.

- Alternative 4, Scenario H1: The largest increase of estimated selenium concentrations in all biota would be at Buckley Cove for drought years (except for bird eggs [assuming a fish diet] at Buckley Cove for all years) and in sturgeon at the San Joaquin River at Antioch in all years; the largest decrease in all biota would be at Staten Island for all years (except for bird eggs [assuming a fish diet] at Staten Island for drought years).

- Alternative 4, Scenario H2: The largest increase of estimated selenium concentrations in all biota would be at Buckley Cove for drought years (except for bird eggs [assuming a fish diet] at Buckley Cove for all years) and in sturgeon at the San Joaquin River at Antioch in all years; the largest decrease for all biota would be at Staten Island for drought years.
- Alternatives 4, Scenarios H3 and H4: The largest increase of estimated selenium concentrations in all biota would be at Buckley Cove for drought years (except for bird eggs [assuming a fish diet] at Contra Costa PP for all years) and in sturgeon at the San Joaquin River at Antioch in all years; the largest decrease for all biota would be at Staten Island for drought years.

Except for sturgeon in the western Delta, concentrations of selenium in whole-body fish and bird eggs (invertebrate and fish diets) would exceed only the lower benchmarks (4 and 6 mg/kg dry weight, respectively, indicating a low potential for effects) at Buckley Cove, under drought conditions, for Existing Conditions, No Action Alternative, and all scenarios for Alternative 4 (Figures 8-61, 8-62, and 8-63). However, Exceedance Quotients for these exceedances of the lower benchmarks for all Alternative 4 scenarios are between 1.0 and 1.5 (similar to Existing Conditions, and No Action Alternative), indicating a low risk to biota in the Delta and no substantial difference from baseline conditions. Estimated selenium concentrations in fish fillets would not exceed the screening value for protection of human health (Figure 8-64). For sturgeon in the western Delta, whole-body selenium concentrations would increase from 12.3 mg/kg under Existing Conditions and the No Action Alternative to 13.1-13.5 mg/kg under Alternative 4 (depending on the operational scenario), a 7-10% increase (Table M.A-2). Although all of these values exceed both the low and high toxicity benchmarks, it is unlikely that the modeled increases in whole-body selenium for sturgeon would be measurable in the environment (see also the discussion of results provided in Addendum M.A to Appendix 8M).

Selenium concentrations in water and biota would slightly increase progressively from Alternative 4, Scenario H1 (smallest) to Alternative 4, Scenario H4 (largest). However, relative to baseline conditions, all scenarios under Alternative 4 would result in essentially no change in selenium concentrations throughout the Delta. Consequently, Alternative 4 scenarios would not be expected to substantially increase the frequency with which applicable benchmarks would be exceeded in the Delta or substantially degrade the quality of water in the Delta, with regard to selenium.

SWP/CVP Export Service Areas

Alternative 4 scenarios would result in small changes in average selenium concentrations in water at both modeled Export Service Area assessment locations relative to baseline conditions (Appendix 8M, Table M-10B). These small changes are reflected in small percent changes (10% or less) in available assimilative capacity for selenium for all years (Figures 8-59 and 8-60) and generally would have a small positive effect on the Export Service Area locations. Relative to Existing Conditions, Alternative 4, Scenarios H1, H2, H3, and H4 would result in modeled increases in assimilative capacity at Banks PP (5%, 4%, 5%, and 4%, respectively) and at Jones PP (7%, 8%, 8%, and 8%, respectively). Relative to the No Action Alternative, Alternative 4, Scenarios H1, H2, H3, and H4 would result in modeled increases in assimilative capacity at Banks PP (5%, 4%, 4%, and 4%, respectively) and at Jones PP (8%, 9%, 9%, and 9%, respectively). The modeled selenium concentrations in water (Appendix 8M, Table M-10B) for Existing Conditions (range 0.37–0.58 μg/L), No Action Alternative (range 0.37–0.59 μg/L), Alternative 4, Scenarios H1 (range 0.37–0.47

μg/L), H2 (range 0.37–0.46 μg/L), H3 (range 0.37–0.47 μg/L), and H4 (range 0.37–0.46 μg/L) are all similar, and all would be below the ecological risk benchmark (2 μg/L).

Relative to baseline conditions for Export Service Areas, all scenarios under Alternative 4 would result in small changes in estimated selenium concentrations in biota (Appendix 8M, Table M-15A through M-15D). Relative to Existing Conditions and No Action Alternative, the largest increase of selenium concentrations in biota, under all scenarios, would be at Banks PP for drought years (except for bird eggs [assuming a fish diet] at Banks PP for all years). Relative to Existing Conditions, under all scenarios, the largest decrease would be at Jones PP for all years (except for bird eggs (assuming a fish diet) at Jones PP for drought years). Relative to the No Action Alternative, the largest decreases in estimated selenium concentrations in biota for each scenario are provided below.

- Scenarios H1, H2, and H3: The largest decrease of estimated selenium concentration for biota would be at Jones PP for all years (except for bird eggs (assuming a fish diet) at Jones PP for drought years).
- Scenario H4: the largest decrease of selenium concentrations in all biota would be at Jones PP for drought years.

Concentrations of selenium in biota would not exceed any benchmarks under any scenario for Alternative 4 (Figures 8-61 through 8-64). Thus, relative to baseline conditions, all scenarios under Alternative 4 would result in minimal changes in selenium concentrations at the Export Service Area locations. Selenium concentrations in water and biota generally would decrease for Alternative 4 scenarios and would not exceed ecological benchmarks at either location, whereas the lower benchmark for bird eggs (fish diet) would be exceeded under Existing Conditions and No Action Alternative at Jones PP under drought conditions. This small positive change in selenium concentrations under Alternative 4 scenarios would be expected to slightly decrease the frequency with which applicable benchmarks would be exceeded or slightly improve the quality of water at the Export Service Area locations, with regard to selenium.

***NEPA Effects*:** Selenium concentrations in water and biota very slightly increase progressively from Scenario H1 (smallest) to Scenario H4 (largest). However, based on the discussion above, the effects on selenium (both as waterborne and as bioaccumulated in biota) from all scenarios under Alternative 4 are not considered to be adverse.

Based on the discussion above, the effects on selenium (both as waterborne and as bioaccumulated in biota) from Alternative 4 are not considered to be adverse.

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

There are no substantial point sources of selenium in watersheds upstream of the Delta, and no substantial nonpoint sources of selenium in the watersheds of the Sacramento River and the eastern tributaries. Nonpoint sources in the San Joaquin Valley that contribute selenium to the Delta will be controlled through a TMDL developed by the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the Grassland Bypass Project, and Basin Plan objectives (Central Valley Water Board 2010c) and State Water Board (2010d, 2010e) that are expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta. Consequently, any modified reservoir operations and subsequent changes in river flows under Alternative 4 scenarios, relative to Existing Conditions, are expected to cause negligible changes in selenium concentrations in water. Any negligible changes in selenium concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies as related to selenium.

Relative to Existing Conditions, modeling estimates indicate that all scenarios under Alternative 4 would result in essentially no change in selenium concentrations throughout the Delta.

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, all scenarios under Alternative 4 would slightly decrease the frequency with which applicable benchmarks would be exceeded or slightly improve the quality of water in selenium concentrations at the Banks and Jones pumping plants locations.

Based on the above, selenium concentrations that would occur in water under all Alternative 4 scenarios would not cause additional exceedances of applicable state or federal numeric or narrative water quality objectives/criteria, or other relevant water quality effects thresholds identified for this assessment (Table 8-54), by frequency, magnitude, and geographic extent that would result in adverse effects to one or more beneficial uses within affected water bodies. In comparison to Existing Conditions, water quality conditions under all scenarios for Alternative 4 would not increase levels of selenium by frequency, magnitude, and geographic extent such that the affected environment would be expected to have measurably higher body burdens of selenium in aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish) or humans consuming those organisms. Water quality conditions under these alternative scenarios with respect to selenium would not cause long-term degradation of water quality in the affected environment, and therefore would not result in use of available assimilative capacity such that exceedances of water quality objectives/criteria would be likely and would result in substantially increased risk for adverse effects to one or more beneficial uses. All scenarios under this alternative would not further degrade water quality by measurable levels, on a long-term basis, for selenium and, thus, cause the 303(d)-listed impairment of beneficial use to be made discernibly worse. This impact is considered to be less than significant. No mitigation is required.

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

***NEPA Effects*: **In general, with the possible exception of changes in Delta hydrodynamics resulting from habitat restoration, CM2–CM11 would not substantially increase selenium concentrations in the water bodies of the affected environment. Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, and thus such effects of these restoration measures were included in the assessment of CM1 facilities operations and maintenance (see Impact WQ-25).

However, implementation of these conservation measures may increase water residence time within the restoration areas. Increased restoration area water residence times could potentially increase the bioaccumulation of selenium in biota, thereby potentially increasing fish tissue and bird egg concentrations of selenium, but models are not available to quantitatively estimate the level of changes in residence time and the associated selenium bioavailability. If increases in fish tissue or bird egg selenium were to occur, the increases would likely be of concern only where fish tissues or bird eggs are already elevated in selenium to near or above thresholds of concern. That is, where biota concentrations are currently low and not approaching thresholds of concern, changes in residence time alone would not be expected to cause them to then approach or exceed thresholds of concern. In consideration of this factor, although the Delta as a whole is a 303(d)-listed water body for selenium, and although monitoring data of fish tissue or bird eggs in the Delta are sparse, the most likely areas in which biota tissues would be at levels high enough that additional bioaccumulation due to increased residence time from restoration areas would be a concern are the western Delta and Suisun Bay, and the South Delta in areas that receive San Joaquin River water.

The western Delta and Suisun Bay receive elevated selenium loads from North San Francisco Bay (including San Pablo Bay, Carquinez Strait, and Suisun Bay) and from the San Joaquin River. Point sources of selenium in North San Francisco Bay (i.e., refineries) that contribute selenium to Suisun Bay are expected to be reduced through a TMDL under development by the San Francisco Bay Water Board (San Francisco Bay Water Board 2012) that is expected to result in decreasing discharges of selenium. Nonpoint sources of selenium in the San Joaquin Valley that contribute selenium to the San Joaquin River, and thus the Delta and Suisun Bay, will be controlled through a TMDL developed by the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the Grassland Bypass Project, and Basin Plan objectives (Central Valley Water Board 2010c, d) that are expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta. If selenium levels are not sufficiently reduced via these efforts, it is expected that the State Water Board and the San Francisco Bay and Central Valley Water Boards would initiate additional actions to further control sources of selenium.

The South Delta receives elevated selenium loads from the San Joaquin River. In contrast to Suisun Bay and possibly the western Delta in the future, the South Delta lacks the overbite clam (*Corbula* [*Potamocorbula*] *amurensis*), which is considered a key driver of selenium bioaccumulation in Suisun Bay, due to its high bioaccumulation of selenium and its role in the benthic food web that includes long-lived sturgeon. The South Delta does have *Corbicula fluminea*, another bivalve that bioaccumulates selenium, but it is not as invasive as the overbite clam and thus likely makes up a smaller fraction of sturgeon diet. Also, as mentioned above, nonpoint sources of selenium in the San Joaquin Valley that contribute selenium to the Delta will be controlled through a TMDL developed by the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the Grassland Bypass Project, and Basin Plan objectives (Central Valley Water Board 2010c, d) that are expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta. Further, if selenium levels in the San Joaquin River are not sufficiently reduced via these efforts, it is expected that the State Water Board and Central Valley Water Board would initiate additional TMDLs to further control nonpoint sources of selenium.

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

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

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

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

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

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

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

Impact WQ-27: Effects on Trace Metal Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Relative to Existing Conditions and the No Action Alternative, under Alternative 4, Scenarios H1–H4, sources of trace metals would not be expected to change substantially with exception to sources related to population growth, such as increased municipal wastewater discharges and development contributing to increased urban dry and wet weather runoff. Facility operations could have an effect on these sources if concentrations of dissolved metals were closely correlated to river flow, suggesting that changes in river flow, and the related capacity to dilute these sources, could ultimately have a substantial effect on long-term metals concentrations.

On the Sacramento River, available dissolved trace metals data and river flow at Freeport are poorly associated (Appendix 8N, Figure 1). Similarly, dissolved copper, iron, and manganese concentrations on the San Joaquin River at Vernalis are poorly associated (Appendix 8N, Figure 2). While there is an insufficient number of data for the other trace metals to observe trends at Vernalis, it is reasonable to assume that these metals similarly show poor association to San Joaquin River flow, as shown for the corresponding dissolved metals on the Sacramento River.

Given the poor association of dissolved trace metal concentrations with flow, river flow rate and reservoir storage reductions that would occur under Alternative 4, Scenarios H1–H4, relative to Existing Conditions and the No Action Alternative, would not be expected to result in a substantial adverse change in trace metal concentrations in the reservoirs and rivers upstream of the Delta. As such, the Alternative 4, Scenarios H1–H4, would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or CTR criteria would be exceeded in water bodies of the affected environment located upstream of the Delta or substantially degrade the quality of these water bodies, with regard to trace metals.

Delta

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

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

Relative to Existing Conditions and the No Action Alternative, facilities operation under Alternative 4, Scenarios H1–H4, would result in negligible change in trace metal concentrations throughout the Delta. The operational scenarios of Alternative 4 would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or CTR criteria would be exceeded in the Delta or substantially degrade the quality of water in the Delta, with regard to trace metals.

SWP/CVP Export Service Areas

Alternative 4, Scenarios H1–H4, would not result in substantial increases in trace metal concentrations in the water exported from the Delta or diverted from the Sacramento River through the proposed conveyance facilities. As such, there is not expected to be substantial changes in trace metal concentrations in the SWP/CVP export service area waters under any operational scenario of Alternative 4, relative to Existing Conditions or the No Action Alternative. As such, Alternative 4, Scenarios H1–H4, would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or CTR criteria would be exceeded in the water bodies of the affected environment in the SWP and CVP Service Area or substantially degrade the quality of these water bodies, with regard to trace metals.

NEPA Effects**:** In summary, relative to the No Action Alternative, Alternative 4, Scenarios H1–H4, would not cause a substantial increase in long-term average trace metals concentrations within the affected environment, nor would it cause an increased frequency of water quality objective/criteria exceedances within the affected environment. The effect on trace metals is determined not to be adverse.

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

While greater water demands under the operational scenarios of Alternative 4 would alter the magnitude and timing of reservoir releases north, south and east of the Delta, these activities would have no substantial effect on the various watershed sources of trace metals. Moreover, long-term average flow and trace metals at Sacramento River at Hood and San Joaquin River at Vernalis are poorly correlated; therefore, changes in river flows would not be expected to cause a substantial long-term change in trace metal concentrations upstream of the Delta.

Average and 95th percentile trace metal concentrations are very similar across the primary source waters to the Delta. Given this similarity, very large changes in source water fraction would be necessary to effect a relatively small change in trace metal concentration at a particular Delta location. Moreover, average and 95th percentile trace metal concentrations for these primary source waters are all below their respective water quality criteria, including those that are hardness-based without a WER adjustment. No mixing of these three source waters could result in a metal concentration greater than the highest source water concentration, and given that trace metals do not already exceed water quality criteria, more frequent exceedances of criteria in the Delta would not be expected to occur under any operational scenario of Alternative 4.

The assessment of Alternative 4, Scenario H1–H4, effects on trace metals in the SWP/CVP Export Service Areas is based on assessment of changes in trace metal concentrations at Banks and Jones pumping plants. As just discussed regarding similarities in Delta source water trace metal concentrations, no operational scenario of Alternative 4 is expected to result in substantial changes in trace metal concentrations in Delta waters, including Banks and Jones pumping plants, therefore effects on trace metal concentrations in the SWP/CVP Export Service Area are expected to be negligible.

Based on the above, there would be no substantial long-term increase in trace metal concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the SWP/CVP export service area waters under any operational scenario of Alternative 4 relative to Existing Conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because trace metal concentrations are not expected to increase substantially, no long-term water quality degradation for trace metals is expected to occur and, thus, no adverse effects to beneficial uses would occur. Furthermore, any negligible changes in long-term trace metal concentrations that may occur in water bodies of the affected environment would not be expected to make any existing beneficial use impairments measurably worse. The trace metals discussed in this assessment are not considered bioaccumulative, and thus would not directly cause bioaccumulative problems in aquatic life or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-28: Effects on Trace Metal Concentrations Resulting from Implementation of CM2–CM22

NEPA Effects: Implementation of CM2–CM22 present no new sources of trace metals to the affected environment, including areas upstream of the Delta, within the Delta, or in the SWP and CVP service areas. However, CM19, which would fund projects to contribute to reducing pollutant discharges in urban stormwater, would be expected to reduce trace metal loading to surface waters of the affected environment. The remaining conservation measures would not be expected to affect trace metal levels, because they are actions that do not affect the presence of trace metal sources. As they pertain to trace metals, implementation of these conservation measures would not be expected to adversely affect beneficial uses of the affected environment or substantially degrade water quality with respect to trace metals.

In summary, implementation of CM2–CM22 under Alternative 4 relative to Existing Conditions and the No Action Alternative, would have negligible, if any, effect on trace metals concentrations. The effect on trace metals from implementing CM2–CM22 is determined not to be adverse.

CEQA Conclusion: Implementation of CM2–CM22 under Alternative 4 would not cause substantial long-term increase in trace metal concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the SWP/CVP export service area. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because trace metal concentrations are not expected to increase substantially, no long-term water quality degradation for trace metals is expected to occur and, thus, no adverse effects to beneficial uses would occur. Furthermore, any negligible changes in long-term trace metal concentrations that may occur throughout the affected environment would not be expected to make any existing beneficial use impairments measurably worse. The trace metals discussed in this assessment are not considered bioaccumulative, and thus would not directly cause bioaccumulative problems in aquatic life or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-29: Effects on TSS and Turbidity Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

TSS concentrations and turbidity levels in rivers upstream of the Delta are affected primarily by: 1) TSS concentrations and turbidity levels of the water released from the upstream reservoirs, 2) erosion occurring within the river channel beds, which is affected by river flow velocity and bank protection, 3) TSS concentrations and turbidity levels of tributary inflows, point-source inputs, and nonpoint runoff as influenced by surrounding land uses; and 4) phytoplankton, zooplankton and other biological material in the water.

Alternative 4, Scenarios H1–H4, would alter the magnitude and timing of water releases from reservoirs upstream of the Delta relative to Existing Conditions and the No Action Alternative, which in turn would alter downstream river flows. With respect to TSS and turbidity, an increase in river flow is generally the concern, as this increases shear stress on the channel, suspending particles resulting in higher TSS concentrations and turbidity levels. Schoellhamer et al. (2007b) noted that suspended sediment concentration was more affected by season than flow, with the higher concentrations for a given flow rate occurring during "first flush events" and lower concentrations occurring during spring snowmelt events. Because of such a relationship, the changes in mean monthly average river flows under the operational scenarios of Alternative 4 are not expected to cause river TSS concentrations or turbidity levels (highs, lows, typical conditions) to be outside the ranges occurring under Existing Conditions or the No Action Alternative. Consequently, this alternative is expected to have minimal effect on TSS concentrations and turbidity levels in the reservoirs and rivers upstream of the Delta.

Changes in land use that would occur relative to Existing Conditions and the No Action Alternative could have minor effects on TSS concentrations and turbidity levels throughout this portion of the affected environment. Site-specific and temporal exceptions may occur due to localized temporary construction activities, dredging activities, development, or other land use changes. These localized actions would generally require agency permits that would regulate and limit both their short-term and long-term effects on TSS concentrations and turbidity levels to less-than-substantial levels.

Delta

TSS concentrations and turbidity levels in Delta waters are affected by TSS concentrations and turbidity levels of the Delta inflows (and associated sediment load). TSS concentrations and turbidity levels within Delta waters also are affected by fluctuation in flows within the channels due to the tides, with sediments depositing as flow velocities and turbulence are low at periods of slack tide, and sediments becoming suspended when flow velocities and turbulence increase when tides are near the maximum. TSS and turbidity variations can also be attributed to phytoplankton, zooplankton and other biological material in the water.

Under Alternative 4, Scenarios H1–H4, any land use changes that may occur under this alternative would not be expected to have permanent, substantial effects on TSS concentrations and turbidity levels of Delta waters, relative to Existing Conditions or the No Action Alternative. Furthermore, this alternative would not cause the TSS concentrations or turbidity levels in the rivers contributing inflows to the Delta to be outside the ranges occurring under Existing Conditions or the No Action Alternative. Consequently, this alternative is expected to have minimal effect on TSS concentrations and turbidity levels in the Delta region. As such, any minor TSS and turbidity changes that may occur under Alternative 4, Scenarios H1–H4, would not be of sufficient frequency, magnitude, and geographic extent that would result in adverse effects on beneficial uses in the Delta region, or substantially degrade the quality of these water bodies, with regard to TSS and turbidity.

SWP/CVP Export Service Areas

The operational scenarios of Alternative 4 are expected to have minimal effect on TSS concentrations and turbidity levels in Delta waters, including water exported at the south Delta pumps, relative to Existing Conditions or the No Action Alternative. As such, Alternative 4 is expected to have minimal effect on TSS concentrations and turbidity levels in the SWP/CVP Export Service Areas waters.

***NEPA Effects*:** The effects on TSS and turbidity from implementing any operational scenario of Alternative 4 is determined to not be adverse.

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

Changes in river flow rate and reservoir storage that would occur under the operational scenarios of Alternative 4, relative to Existing Conditions, would not be expected to result in a substantial adverse change in TSS concentrations and turbidity levels in the reservoirs and rivers upstream of the Delta, given that suspended sediment concentrations are more affected by season than flow. Site-specific and temporal exceptions may occur due to localized temporary construction activities, dredging activities, development, or other land use changes would be site-specific and temporal, which would be regulated to limit both their short-term and long-term effects on TSS and turbidity levels to less than substantial levels.

Within the Delta, geomorphic changes associated with sediment transport and deposition are usually gradual, occurring over years, and high storm event inflows would not be substantially affected. Thus, it is expected that the TSS concentrations and turbidity levels in the affected channels would not be substantially different from the levels under Existing Conditions. Consequently, this alternative is expected to have minimal effect on TSS concentrations and turbidity levels in the Delta region, relative to Existing Conditions.

There is not expected to be substantial, if even measurable, changes in TSS concentrations and turbidity levels in the SWP/CVP Export Service Areas waters under any operational scenario of Alternative 4, relative to Existing Conditions, because as stated above, this alternative is not expected to result in substantial changes in TSS concentrations and turbidity levels at the south Delta export pumps, relative to Existing Conditions.

Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives where such objectives are not exceeded under Existing Conditions. Because TSS concentrations and turbidity levels are not expected to be substantially different, long-term water quality degradation is not expected, and, thus, beneficial uses are not expected to be adversely affected. Finally, TSS and turbidity are neither bioaccumulative nor Clean Water Act section 303(d) listed constituents. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-30: Effects on TSS and Turbidity Resulting from Implementation of CM2–CM22

NEPA Effects**:** Creation of habitat and open water through implementation of CM2–CM11 could affect Delta hydrodynamics and, thus, erosion and deposition potential in certain Delta channels. The magnitude of increases in TSS concentrations and turbidity levels in the affected channels due to higher potential of erosion cannot be readily quantified. The increases in TSS concentrations and turbidity levels in the affected channels could be substantial in localized areas, depending on how rapidly the Delta hydrodynamics are altered and the channels equilibrate with the new tidal flux regime, after implementation of this alternative. However, geomorphic changes associated with sediment transport and deposition are usually gradual, occurring over years. Within the reconfigured channels there could be localized increases in TSS concentrations and turbidity levels, but within the greater Plan Area it is expected that the TSS concentrations and turbidity levels would not be substantially different from the levels under the No Action Alternative.

CM19, which would fund projects to contribute to reducing pollutant discharges in stormwater, would be expected to reduce TSS and turbidity in urban discharges relative to the No Action Alternative. The remaining conservation measures would not be expected to affect TSS concentrations and turbidity levels, because they are actions that do not affect the presence of TSS and turbidity sources.

The effects on TSS and turbidity from implementing CM2–CM22 is determined to not be adverse.

CEQA Conclusion**:** It is expected that the TSS concentrations and turbidity levels Upstream of the Delta, in the Plan Area, and the SWP/CVP Export Service Areas due to implementation of CM2–CM22 under Alternative 4 would not be substantially different relative to Existing Conditions, except within localized areas of the Delta modified through creation of habitat and open water. Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives where such objectives are not exceeded under Existing Conditions. Because TSS concentrations and turbidity levels Upstream of the Delta, in the greater Plan Area, and in the SWP/CVP Export Service Areas are not expected to be substantially different, long-term water quality degradation is not expected relative to TSS and turbidity, and, thus, beneficial uses are not expected to be adversely affected. Finally, TSS and turbidity are neither bioaccumulative nor Clean Water Act section 303(d) listed constituents. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-31: Water Quality Effects Resulting from Construction-Related Activities (CM1–CM22)

This section addresses construction-related water quality effects to constituents of concern other than effects caused by changes in the operations and maintenance of CM1–CM22, which are addressed in terms of constituent-specific impact assessments elsewhere in this chapter. The conveyance features for CM1 under Alternative 4 would be very similar to those discussed for Alternative 1A and most of the construction activity would occur in the Delta. The primary difference between Alternative 4 and Alternative 1A is that under Alternative 4, there would be two fewer intakes and two fewer pumping plant locations, which would result in a reduced level of construction activity. However, construction techniques and locations of major features of the conveyance system within the Delta would be similar. Alternative 4 additionally would include construction of an operable barrier at the head of Old River. The remainder of the facilities constructed under Alternative 4, including CM2–CM22, would be very similar to, or the same as, those to be constructed for Alternative 1A. Few, if any, of the CM1–CM22 actions involve construction work in the SWP and CVP Service Area or areas upstream of the Delta. The conservation measures, or components of measures, that are anticipated to be constructed in areas upstream of the Delta would be limited to: (1) the Yolo Bypass Fishery Enhancement (CM2) (i.e., the Fremont Weir component of the action), (2) Conservation Hatcheries (CM18) (i.e., the new hatchery facility), and (3) Urban Stormwater Treatment (CM19). Anticipated construction activities that may occur under CM11–CM22, if any, would involve relatively minor disturbances, and thus would not be anticipated to result in substantial discharges of any constituents of concern.

Within the Delta, the construction-related activities for Alternative 4 would be most extensive for CM1 involving the new water conveyance facilities. Construction of water conveyance facilities would involve vegetation removal, material storage and handling, excavation, overexcavation for facility foundations, surface grading, trenching, road construction, levee construction, construction site dewatering, soil stockpiling, RTM dewatering basin construction and storage operations, and other general facility construction activities (i.e., concrete, steel, carpentry, and other building trades) over approximately 7,500 acres during the course of constructing the facilities. Vegetation would be removed (via grubbing and clearing) and grading and other earthwork would be conducted at the intakes, pumping plants, the intermediate forebay, the expanded Clifton Court Forebay, culvert siphon between the northern cell of the expanded Clifton Court Forebay to a new canal to the Jones Pumping Plant and a siphon under the Byron Highway into a short segment of canal leading to the Banks Pumping Plant, borrow areas, RTM and spoil storage areas, setback and transition levees, sedimentation basins, solids handling facilities, transition structures, surge shafts and towers, substations, transmission line footings, access roads, concrete batch plants, fuel stations, bridge abutments, barge unloading facilities, and laydown areas. Construction of each intake would take nearly 4 years to complete.

Construction activities necessary to develop the new habitat restoration areas for CM2 and CM4–CM10 including restored tidal wetlands, floodplain, and related channel margin and off-channel habitats, would likely involve a variety of extensive conventional clearing and grading activities on relatively dry sites of the Delta that are currently separated from the Delta channels by levees. Construction would involve new setback levees, excavation and soil placement for new wetland and other habitat feature development, and a variety of potential in-water construction activities such as excavation, sediment dredging, levee breaching, and hauling and placement or disposal of excavated sediment or dredge material. Construction activities for the proposed restoration sites, due to the direct connectivity with Delta channels, have the potential to result in direct discharge of eroded soil and construction-related contaminants, or indirectly through erosion and site inundation during the weeks or months following construction prior to stabilization of newly contoured and restored landforms and colonization by vegetation.

NEPA Effects: The types and magnitude of potential construction-related water quality effects associated with implementation of CM1–CM22 under Alternative 4 would be very similar to the effects discussed for Alternative 1A, and the effects anticipated with implementation of CM2–CM22 would be essentially identical. Potential construction-related water quality effects may include discharges of turbidity/TSS due to the erosion of disturbed soils and associated sedimentation entering surface water bodies or other construction-related wastes (e.g., concrete, asphalt, cleaning agents, paint, and trash). Construction activities also may result in temporary or permanent changes in stormwater generation or drainage and runoff patterns (i.e., velocity, volume, and direction) that may cause or contribute to soil erosion and offsite sedimentation, such as creation of additional impervious surfaces (e.g., pavement, buildings, compacted soils), blockage or restriction of existing drainage channels, or general surface drainage changes from grading and excavation activity. Additionally, the use of heavy earthmoving equipment may result in spills and leakage of oils, gasoline, diesel fuel, and related petroleum contaminants used in the fueling and operation of such construction equipment.

Land surface grading and excavation activities, or exposure of disturbed sites immediately following construction and prior to stabilization, could result in rainfall- and stormwater-related soil erosion, runoff, and offsite sedimentation in surface water bodies. The initial runoff following construction, or return of seasonal rains to previously disturbed sites, can result in runoff with peak pollutant levels and is referred to as “first flush” storm events. Soil erosion and runoff can also result in increased concentrations and loading of organic matter, nutrients (nitrogen and phosphorus), and other contaminants contained in the soil such as trace metals, pesticides, or animal-related pathogens. Graded and exposed soils also can be compacted by heavy machinery, resulting in reduced infiltration of rainfall and runoff, thus increasing the rate of runoff (and hence contaminants) to downstream water bodies.

Construction activities also would be anticipated to involve the transport, handling, and use of a variety of hazardous substances and non-hazardous materials that may adversely affect water quality if discharged inadvertently to construction sites or directly to water bodies. Typical construction-related contaminants include petroleum products for refueling and maintenance of machinery (e.g., fuel, oils, solvents), concrete, paints and other coatings, cleaning agents, debris and trash, and human wastes. Construction activities also would involve large material storage and laydown areas, and occasional accidental spills of hazardous materials stored and used for construction may occur. Contaminants released or spilled on bare soil also may result in groundwater contamination. Dewatering operations may contain elevated levels of suspended sediment or other constituents that may cause water quality degradation.

The intensity of construction activity along with the fate and transport characteristics of the chemicals used, would largely determine the magnitude, duration, and frequency of construction-related discharges and resulting concentrations and degradation associated with the specific constituents of concern. The potential water quality concerns associated with the major categories of contaminants that might be discharged as a result of construction activity include the following.

- Suspended sediment: May increase turbidity (i.e., reduce water clarity) that can affect aquatic organisms and increase the costs and effort of removal in municipal/industrial water supplies.

Downstream sedimentation can affect aquatic habitat, or cause a nuisance if it affects functions of agricultural or municipal intakes, or boat navigation.

- Organic matter: May contribute turbidity and oxygen demanding substances (i.e., reduce dissolved oxygen levels) that can affect aquatic organisms. Organic carbon may increase the potential for disinfection byproduct formation in municipal drinking water supplies.
- Nutrients: May contribute nitrogen, phosphorus, and other key nutrients that can contribute to nuisance biostimulation of algae and vascular aquatic plants, which may affect municipal water supplies, recreation, aquatic life, and aesthetics.
- Petroleum hydrocarbons: May contribute toxic compounds to aquatic life, and oily sheens may reduce oxygen/gas transfer in water, foul aquatic habitats, and reduce water quality for municipal supplies, recreation, and aesthetics.
- Trace constituents (metals, pesticides, synthetic organic compounds): Compounds in eroded soil or construction-related materials (e.g., paints, coatings, cleaning agents) may be toxic to aquatic life.
- Pathogens: Bacteria, viruses, and protozoans may affect aquatic life and increase human health risks via municipal water supplies, reduced recreational water quality, or contaminated shellfish beds.
- Other inorganic compounds: Construction-related materials can contain inorganic compounds such as acidic/basic materials which can change pH and may adversely affect aquatic life and habitats. Concrete contains lime which can increase pH levels, and drilling fluids may alter pH.

Some construction-related contaminants, such as PAHs that may be in some fuel and oil petroleum byproducts, may be bioaccumulative in aquatic and terrestrial organisms. Construction activities also may disturb areas where bioaccumulative constituents are present in the soil (e.g., mercury, selenium, organochlorine pesticides, PCBs, and dioxin/furan compounds), or may disturb soils that contain constituents included on the Section 303(d) lists of impaired water bodies in the affected environment. While the 303(d)-listed Delta channels impaired by mercury are widespread, impairment by selenium, pesticides, PCBs, and dioxin/furan compounds is more limited, and there are no 303(d) listings for PAH impairment. Bioaccumulation of constituents in the aquatic foodchain, and 303(d)-related impaired water bodies, arise as a result of long-term loading of a constituent or a pervasive and widespread source of constituent discharge (e.g., mercury). However, as a result of the generally localized disturbances, and intermittent and temporary nature of construction-related activities, construction would not be anticipated to result in contaminant discharges of substantial magnitude or duration to contribute to long-term bioaccumulation processes, or cause measureable long-term degradation such that existing 303(d) impairments would be made discernibly worse or TMDL actions to reduce loading would be adversely affected.

The environmental commitments for construction-related water quality protection would be specifically designed as a part of the final design, included in construction contracts as a required element, and would be implemented for Alternative 4 to avoid, prevent, and minimize the potential discharges of constituents of concern to water bodies and associated adverse water quality effects and comply with state water quality regulations. Additionally, temporary and permanent changes in stormwater drainage and runoff would be minimized and avoided through construction of new or modified drainage facilities, as described in the Chapter 3, *Description of Alternatives*. Alternative 4 would include installation of temporary drainage bypass facilities, long-term cross drainage, and replacement of existing drainage facilities that would be disrupted due to construction of new facilities.

Construction-related activities under Alternative 4 would be conducted in accordance with the environmental commitment to develop and implement BMPs for all activities that may result in discharge of soil, sediment, or other construction-related contaminants to surface water bodies, and obtain authorization for the construction activities under the State Water Board's NPDES Stormwater General Permit for Stormwater Discharges Associated with Construction and Land Disturbance Activities (Order No. 2009-0009-DWQ/NPDES Permit No. CAS000002). The General Construction NPDES Permit requires the preparation and implementation of SWPPPs, which are the principal plans within the required PRDs that identify the proposed erosion control and pollution prevention BMPs that would be used to avoid and minimize construction-related erosion and contaminant discharges. The development of the SWPPPs, and applicability of other provisions of this General Construction Permit depends on the "risk" classification for the construction which is determined based on the potential for erosion to occur as well as the susceptibility of the receiving water to potential adverse effects of construction. While the determination of project risk level, and planning and development of the SWPPPs and BMPs to be implemented, would be completed as a part of final design and contracting for the work, the responsibility for compliance with the provisions of the General Construction Permit necessitates that BMPs are applied to all disturbance activities. In addition to the BMPs, the SWPPPs would include BMP inspection and monitoring activities, and identify responsibilities of all parties, contingency measures, agency contacts, and training requirements and documentation for those personnel responsible for installation, inspection, maintenance, and repair of BMPs. The General Construction Permit contains NALs and for pH and turbidity, and specifies storm event water quality monitoring to determine if construction is resulting in elevated discharges of these constituents, and monitoring for any non-visible contaminants determined to have been potentially released. If an NAL is determined to have been exceeded, the General Construction Permit requires the discharger to conduct a construction site and run-on evaluation to determine whether contaminant sources associated with the site's construction activity may have caused or contributed to the exceedance and immediately implement corrective actions if they are needed.

The BMPs that are routinely implemented in the construction industry and have proven successful at reducing adverse water quality effects include, but are not limited to, the following broad categories of actions (letters refer to categories of specific BMPs identified in Appendix 3B, *Environmental Commitments*), for which Appendix 3B identifies specific BMPs within these categories:

- Waste Management and Spill Prevention and Response (BMP categories A.2 and A.3): Waste management BMPs are designed to minimize exposure of waste materials at all construction sites and staging areas such as waste collection and disposal practices, containment and protection of wastes from wind and rain, and equipment cleaning measures. Spill prevention and response BMPs involve planning, equipment, and training for personnel for emergency event response.

- Erosion and Sedimentation Control (BMP categories A.4 and A.5): Erosion control BMPs are designed to prevent erosion processes or events including scheduling work to avoid rain events, stabilizing exposed soils; minimize offsite sediment runoff; remove sediment from onsite runoff before it leaves the site; and slow runoff rates across construction sites. Identification of appropriate temporary and long-term seeding, mulching, and other erosion control measures as necessary. Sedimentation BMPs are designed to minimize offsite sediment runoff once erosion has occurred involving drainage controls, perimeter controls, detention/sedimentation basins, or other containment features.

- Good Housekeeping and Non-Stormwater Discharge Management (BMP category A.6 and A.7): Good housekeeping BMPs are designed to reduce exposure of construction sites and materials storage to stormwater runoff including truck tire tracking control facilities; equipment washing; litter and construction debris; and designated refueling and equipment inspection/maintenance practices Non-stormwater discharge management BMPs involve runoff measures for contaminants not directly associated with rain or wind including vehicle washing and street cleaning operations.
- Construction Site Dewatering and Pipeline Testing (BMP category A.8). Dewatering BMPs involve actions to prevent discharge of contaminants present in dewatering of groundwater during construction, discharges of water from testing of pipelines or other facilities, or the indirect erosion that may be caused by dewatering discharges.
- BMP Inspection and Monitoring (BMP category A.9): Identification of clear objectives for evaluating compliance with SWPPP provisions, and specific BMP inspection and monitoring procedures, environmental awareness training, contractor and agency roles and responsibilities, reporting procedures, and communication protocols.

In addition to the Category “A” BMPs for surface land disturbances identified in the environmental commitments (Appendix 3B, *Environmental Commitments*), BMPs implemented for Alternative 4 also would include the Category “B” BMPs for tunnel/pipeline construction that involves actions primarily to avoid and minimize sediment and contaminant discharges associated with RTM excavation, hauling, and RTM dewatering operations. Additionally, habitat restoration activities under CM2 and CM4–CM10 would be subject to implementation of the Category “C” BMPs (In-Water Construction BMPs) and Category “D” BMPs (Tidal and Wetland Restoration) designed to minimize disturbance and direct discharge of turbidity/suspended solids to the water during in-water construction activities. Category “E” BMPs identify general permanent post-construction actions that would be implemented for all terrestrial, in-water, and habitat restoration activities and would involve planning, design, and development of final site stabilization, revegetation, and drainage control features.

Finally, acquisition of applicable environmental permits may be required for specific conservation measures, which as described for the No Action Alternative, may include specific WDRs or CWA Section 401 water quality certifications from the appropriate Regional Water Boards, CDFW Streambed Alteration Agreements, and USACE CWA Section 404 dredge and fill permits. These other permit processes may include requirements to implement additional action-specific BMPs that may reduce potential adverse discharge effects of constituents of concern.

The potential construction-related contaminant discharges that could result from projects defined under Alternative 4 would not be anticipated to result in adverse water quality effects at a magnitude, frequency, or regional extent that would cause substantial adverse effects to aquatic life. Relative to Existing Conditions, this assessment indicates the following.

- Projects would be managed under state water quality regulations and project-defined actions to avoid and minimize contaminant discharges.
- Individual projects would generally be dispersed, and involve infrequent and temporary activities, thus not likely resulting in substantial exceedances of water quality standards or long-term degradation.

- Potential construction-related contaminant discharges under the Alternative 4 would not cause additional exceedance of applicable water quality objectives where such objectives are not exceeded under Existing Conditions. Long-term water quality degradation is not anticipated, and hence would not be expected to adversely affect beneficial uses.
- By the intermittent and temporary frequency of construction-related activities and potential contaminant discharges, the constituent-specific effects would not be of substantial magnitude or duration to contribute to long-term bioaccumulation processes, or cause measureable long-term degradation such that existing 303(d) impairments would be made discernibly worse or TMDL actions to reduce loading would be adversely affected.

Consequently, because the construction-related activities for the conservation measures would be conducted with implementation of environmental commitments, including but not limited to those identified in Appendix 3B, with respect to the Existing Conditions and No Action Alternative conditions, Alternative 4 would not be expected to cause constituent discharges of sufficient frequency and magnitude to result in a substantial increase of exceedances of water quality objectives/criteria, or substantially degrade water quality with respect to the constituents of concern, and thus would not adversely affect any beneficial uses in the Delta.

In summary, with implementation of environmental commitments in Appendix 3B, the potential construction-related water quality effects are considered to be not adverse.

***CEQA Conclusion*:** Because environmental commitments would be implemented under Alternative 4 for construction-related activities along with agency-issued permits that also contain construction requirements to protect water quality, the construction-related effects, relative to Existing Conditions, would not be expected to cause or contribute to substantial alteration of existing drainage patterns which would result in substantial erosion or siltation on- or off-site, substantial increased frequency of exceedances of water quality objectives/criteria, or substantially degrade water quality with respect to the constituents of concern on a long-term average basis, and thus would not adversely affect any beneficial uses in water bodies upstream of the Delta, within the Delta, or in the SWP and CVP service area. Moreover, because the construction-related activities would be temporary and intermittent in nature, the construction would involve negligible discharges, if any, of bioaccumulative or 303(d) listed constituents to water bodies of the affected environment. As such, construction activities would not contribute measurably to bioaccumulation of contaminants in organisms or humans or cause 303(d) impairments to be discernibly worse. Based on these findings, this impact is determined to be less than significant. No mitigation is required.

8.4.3.10 Alternative 5—Dual Conveyance with Pipeline/Tunnel and Intake (3,000 cfs; Operational Scenario C)

Alternative 5 would comprise physical/structural components similar to those under Alternative 1A with the principal exception that Alternative 5 would convey up to 3,000 cfs of water from the north Delta to the south Delta. Diverted water would be conveyed through pipelines/tunnels from a single screened intake (i.e., Intake 1) located on the east bank of the Sacramento River between Clarksburg and Walnut Grove. Alternative 5 would include a 750 acre intermediate forebay and pumping plant. A new 600 acre Byron Tract Forebay, adjacent to and south of Clifton Court Forebay, would be constructed which would provide water to the south Delta pumping plants. Water supply and conveyance operations would follow the guidelines described as Scenario C, which includes fall X2.

Conservation Measures 2–22 (CM2–22) would be implemented under this alternative, and would be the same as those under Alternative 1A with the exception of CM4, which would involve 25,000 acres of tidal habitat restoration instead of 65,000 acres under the other action alternatives. See Chapter 3, *Description of Alternatives*, Section 3.5.10, for additional details on Alternative 5.

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 5, over the long term, average annual delta exports are anticipated to decrease by 358 TAF relative to Existing Conditions, and increase by 346 TAF relative to the No Action Alternative. Since, over the long-term, approximately 25% 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 5–Old River at Rock Slough for ALL years (1976–1991), which shows increased San Joaquin River (SJR) percentage and decreased Sacramento River (SAC) percentage under the alternative, relative to Existing Conditions and the No Action Alternative.

Under Alternative 5, long-term average annual Delta outflow is anticipated to increase 401 TAF relative to Existing Conditions, due to both changes in operations (including north Delta intake capacity of 3,000 cfs and numerous other operational components of Scenario C) and climate change/sea level rise (see Chapter 5, *Water Supply*, for more information). Long-term average annual Delta outflow is anticipated to decrease under Alternative 5 by 349 TAF relative to the No Action Alternative, due only to changes in operations. The result of this is increased sea water intrusion in the west Delta. The increases in sea water intrusion (represented by an increase in San Francisco Bay (BAY) percentage) can be seen, for example, in Appendix 8D, ALT 5–Sacramento River at Mallard Island for ALL years (1976–1991).

Impact WQ-1: Effects on Ammonia Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative, Alternative 5 would have negligible, if any, effect on ammonia concentrations in the rivers and reservoirs upstream of the Delta relative to Existing Conditions and the No Action Alternative. Any negligible increases in ammonia-N concentrations that could occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regard to ammonia.

Delta

Assessment of effects of ammonia under Alternative 5 is the same as discussed under Alternative 1A, except that because flows in the Sacramento River at Freeport are different between the two alternatives, estimated monthly average and long term annual average predicted ammonia-N concentrations in the Sacramento River downstream of Freeport are different.

As Table 8-68 shows, estimated ammonia-N concentrations in the Sacramento River downstream of Freeport (upon full mixing of the SRWTP discharge with river water) under Alternative 5 and the No Action Alternative are expected to be similar. Minor increases in ammonia-N concentrations would occur during January through March, August, September, November, and December, and remaining months would be unchanged or have a minor decrease. A minor increase in the annual average concentration would occur under Alternative 5, compared to the No Action Alternative. Moreover, the estimated concentrations downstream of Freeport under Alternative 5 would be similar to existing source water concentrations for the San Francisco Bay and San Joaquin River. Consequently, changes in source water fraction anticipated under Alternative 5, relative to the No Action Alternative, are not expected to substantially increase ammonia concentrations at any Delta locations.

Table 8-68. Estimated Ammonia-N (mg-L as N) Concentrations in the Sacramento River Downstream of the Sacramento Regional Wastewater Treatment Plant for the No Action Alternative and Alternative 5

	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
Alternative 5	0.072	0.088	0.070	0.061	0.058	0.061	0.058	0.064	0.064	0.060	0.070	0.067	0.066

Any negligible increases in ammonia-N concentrations that could occur at certain locations in the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to ammonia.

SWP/CVP Export Service Areas

The assessment of effects on ammonia in the SWP/CVP Export Service Area is based on assessment of ammonia-N concentrations at Banks and Jones pumping plants. Similar to the discussion for Alternative 1A, under Alternative 5 for areas of the Delta that are influenced by Sacramento River water, including Banks and Jones pumping plants, ammonia-N concentrations are expected to decrease, relative to Existing Conditions (in association with less diversion of water influenced by the SRWTP). This decrease in ammonia-N concentrations for water exported via the south Delta pumps is not expected to result in adverse effects on beneficial uses or substantially degrade water quality of exported water, with regards to ammonia.

Furthermore, as discussed above for the Plan Area, for all areas of the Delta, including Banks and Jones pumping plants, ammonia-N concentrations are not expected to be substantially different under Alternative 5, relative to No Action Alternative. Any negligible increases in ammonia-N concentrations that could occur at Banks and Jones pumping plants would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to ammonia.

NEPA Effects**:** In summary, based on the discussion above, effects on ammonia from implementation of CM1 are considered to be not adverse.

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

Ammonia-N concentrations are generally low in the reservoirs and rivers of the watersheds, owing to the lack of substantial point and nonpoint sources of ammonia-N upstream of the SRWTP in the Sacramento River watershed, in the watersheds of the eastern tributaries (Cosumnes, Mokelumne, and Calaveras Rivers), or upstream of the Delta in the San Joaquin River watershed. Consequently, any modified reservoir operations and subsequent changes in river flows under Alternative 5, relative to Existing Conditions, are expected to have negligible, if any, effects on reservoir and river ammonia-N concentrations upstream of Freeport in the Sacramento River watershed and upstream of the Delta in the San Joaquin River watershed.

Ammonia-N concentrations in the Sacramento River downstream of the SRWTP would be substantially lower under Alternative 5, relative to Existing Conditions, due to upgrades to the SRWTP that are assumed to be in place, and thus, ammonia concentrations for all areas of the Delta that are influenced by Sacramento River water are expected to decrease. At locations which are not influenced notably by Sacramento River water, concentrations are expected to remain relatively unchanged, due to the similarity in SJR and BAY concentrations and the lack of expected changes in either of these concentrations.

The assessment of effects on ammonia in the SWP/CVP Export Service Areas is based on assessment of ammonia-N concentrations at Banks and Jones pumping plants. As discussed above for the Plan Area, for areas of the Delta that are influenced by Sacramento River water, including Banks and Jones pumping plants, ammonia-N concentrations are expected to decrease under Alternative 5, relative to Existing Conditions.

Based on the above, there would be no substantial, long-term increase in ammonia-N concentrations in the rivers and reservoirs upstream of the Delta, in the Plan Area, or the waters exported to the CVP and SWP service areas under Alternative 5 relative to Existing Conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because ammonia concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects on beneficial uses would occur. Ammonia is not 303(d) listed within the affected environment and thus any minor increases that could occur in some areas would not make any existing ammonia-related impairment measurably worse because no such impairments currently exist. Because ammonia-N is not bioaccumulative, minor increases that could occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-2: Effects on Ammonia Concentrations Resulting from Implementation of CM2–CM22

NEPA Effects**:** Effects of CM2–CM22 on ammonia under Alternative 5 are the same as those discussed for Alternative 1A and are considered to be not adverse.

CEQA Conclusion**:** Conservation Measures 2–22 proposed under Alternative 5 would be similar to those proposed under Alternative 1A. As such, effects on ammonia resulting from the implementation of CM2–CM22 would be similar to that previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-3: Effects on Boron Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Effects of CM1 on boron under Alternative 5 in areas upstream of the Delta would be very similar to the effects discussed for Alternative 1A. There would be no expected change to the sources of boron in the Sacramento and east-side tributary watersheds, and resultant changes in flows from altered system-wide operations would have negligible, if any, effects on the concentration of boron in the rivers and reservoirs of these watersheds. The modeled long-term annual average lower San Joaquin River flow at Vernalis would decrease slightly compared to Existing Conditions (in association with project operations, climate change, and increased water demands) and would be similar compared to the No Action Alternative considering only changes due to Alternative 5 operations. The reduced flow would result in possible increases in long-term average boron concentrations of up to about 3% relative to the Existing Conditions (Appendix 8F, Table 24). The increased boron concentrations would not increase the frequency of exceedances of any applicable objectives or criteria and would not be expected to cause further degradation at measurable levels in the lower San Joaquin River, and thus would not cause the existing impairment there to be discernibly worse. Consequently, Alternative 5 would not be expected to cause exceedance of boron objectives/criteria or substantially degrade water quality with respect to boron, and thus would not adversely affect any beneficial uses of the Sacramento River, the east-side tributaries, associated reservoirs upstream of the Delta, or the San Joaquin River.

Delta

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

Effects of CM1 on boron under Alternative 5 in the Delta would be similar to the effects discussed for Alternative 1A. Relative to the Existing Conditions and No Action Alternative, Alternative 5 would result in increased long-term average boron concentrations for the 16-year period modeled at interior and western Delta locations (by as much as 7% at the SF Mokelumne River at Staten Island, 2% at the San Joaquin River at Buckley Cove, 8% at Franks Tract, and 7% at Old River at Rock Slough) (Appendix 8F, Table Bo-14). This comparison to Existing Conditions reflects changes 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. The comparison to the No Action Alternative reflects changes due only to operations.

Implementation of tidal habitat restoration under CM4 also may contribute to increased boron concentrations at western Delta assessment locations (more discussion of this phenomenon is included in Section 8.3.1.3), and thus would not be anticipated to substantially affect agricultural diversions which occur primarily at interior Delta locations. The long-term annual average and monthly average boron concentrations, for either the 16-year period or drought period modeled, would never exceed the 2,000 μg/L human health advisory objective (i.e., for children) or 500 μg/L agricultural objective at any of the eleven Delta assessment locations, which represents no change from the Existing Conditions and No Action Alternative (Appendix 8F, Table Bo-3A). Reductions in long-term average assimilative capacity of up to 4% at interior Delta locations (i.e., Franks Tract and Old River at Rock Slough) would be small with respect to the 500 μg/L agricultural objective (Appendix 8F, Table Bo-15). However, because the absolute boron concentrations would still be well below the lowest 500 μg/L objective for the protection of the agricultural beneficial use under Alternative 5, the levels of boron degradation would not be of sufficient magnitude to substantially increase the risk of exceeding objectives or cause adverse effects to municipal and agricultural water supply beneficial uses, or any other beneficial uses, in the Delta (Appendix 8F, Figure Bo-4).

SWP/CVP Export Service Areas

Effects of CM1 on boron under Alternative 5 in the Delta would be similar to the effects discussed for Alternative 1A. Under Alternative 5, long-term average boron concentrations would decrease by as much as 11% at the Banks Pumping Plant and Jones Pumping Plant relative to the Existing Conditions and No Action Alternative (Appendix 8F, Table Bo-14) as a result of export of a greater proportion of low-boron Sacramento River water. Commensurate with the decrease in exported boron concentrations, boron concentrations in the lower San Joaquin River may be reduced and would likely alleviate or lessen any expected increase in boron concentrations at Vernalis associated with flow reductions (see discussion of Upstream of the Delta), as well as locations in the Delta receiving a large fraction of San Joaquin River water. Reduced export boron concentrations also may contribute to reducing the existing 303(d) impairment in the lower San Joaquin River and associated TMDL actions for reducing boron loading.

Maintenance of SWP and CVP facilities under Alternative 5 would not be expected to create new sources of boron or contribute towards a substantial change in existing sources of boron in the affected environment. Maintenance activities would not be expected to cause any substantial increases in boron concentrations or degradation with respect to boron such that objectives would be exceeded more frequently, or any beneficial uses would be adversely affected anywhere in the affected environment.

NEPA Effects: In summary, relative to the No Action Alternative conditions, Alternative 5 would result in relatively small increases in long-term average boron concentrations in the Delta and not appreciably change boron levels in the lower San Joaquin River. However, the predicted changes would not be expected to cause exceedances of applicable objectives or further measurable water quality degradation, and thus would not constitute an adverse effect on water quality.

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

Boron is not a constituent of concern in the Sacramento River watershed upstream of the Delta, thus river flow rate and reservoir storage reductions that would occur under the Alternative 5, relative to Existing Conditions, would not be expected to result in a substantial adverse change in boron levels. Additionally, relative to Existing Conditions, Alternative 5 would not result in reductions in river flow rates (i.e., less dilution) or increased boron loading such that there would be any substantial increases in boron concentration upstream of the Delta in the San Joaquin River watershed.

Small increased boron levels predicted for interior and western Delta locations in response (i.e., up to 8% increase) to a shift in the Delta source water percentages and tidal habitat restoration under this alternative would not be expected to cause exceedances of objectives, or substantial degradation of these water bodies. Alternative 5 maintenance also would not result in any substantial increases in boron concentrations in the affected environment. Boron concentrations would be reduced in water exported from the Delta to the CVP/SWP Export Service Areas, thus reflecting a potential improvement to boron loading in the lower San Joaquin River.

Boron is not a bioaccumulative constituent, thus any increased concentrations under Alternative 5 would not result in adverse boron bioaccumulation effects to aquatic life or humans. Relative to Existing Conditions, Alternative 5 would not result in substantially increased boron concentrations such that frequency of exceedances of municipal and agricultural water supply objectives would increase. The levels of boron degradation that may occur under Alternative 5 would not be of sufficient magnitude to cause substantially increased risk for adverse effects to municipal or agricultural beneficial uses within the affected environment. Long-term average boron concentrations would decrease in Delta water exports to the SWP and CVP service area, which may contribute to reducing the existing 303(d) impairment of agricultural beneficial uses in the lower San Joaquin River. Based on these findings, this impact is determined to be less than significant. No mitigation is required.

Impact WQ-4: Effects on Boron Concentrations Resulting from Implementation of CM2–CM22

NEPA Effects: Effects of CM2–CM22 on boron under Alternative 5 are the same as those discussed for Alternative 1A and are determined to be not adverse.

CEQA Conclusion: Conservation Measures 2–22 proposed under Alternative 5 would be similar to those proposed under Alternative 1A. As such, effects on boron resulting from the implementation of CM2–CM22 would be similar to that previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

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

Upstream of the Delta

Under Alternative 5 there would be no expected change to the sources of bromide in the Sacramento and eastside tributary watersheds. Bromide loading in these watersheds would remain unchanged and resultant changes in flows from altered system-wide operations under Alternative 5 would have negligible, if any, effects on the concentration of bromide in the rivers and reservoirs of these watersheds. Consequently, Alternative 5 would not be expected to adversely affect the MUN beneficial use, or any other beneficial uses, of the Sacramento River, the eastside tributaries, or their associated reservoirs upstream of the Delta.

Under Alternative 5, modeling indicates that long-term annual average flows on the San Joaquin River would decrease by 6%, relative to Existing Conditions, and would remain virtually the same relative to the No Action Alternative (Appendix 5A). These decreases in flow would result in possible increases in long-term average bromide concentrations of about 3%, relative to Existing Conditions and less than <1% relative to the No Action Alternative (Appendix 8E, Bromide Table 22). The small increases in lower San Joaquin River bromide levels that could occur under Alternative 5, relative to existing and the No Action Alternative conditions would not be expected to adversely affect the MUN beneficial use, or any other beneficial uses, of the lower San Joaquin River.

Delta

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

Under Alternative 5, the geographic extent of effects pertaining to long-term average bromide concentrations in the Delta would be similar to that previously described for Alternative 1A, although the magnitude of predicted long-term change and relative frequency of concentration threshold exceedances would be different. Using the mass-balance modeling approach for bromide (see Section 8.3.1.3), relative to Existing Conditions, modeled long-term average bromide concentrations would increase at Staten Island, Emmaton, and Barker Slough, while modeled long-term average bromide concentrations would decrease at the other assessment locations (Appendix 8E, *Bromide*, Table 12). Overall effects would be greatest at Barker Slough, where predicted long-term average bromide concentrations would increase from 51 μg/L to 63 μg/L (23% relative increase) for the modeled 16-year hydrologic period and would increase from 54 μg/L to 98 μg/L (84% relative increase) for the modeled drought period. At Barker Slough, the predicted 50 μg/L exceedance frequency would decrease from 49% under Existing Conditions to 38% under Alternative 5, but would increase from 55% to 68% during the drought period. At Barker Slough, the predicted 100 μg/L exceedance frequency would increase from 0% under Existing Conditions to

18% under Alternative 5, and would increase from 0% to 38% during the drought period. In contrast, increases in bromide at Staten Island would result in a 50 µg/L bromide threshold exceedance increase from 47% under Existing Conditions to 67% under Alternative 5 (52% to 77% during the modeled drought period). However, unlike Barker Slough, modeling shows that long-term average bromide concentration at Staten Island would exceed the 100 µg/L assessment threshold concentration 1% under Existing Conditions and 2% under Alternative 5 (0% to 2% during the modeled drought period). The long-term average bromide concentrations would be 59 µg/L (62 µg/L for the modeled drought period) at Staten Island under Alternative 5. Changes in exceedance frequency of the 50 µg/L and 100 µg/L concentration thresholds, as well as relative change in long-term average concentration, at other assessment locations would be less substantial. This comparison to Existing Conditions reflects changes in bromide due to both Alternative 5 operations (including north Delta intake capacity of 3,000 cfs and numerous other operational components of Scenario C) and climate change/sea level rise.

Due to the relatively small differences between modeled Existing Conditions and No Action baseline, changes in long-term average bromide concentrations and changes in exceedance frequencies relative to the No Action Alternative are generally of similar magnitude to those previously described for the existing condition comparison (Appendix 8E, *Bromide*, Table 12). Modeled long-term average bromide concentration increases would similarly be greatest at Barker Slough, where long-term average concentrations are predicted to increase by 27% (83% for the modeled drought period) relative to the No Action Alternative. However, unlike the Existing Conditions comparison, long-term average bromide concentrations at Buckley Cove, Rock Slough, and Contra Costa PP No. 1 would increase relative to No Action Alternative, although the increases would be relatively small (≤4%). Unlike the comparison to Existing Conditions, this comparison to the No Action Alternative reflects changes in bromide due only to Alternative 5 operations.

At Barker Slough, modeled long-term average bromide concentrations for the two baseline conditions are very similar (Appendix 8E, *Bromide*, Table 12). Such similarity demonstrates that the modeled Alternative 5 change in bromide is almost entirely due to Alternative 5 operations, and not climate change/sea level rise. Therefore, operations are the primary driver of effects on bromide at Barker Slough, regardless whether Alternative 5 is compared to Existing Conditions, or compared to the No Action Alternative.

Results of the modeling approach which used relationships between EC and chloride and between chloride and bromide (see Section 8.3.1.3) differed somewhat from what is presented above for the mass-balance approach (see Appendix 8E, *Bromide*, Table 13). For most locations, the frequency of exceedance of the 50 µg/L and 100 µg/L were similar. The greatest difference between the methods was predicted for Barker Slough. The increases in frequency of exceedance of the 100 µg/L threshold, relative to Existing Conditions and the No Action Alternative, were not as great using this alternative EC to chloride and chloride to bromide relationship modeling approach as compared to that presented above from the mass-balance modeling approach. However, there were still substantial increases, resulting in 9% exceedance over the modeled period under Alternative 5, as compared to 1% under Existing Conditions and 2% under the No Action Alternative. For the drought period, exceedance frequency increased from 0% under Existing Conditions and the No Action Alternative, to 20% under Alternative 5. Because the mass-balance approach predicts a greater level of impact at Barker Slough, determination of impacts was based on the mass-balance results.

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

The seasonal intakes at Mallard Slough and City of Antioch are infrequently used due to water quality constraints related to sea water intrusion. On a long-term average basis, bromide at these locations is in excess of 3,000 µg/L, but during seasonal periods of high Delta outflow can be <300 µg/L. Based on modeling using the mass-balance approach, use of the seasonal intakes at Mallard Slough and City of Antioch under Alternative 5 would experience a period average increase in bromide during the months when these intakes would most likely be utilized. For those wet and above normal water year types where mass balance modeling would predict water quality typically suitable for diversion, predicted long-term average bromide would increase from 103 µg/L to 128 µg/L (25% increase) at City of Antioch and would increase from 150 µg/L to 194 µg/L (30% increase) at Mallard Slough relative to Existing Conditions (Appendix 8E, *Bromide*, Table 23). Increases would be similar for the No Action Alternative comparison. Modeling results using the EC to chloride and chloride to bromide relationships show increases during these months, but the relative magnitude of the increases is much lower (Appendix 8E, Bromide Table 24). Regardless of the differences in the data between the two modeling approaches, the decisions surrounding the use of these seasonal intakes is largely driven by acceptable water quality, and thus have historically been opportunistic. Opportunity to use these intakes would remain, and the predicted increases in bromide concentrations at the City of Antioch and Mallard Slough intake would not be expected to adversely affect MUN beneficial uses, or any other beneficial use, at these locations.

SWP/CVP Export Service Areas

Under Alternative 5, improvement in long-term average bromide concentrations would occur at the Banks and Jones pumping plants. Long-term average bromide concentrations for the modeled 16-year hydrologic period at these locations would decrease by as much as 30% relative to Existing Conditions and 20% relative to No Action Alternative. Relative change in long-term average bromide concentration would be less during drought conditions (≤27%), but would still represent considerable improvement (Appendix 8E, Bromide Table 12). As a result, less frequent bromide concentration exceedances of the 50 µg/L and 100 µg/L assessment thresholds would be predicted and an overall improvement in Export Service Areas water quality would be experienced respective to bromide. Commensurate with the decrease in exported bromide, an improvement in lower San Joaquin River bromide would also be observed since bromide in the lower San Joaquin River is principally related to irrigation water deliveries from the Delta. While the magnitude of this expected lower San Joaquin River improvement in bromide is difficult to predict, the relative decrease in overall loading of bromide to the Export Service Areas would likely alleviate or lessen any expected increase in bromide concentrations at Vernalis (see discussion of Upstream of the

Delta) as well as locations in the Delta receiving a large fraction of San Joaquin River water, such as much of the south Delta.

The discussion above is based on results of the mass-balance modeling approach. Results of the modeling approach which used relationships between EC and chloride and between chloride and bromide (see Section 8.3.1.3) were consistent with the discussion above, and assessment of bromide using these data results in the same conclusions as are presented above for the mass-balance approach (see Appendix 8E, *Bromide*, Table 13).

Similar to the discussion pertaining to the No Action Alternative, maintenance of SWP and CVP facilities under Alternative 5 would not be expected to create new sources of bromide or contribute towards a substantial change in existing sources of bromide in the affected environment. Maintenance activities would not be expected to cause any substantial change in bromide such that MUN beneficial uses, or any other beneficial use, would be adversely affected anywhere in the affected environment.

***NEPA Effects*:** In summary, Alternative 5 operations and maintenance, relative to the No Action Alternative, would result in small increases (i.e., <1%) in long-term average bromide concentrations at Vernalis related to relatively small declines in long-term average flow on the San Joaquin River. However, Alternative 5 operation and maintenance activities would cause substantial degradation to water quality with respect to bromide at Barker Slough, source of the North Bay Aqueduct. Resultant substantial change in long-term average bromide at Barker Slough could necessitate changes in water treatment plant operations or require treatment plant upgrades in order to maintain DBP compliance, and thus would constitute an adverse effect on water quality. Mitigation Measure WQ-5 is available to reduce these effects (implementation of this measure along with a separate, non-environmental commitment as set forth in EIR/EIS Appendix 3B, *Environmental Commitments*, relating to the potential increased treatment costs associated with bromide-related changes would reduce these effects).

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

Under Alternative 5 there would be no expected change to the sources of bromide in the Sacramento and eastside tributary watersheds. Bromide loading in these watersheds would remain unchanged and resultant changes in flows from altered system-wide operations under Alternative 5 would have negligible, if any, effects on the concentration of bromide in the rivers and reservoirs of these watersheds. However, south of the Delta, the San Joaquin River is a substantial source of bromide, primarily due to the use of irrigation water imported from the southern Delta. Concentrations of bromide at Vernalis are inversely correlated to net river flow. Under Alternative 5, long-term average flows at Vernalis would decrease only slightly, resulting in less than substantial predicted increases in long-term average bromide of about 3% relative to Existing Conditions.

Relative to Existing Conditions, Alternative 5 would result in small decreases in long-term average bromide concentration at most Delta assessment locations, with principal exceptions being the North Bay Aqueduct at Barker Slough, Staten Island, and Emmaton on the Sacramento River. Overall effects would be greatest at Barker Slough, where substantial increases in long-term average bromide concentrations would be predicted. The increase in long-term average bromide concentrations predicted for Barker Slough would result in a substantial change in source water quality to existing drinking water treatment plants drawing water from the North Bay Aqueduct. These modeled increases in bromide at Barker Slough could lead to adverse changes in the formation of disinfection byproducts at drinking water treatment plants such that considerable water treatment plant upgrades would be necessary in order to achieve equivalent levels of drinking water health protection.

The assessment of effects on bromide in the SWP/CVP Export Service Areas is based on assessment of changes in bromide concentrations at Banks and Jones pumping plants. Under Alternative 5, substantial improvement would occur at the Banks and Jones pumping plants, where predicted long-term average bromide concentrations are predicted to decrease by as much as 30% relative to Existing Conditions. An overall improvement in bromide-related water quality would be predicted in the SWP/CVP Export Service Areas.

Based on the above, Alternative 5 operation and maintenance would not result in any substantial change in long-term average bromide concentration upstream of the Delta. Furthermore, under Alternative 5, water exported from the Delta to the SWP/CVP service area would be substantially improved relative to bromide. Bromide is not bioaccumulative, therefore change in long-term average bromide concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Additionally, bromide is not a constituent related to any 303(d) listings. Alternative 5 operation and maintenance activities would not cause substantial long-term degradation to water quality respective to bromide with the exception of water quality at Barker Slough, source of the North Bay Aqueduct. At Barker Slough, modeled long-term annual average concentrations of bromide would increase by 23%, and 84% during the modeled drought period. For the modeled 16-year hydrologic period the frequency of predicted bromide concentrations exceeding 100 µg/L would increase from 0% under Existing Conditions to 18% under Alternative 5, while for the modeled drought period, the frequency would increase from 0% to 38%. Substantial changes in long-term average bromide could necessitate changes in treatment plant operation or require treatment plant upgrades in order to maintain DBP compliance. The model predicted change at Barker Slough is substantial and, therefore, would represent a substantially increased risk for adverse effects on existing MUN beneficial uses should treatment upgrades not be undertaken. The impact is considered significant.

Implementation of Mitigation Measure WQ-5 along with a separate, non-environmental commitment relating to the potential increased treatment costs associated with bromide-related changes would reduce these effects. While mitigation measures to reduce these water quality effects in affected water bodies to less than significant levels are not available, implementation of Mitigation Measure WQ-5 is recommended to attempt to reduce the effect that increased bromide concentrations may have on Delta beneficial uses. However, because the effectiveness of this mitigation measure to result in feasible measures for reducing water quality effects is uncertain, this impact is considered to remain significant and unavoidable. Please see Mitigation Measure WQ-5 under Impact WQ-5 in the discussion of Alternative 1A.

In addition to and to supplement Mitigation Measure WQ-5, the BDCP proponents have incorporated into the BDCP, as set forth in EIR/EIS Appendix 3B, *Environmental Commitments*, a separate, non-environmental commitment to address the potential increased water treatment costs that could result from bromide-related concentration effects on municipal water purveyor operations. Potential options for making use of this financial commitment include funding or providing other assistance towards implementation of the North Bay Aqueduct AIP, acquiring alternative water supplies, or other actions to indirectly reduce the effects of elevated bromide and DOC in existing water supply diversion facilities. Please refer to Appendix 3B, *Environmental Commitments*, for the full list of potential actions that could be taken pursuant to this commitment in order to reduce the water quality treatment costs associated with water quality effects relating to chloride, electrical conductivity, and bromide.

Mitigation Measure WQ-5: Avoid, Minimize, or Offset, as Feasible, Adverse Water Quality Conditions

Please see Mitigation Measure WQ-5 under Impact WQ-5 in the discussion of Alternative 1A.

Impact WQ-6: Effects on Bromide Concentrations Resulting from Implementation of CM2–CM22

NEPA Effects**:** Conservation Measures 2–22 proposed under Alternative 5 would be the same as those proposed under Alternative 1A, except that 25,000 rather than 65,000 acres of tidal habitat would be restored. As discussed for Alternative 1A, implementation of the CM2–CM22 would not present new or substantially changed sources of bromide to the study area. Some conservation measures may replace or substitute for existing irrigated agriculture in the Delta. This replacement or substitution is not expected to substantially increase or present new sources of bromide. CM2–CM22 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.

In summary, implementation of CM2–CM22 under Alternative 5, relative to the No Action Alternative, would have negligible, if any, effects on bromide concentrations. The effects on bromide from implementing CM2–CM22 are determined to not be adverse.

CEQA Conclusion**:** Conservation Measures 2–22 proposed under Alternative 5 would be similar to those proposed under Alternative 1A, except that 25,000 rather than 65,000 acres of tidal habitat would be restored. As discussed for Alternative 1A, implementation of the CM2–CM22 (CM2–CM22) would not present new or substantially changed sources of bromide to the study area. As such, effects on bromide resulting from the implementation of CM2–CM22 would be similar to that previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

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

Upstream of the Delta

Under Alternative 5 there would be no expected change to the sources of chloride in the Sacramento and eastside tributary watersheds. Chloride loading in these watersheds would remain unchanged and resultant changes in flows from altered system-wide operations would have negligible, if any, effects on the concentration of chloride in the rivers and reservoirs of these watersheds. The modeled long-term annual average flows on the lower San Joaquin River at Vernalis would decrease slightly compared to Existing Conditions and be similar compared to the No Action Alternative (as a result of climate change). The reduced flow would result in possible increases in long-term average chloride concentrations of about 2%, relative to the Existing Conditions and no change relative to No Action Alternative (Appendix 8G, Table Cl-62). Consequently, Alternative 5 would not be expected to cause exceedance of chloride objectives/criteria or substantially degrade water quality with respect to chloride, and thus would not adversely affect any beneficial uses of the Sacramento River, the eastside tributaries, associated reservoirs upstream of the Delta, or the San Joaquin River.

Delta

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

Relative to Existing Conditions, modeling predicts that Alternative 5 would result in similar or reduced long-term average chloride concentrations for the 16-year period modeled at most of the assessment locations, and, depending on modeling approach (see Section 8.3.1.3), would result in increased concentrations at the North Bay Aqueduct at Barker Slough (i.e., ≤18%), Sacramento River at Emmaton (i.e., ≤3%), and San Joaquin River at Staten Island (i.e., ≤16%) (Appendix 8G, *Chloride*, Table Cl-31 and Table Cl-32). Additionally, implementation of tidal habitat restoration under CM4 would increase the tidal exchange volume in the Delta, and thus may contribute to increased chloride concentrations in the Bay source water as a result of increased salinity intrusion. More discussion of this phenomenon is included in Section 8.3.1.3. Consequently, while uncertain, the magnitude of chloride increases may be greater than indicated herein and would affect the western Delta assessment locations the most which are influenced to the greatest extent by the Bay source water. This comparison to Existing Conditions reflects changes in chloride due to both Alternative 5 operations (including north Delta intake capacity of 3,000 cfs and numerous other operational components of Scenario C) and climate change/sea level rise.

Relative to the No Action Alternative conditions, the mass balance analysis of modeling results indicated that Alternative 5 would result in similar or reduced long-term average chloride concentrations for the 16-year period modeled at four of the assessment locations. Chloride concentrations would increase at the SF Mokelumne River at Staten Island (up to 19%) and the North Bay Aqueduct at Barker Slough (up to 23%) compared to the No Action Alternative conditions and increase only incrementally (3% or less) at five other stations (Appendix 8G, Table Cl-31). The comparison to the No Action Alternative reflects changes in chloride due only to operations.

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

Municipal Beneficial Uses–Relative to Existing Conditions

Estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3) were used to evaluate the 150 mg/L Bay-Delta WQCP objective for municipal and industrial beneficial uses on a basis of the percent of years the chloride objective is exceeded for the modeled 16-year period. The objective is exceeded if chloride concentrations exceed 150 mg/L for a specified number of days in a given water year at both the Antioch and Contra Costa Pumping Plant #1 locations. For Alternative 5, the modeled frequency of objective exceedance would approximately double from 6% of years under Existing Conditions, to 13% of years under Alternative 5 (Appendix 8G, Table Cl-64).

Similarly, estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3) were also used to evaluate the 250 mg/L Bay-Delta WQCP objective for chloride at Contra Costa Pumping Plant #1 where daily average objectives apply. The basis for the evaluation was the predicted number of days the objective was exceeded for the modeled 16-year period. For Alternative 5, the modeled frequency of objective exceedance would decrease by approximately one half, from 6% of modeled days under Existing Conditions, to 3% of modeled days under Alternative 5 (Appendix 8G, Table Cl-63).

Given the limitations inherent to estimating future chloride concentrations (see Section 8.3.1.3), estimation of chloride concentrations through both a mass balance approach and an EC-chloride relationship approach was used to evaluate the 250 mg/L Bay-Delta WQCP objectives in terms of both frequency of exceedance and use of assimilative capacity. When utilizing the mass balance approach to model monthly average chloride concentrations for the 16-year period, the predicted frequency of exceeding the 250 mg/L objective would decrease at the Contra Costa Canal at Pumping Plant #1 (Appendix 8G, Table Cl-33 and Figure Cl-9). The frequency of exceedances would increase for the 16-year period modeled at the San Joaquin River at Antioch (i.e., from 66% under Existing Conditions to 72%) and Sacramento River at Mallard Island (i.e., from 85% under Existing Conditions to 87%) (Appendix 8G, Table Cl-33), and would cause further degradation at Antioch in March and April (i.e., maximum reduction of 45% of assimilative capacity for the 16-year period modeled, and 100% reduction, or elimination of assimilative capacity, during the drought period modeled) (Appendix 8G, Table Cl-35 and Figure Cl-9).

In comparison, when utilizing the chloride-EC relationship to model monthly average chloride concentrations for the 16-year period, trends in frequency of exceedance and use of assimilative capacity would be similar to that discussed when utilizing the mass balance modeling approach (Appendix 8G, Table Cl-34 and Table Cl-36). However, as with Alternative 1A the modeling approach utilizing the chloride-EC relationships predicted changes of lesser magnitude, where predictions of change utilizing the mass balance approach were generally of greater magnitude, and thus more conservative. As discussed in Section 8.3.1.3, in cases of such disagreement, the approach that yielded the more conservative predictions was used as the basis for determining adverse impacts.

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

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

With respect to the 303(d) listing for chloride in Tom Paine Slough, the monthly average chloride concentrations for the 16-year period modeled at Old River at Tracy Road would generally be similar compared to Existing Conditions, and thus, would not be further degraded on a long-term basis (Appendix 8G, Figure Cl-10). With respect to Suisun Marsh, the monthly average chloride concentrations for the 16-year period modeled would generally increase compared to Existing Conditions in some months during October through May at the Sacramento River at Collinsville (Appendix 8G, Figure Cl-11), Mallard Island (Appendix 8G, Figure Cl-9), and increase substantially at the Montezuma Slough at Beldon's Landing (i.e., over a doubling of concentration in December through February) (Appendix 8G, Figure Cl-12), thereby contributing to additional, measureable long-term degradation that potentially would adversely affect the necessary actions to reduce chloride loading for any TMDL that is developed.

Municipal Beneficial Uses–Relative to No Action Alternative

Similar to the assessment conducted for Existing Conditions, estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3) were used to evaluate the 150 mg/L Bay-Delta WQCP objective for municipal and industrial beneficial uses. For Alternative 5, the modeled frequency of objective exceedance would increase from 6% under the No Action Alternative to 13% of years under Alternative 5 (Appendix 8G, Table Cl-64).

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

Similar to Existing Conditions, a comparative assessment of modeling approaches was utilized to evaluate the 250 mg/L Bay-Delta WQCP objectives in terms of both frequency of exceedance and use of assimilative capacity on a monthly average basis. When utilizing the mass balance approach to model monthly average chloride concentrations for the 16-year period, a small decrease in exceedance frequency would be predicted at the San Joaquin River at Antioch (i.e., from 73% for the No Action Alternative to 72%), however, available assimilative capacity would be reduced in April (i.e., up to 10% for the 16 year period modeled, and 100% [i.e., eliminated] for the drought period modeled) (Appendix 8G, Table Cl-35). The exceedance frequency would increase slightly at the Sacramento River at Mallard Island (i.e., from 86% to 87%) and at the Contra Costa Canal at Pumping Plant #1 (i.e., from 14% to 18%) (Appendix 8G, Table Cl-33), along with reduced assimilative capacity at the Contra Costa Canal at Pumping Plant #1 in September (i.e., up to 56%), reflecting substantial degradation during when average concentrations would be near, or exceed, the objective (Appendix 8G, Table Cl-35).

In comparison, when utilizing the chloride-EC relationship to model monthly average chloride concentrations for the 16-year period, trends in frequency of exceedance and use of assimilative capacity would be similar to that discussed when utilizing the mass balance modeling approach (Appendix 8G, Table Cl-34 and Table Cl-36). However, as with Alternative 1A the modeling approach utilizing the chloride-EC relationships predicted changes of lesser magnitude, where predictions of change utilizing the mass balance approach were generally of greater magnitude, and thus more conservative. As discussed in Section 8.3.1.3, in cases of such disagreement, the approach that yielded the more conservative predictions was used as the basis for determining adverse impacts.

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

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

With respect to the 303(d) listing for chloride, Alternative 5 would generally result in similar changes to those discussed for the comparison to Existing Conditions. Monthly average chloride concentrations at Tom Paine Slough would not be further degraded on a long-term basis (Appendix 8G, Figure Cl-10). Monthly average chloride concentrations at source water channel locations for the

Suisun Marsh (Appendix 8G, Figures Cl-5, Cl-7, and Cl-8) would increase substantially in some months during October through May compared to the No Action Alternative conditions. Therefore, additional, measureable long-term degradation would occur in Suisun Marsh that potentially would adversely affect the necessary actions to reduce chloride loading for any TMDL that is developed.

SWP/CVP Export Service Areas

Under Alternative 5, long-term average chloride concentrations based on the mass balance analysis of modeling results for the 16-year period modeled at the Banks and Jones pumping plants would decrease by as much as 29% relative to Existing Conditions and 19% compared to No Action Alternative (Appendix 8G, *Chloride*, Table Cl-31). The modeled frequency of exceedances of applicable water quality objectives/criteria would decrease relative to Existing Conditions and No Action Alternative, for both the 16-year period and the drought period modeled (Appendix 8G, *Chloride*, Table Cl-33). Consequently, water exported into the SWP/CVP service area would generally be of similar or better quality with regards to chloride relative to Existing Conditions and the No Action Alternative conditions.

Results of the modeling approach which used relationships between EC and chloride (see Section 8.3.1.3) were consistent with the discussion above, and assessment of chloride using these data results in the same conclusions as are presented above for the mass-balance approach (Appendix 8G, Table Cl-32 and Table Cl-34).

Commensurate with the reduced chloride concentrations in water exported to the service area, reduced chloride loading in the lower San Joaquin River would be anticipated which would likely alleviate or lessen any expected increase in chloride at Vernalis related to decreased annual average San Joaquin River flows (see discussion of Upstream of the Delta).

Maintenance of SWP and CVP facilities would not be expected to create new sources of chloride or contribute towards a substantial change in existing sources of chloride in the affected environment. Maintenance activities would not be expected to cause any substantial change in chloride such that any long-term water quality degradation would occur, thus, beneficial uses would not be adversely affected anywhere in the affected environment.

***NEPA Effects*:** In summary, relative to the No Action Alternative conditions, Alternative 5 would result in increased water quality degradation and frequency of exceedance of the 150 mg/L objective at Contra Costa Pumping Plant #1 and Antioch, increased water quality degradation with respect to the 250 mg/L municipal and industrial objective at interior and western Delta locations on a monthly average chloride basis, and measureable water quality degradation relative to the 303(d) impairment in Suisun Marsh. The predicted chloride increases constitute an adverse effect on water quality (see Mitigation Measure WQ-7 below; implementation of this measure along with a separate, non-environmental commitment relating to the potential increased chloride treatment costs would reduce these effects). Additionally, the predicted changes relative to the No Action Alternative conditions indicate that in addition to the effects of climate change/sea level rise, implementation of CM1 and CM4 under Alternative 5 would contribute substantially to the adverse water quality effects.

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

Chloride is not a constituent of concern in the Sacramento River watershed upstream of the Delta, thus river flow rate and reservoir storage reductions that would occur under the Alternative 5, relative to Existing Conditions, would not be expected to result in a substantial adverse change in chloride levels. Additionally, relative to Existing Conditions, the Alternative 5 would not result in reductions in river flow rates (i.e., less dilution) or increased chloride loading such that there would be any substantial increase in chloride concentrations upstream of the Delta in the San Joaquin River watershed.

Relative to Existing Conditions, the Alternative 5 would result in substantially increased chloride concentrations in the Delta such that frequency of exceeding the 150 mg/L Bay-Delta WQCP objective would approximately double. Moreover, the frequency of exceedance of the 250 mg/L Bay-Delta WQCP objective would increase at the San Joaquin River at Antioch (by 6%) and at Mallard Slough (by 2%), and long-term degradation may occur, that may result in adverse effects on the municipal and industrial water supply beneficial use (see Mitigation Measure WQ-7 below; implementation of this measure along with a separate, non-environmental commitment relating to the potential increased chloride treatment costs would reduce these effects). Relative to the Existing Conditions, the modeled increased chloride concentrations and degradation in the western Delta could further contribute, at measurable levels (i.e., over a doubling of concentration), to the existing 303(d) listed impairment due to chloride in Suisun Marsh for the protection of fish and wildlife.

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

Chloride is not a bioaccumulative constituent, thus any increased concentrations under Alternative 5 would not result in substantial chloride bioaccumulation impacts on aquatic life or humans. Alternative 5 maintenance would not result in any substantial changes in chloride concentration upstream of the Delta or in the SWP/CVP Export Service Areas. However, based on these findings, this impact is determined to be significant due to increased chloride concentrations and degradation at western Delta locations and its effects on municipal and industrial water supply and fish and wildlife beneficial uses.

While mitigation measures to reduce these water quality effects in affected water bodies to less than significant levels are not available, implementation of Mitigation Measure WQ-7 is recommended to attempt to reduce the effect that increased chloride concentrations may have on Delta beneficial uses. However, because the effectiveness of this mitigation measure to result in feasible measures for reducing water quality effects is uncertain, this impact is considered to remain significant and unavoidable. Please see Mitigation Measure WQ-7 under Impact WQ-7 in the discussion of Alternative 1A.

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

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

Please see Mitigation Measure WQ-7 under Impact WQ-7 in the discussion of Alternative 1A.

Impact WQ-8: Effects on Chloride Concentrations Resulting from Implementation of CM2–CM22

NEPA Effects: Under Alternative 5, the types and geographic extent of effects on chloride concentrations in the Delta as a result of implementation of the other conservation measures (i.e., CM2–CM22) would be similar to, and undistinguishable from, those effects previously described for Alternative 1A. The conservation measures would present no new direct sources of chloride to the affected environment. Moreover, some habitat restoration conservation measures (CM4–10) would occur on lands within the Delta currently used for irrigated agriculture, thus replacing agricultural land uses with restored tidal wetlands, floodplain, and related channel margin and off-channel habitats. The potential reduction in irrigated lands within the Delta may result in reduced discharges of agricultural field drainage with elevated chloride concentrations, which would be considered an improvement compared to No Action Alternative conditions.

In summary, based on the discussion above, the effects on chloride from implementing CM2-CM22 are considered to be not adverse.

CEQA Conclusion: Implementation of the CM2–CM22 for Alternative 5 would not present new or substantially changed sources of chloride to the affected environment upstream of the Delta, within Delta, or in the SWP/CVP service area. Replacement of irrigated agricultural land uses in the Delta with habitat restoration conservation measures may result in some reduction in discharge of agricultural field drainage with elevated chloride concentrations, thus resulting in improved water quality conditions. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

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

NEPA Effects: Effects of CM1 on DO under Alternative 5 are the same as those discussed for Alternative 1A and are considered to not be adverse.

CEQA Conclusion: Effects of CM1 on DO under Alternative 5 would be similar to those discussed for Alternative 1A, and are summarized here, then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion under the Alternative 1A.

River flow rate and reservoir storage reductions that would occur under Alternative 5, relative to Existing Conditions, would not be expected to result in a substantial adverse change in DO levels in the reservoirs and rivers upstream of the Delta, given that mean monthly flows would remain within the ranges historically seen under Existing Conditions and the affected river are large and turbulent.

Any reduced DO saturation level that may be caused by increased water temperature would not be expected to cause DO levels to be outside of the range seen historically. Finally, amounts of oxygen demanding substances and salinity would not be expected to change sufficiently to affect DO levels.

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

There is not expected to be substantial, if even measurable, changes in DO levels in the SWP/CVP Export Service Areas waters under Alternative 5, relative to Existing Conditions, because the biochemical oxygen demand of the exported water would not be expected to substantially differ from that under Existing Conditions (due to ever increasing water quality regulations), canal turbulence and exposure of the water to the atmosphere and the algal communities that exist within the canals would establish an equilibrium for DO levels within the canals. The same would occur in downstream reservoirs.

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

Impact WQ-10: Effects on Dissolved Oxygen Resulting from Implementation of CM2–CM22

NEPA Effects**:** Effects of CM2–CM22 on DO under Alternative 5 are the same as those discussed for Alternative 1A and are considered to not be adverse.

CEQA Conclusion**:** Conservation Measures 2–22 proposed under Alternative 5 would be similar to those proposed under Alternative 1A. As such, effects on DO resulting from the implementation of CM2–CM22 would be similar to that previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

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

Upstream of the Delta

For the same reasons stated for the No Action Alternative, EC levels (highs, lows, typical conditions) in the Sacramento River and its tributaries, the eastside tributaries, their associated reservoirs, and the San Joaquin River upstream of the Delta under Alternative 5 are not expected to be outside the ranges occurring under Existing Conditions or would occur under the No Action Alternative. Any minor changes in EC levels that could occur under Alternative 5 in water bodies upstream of the

Delta would not be of sufficient magnitude, frequency and geographic extent that would cause adverse effects on beneficial uses or substantially degrade water quality with regard to EC.

Delta

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

Relative to Existing Conditions, Alternative 5 would result in an increase in the number of days the Bay-Delta WQCP EC objectives would be exceeded in the Sacramento River at Emmaton, San Joaquin River at San Andreas Landing and Prisoners Point, and Old River at Tracy Bridge (Appendix 8H, Table EC-5). The percent of days the Emmaton EC objective would be exceeded for the entire period modeled (1976–1991) would increase from 6% under Existing Conditions to 23% under Alternative 5, and the percent of days out of compliance would increase from 11% under Existing Conditions to 35% under Alternative 5. The percent of days the San Andreas Landing EC objective would be exceeded would increase from 1% under Existing Conditions to 4% under Alternative 5, and the percent of days out of compliance with the EC objective would increase from 1% under Existing Conditions to 7% under Alternative 5. The percent of days the Prisoners Point EC objective would be exceeded for the entire period modeled would increase from 6% under Existing Conditions to 9% under Alternative 5, and the percent of days out of compliance with the EC objective would increase from 10% under Existing Conditions to 13% under Alternative 5. In Old River at Tracy Bridge, the percent of days exceeding the EC objective would increase from 4% under Existing Conditions to 5% under Alternative 5; the percent of days out of compliance would increase by <1% and would be 10% under both Existing Conditions and Alternative 5. Average EC levels at the western and southern Delta compliance locations, except at Emmaton in the western Delta, would decrease from 2–35% for the entire period modeled and 3–32% during the drought period modeled (1987–1991) (Appendix 8H, Table EC-16). At Emmaton, average EC would increase by 3% for the entire period modeled and 10% for the drought period modeled. At the two interior Delta locations, there would be increases in average EC: the S. Fork Mokelumne River at Terminous average EC would increase 3% for the entire and drought periods modeled; and San Joaquin River at San Andreas Landing average EC would increase 5% for the entire period modeled and 10% during the drought period modeled. On average, EC would increase at Emmaton during February through August. Average EC would increase at San Andreas Landing from January through September. Average EC in the S. Fork Mokelumne River at Terminous would increase from March through December (Appendix 8H, Table EC-16). The comparison to Existing Conditions reflects changes in EC due to both Alternative 5 operations (including north Delta intake capacity of 3,000 cfs and numerous other operational components of Scenario C) and climate change/sea level rise.

Relative to the No Action Alternative, the percent of days exceeding EC objectives and percent of days out of compliance would increase at: Sacramento River at Emmaton, San Joaquin River at Jersey Point, San Andreas Landing, and Prisoners Point; and Old River near Middle River and at Tracy Bridge (Appendix 8H, Table EC-5). The increase in percent of days exceeding the EC objective would be 11% at Emmaton and 8% or less at the remaining locations. The increase in percent of days out of compliance would be 13% at Emmaton and 12% or less at the remaining locations. For the entire period modeled, average EC levels would increase at: Sacramento River at Emmaton (2%),

S. Fork Mokelumne River (4%), San Joaquin River at San Andreas Landing (10%), and San Joaquin River at Prisoners Point (4%) (Appendix 8H, Table EC-16). During the drought period modeled, average EC would increase at these same locations, except at Emmaton, by a similar percentage as well as the San Joaquin River at Brandt Bridge (1%). The comparison to the No Action Alternative reflects changes in EC due only to Alternative 5 operations (including north Delta intake capacity of 3,000 cfs and numerous other operational components of Scenario C).

For Suisun Marsh, October–May is the period when Bay-Delta WQCP EC objectives for protection of fish and wildlife apply. Long-term average EC would increase under Alternative 5, relative to Existing Conditions, during the months of March through May by 0.4–0.6 mS/cm in the Sacramento River at Collinsville (Appendix 8H, Table EC-21). Long-term average EC would decrease relative to Existing Conditions in Montezuma Slough at National Steel during October–May (Appendix 8H, Table EC-22). The most substantial increase would occur near Beldon Landing, with long-term average EC levels increasing by 1.6–5.0 mS/cm, depending on the month, at least doubling during some months the long-term average EC relative to Existing Conditions (Appendix 8H, Table EC-23). Sunrise Duck Club and Volanti Slough also would have long-term average EC increases during all months of 0.9–2.8 mS/cm (Appendix 8H, Tables EC-24 and EC-25). The degree to which the long-term average EC increases would cause exceedance of Bay-Delta WQCP objectives is unknown, because objectives are expressed as a monthly average of daily high tide EC, which does not have to be met if it can be demonstrated “equivalent or better protection will be provided at the location” (State Water Resources Control Board 2006:14). 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 be substantial and it is uncertain the degree to which current management plans for the Suisun Marsh would be able to address these substantially higher EC levels and protect beneficial uses. Thus, these increased EC levels in Suisun Marsh are considered to have a potentially adverse effect on marsh beneficial uses. Long-term average EC increases in Suisun Marsh under Alternative 5 relative to the No Action Alternative would be similar to the increases relative to Existing Conditions.

Given that the southern Delta is Clean Water Act section 303(d) listed as impaired due to elevated EC, the increase in the incidence of exceedance of EC objectives under Alternative 5, relative to Existing Conditions and the No Action Alternative, has the potential to contribute to additional impairment and potentially adversely affect beneficial uses. Suisun Marsh also is section 303(d) listed as impaired due to elevated EC, and the potential increases in long-term average EC concentrations could contribute to additional impairment, because the increases would be double that relative to Existing Conditions and the No Action Alternative.

SWP/CVP Export Service Area

At the Banks and Jones pumping plants, Alternative 5 would result in no exceedances of the Bay-Delta WQCP’s 1,000 µmhos/cm EC objective for the entire period modeled (Appendix 8H, Table EC-10). Thus, there would be no adverse effect on the beneficial uses in the SWP/CVP Export Service Areas using water pumped at this location under the Alternative 5.

At the Banks pumping plant, relative to Existing Conditions, average EC levels under Alternative 5 would decrease 19% for the entire period modeled and 18% during the drought period modeled. Relative to the No Action Alternative, average EC levels would decrease by 13% for the entire period modeled and 12% during the drought period modeled. (Appendix 8H, Table EC-16)

At the Jones pumping plant, relative to Existing Conditions, average EC levels under Alternative 5 would decrease 15% for the entire period modeled and 16% during the drought period modeled. Relative to the No Action Alternative, average EC levels would decrease by 11% for the entire period modeled and 12% during the drought period modeled. (Appendix 8H, Table EC-16)

Based on the decreases in long-term average EC levels that would occur at the Banks and Jones pumping plants, Alternative 5 would not cause degradation of water quality with respect to EC in the SWP/CVP Export Service Areas; rather, Alternative 5 would improve long-term average EC conditions in the SWP/CVP Export Service Areas.

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

The export area of the Delta is listed on the state's CWA Section 303(d) list as impaired due to elevated EC. Alternative 5 would result in lower average EC levels relative to Existing Conditions and the No Action Alternative and, thus, would not contribute to additional beneficial use impairment related to elevated EC in the SWP/CVP Export Service Areas waters.

NEPA Effects**:** In summary, the increased frequency of exceedance of EC objectives and increased long-term and drought period average EC levels that would occur at western, interior, and southern Delta compliance locations under Alternative 5, relative to the No Action Alternative, would contribute to adverse effects on the agricultural beneficial uses. In addition. the increased frequency of exceedance of the San Joaquin River at Prisoners Point EC objective and long-term and drought period average EC could contribute to adverse effects on fish and wildlife beneficial uses. Given that the western and southern Delta are Clean Water Act section 303(d) listed as impaired due to elevated EC, the increase in the incidence of exceedance of EC objectives and long-term average and drought period average EC in these portions of the Delta has the potential to contribute to additional beneficial use impairment. The increases in long-term average EC levels that would occur in Suisun Marsh would further degrade existing EC levels and could contribute additional to adverse effects on the fish and wildlife beneficial uses. Suisun Marsh is section 303(d) listed as impaired due to elevated EC, and the potential increases in long-term average EC levels could contribute to additional beneficial use impairment. These increases in EC constitute an adverse effect on water quality. Mitigation Measure WQ-11 would be available to reduce these effects (implementation of this measure along with a separate, non-environmental commitment as set forth in EIR/EIS Appendix 3B, *Environmental Commitments*, relating to the potential EC-related changes would reduce these effects).

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

River flow rate and reservoir storage reductions that would occur under Alternative 5, relative to Existing Conditions, would not be expected to result in a substantial adverse change in EC levels in the reservoirs and rivers upstream of the Delta, given that: changes in the quality of watershed runoff and reservoir inflows would not be expected to occur in the future; the state's aggressive regulation of point-source discharge effects on Delta salinity-elevating parameters and the expected further regulation as salt management plans are developed; the salt-related TMDLs adopted and being developed for the San Joaquin River; and the expected improvement in lower San Joaquin River average EC levels commensurate with the lower EC of the irrigation water deliveries from the Delta.

Relative to Existing Conditions, Alternative 5 would not result in any substantial increases in long-term average EC levels in the SWP/CVP Export Service Areas. There would be no exceedance of the EC objective at the Jones and Banks pumping plants. Average EC levels for the entire period modeled would decrease at both plants and, thus, this alternative would not contribute to additional beneficial use impairment related to elevated EC in the SWP/CVP Export Service Areas waters. Rather, this alternative would improve long-term EC levels in the SWP/CVP Export Service Areas, relative to Existing Conditions.

In the Plan Area, Alternative 5 would result in an increase in the frequency with which Bay-Delta WQCP EC objectives are exceeded for the entire period modeled (1976–1991): in the Sacramento River at Emmaton (agricultural objective; 17%; increase) in the western Delta, in the San Joaquin River at San Andreas Landing (agricultural objective; 3% increase) and Prisoners Point (fish and wildlife objective; 3% increase), both in the interior Delta; and in Old River at Tracy Bridge (agricultural objective; 1% increase) in the southern Delta. Further, long-term average EC levels would increase in the Sacramento River at Emmaton by 3% for the entire period modeled and 10% during the drought period modeled, and in the San Joaquin River at San Andreas Landing by 5% during for the entire period modeled and 10% during the drought period modeled. The increases in long-term and drought period average EC levels and increased frequency of exceedance of EC objectives that would occur in the Sacramento River at Emmaton and San Joaquin River at San Andreas Landing would potentially contribute to adverse effects on the agricultural beneficial uses in the western and interior Delta. Further, the increased frequency of exceedance of the fish and wildlife objective at Prisoners Point could contribute to adverse effects on aquatic life. Because EC is not bioaccumulative, the increases in long-term average EC levels would not directly cause bioaccumulative problems in aquatic life or humans. The western and southern Delta are Clean Water Act section 303(d) listed for elevated EC and the increased frequency of exceedance of EC objectives that would occur in these portions of the Delta could make beneficial use impairment measurably worse. This impact is considered to be significant.

Further, relative to Existing Conditions, Alternative 5 would result in substantial increases in long-term average EC during the months of October through May in Suisun Marsh, such that EC levels would be double that relative to Existing Conditions. The increases in long-term average EC levels that would occur in Suisun Marsh could further degrade existing EC levels and thus contribute additionally to adverse effects on the fish and wildlife beneficial uses. Because EC is not bioaccumulative, the increases in long-term average EC levels would not directly cause bioaccumulative problems in fish and wildlife. Suisun Marsh is Clean Water Act section 303(d) listed for elevated EC and the increases in long-term average EC that would occur in the marsh could make beneficial use impairment measurably worse. This impact is considered to be significant.

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

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

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

Please see Mitigation Measure WQ-11 under Impact WQ-11 in the discussion of Alternative 1A.

Impact WQ-12: Effects on Electrical Conductivity Resulting from Implementation of CM2–CM22

NEPA Effects: Effects of CM2–CM22 on EC under Alternative 5 are the same as those discussed for Alternative 1A and are considered not to be adverse.

CEQA Conclusion: Conservation Measures 2–22 proposed under Alternative 5 would be similar to those proposed under Alternative 1A. As such, effects on EC resulting from the implementation of CM2–CM22 would be similar to that previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

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

Upstream of the Delta

Under Alternative 5, the magnitude and timing of reservoir releases and river flows upstream of the Delta in the Sacramento River watershed and east-side tributaries would be altered, relative to Existing Conditions and the No Action Alternative.

The Sacramento River at Freeport and San Joaquin River at Vernalis (as summarized for water quality average concentrations in Tables 8-48 and 8-49) were examined for flow/concentration relationships for mercury and methylmercury. No significant, predictive regression relationships were discovered for mercury or methylmercury, except for total mercury with flow at Freeport (monthly or annual)(Figures 8I-10 through 8I-13, Appendix 8I). Such a positive relationship between total mercury and flow is to be expected based on the association of mercury with suspended sediment and the mobilization of sediments during storm flows. However, the changes in flow in the Sacramento River under Alternative 5 relative to Existing Conditions and the No Action Alternative are not of the magnitude of storm flows, in which substantial sediment-associated mercury is mobilized. Therefore mercury loading should not be substantially different due to changes in flow. In addition, even though it may be flow-affected, total mercury concentrations remain well below criteria at upstream locations. Any negligible changes in mercury concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies as related to mercury. Both waterborne methylmercury concentrations and largemouth bass fillet mercury concentrations are expected to remain above guidance levels at upstream of Delta locations, but will not change substantially relative to Existing Conditions or the No Action Alternative due to changes in flows under Alternative 5.

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

Delta

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

The water quality impacts of waterborne concentrations of mercury and methylmercury and fish tissue mercury concentrations were evaluated for 9 Delta locations. The analysis of percentage change in assimilative capacity of waterborne total mercury of Alternative 5 relative to the 25 ng/L ecological risk benchmark as compared to Existing Conditions showed the greatest decrease to be 0.9% at Old River at Rock Slough and the Contra Costa Pumping Plant, and 0.9% at Franks Tract relative to the No Action Alternative (Figures 8-53 and 8-54). These changes are not expected to result in adverse effects to beneficial uses. Similarly, changes in methylmercury concentration are expected to be very small. The greatest annual average methylmercury concentration for drought conditions was 0.165 ng/L for the San Joaquin River at Buckley Cove which was slightly higher than Existing Conditions (0.161 ng/L) and slightly lower than the No Action Alternative (0.167 ng/L) (Appendix 8I, Table I-6). All modeled input concentrations exceeded the methylmercury TMDL guidance objective of 0.06 ng/L, therefore percentage change in assimilative capacity was not evaluated for methylmercury.

Fish tissue estimates show only small or no increases in exceedance quotients based on long-term annual average concentrations for mercury at the Delta locations. The greatest change in exceedance quotients of 6 - 8% is expected for Franks Tract and Old River at Rock Slough relative to Existing Conditions and 7% for the Mokelumne River (South Fork) at Staten Island relative to the No Action Alternative (Figure 8-55, Appendix 8I, Table I-12b).

SWP/CVP Export Service Areas

The analysis of mercury and methylmercury in the SWP/CVP Export Service Areas was based on concentrations estimated at the Banks and Jones pumping plants. Both waterborne total and methylmercury concentrations for Alternative 5 are projected to be lower than Existing Conditions and the No Action Alternative at the Jones and Banks pumping plants (Appendix 8I, Figures 8I-6 and 8I-7). Therefore, mercury shows an increased assimilative capacity at these locations (Figures 8-53 and 8-54). Bass tissue mercury concentrations are also improved under Alternative 5, relative to Existing Conditions and the No Action Alternative (Figure 8-55; Appendix 8I, Table I-12a,b).

***NEPA Effects*:** Based on the above discussion, the effects of mercury and methylmercury in comparison of Alternative 5 to the No Action Alternative (as waterborne and bioaccumulated forms) are not considered to be adverse.

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

Under Alternative 5, greater water demands and climate change would alter the magnitude and timing of reservoir releases and river flows upstream of the Delta in the Sacramento River watershed and east-side tributaries, relative to Existing Conditions. Concentrations of mercury and methylmercury upstream of the Delta will not be substantially different relative to Existing Conditions due to the lack of important relationships between mercury/methylmercury concentrations and flow for the major rivers.

Methylmercury concentrations exceed criteria at all locations in the Delta and no assimilative capacity exists. However, monthly average waterborne concentrations of total and methylmercury, over the period of record, are very similar to Existing Conditions. Similarly, estimates of fish tissue mercury concentrations show almost no differences would occur among sites for Alternative 5 as compared to Existing Conditions for Delta sites.

Assessment of effects of mercury in the SWP and CVP Export Service Areas were based on effects on mercury concentrations and fish tissue mercury concentrations at the Banks and Jones pumping plants. The Banks and Jones pumping plants are expected to show increased assimilative capacity for waterborne mercury and decreased fish tissue concentrations of mercury for Alternative 5 as compared to Existing Conditions.

As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because mercury concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Because any increases in mercury or methylmercury concentrations are not likely to be measurable, changes in mercury concentrations or fish tissue mercury concentrations would not make any existing mercury-related impairment measurably worse. In comparison to Existing Conditions, Alternative 5 would not increase levels of mercury by frequency, magnitude, and geographic extent such that the affected environment would be expected to have measurably higher body burdens of mercury in aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish) or humans consuming those organisms. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-14: Effects on Mercury Concentrations Resulting from Implementation of CM2–CM22

NEPA Effects: Some habitat restoration activities under Alternative 5 would occur on lands in the Delta formerly used for irrigated agriculture. Tidal and other restoration proposed under Alternative 5 have the potential to increase water residence times and increase accumulation of organic sediments that are known to enhance methylmercury bioaccumulation in biota in the restored habitat. Therefore, increases in mercury methylation in the habitat restoration areas is possible but uncertain depending on the specific restoration design implemented at a particular Delta location. Models to estimate the potential for methylmercury formation in restored areas are not currently available. However, DSM2 modeling for Alternative 5 operations does incorporate assumptions for certain habitat restoration activities proposed under CM2 and CM4 (see Section 8.3.1.3) that result in changes to Delta hydrodynamics compared to the No Action Alternative. These modeled restoration assumptions provide some insight into potential hydrodynamic changes that could be expected related to implementing CM2 and CM4 and are considered in the evaluation of the potential for increased mercury and methylmercury concentrations under Alternative 5.

BDCP Conservation Measure 12 (CM12) addresses the potential for methylmercury bioaccumulation associated with restoration activities and acknowledges the uncertainties associated with mitigating or minimizing this potential effect. CM12 proposes project-specific mercury management plans for restoration actions that will incorporate relevant approaches recommended in Phase 1 Methylmercury TMDL control studies. Specific approaches recommended under CM12 that are intended to minimize or mitigate for potential increases in methylmercury bioaccumulation at future restoration sites include:

- Characterizing mercury, methylmercury, organic carbon, iron, and sulfate concentrations to better inform restoration design,
- Sequestering methylmercury at restoration sites using low intensity chemical dosing techniques,
- Minimizing microbial methylation associated with anoxic conditions by reducing the amount of organic material at a restoration site,
- Designing restoration sites to enhance photo degeneration that converts methylmercury into a biologically unavailable, inorganic form of mercury,
- Remediating restoration site soils with iron to reduce methylation in sulfide rich soils, and
- Considering capping mercury laden sediments, where possible to reduce methylation potential at a site.

Because of the uncertainties associated with site-specific estimates of methylmercury concentrations and the uncertainties in source modeling and tissue modeling, the effectiveness of methylmercury management proposed under CM12 to reduce methylmercury concentrations would need to be evaluated separately for each restoration effort, as part of design and implementation. Because of this uncertainty and the known potential for methylmercury creation in the Delta this potential effect of implementing CM2–CM22 is considered adverse.

CEQA Conclusion: There would be no substantial, long-term increase in mercury or methylmercury concentrations or loads in the rivers and reservoirs upstream of the Delta or the waters exported to the CVP and SWP service areas due to implementation of CM2–CM22 relative to Existing Conditions. However, uptake of mercury from water and/or methylation of inorganic mercury may increase to an unquantified degree as part of the creation of new, marshy, shallow, or organic-rich restoration areas. Methylmercury is 303(d)-listed within the affected environment, and therefore any potential measurable increase in methylmercury concentrations would make existing mercury-related impairment measurably worse. Because mercury is bioaccumulative, increases in water-borne mercury or methylmercury that could occur in some areas could bioaccumulate to somewhat greater levels in aquatic organisms and would, in turn, pose health risks to fish, wildlife, or humans. Design of restoration sites under Alternative 5 would be guided by CM12 which requires development of site specific mercury management plans as restoration actions are implemented. The effectiveness of minimization and mitigation actions implemented according to the mercury management plans is not known at this time although the potential to reduce methylmercury concentrations exists based on current research. Although the BDCP will implement CM12 with the goal to reduce this potential effect the uncertainties related to site specific restoration conditions and the potential for increases in methylmercury concentrations in the Delta result in this potential impact being considered significant. No mitigation measures would be available until specific restoration actions are proposed. Therefore this programmatic impact is considered significant and unavoidable.

Impact WQ-15: Effects on Nitrate Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative, Alternative 5 would have negligible, if any, impact on nitrate concentrations in the rivers and reservoirs upstream of the Delta in the Sacramento River watershed relative to Existing Conditions and the No Action Alternative.

Under Alternative 5, modeling indicates that long-term annual average flows on the San Joaquin River would decrease by an estimated 6%, relative to Existing Conditions, and would remain virtually the same relative to the No Action Alternative (Appendix 5A). Given these relatively small decreases in flows and the weak correlation between nitrate and flows in the San Joaquin River (see Nitrate Appendix 8J, Figure 2), it is expected that nitrate concentrations in the San Joaquin River would be minimally affected, if at all, by changes in flow rates under Alternative 5.

Any negligible changes in nitrate-N concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regards to nitrate.

Delta

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

Results of the mixing calculations indicate that under Alternative 5, relative to Existing Conditions and the No Action Alternative, nitrate concentrations throughout the Delta are anticipated to remain low (<1.4 mg/L-N) relative to adopted objectives (Nitrate Appendix 8J, Table 19 and 20). Although changes at specific Delta locations and for specific months may be substantial on a relative basis, the absolute concentration of nitrate in Delta waters would remain low (<1.4 mg/L-N) in relation to the drinking water MCL of 10 mg/L-N, as well as all other thresholds identified in Table 8-50. Long-term average nitrate concentrations are anticipated to remain below 1 mg/L-N at all 11 assessment locations except the San Joaquin River at Buckley Cove, where long-term average concentrations would be somewhat above 1 mg/L-N. Nevertheless, at this location, long-term average nitrate concentration would be somewhat reduced under Alternative 5, relative to Existing Conditions, and slightly increased relative to the No Action Alternative. No additional exceedances of the MCL are anticipated at any location (Nitrate Appendix 8J, Table 19). On a monthly average basis and on a long term annual average basis, for all modeled years and for the drought period (1987–1991) only, use of assimilative capacity available under Existing Conditions and the No Action Alternative, relative to the drinking water MCL of 10 mg/L-N, was low or negligible (i.e., <4%) for all locations and months, except San Joaquin River at Buckley Cove in August, which showed a 5.6% use of assimilative capacity available under the No Action Alternative, for the drought period (1987–1991) (Nitrate Appendix 8J, Table 21).

Nitrate concentrations will likely be higher than the modeling results indicate in certain locations. This includes in the Sacramento River between Freeport and Mallard Island and other areas in the Delta downstream of Freeport that are influenced by Sacramento River water. These increases are associated with ammonia and nitrate that are discharged from the SRWTP, which are not included in the modeling.

- Under Existing Conditions, most of the ammonia discharged from the SRWTP is converted to nitrate downstream of the facility's discharge at Freeport, and thus, nitrate concentrations under Existing Conditions in these areas are expected to be higher than the modeling predicts, the increase becoming greater with increasing distance downstream. However, the increase in nitrate concentrations downstream of the SRWTP is expected to be small—the existing increase appears to be from approximately 0.1 mg/L-N to approximately 0.4–0.5 mg/L-N over this reach, due to approximately a 1:1 conversion of ammonia-N to nitrate-N (Central Valley Water Board 2010a:32).

- Under Alternative 5, the planned upgrades to the SRWTP, which include nitrification/partial denitrification, would substantially decrease ammonia concentrations in the discharge, but would increase nitrate concentrations in the discharge up to 10 mg/L-N, which is substantially higher than under Existing Conditions.

- Overall, under Alternative 5, the nitrogen load from the SRWTP discharge is expected to decrease (by up to 50%), relative to Existing Conditions, due to nitrification/partial dentrification ugrades at the SRWTP facility. Thus, while concentrations of nitrate downstream of the facility are expected to be higher than modeling results indicate for both Existing Conditions and Alternative 5, the increase is expected to be greater under Existing Conditions than for Alternative 5 due to the upgrades that are assumed under Alternative 5.

The other areas in which nitrate concentrations will be higher than the modeling results indicate are immediately downstream of other wastewater treatment plants that practice nitrification, but not denitrification (e.g., City of Rio Vista Beach WWTF, Town of Discovery Bay WWTF, City of Stockton

RWCF). For all such facilities in the Delta, the Regional Water Boards have issued NPDES permits that allow discharge of wastewater containing nitrate into the Delta, and under these permits, the State has determined that no beneficial uses are adversely affected by the discharge, and that the discharger's use of available assimilative capacity of the water body is acceptable. When dilution is necessary in order for the discharge to be in compliance with the Basin Plans (which incorporate the 10 mg/L-N MCL by reference), not all of the assimilative capacity of the receiving water is granted to the discharger. Thus, limited decreases in flows are not anticipated to result in systemic exceedances of the MCLs by these POTWs. Furthermore, NPDES permits are renewed on a 5-year basis, and thus, if under changes in flows, dilution was no longer sufficient to maintain nitrate below the MCL in the receiving water, the NPDES permit renewal process would address such cases.

Therefore, any increases in nitrate-N concentrations that may occur at certain locations within the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to nitrate.

SWP/CVP Export Service Areas

Assessment of effects of nitrate in the SWP and CVP Export Service Areas is based on effects on nitrate-N at the Banks and Jones pumping plants.

Results of the mixing calculations indicate that under Alternative 5, relative to Existing Conditions and the No Action Alternative, nitrate concentrations at Banks and Jones pumping plants are anticipated to decrease on a long-term average annual basis (Nitrate Appendix 8J, Table 19 and 20). During the late summer, particularly in the drought period assessed, concentrations are expected to increase substantially on a relative basis (i.e., >50%), but the absolute value of these changes (i.e., in mg/L-N) is small. Additionally, given the many factors that contribute to potential algal blooms in the SWP and CVP canals within the Export Service Area, and the lack of studies that have shown a direct relationship between nutrient concentrations in the canals and reservoirs and problematic algal blooms in these water bodies, there is no basis to conclude that these small (i.e., generally <0.3 mg/L-N), seasonal increases in nitrate concentrations would increase the potential for problem algal blooms in the SWP and CVP Export Service Area. No additional exceedances of the MCL are anticipated (Nitrate Appendix 8J, Table 19). On a monthly average basis and on a long term annual average basis, for all modeled years and for the drought period (1987–1991) only, use of assimilative capacity available under Existing Conditions and the No Action Alternative, relative to the 10 mg/L-N MCL, was negligible (<4%) for both Banks and Jones pumping plants (Nitrate Appendix 8J, Table 21).

Any increases in nitrate-N concentrations that may occur in water exported via Banks and Jones pumping plants are not expected to result in adverse effects to beneficial uses or substantially degrade the quality of exported water, with regards to nitrate.

NEPA Effects**:** In summary, based on the discussion above, the effects on nitrate from implementing CM1 are considered to be not adverse.

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

Nitrate-N concentrations are generally low in the reservoirs and rivers of the watersheds, owing to substantial dilution available for point sources and the lack of substantial nonpoint sources of nitrate-N upstream of the SRWTP in the Sacramento River watershed, and in the watersheds of the eastern tributaries (Cosumnes, Mokelumne, and Calaveras Rivers). Although higher in the San Joaquin River watershed, nitrate-N concentrations are not well-correlated with flow rates. Consequently, any modified reservoir operations and subsequent changes in river flows under Alternative 5, relative to Existing Conditions, are expected to have negligible, if any, effects on reservoir and river nitrate-N concentrations upstream of Freeport in the Sacramento River watershed and upstream of the Delta in the San Joaquin River watershed.

In the Delta, results of the mixing calculations indicate that under Alternative 5, relative to Existing Conditions, nitrate concentrations throughout the Delta are anticipated to remain low (<1.4 mg/L-N) relative to adopted objectives. No additional exceedances of the MCL are anticipated at any location, and use of assimilative capacity available under Existing Conditions, relative to the drinking water MCL of 10 mg/L-N, was low or negligible (i.e., <4%) for virtually all locations and months.

Assessment of effects of nitrate in the SWP and CVP Export Service Areas is based on effects on nitrate-N concentrations at the Banks and Jones pumping plants. Results of the mixing calculations indicate that under Alternative 5, relative to Existing Conditions, long-term average nitrate concentrations at Banks and Jones pumping plants are anticipated to change negligibly. No additional exceedances of the MCL are anticipated, and use of assimilative capacity available under Existing Conditions, relative to the MCL was negligible (i.e., <4%) for both Banks and Jones pumping plants for all months.

Based on the above, there would be no substantial, long-term increase in nitrate-N concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the waters exported to the CVP and SWP service areas under Alternative 5 relative to Existing Conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because nitrate concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Nitrate is not 303(d) listed within the affected environment and thus any increases that may occur in some areas and months would not make any existing nitrate-related impairment measurably worse because no such impairments currently exist. Because nitrate is not bioaccumulative, increases that may occur in some areas and months would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-16: Effects on Nitrate Concentrations Resulting from Implementation of CM2–CM22

NEPA Effects**:** Effects of CM2–CM22 on nitrate under Alternative 5 are the same as those discussed for Alternative 1A and are considered not to be adverse.

CEQA Conclusion**:** Conservation Measures 2–22 proposed under Alternative 5 would be similar to those proposed under Alternative 1A. As such, effects on nitrate resulting from the implementation of CM2–CM22 would be similar to that previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-17: Effects on Dissolved Organic Carbon Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Under Alternative 5, there would be no substantial change to the sources of DOC within the watersheds upstream of the Delta. Moreover, long-term average flow and DOC levels in the Sacramento River at Hood and San Joaquin River at Vernalis are poorly correlated. Thus changes in system operations and resulting reservoir storage levels and river flows would not be expected to cause a substantial long-term change in DOC concentrations in the water bodies upstream of the Delta. Any negligible changes in DOC levels in water bodies upstream of the Delta under Alternative 5, relative to Existing Conditions and the No Action Alternative, would not be of sufficient frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regards to DOC.

Delta

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

Under Alternative 5, the geographic extent of effects pertaining to long-term average DOC concentrations in the Delta would be similar to that previously described for Alternative 1A, although the magnitude of predicted long-term change and relative frequency of concentration threshold exceedances would be distributed differently. Modeled effects would be greatest at Franks Tract, Rock Slough, and Contra Costa PP No. 1., where for the 16-year hydrologic period and the modeled drought period, long-term average concentration increases ranging from 0.2–0.3 mg/L would be predicted (≤8% net increase) (Appendix 8K, DOC Table 6). Increases in long-term average concentrations would correspond to more frequent concentration threshold exceedances, with the greatest change occurring at Rock Slough and Contra Costa PP No. 1 locations. For Rock Slough, long-term average DOC concentrations exceeding 3 mg/L would increase from 52% under Existing Conditions to 64% under the Alternative 5 (an increase from 47% to 62% for the drought period), and concentrations exceeding 4 mg/L would increase from 30% to 32% (32% to 37% for the drought period). For Contra Costa PP No. 1, long-term average DOC concentrations exceeding 3 mg/L would increase from 52% under Existing Conditions to 70% under Alternative 5 (45% to 75% for the drought period), and concentrations exceeding 4 mg/L would increase from 32% to 35% (35% to 40% for the drought period). Relative change in frequency of threshold exceedance for other assessment locations would be similar or less. While Alternative 5 would generally lead to slightly higher long-term average DOC concentrations (≤0.3 mg/L) at some municipal water intakes and Delta interior locations, the predicted change would not be expected to adversely affect MUN beneficial uses, or any other beneficial use. This comparison to Existing Conditions reflects changes in DOC due to both Alternative 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.

In comparison, Alternative 5 relative to the No Action Alternative would generally result in a similar magnitude of change to that discussed for the comparison to Existing Conditions. Maximum increases of 0.1–0.2 mg/L DOC (i.e., ≤6%) would be predicted at Franks Tract, Rock Slough, and

Contra Costa PP No. 1 relative to No Action Alternative (Appendix 8K, DOC Table 6). Threshold concentration exceedance frequency trends would also be similar to that discussed for the existing condition comparison, with exception to the predicted 4 mg/L exceedance frequency at Buckley Cove. In comparison to the No Action Alternative, the frequency which long-term average DOC concentrations exceeded 4 mg/L at Buckley Cove would increase from 27% to 31% (42% to 53% for the modeled drought period). While the Alternative 5 would generally lead to slightly higher long-term average DOC concentrations at some Delta assessment locations when compared to No Action Alternative conditions, the predicted change would not be expected to adversely affect MUN beneficial uses, or any other beneficial use, particularly when considering the relatively small change in long-term annual average concentration. Unlike the comparison to Existing Conditions, this comparison to the No Action Alternative reflects changes in DOC due only to Alternative 5 operations.

As discussed for Alternative 1A, substantial change in ambient DOC concentrations would need to occur before significant changes in drinking water treatment plant design or operations are triggered. The increases in long-term average DOC concentrations estimated to occur at various Delta locations under Alternative 5 are of sufficiently small magnitude that they would not require existing drinking water treatment plants to substantially upgrade treatment for DOC removal above levels currently employed.

Relative to existing and No Action Alternative conditions, Alternative 5 would lead to predicted improvements in long-term average DOC concentrations at Barker Slough, as well as Banks and Jones pumping plants (discussed below). At Barker Slough, long-term average DOC concentrations would be predicted to decrease by as much as 0.1–0.2 mg/L depending on baseline conditions comparison and modeling period.

SWP/CVP Export Service Areas

Under Alternative 5, modeled long-term average DOC concentrations would decrease at Banks and Jones pumping plants for the modeled 16-year hydrologic period, relative to Existing Conditions and No Action Alternative. Relative to Existing Conditions, long-term average DOC concentrations at Banks would be predicted to decrease by 0.3 mg/L (0.1 mg/L during drought period) (Appendix 8K, DOC Table 6). At Jones, long-term average DOC concentrations would be predicted to decrease by 0.2 mg/L, but be predicted to increase by 0.1 mg/L for the modeled drought period. Such decreases in long-term average DOC, however, would not necessarily translate into lower exceedance frequencies for concentration thresholds. To the contrary, long-term average DOC concentrations at Banks exceeding 3 mg/L would increase from 64% under Existing Conditions to 69% under Alternative 5 (57% to 83% for the drought period), and at Jones would increase from 71% to 78% (72% to 93% for the drought period). Relative to the 4 mg/L concentration threshold, long-term average DOC concentrations at Banks would decrease from 33% under Existing Conditions to 27% under Alternative 5, but would increase slightly from 42% to 44% for the modeled drought period. At Jones, concentrations exceeding 4 mg/L would increase slightly from 26% to 27% (35% to 39% for the drought period). Frequency of exceedance comparisons to the No Action Alternative yield similar trends, but with slightly smaller 16-year hydrologic period and drought period changes. Overall, modeling results for the SWP/CVP Export Service Areas predict a slight long-term improvement in Export Service Areas water quality respective to DOC. This improvement is principally obtained through overall lower long-term average DOC concentrations at Banks and Jones.

Similar to the discussion pertaining to the No Action Alternative, maintenance of SWP and CVP facilities under Alternative 5 would not be expected to create new sources of DOC or contribute towards a substantial change in existing sources of DOC in the affected area. Maintenance activities would not be expected to cause any substantial change in long-term average DOC concentrations such that MUN beneficial uses, or any other beneficial use, would be adversely affected.

NEPA Effects: In summary, Alternative 5, relative to the No Action Alternative, would not cause a substantial long-term change in DOC concentrations in the water bodies upstream of the Delta. Long-term average DOC concentrations at Banks and Jones pumping plants are predicted to decrease by as much as 0.3 mg/L, while long-term average DOC concentrations for some Delta interior locations, including Contra Costa PP #1, are predicted to increase by as much as 0.2 mg/L. The increase in long-term average DOC concentration that could occur within the Delta interior would not be of sufficient magnitude to adversely affect the MUN beneficial use, or any other beneficial uses, of Delta waters. The effect of Alternative 1A operations and maintenance (CM1) on DOC is determined not to be adverse.

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

While greater water demands under the Alternative 5 would alter the magnitude and timing of reservoir releases north, south and east of the Delta, these activities would have no substantial effect on the various watershed sources of DOC. Moreover, long-term average flow and DOC at Sacramento River at Hood and San Joaquin River at Vernalis are poorly correlated; therefore, changes in river flows would not be expected to cause a substantial long-term change in DOC concentrations upstream of the Delta.

Relative to Existing Conditions, Alternative 5 would result in relatively small increases (i.e., ≤8%) in long-term average DOC concentrations at some Delta interior locations, including Franks Tract, Rock Slough, and Contra Costa PP No. 1. However, these increases would not substantially increase the frequency with which long-term average DOC concentrations exceeds 2, 3, or 4 mg/L. While Alternative 5 would generally lead to slightly higher long-term average DOC concentrations (≤0.3 mg/L) within the Delta interior and some municipal water intakes, the predicted change would not be expected to adversely affect MUN beneficial uses, or any other beneficial use.

The assessment of Alternative 5 effects on DOC in the SWP/CVP Export Service Areas is based on assessment of changes in DOC concentrations at Banks and Jones pumping plants. Relative to the existing condition, long-term average DOC concentrations would decrease by as much as 0.3 mg/L at Banks and Jones pumping plants, although slightly more frequent export of >3 mg/L DOC water is predicted. Nevertheless, an overall improvement in DOC-related water quality would be predicted in the SWP/CVP Export Service Areas.

Based on the above, Alternative 5 operation and maintenance would not result in any substantial change in long-term average DOC concentration upstream of the Delta or result in substantial increase in the frequency with which long-term average DOC concentrations exceeds 2, 3, or 4 mg/L levels at the 11 assessment locations analyzed for the Delta. Modeled long-term average DOC concentrations would increase by no more than 0.3 mg/L at any single Delta assessment location (i.e., ≤8% relative increase), with long-term average concentrations estimated to remain at or below

4.0 mg/L at all Delta locations assessed, with the exception of Buckley Cove on the San Joaquin River during the drought period modeled. Nevertheless, long-term average concentrations at Buckley Cove are expected to decrease slightly during the drought period, relative to Existing Conditions. The increases in long-term average DOC concentration that could occur within the Delta would not be of sufficient magnitude to adversely affect the MUN beneficial use, or any other beneficial uses, of Delta waters or waters of the SWP/CVP Service Area. Because DOC is not bioaccumulative, the increases in long-term average DOC concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Finally, DOC is not causing beneficial use impairments and thus is not 303(d) listed for any water body within the affected environment. Thus, the increases in long-term average DOC that could occur at various locations would not make any beneficial use impairment measurably worse. Because long-term average DOC concentrations are not expected to increase substantially, no long-term water quality degradation with respect to DOC is expected to occur and, thus, no adverse effects on beneficial uses would occur This impact is considered to be less than significant. No mitigation is required.

Impact WQ-18: Effects on Dissolved Organic Carbon Concentrations Resulting from Implementation of CM2–CM22

***NEPA Effects*:** Conservation Measures 2–22 proposed under Alternative 5 would be the same as those proposed under Alternative 1A, except that 25,000 rather than 65,000 acres of tidal habitat would be restored. Effects on DOC resulting from the implementation of CM2–CM22 would be similar to that previously discussed for Alternative 1A, except that the reduced acreage of proposed tidal habitat would reduce the overall Alternative 5 related DOC loading to the Delta. While this reduced acreage would result in reduced DOC loading relative to other action Alternatives, CM4–CM7 and CM10 could still contribute substantial amounts of DOC to raw drinking water supplies, largely depending on final design and operational criteria for the related wetland and riparian habitat restoration activities. Substantially increased long-term average DOC in raw water supplies could lead to a need for treatment plant upgrades in order to appropriately manage DBP formation in treated drinking water. This potential for future DOC increases would lead to substantially greater associated risk of long-term adverse effects on the MUN beneficial use.

In summary, the habitat restoration elements of CM4–CM7 and CM10 under Alternative 5 would present new localized sources of DOC to the study area, and in some circumstances would substitute for existing sources related to replaced agriculture. Depending on localized hydrodynamics and proximity to municipal drinking water intakes, such restoration activities could contribute substantial amounts of DOC to municipal raw water. Substantial increases in municipal raw water DOC could necessitate changes in water treatment plant operations or require treatment plant upgrades in order to maintain DBP compliance, and thus would constitute an adverse effect on water quality. Mitigation Measure WQ-18 is available to reduce these effects.

***CEQA Conclusion*:** Effects of CM4–CM7 and CM10 on DOC under Alternative 5 would be similar to those discussed for Alternative 1A, although the overall magnitude of effect is expected to be less due to the smaller acreage proposed for tidal habitat restoration. Regardless of the smaller proposed acreage, these restoration activities could present a substantial source of DOC loading to the Delta. Similar to Alternative 1A, this impact is considered to be significant and mitigation is required. It is uncertain whether implementation of Mitigation Measure WQ-18 would reduce identified impacts to a less-than-significant level. Hence, this impact remains significant and unavoidable.

In addition to and to supplement Mitigation Measure WQ-18, the BDCP proponents have incorporated into the BDCP, as set forth in EIR/EIS Appendix 3B, *Environmental Commitments*, a separate, non-environmental commitment to address the potential increased water treatment costs that could result from DOC concentration effects on municipal and industrial water purveyor operations. Potential options for making use of this financial commitment include funding or providing other assistance towards implementing treatment for DOC and/or DBPs or DOC source control strategies. Please refer to Appendix 3B, *Environmental Commitments*, for the full list of potential actions that could be taken pursuant to this commitment in order to reduce the water quality treatment costs associated with water quality effects relating to DOC.

Mitigation Measure WQ-18: Design Wetland and Riparian Habitat Features to Minimize Effects on Municipal Intakes

Please see Mitigation Measure WQ-18 under Impact WQ-18 in the discussion of Alternative 1A.

Impact WQ-19: Effects on Pathogens Resulting from Facilities Operations and Maintenance (CM1)

***NEPA Effects*:** Effects of CM1 on pathogens under Alternative 5 are the same as those discussed for Alternative 1A and are considered to not be adverse.

***CEQA Conclusion*:** Effects of CM1 on pathogens under Alternative 5 are the same as those discussed for Alternative 1A, and are summarized here, then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion under Alternative 1A.

River flow rate and reservoir storage reductions that would occur due to implementation of CM1 (water facilities and operations) under Alternative 5, relative to Existing Conditions, would not be expected to result in a substantial adverse change in pathogen concentrations in the reservoirs and rivers upstream of the Delta, given the small magnitude of urban runoff contributions relative to the magnitude of river flows, that pathogen concentrations in the rivers have a minimal relationship to river flow rate, and the expected reduced pollutant loadings in response to NPDES stormwater-related regulations.

It is expected there would be no substantial change in Delta pathogen concentrations in response to a shift in the Delta source water percentages under this alternative or substantial degradation of these water bodies, with regard to pathogens. This conclusion is based on the Pathogens Conceptual Model, which found that pathogen sources in close proximity to a Delta site appear to have the greatest influence on pathogen levels at the site, rather than the primary source(s) of water to the site. In-Delta potential pathogen sources, including water-based recreation, tidal habitat, wildlife, and livestock-related uses, would continue under this alternative.

In the SWP/CVP Export Service Areas waters, relative to Existing Conditions, an increased proportion of water coming from the Sacramento River would not adversely affect beneficial uses in the SWP/CVP Export Service Areas. The pathogen levels in the Sacramento River are similar to or lower than the water diverted at the Delta export pumps. Further, it is localized sources of pathogens that appear to have the greatest influence on concentrations. Thus, an increased proportion of Sacramento River water diverted to the SWP/CVP Export Service Areas would result in minimal changes in pathogen levels in the SWP/CVP Export Service Areas waters.

Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because pathogen concentrations are not expected to increase substantially, no long-term water quality degradation for pathogens is expected to occur and, thus, no adverse effects on beneficial uses would occur. The San Joaquin River in the Stockton Deep Water Ship Channel is Clean Water Act section 303(d) listed for pathogens. Because no measurable increase in Deep Water Ship Channel pathogen concentrations are expected to occur on a long-term basis, further degradation and impairment of this area is not expected to occur. Finally, pathogens are not bioaccumulative constituents. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-20: Effects on Pathogens Resulting from Implementation of CM2–CM22

NEPA Effects: Effects of CM2–CM22 on pathogens under Alternative 5 are the same as those discussed for Alternative 1A and are considered to not be adverse.

CEQA Conclusion: Conservation Measures 2–22 proposed under Alternative 5 would be similar to those proposed under Alternative 1A. As such, effects on pathogens resulting from the implementation of CM2–CM22 would be similar to that previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-21: Effects on Pesticide Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative, under Alternative 5 no specific operations or maintenance activity of the SWP or CVP would substantially drive a change in pesticide use, and thus pesticide sources would remain unaffected upstream of the Delta. Nevertheless, changes in the timing and magnitude of reservoir releases could have an effect on available dilution capacity along river segments such as the Sacramento, Feather, American, and San Joaquin Rivers.

Under Alternative 5, winter (November–March) and summer (April–October) season average flow rates on the Sacramento River at Freeport, American River at Nimbus, Feather River at Thermalito and the San Joaquin River at Vernalis would change. Relative to existing condition and the No Action Alternative, seasonal average flow rates on the Sacramento would decrease no more than 3% during the summer and 4% during the winter (Appendix 8L, Seasonal average flows Tables 1-4). On the Feather River, average flow rates would decrease no more than 4% during the summer, but would increase by as much as 5% in the winter. American River average flow rates would decrease by as much as 15% in the summer and 1% in the winter. Seasonal average flow rates on the San Joaquin River would decrease by as much as 12% in the summer, but increase by as much as 1% in the winter. For the same reasons stated for the No Action Alternative, decreased seasonal average flow of ≤15% is not considered to be of sufficient magnitude to substantially increase pesticide concentrations or alter the long-term risk of pesticide-related toxicity to aquatic life, nor adversely affect other beneficial uses of water bodies upstream of the Delta.

Delta

Sources of diuron, OP and pyrethroid insecticides to the Plan Area include direct input of surface runoff from in-Delta agriculture and Delta urbanized areas as well as inputs from rivers upstream of the Delta. Similar to Upstream of the Delta, CVP/SWP operations would not affect these sources.

Under Alternative 5, the distribution and mixing of Delta source waters would change. Percent change in monthly average source water fraction were evaluated for the modeled 16-year (1976–1991) hydrologic period and a representative drought period (1987–1991), with special attention given to changes in San Joaquin River, Sacramento River and Delta Agriculture sources water fractions. Relative to Existing Conditions, under Alternative 5 modeled San Joaquin River fractions would increase greater than 10% (excluding Banks and Jones pumping plants) at Rock Slough and Contra Costa PP No. 1 (Appendix 8D, Source Water Fingerprinting). At Rock Slough, modeled San Joaquin River source water fractions would increase 16% during November (13% for the modeled drought period), while at Contra Costa PP No. 1 San Joaquin River source water fractions would increase 15% during November and 12% during March. Corresponding increases for the modeled drought period would not be greater than 8% at Contra Costa PP No. 1. Relative to Existing Conditions, there would be no modeled increases in Sacramento River fractions greater than 14% (with exception to Banks and Jones which are discussed below) and Delta agricultural fractions greater than 7%. These modeled changes in the source water fractions of Sacramento, San Joaquin and Delta agriculture water are not of sufficient magnitude to substantially alter the long-term risk of pesticide-related toxicity to aquatic life, nor adversely affect other beneficial uses of the Delta.

When compared to the No Action Alternative, changes in source water fractions would be similar in season, geographic extent, and magnitude to those discussed for Existing Conditions with exception to Buckley Cove. Relative to the No Action Alternative, on a source water basis Buckley Cove is comprised predominantly of water of San Joaquin River origin (i.e., typically >80% San Joaquin River) for all months of the year but July and August. In July and August, the combined operational effects on Delta hydrodynamics of the Delta Cross Channel being open, the absence of a barrier at Head of Old River, and seasonally high exports from south Delta pumps results in substantially lower San Joaquin River source water fraction at Buckley Cove relative to all other months of the year. Under the operational scenarios of Alternative 2A, however, modeled July and August San Joaquin River fractions at Buckley Cove would increase relative to the No Action Alternative, with increases of 12% in July (25% for the modeled drought period) and 22% in August (43% for the modeled drought period) (Appendix 8D, Source Water Fingerprinting). Despite these San Joaquin River increases, the resulting net San Joaquin River source water fraction for July and August would remain less than all other months. As a result, these modeled changes in the source water fractions are not of sufficient magnitude to substantially alter the long-term risk of pesticide-related toxicity to aquatic life, nor adversely affect other beneficial uses of the Delta.

SWP/CVP Export Service Areas

Assessment of effects in SWP/CVP Export Service Areas is based on effects seen in the Plan Area at the Banks and Jones pumping plants*.* Under Alternative 5, Sacramento River source water fractions would increase substantially at both Banks and Jones pumping plants relative to Existing Conditions and the No Action Alternative (Appendix 8D, Source Water Fingerprinting). At Banks pumping plant, Sacramento source water fractions would generally increase from 14–28% for March through June (17% for April of the modeled drought period) and at Jones pumping plant Sacramento source water fractions would generally increase from 12–24% for January through June (15–27% for March through May of the modeled drought period). These increases in Sacramento source water fraction would primarily balance through equivalent decreases in San Joaquin River water. Based on the general observation that San Joaquin River, in comparison to the Sacramento River, is a greater contributor of OP insecticides in terms of greater frequency of incidence and presence at concentrations exceeding water quality benchmarks, modeled increases in Sacramento River fraction at Banks and Jones would generally represent an improvement in export water quality respective to pesticides.

NEPA Effects: In summary, the changes in long-term average flows on the Sacramento, Feather, American, and San Joaquin Rivers, under Alternative 5 relative to the No Action Alternative, are of insufficient magnitude to substantially increase the long-term risk of pesticide-related water quality degradation and related toxicity to aquatic life in these water bodies upstream of the Delta. Similarly, modeled changes in source water fractions to the Delta are of insufficient magnitude to substantially alter the long-term risk of pesticide-related water quality degradation and related toxicity to aquatic life in the Delta or CVP/SWP export service areas. The effects on pesticides from operations and maintenance (CM1) are determined not to be adverse.

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

Sources of pesticides upstream of the Delta include direct input of pesticide containing surface runoff from agriculture and urbanized areas. Flows in rivers receiving these discharges dilute these pesticide inputs. Relative to Existing Conditions, however, modeled changes in long-term average flows on the Sacramento, Feather, American, and San Joaquin Rivers are of insufficient magnitude to substantially increase the long-term risk of pesticide-related water quality degradation and related toxicity to aquatic life in these water bodies upstream of the Delta.

In the Delta, sources of pesticides include direct input of surface runoff from Delta agriculture and Delta urbanized areas as well as inputs from rivers upstream of the Delta. While facilities operations and maintenance activities would not affect these sources, changes in Delta source water fraction could change the relative risk associated with pesticide related toxicity to aquatic life. Under Alternative 5, however, modeled changes in source water fractions relative to Existing Conditions are of insufficient magnitude to substantially alter the long-term risk of pesticide-related toxicity to aquatic life within the Delta, nor would such changes result in adverse pesticide-related effects on any other beneficial uses of Delta waters.

The assessment of Alternative 5 effects on pesticides in the SWP/CVP Export Service Areas is based on assessment of changes predicted at Banks and Jones pumping plants. As just discussed regarding effects to pesticides in the Delta, modeled changes in source water fractions at the Banks and Jones pumping plants are of insufficient magnitude to substantially alter the long-term risk of pesticide-related toxicity to aquatic life beneficial uses, or any other beneficial uses, in water bodies of the SWP and CVP export service area.

Based on the above, Alternative 5 would not result in any substantial change in long-term average pesticide concentration or result in substantial increase in the anticipated frequency with which long-term average pesticide concentrations would exceed aquatic life toxicity thresholds or other beneficial use effect thresholds upstream of the Delta, at the 11 assessment locations analyzed for the Delta, or the SWP/CVP service area. Numerous pesticides are currently used throughout the affected environment, and while some of these pesticides may be bioaccumulative, those present-use pesticides for which there is sufficient evidence for their presence in waters affected by SWP and CVP operations (i.e., diazinon, chlorpyrifos, diuron, and pyrethroids) are not considered bioaccumulative, and thus changes in their concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Furthermore, while there are numerous 303(d) listings throughout the affected environment that name pesticides as the cause for beneficial use impairment, the modeled changes in upstream river flows and Delta source water fractions would not be expected to make any of these beneficial use impairments measurably worse. Because long-term average pesticide concentrations are not expected to increase substantially, no long-term water quality degradation with respect to pesticides is expected to occur and, thus, no adverse effects on beneficial uses would occur. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-22: Effects on Pesticide Concentrations Resulting from Implementation of CM2–CM22

NEPA Effects**:** Conservation Measures 2–22 proposed under Alternative 5 would be the same as those proposed under Alternative 1A, except that 25,000 rather than 65,000 acres of tidal habitat would be restored. As such, effects on pesticides resulting from the implementation of CM2–CM22 would be similar to that previously discussed for Alternative 1A, except that the likely overall use of herbicides to control invasive aquatic vegetation would likely be reduced commensurate with the reduction in restored acres of tidal habitat. Nevertheless, herbicides directly applied to water could include adverse effects on non-target aquatic life, such as aquatic invertebrates and beneficial aquatic plants. As such, aquatic life toxicity objectives could be exceeded with sufficient frequency and magnitude such that beneficial uses would be impacted, thus constituting an adverse effect on water quality.

In summary, based on the discussion above, the effects on pesticides from implementing CM2-CM22 are considered to be adverse. Mitigation Measure WQ-22 would be available to reduce this adverse effect.

CEQA Conclusion**:** Effects of CM2–CM22 on pesticides under Alternative 5 are similar to those discussed for Alternative 1A. Potential environmental effects related only to CM13 are considered to be significant. Mitigation is required. While Mitigation Measure WQ-22 is available to partially reduce this impact of pesticides, no feasible mitigation is available that would reduce it to a level that would be less than significant.

Mitigation Measure WQ-22: Implement Least Toxic Integrated Pest Management Strategies

Please see Mitigation Measure WQ-22 under Impact WQ-22 in the discussion of Alternative 1A.

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

NEPA Effects**:** Effects of water facilities and operations (CM1) on phosphorus levels in water bodies of the affected environment under Alternative 5 would be very similar (i.e., nearly the same) to those discussed for Alternative 1A. Consequently, the environmental consequences to phosphorus levels discussed in detail for Alternative 1A also adequately represent the effects under Alternative 5, which are considered to be not adverse.

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

Because phosphorus loading to waters upstream of the Delta is not anticipated to change, and because changes in flows do not necessarily result in changes in concentrations or loading of phosphorus to these water bodies, substantial changes in phosphorus concentration upstream of the Delta are not anticipated for Alternative 5, relative to Existing Conditions.

Because phosphorus concentrations in the major source waters to the Delta are similar for much of the year, phosphorus concentrations in the Delta are not anticipated to change substantially on a long term-average basis under Alternative 5, relative to Existing Conditions. Algal growth rates are limited by availability of light in the Delta, and therefore any minor increases in phosphorus levels that may occur at some locations and times within the Delta would be expected to have little effect on primary productivity in the Delta.

The assessment of effects of phosphorus under Alternative 5 in the SWP and CVP Export Service Areas is based on effects on phosphorus at the Banks and Jones pumping plants. As noted above, phosphorus concentrations in the Delta (including Banks and Jones pumping plants) are not anticipated to change substantially on a long term-average basis.

Based on the above, there would be no substantial, long-term increase in phosphorus concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the waters exported to the CVP and SWP service areas under Alternative 5 relative to Existing Conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because phosphorus concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Phosphorus is not 303(d) listed within the affected environment and thus any minor increases that may occur in some areas would not make any existing phosphorus-related impairment measurably worse because no such impairments currently exist. Because phosphorus is not bioaccumulative, minor increases that may occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-24: Effects on Phosphorus Concentrations Resulting from Implementation of CM2–CM22

NEPA Effects**:** Effects of CM2–CM22 on phosphorus levels in water bodies of the affected environment under Alternative 5 would be very similar (i.e., nearly the same) to those discussed for Alternative 1A. Consequently, the environmental consequences to phosphorus levels from implementing CM2–CM22 discussed in detail for Alternative 1A also adequately represent the effects of these same actions under Alternative 5, which are considered to be not adverse.

CEQA Conclusion: Conservation Measures 2–22 proposed under Alternative 5 would be similar to those proposed under Alternative 1A. As such, effects on phosphorus resulting from the implementation of CM2–CM22 would be similar to that previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

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

Upstream of the Delta

For the same reasons stated for the No Action Alternative, Alternative 5 would have negligible, if any, effect on selenium concentrations in the rivers and reservoirs upstream of the Delta relative to Existing Conditions and the No Action Alternative. Any negligible increases in selenium concentrations that could occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regard to selenium.

Delta

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

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, Table M-10A). These small changes in selenium concentrations in water are reflected in small percent changes (10% or less) in available assimilative capacity for selenium (based on 2 µg/L ecological risk benchmark) for all years. Relative to Existing Conditions, 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, the ranges of modeled selenium concentrations in water (Appendix 8M, Table M-10A) for Alternative 5 (range 0.21–0.73 µg/L), Existing Conditions (range 0.21–0.76 µg/L), and the No Action Alternative (range 0.21–0.69 µg/L) are similar and would be well below the ecological risk benchmark (2 µg/L).

Relative to Existing Conditions and the No Action Alternative, Alternative 5 would result in small changes in estimated selenium concentrations in biota (whole-body fish, bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets) (Appendix 8M, Table M-16 and Addendum M.A to Appendix 8M, Table M.A-2). Relative to Existing Conditions, the largest increase of selenium concentrations in biota would be at Barker Slough PP for drought years (except for bird eggs [assuming a fish diet] at Contra Costa PP for all years) and in sturgeon at the two western Delta locations in all years, and the largest decrease would be at Buckley Cove for drought years. Relative to the No Action Alternative, the largest increase would be at Buckley Cove for drought years (except for bird eggs [assuming a fish diet] at Buckley Cove for all years) and in sturgeon at the two western Delta locations in all years; the largest decrease would be at Staten Island for drought years. Except for sturgeon in the western Delta, concentrations of selenium in whole-body fish and bird eggs (invert and fish diets) would exceed only the lower benchmarks (4 and 6 mg/kg dry weight, respectively, indicating a low potential for effects), under drought conditions, at Buckley Cove for Existing Conditions and the No Action Alternative and Alternative 5 (Figures 8-61 through 8-63). However, Exceedance Quotients for these exceedances of the lower benchmarks are between 1.0 and 1.5, indicating a low risk to biota in the Delta and no substantial difference from Existing Conditions and the No Action Alternative. Selenium concentrations in fish fillets would not exceed the screening value for protection of human health (Figure 8-64). For sturgeon in the western Delta, whole-body selenium concentrations would increase from 12.3 mg/kg under Existing Conditions and the No Action Alternative to 12.7 mg/kg under Alternative 5, a 3% increase (Table M.A-2). Although all of these values exceed both the low and high toxicity benchmarks, it is unlikely that the modeled increases in whole-body selenium for sturgeon would be measurable in the environment (see also the discussion of results provided in Addendum M.A to Appendix 8M).

Relative to Existing Conditions and the No Action Alternative, Alternative 5 would result in effectively no change in selenium concentrations throughout the Delta. Alternative 5 would not be expected to substantially increase the frequency with which applicable benchmarks would be exceeded in the Delta or substantially degrade the quality of water in the Delta, with regard to selenium.

SWP/CVP Export Service Areas

Alternative 5 would result in small changes in average selenium concentrations in water at the two modeled Export Service Area assessment locations relative to Existing Conditions and the No Action Alternative (Appendix 8M, Table M-10A). These small changes are reflected in small percent changes (10% or less) in available assimilative capacity for selenium for all years. Relative to Existing Conditions and the No Action Alternative, Alternative 5 would result in modeled increases in assimilative capacity at Jones PP (3% and 4%, respectively) and at Banks PP (2%, Existing Conditions and the No Action Alternative) (Figures 8-59 and 8-60) and generally have a small positive effect on the Export Service Area locations. The ranges of modeled selenium concentrations in water (Appendix 8M, Table M-10) for Alternative 5 (range 0.37–0.53 μg/L), Existing Conditions (range 0.37–0.58 μg/L), and the No Action Alternative (range 0.37–0.59 μg/L) are similar, and all would be well below the ecological risk benchmark (2 μg/L).

Relative to Existing Conditions and the No Action Alternative, Alternative 5 would result in small changes in estimated selenium concentrations in biota (Appendix 8M, Table M-16). Relative to Existing Conditions, the largest increase of selenium concentrations in biota would be at Barker Slough PP for drought years (except for bird eggs [assuming a fish diet] at Barker Slough PP for all years), and the largest decrease would be at Jones PP for all years (except for bird eggs [assuming a fish diet] at Jones PP for drought years). Relative to the No Action Alternative, the largest increase of selenium in biota would be at Barker Slough PP for drought years (except for bird eggs [assuming a fish diet] at Barker Slough PP for all years), and the largest decrease would be at Jones PP for drought years. Concentrations in biota would not exceed any benchmarks for Alternative 5 (Figures 8-61 through 8-64).

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 2010c) and State Water Board (2010d, 2010e) that are expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta. Consequently, any modified reservoir operations and subsequent changes in river flows under 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 throughout the Delta.

Assessment of effects of selenium in the SWP and CVP Export Service Areas is based on effects on selenium concentrations at the Banks and Jones pumping plants. Relative to Existing Conditions, Alternative 5 would slightly decrease the frequency with which applicable benchmarks would be exceeded or slightly improve the quality of water in selenium concentrations at the Banks and Jones pumping plants locations.

Based on the above, selenium concentrations that would occur in water under Alternative 5 would not cause additional exceedances of applicable state or federal numeric or narrative water quality objectives/criteria, or other relevant water quality effects thresholds identified for this assessment (Table 8-54), by frequency, magnitude, and geographic extent that would result in adverse effects to one or more beneficial uses within affected water bodies. In comparison to Existing Conditions and the No Action Alternative, water quality conditions under this alternative would not increase levels of selenium by frequency, magnitude, and geographic extent such that the affected environment would be expected to have measurably higher body burdens of selenium in aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish) or humans consuming those organisms. Water quality conditions under this alternative with respect to selenium would not cause long-term degradation of water quality in the affected environment, and therefore would not result in use of available assimilative capacity such that exceedances of water quality objectives/criteria would be likely and would result in substantially increased risk for adverse effects to one or more beneficial uses. This alternative would not further degrade water quality by measurable levels, on a long-term basis, for selenium and, thus, cause the 303(d)-listed impairment of beneficial use to be made discernibly worse. This impact is considered to be less than significant. No mitigation is required.

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

NEPA Effects**:** In general, with the possible exception of changes in Delta hydrodynamics resulting from habitat restoration, CM2–CM11 would not substantially increase selenium concentrations in the water bodies of the affected environment. Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, and thus such effects of these restoration measures were included in the assessment of CM1 facilities operations and maintenance (see Impact WQ-25).

However, implementation of these conservation measures may increase water residence time within the restoration areas. Increased restoration area water residence times could potentially increase the bioaccumulation of selenium in biota, thereby potentially increasing fish tissue and bird egg concentrations of selenium, but models are not available to quantitatively estimate the level of changes in residence time and the associated selenium bioavailability. If increases in fish tissue or bird egg selenium were to occur, the increases would likely be of concern only where fish tissues or bird eggs are already elevated in selenium to near or above thresholds of concern. That is, where biota concentrations are currently low and not approaching thresholds of concern, changes in residence time alone would not be expected to cause them to then approach or exceed thresholds of concern. In consideration of this factor, although the Delta as a whole is a 303(d)-listed water body for selenium, and although monitoring data of fish tissue or bird eggs in the Delta are sparse, the most likely areas in which biota tissues would be at levels high enough that additional bioaccumulation due to increased residence time from restoration areas would be a concern are the western Delta and Suisun Bay, and the South Delta in areas that receive San Joaquin River water.

The western Delta and Suisun Bay receive elevated selenium loads from North San Francisco Bay (including San Pablo Bay, Carquinez Strait, and Suisun Bay) and from the San Joaquin River. Point sources of selenium in North San Francisco Bay (i.e., refineries) that contribute selenium to Suisun Bay are expected to be reduced through a TMDL under development by the San Francisco Bay Water Board (San Francisco Bay Water Board 2012) that is expected to result in decreasing discharges of selenium. Nonpoint sources of selenium in the San Joaquin Valley that contribute selenium to the San Joaquin River, and thus the Delta and Suisun Bay, will be controlled through a TMDL developed by the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the Grassland Bypass Project, and Basin Plan objectives (Central Valley Water Board 2010c, d) that are expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta. If selenium levels are not sufficiently reduced via these efforts, it is expected that the State Water Board and the San Francisco Bay and Central Valley Water Boards would initiate additional actions to further control sources of selenium.

The South Delta receives elevated selenium loads from the San Joaquin River. In contrast to Suisun Bay and possibly the western Delta in the future, the South Delta lacks the overbite clam (*Corbula* [*Potamocorbula*] *amurensis*), which is considered a key driver of selenium bioaccumulation in

Suisun Bay, due to its high bioaccumulation of selenium and its role in the benthic food web that includes long-lived sturgeon. The South Delta does have *Corbicula fluminea*, another bivalve that bioaccumulates selenium, but it is not as invasive as the overbite clam and thus likely makes up a smaller fraction of sturgeon diet. Also, as mentioned above, nonpoint sources of selenium in the San Joaquin Valley that contribute selenium to the Delta will be controlled through a TMDL developed by the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the Grassland Bypass Project, and Basin Plan objectives (Central Valley Water Board 2010c, d) that are expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta. Further, if selenium levels in the San Joaquin River are not sufficiently reduced via these efforts, it is expected that the State Water Board and Central Valley Water Board would initiate additional TMDLs to further control nonpoint sources of selenium.

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

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

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

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

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

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

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

Impact WQ-27: Effects on Trace Metal Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative, Alternative 5 would result in negligible, and likely immeasurable, increases in trace metal concentrations in the rivers and reservoirs upstream of the Delta, relative to Existing Conditions and the No Action Alternative. Effects due to the operation and maintenance of the conveyance facilities are expected to be immeasurable, on an annual and long-term average basis. As such, Alternative 5 would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or CTR criteria would be exceeded in water bodies of the affected environment located upstream of the Delta or substantially degrade the quality of these water bodies, with regard to trace metals.

Delta

For the same reasons stated for the No Action Alternative, Alternative 5 would not result in substantial increases in trace metal concentrations in the Delta relative to Existing Conditions and the No Action Alternative. Effects due to the operation and maintenance of the conveyance facilities are expected to be negligible, on a long-term average basis. As such, Alternative 5 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 Delta waters, with regard to trace metals.

SWP/CVP Export Service Areas

For the same reasons stated for the No Action Alternative, Alternative 5 would not result in substantial increases in trace metal concentrations in the water exported from the Delta or diverted from the Sacramento River through the proposed conveyance facilities. As such, there is not expected to be substantial changes in trace metal concentrations in the SWP/CVP export service area waters under Alternative 5, relative to Existing Conditions and the No Action Alternative. As such, Alternative 5 would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or CTR criteria would be exceeded in the water bodies of the affected environment in the SWP and CVP Service Area or substantially degrade the quality of these water bodies, with regard to trace metals.

***NEPA Effects*:** In summary, Alternative 5, relative to the No Action Alternative, would not cause a substantial increase in long-term average trace metals concentrations within the affected environment, nor would it cause an increased frequency of water quality objective/criteria exceedances within the affected environment. The effect on trace metals is determined not to be adverse.

CEQA Conclusion: Effects of CM1 on trace metals under Alternative 5 would be similar to those discussed for Alternative 1A, and are summarized here, then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion under Alternative 1A.

While greater water demands under the Alternative 5 would alter the magnitude and timing of reservoir releases north, south and east of the Delta, these activities would have no substantial effect on the various watershed sources of trace metals. Moreover, long-term average flow and trace metals at Sacramento River at Hood and San Joaquin River at Vernalis are poorly correlated; therefore, changes in river flows would not be expected to cause a substantial long-term change in trace metal concentrations upstream of the Delta.

Average and 95th percentile trace metal concentrations are very similar across the primary source waters to the Delta. Given this similarity, very large changes in source water fraction would be necessary to effect a relatively small change in trace metal concentration at a particular Delta location. Moreover, average and 95th percentile trace metal concentrations for these primary source waters are all below their respective water quality criteria, including those that are hardness-based without a WER adjustment. No mixing of these three source waters could result in a metal concentration greater than the highest source water concentration, and given that trace metals do not already exceed water quality criteria, more frequent exceedances of criteria in the Delta would not be expected to occur under the Alternative 5.

The assessment of the Alternative 5 effects on trace metals in the SWP/CVP Export Service Areas is based on assessment of changes in trace metal concentrations at Banks and Jones pumping plants. As just discussed regarding similarities in Delta source water trace metal concentrations, the Alternative 5 is not expected to result in substantial changes in trace metal concentrations in Delta waters, including Banks and Jones pumping plants, therefore effects on trace metal concentrations in the SWP/CVP Export Service Area are expected to be negligible.

Based on the above, there would be no substantial long-term increase in trace metal concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the SWP/CVP export service area waters under Alternative 5 relative to Existing Conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because trace metal concentrations are not expected to increase substantially, no long-term water quality degradation for trace metals is expected to occur and, thus, no adverse effects to beneficial uses would occur. Furthermore, any negligible changes in long-term trace metal concentrations that may occur in water bodies of the affected environment would not be expected to make any existing beneficial use impairments measurably worse. The trace metals discussed in this assessment are not considered bioaccumulative, and thus would not directly cause bioaccumulative problems in aquatic life or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-28: Effects on Trace Metal Concentrations Resulting from Implementation of CM2–CM22

NEPA Effects**:** Conservation Measures 2–22 proposed under Alternative 5 would be the same as those proposed under Alternative 1A, except that 25,000 rather than 65,000 acres of tidal habitat would be restored. Effects on trace metals resulting from the implementation of CM2–CM22 would be similar to that previously discussed for Alternative 1A. As they pertain to trace metals, implementation of CM2–CM22 would not be expected to adversely affect beneficial uses of the affected environment or substantially degrade water quality with respect to trace metals.

In summary, implementation of CM2–CM22 under Alternative 5, relative to the No Action Alternative, would have negligible, if any, effect on trace metals concentrations. The effect on trace metals from implementing CM2–CM22 is determined not to be adverse.

CEQA Conclusion**:** Implementation of CM2–CM22 under Alternative 5 would not cause substantial long-term increase in trace metal concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the SWP/CVP export service area. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because trace metal concentrations are not expected to increase substantially, no long-term water quality degradation for trace metals is expected to occur and, thus, no adverse effects to beneficial uses would occur. Furthermore, any negligible changes in long-term trace metal concentrations that may occur throughout the affected environment would not be expected to make any existing beneficial use impairments measurably worse. The trace metals discussed in this assessment are not considered bioaccumulative, and thus would not directly cause bioaccumulative problems in aquatic life or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-29: Effects on TSS and Turbidity Resulting from Facilities Operations and Maintenance (CM1)

NEPA Effects**:** Effects of CM1 on TSS and turbidity under Alternative 5 are the same as those discussed for Alternative 1A. The effects on TSS and turbidity from implementing CM1 is determined to not be adverse.

CEQA Conclusion**:** Effects of CM1 on TSS and turbidity under Alternative 5 would be similar to those discussed for Alternative 1A, and are summarized here, then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion under Alternative 1A.

Changes river flow rate and reservoir storage that would occur under Alternative 5, relative to Existing Conditions, would not be expected to result in a substantial adverse change in TSS concentrations and turbidity levels in the reservoirs and rivers upstream of the Delta, given that suspended sediment concentrations are more affected by season than flow. Site-specific and temporal exceptions may occur due to localized temporary construction activities, dredging activities, development, or other land use changes would be site-specific and temporal, which would be regulated to limit both their short-term and long-term effects on TSS and turbidity levels to less than substantial levels.

Within the Delta, geomorphic changes associated with sediment transport and deposition are usually gradual, occurring over years, and high storm event inflows would not be substantially affected. Thus, it is expected that the TSS concentrations and turbidity levels in the affected channels would not be substantially different from the levels under Existing Conditions. Consequently, this alternative is expected to have minimal effect on TSS concentrations and turbidity levels in the Delta region, relative to Existing Conditions.

There is not expected to be substantial, if even measurable, changes in TSS concentrations and turbidity levels in the SWP/CVP Export Service Areas waters under Alternative 5, relative to Existing Conditions, because as stated above, this alternative is not expected to result in substantial changes in TSS concentrations and turbidity levels at the south Delta export pumps, relative to Existing Conditions.

Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives where such objectives are not exceeded under Existing Conditions. Because TSS concentrations and turbidity levels are not expected to be substantially different, long-term water quality degradation is not expected, and, thus, beneficial uses are not expected to be adversely affected. Finally, TSS and turbidity are neither bioaccumulative nor Clean Water Act section 303(d) listed constituents. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-30: Effects on TSS and Turbidity Resulting from Implementation of CM2–CM22

***NEPA Effects*:** Effects of CM2–CM22 on TSS and turbidity under Alternative 5 are the same as those discussed for Alternative 1A. The effects on TSS and turbidity from implementing CM2–CM22 is determined to not be adverse.

***CEQA Conclusion*:** Conservation Measures 2–22 proposed under Alternative 5 would be similar to those proposed under Alternative 1A. As such, effects on TSS and turbidity resulting from the implementation of CM2–CM22 would be similar to that previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-31: Water Quality Effects Resulting from Construction-Related Activities (CM1–CM22)

The conveyance features for CM1 under Alternative 5 would be very similar to those discussed for Alternative 1A. The primary difference between Alternative 5 and Alternative 1A is that under Alternative 5, there would be four fewer number intakes and four fewer pumping plant locations, which would result in a reduced level of construction activity. However, construction techniques and locations of major features of the conveyance system within the Delta would be similar. The remainder of the facilities constructed under Alternative 5, including CM2–CM22, would be very similar to, or the same as, those to be constructed for Alternative 1A. However, under Alternative 5, there would only be up to 25,000 acres of tidal marsh habitat restored (as opposed to 65,000 acres under the majority of the other alternatives), thus resulting in less in-water construction-related disturbances.

NEPA Effects: The types of potential construction-related water quality effects associated with implementation of CM1–CM22 under Alternative 5 would be very similar to the effects discussed for Alternative 1A, and the effects anticipated with implementation of CM2–CM22 would be essentially identical. However, the construction of fewer intakes and smaller conveyance features for CM1, and less tidal marsh habitat restoration, under Alternative 5 would be anticipated to result in a lower magnitude of construction-related activities. Nevertheless, the construction of CM1, and any individual components necessitated by CM2, and CM4–CM10, with the implementation of the BMPs specified in Appendix 3B, *Environmental Commitments,* and other agency permitted construction requirements would result in the potential water quality effects being largely avoided and minimized. The specific environmental commitments that would be implemented under Alternative 5 would be similar to those described for Alternative 1A. Consequently, relative to Existing Conditions, Alternative 5 would not be expected to cause exceedance of applicable water quality objectives/criteria or substantial water quality degradation with respect to constituents of concern, and thus would not adversely affect any beneficial uses upstream of the Delta, in the Delta, or in the SWP and CVP service area.

In summary, with implementation of environmental commitments in Appendix 3B, the potential construction-related water quality effects are considered to be not adverse.

CEQA Conclusion: Because environmental commitments would be implemented under Alternative 5 for construction-related activities along with agency-issued permits that also contain construction requirements to protect water quality, the construction-related effects, relative to Existing Conditions, would not be expected to cause or contribute to substantial alteration of existing drainage patterns which would result in substantial erosion or siltation on- or off-site, substantial increased frequency of exceedances of water quality objectives/criteria, or substantially degrade water quality with respect to the constituents of concern on a long-term average basis, and thus would not adversely affect any beneficial uses in water bodies upstream of the Delta, within the Delta, or in the SWP and CVP service area. Moreover, because the construction-related activities would be temporary and intermittent in nature, the construction would involve negligible discharges, if any, of bioaccumulative or 303(d) listed constituents to water bodies of the affected environment. As such, construction activities would not contribute measurably to bioaccumulation of contaminants in organisms or humans or cause 303(d) impairments to be discernibly worse. Based on these findings, this impact is determined to be less than significant. No mitigation is required.

8.4.3.11 Alternative 6A—Isolated Conveyance with Pipeline/Tunnel and Intakes 1–5 (15,000 cfs; Operational Scenario D)

Alternative 6A would comprise physical/structural components similar to those under Alternative 1A with the principal exception that Alternative 6A would be an “isolated” conveyance, no longer involving operation of the existing SWP and CVP south Delta export facilities for Clifton Court Forebay and Jones Pumping Plant. Alternative 6A would convey up to 15,000 cfs of water from the north Delta to the south Delta through pipelines/tunnels from five screened intakes (i.e., Intakes 1 through 5) on the east bank of the Sacramento River between Clarksburg and Walnut Grove. Alternative 6A would include a 750 acre intermediate forebay and pumping plant. A new 600 acre Byron Tract Forebay, adjacent to and south of Clifton Court Forebay, would be constructed which would provide water to the south Delta pumping plants. However, this. Water supply and conveyance operations would follow the guidelines described as Scenario D, which includes fall X2. CM2–CM22 would be implemented under this alternative, and would be the same as those under Alternative 1A. See Chapter 3, *Description of Alternatives*, Section 3.5.11, for additional details on Alternative 6A.

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.

The primary differences between Alternative 6A and Alternative 1A are that all of the Delta exports would be via the north Delta diversion intakes, with none through the existing south Delta intakes, and operations include the meeting of Fall X2.

Under Alternative 6A, over the long term, average annual delta exports are anticipated to decrease by 1,386 TAF relative to Existing Conditions, and by 682 TAF relative to the No Action Alternative. All of the exported water will be from the new north Delta intakes, and none of the diversions would be from the existing south Delta intakes (see Chapter 5, *Water Supply*, for more information). The result of this is greatly 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 6–Old River at Rock Slough for ALL years (1976–1991), which shows increased San Joaquin River (SJR) percentage and decreased Sacramento River (SAC) percentage under the alternative, relative to Existing Conditions and the No Action Alternative.

Under Alternative 6A, long-term average annual Delta outflow is anticipated to increase 1,383 TAF relative to Existing Conditions, due to both changes in operations (including north Delta intake capacity of 15,000 cfs and numerous other operational components of Scenario D) and climate change/sea level rise (see Chapter 5, *Water Supply*, for more information). The result of this is decreased sea water intrusion in the west Delta. The decrease of sea water intrusion in the west Delta under Alternative 6A is greater relative to the Existing Conditions because it does not include operations to meet Fall X2, whereas the No Action alternative and Alternative 6A do. Long-term average annual Delta outflow is anticipated to increase under Alternative 6A by 633 TAF relative to the No Action Alternative, due only to changes in operations. The decreases in sea water intrusion (represented by an decrease in San Francisco Bay (BAY) percentage) can be seen, for example, in Appendix 8D, ALT 6A–Sacramento River at Mallard Island for ALL years (1976–1991).

Impact WQ-1: Effects on Ammonia Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative, Alternative 6A would have negligible, if any, effect on ammonia concentrations in the rivers and reservoirs upstream of the Delta relative to Existing Conditions and the No Action Alternative. Any negligible increases in ammonia-N concentrations that could occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regard to ammonia.

Delta

Assessment of effects of ammonia under Alternative 6A is the same as discussed under Alternative 1A, except that because flows in the Sacramento River at Freeport are different between the two alternatives, estimated monthly average and long term annual average predicted ammonia-N concentrations in the Sacramento River downstream of Freeport are different.

As Table 8-69 shows, estimated ammonia-N concentrations in the Sacramento River downstream of Freeport (upon full mixing of the SRWTP discharge with river water) under Alternative 6A and the No Action Alternative are expected to be similar. Minor increases in ammonia-N concentrations would occur during January through April, and July through December, and remaining months would be unchanged. A minor increase in the annual average concentration would occur under Alternative 6A, compared to the No Action Alternative. Moreover, the estimated concentrations downstream of Freeport under Alternative 6A would be similar to existing source water concentrations for the San Francisco Bay and San Joaquin River. Consequently, changes in source water fraction anticipated under Alternative 6A, relative to the No Action Alternative, are not expected to substantially increase ammonia concentrations at any Delta locations.

Table 8-69. Estimated Ammonia-N (mg-L as N) Concentrations in the Sacramento River Downstream of the Sacramento Regional Wastewater Treatment Plant for the No Action Alternative and Alternative 6A

	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
Alternative 6A	0.075	0.086	0.070	0.061	0.058	0.061	0.059	0.064	0.067	0.062	0.068	0.066	0.066

Any negligible increases in ammonia-N concentrations that could occur at certain locations in the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to ammonia.

SWP/CVP Export Service Areas

The assessment of effects on ammonia in the SWP/CVP Export Service Area is based on assessment of ammonia-N concentrations at Banks and Jones pumping plants. Similar to the discussion for Alternative 1A, under Alternative 6A for areas of the Delta that are influenced by Sacramento River water, including Banks and Jones pumping plants, ammonia-N concentrations are expected to decrease, relative to Existing Conditions (in association with diversion of water not influenced by the SRWTP). This decrease in ammonia-N concentrations for water exported via the south Delta pumps is not expected to result in adverse effects on beneficial uses or substantially degrade water quality of exported water, with regards to ammonia.

Furthermore, as discussed above for the Plan Area, for all areas of the Delta, including Banks and Jones pumping plants, ammonia-N concentrations are not expected to be substantially different under Alternative 6A, relative to No Action Alternative. Any negligible increases in ammonia-N concentrations that could occur at Banks and Jones pumping plants would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to ammonia.

NEPA Effects: In summary, based on the discussion above, effects on ammonia from implementation of CM1 are considered to be not adverse.

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

Ammonia-N concentrations are generally low in the reservoirs and rivers of the watersheds, owing to the lack of substantial point and nonpoint sources of ammonia-N upstream of the SRWTP in the Sacramento River watershed, in the watersheds of the eastern tributaries (Cosumnes, Mokelumne, and Calaveras Rivers), or upstream of the Delta in the San Joaquin River watershed. Consequently, any modified reservoir operations and subsequent changes in river flows under Alternative 6A, relative to Existing Conditions, are expected to have negligible, if any, effects on reservoir and river ammonia-N concentrations upstream of Freeport in the Sacramento River watershed and upstream of the Delta in the San Joaquin River watershed.

Ammonia-N concentrations in the Sacramento River downstream of the SRWTP would be substantially lower under Alternative 6A, relative to Existing Conditions, due to upgrades to the SRWTP that are assumed to be in place, and thus, ammonia concentrations for all areas of the Delta that are influenced by Sacramento River water are expected to decrease. At locations which are not influenced notably by Sacramento River water, concentrations are expected to remain relatively unchanged, due to the similarity in SJR and BAY concentrations and the lack of expected changes in either of these concentrations.

The assessment of effects on ammonia in the SWP/CVP Export Service Areas is based on assessment of ammonia-N concentrations at Banks and Jones pumping plants. As discussed above for the Plan Area, for areas of the Delta that are influenced by Sacramento River water, including Banks and

Jones pumping plants, ammonia-N concentrations are expected to decrease under Alternative 6A, relative to Existing Conditions.

Based on the above, there would be no substantial, long-term increase in ammonia-N concentrations in the rivers and reservoirs upstream of the Delta, in the Plan Area, or the waters exported to the CVP and SWP service areas under Alternative 6A relative to Existing Conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because ammonia concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects on beneficial uses would occur. Ammonia is not 303(d) listed within the affected environment and thus any minor increases that could occur in some areas would not make any existing ammonia-related impairment measurably worse because no such impairments currently exist. Because ammonia-N is not bioaccumulative, minor increases that could occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-2: Effects on Ammonia Concentrations Resulting from Implementation of CM2–CM22

***NEPA Effects*:** Effects of CM2–CM22 on ammonia under Alternative 6A are the same as those discussed for Alternative 1A and are considered to be not adverse.

***CEQA Conclusion*:** Conservation Measures 2–22 proposed under Alternative 6A would be similar to those proposed under Alternative 1A. As such, effects on ammonia resulting from the implementation of CM2–CM22 would be similar to that previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-3: Effects on Boron Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Effects of CM1 on boron under Alternative 6A in areas upstream of the Delta would be very similar to the effects discussed for Alternative 1A. There would be no expected change to the sources of boron in the Sacramento and east-side tributary watersheds, and resultant changes in flows from altered system-wide operations would have negligible, if any, effects on the concentration of boron in the rivers and reservoirs of these watersheds. The modeled long-term annual average lower San Joaquin River flow at Vernalis would decrease slightly compared to Existing Conditions (in association with project operations, climate change, and increased water demands) and would be similar compared to the No Action Alternative considering only changes due to Alternative 6A operations. The reduced flow would result in possible increases in long-term average boron concentrations of up to about 3% relative to the Existing Conditions (Appendix 8F, Table 24). The increased boron concentrations would not increase the frequency of exceedances of any applicable objectives or criteria and would not be expected to cause further degradation at measurable levels in the lower San Joaquin River, and thus would not cause the existing impairment there to be discernibly worse. Consequently, Alternative 6A would not be expected to cause exceedance of boron objectives/criteria or substantially degrade water quality with respect to boron, and thus would not adversely affect any beneficial uses of the Sacramento River, the east-side tributaries, associated reservoirs upstream of the Delta, or the San Joaquin River.

Delta

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

Relative to the Existing Conditions and No Action Alternative, Alternative 6A would result in generally widespread increased long-term average boron concentrations for the 16-year period modeled at the interior and western Delta locations (by as much as 14% at the SF Mokelumne River at Staten Island, 4% at the San Joaquin River at Buckley Cove, 43% at Franks Tract, and 74% at Old River at Rock Slough) (Appendix 8F, Table Bo-16). The comparison to Existing Conditions reflects changes due to both Alternative 6A operations (including north Delta intake capacity of 15,000 cfs and numerous other operational components of Scenario D) and climate change/sea level rise. The comparison to the No Action Alternative reflects changes due only to operations.

Implementation of tidal habitat restoration under CM4 also may contribute to increased boron concentrations at western Delta assessment locations (more discussion of this phenomenon is included in Section 8.3.1.3), and thus would not be anticipated to substantially affect agricultural diversions which occur primarily at interior Delta locations. The long-term annual average and monthly average boron concentrations, for either the 16-year period or drought period modeled, would never exceed the 2,000 μg/L human health advisory objective (i.e., for children) or 500 μg/L agricultural objective at any of the eleven Delta assessment locations, which represents no change from the Existing Conditions and No Action Alternative (Appendix 8F, Table Bo-3A). The increased concentrations at interior Delta locations would result in moderate reductions in the long-term average assimilative capacity of up to 21% at Franks Tract and up to 43% at Old River at Rock Slough locations (Appendix 8F, Table Bo-17). However, because the absolute boron concentrations would still be well below the lowest 500 μg/L objective for the protection of the agricultural beneficial use under Alternative 6A, the levels of boron degradation would not be of sufficient magnitude to substantially increase the risk of exceeding objectives or cause adverse effects to municipal and agricultural water supply beneficial uses, or any other beneficial uses, in the Delta (Appendix 8F, Figure Bo-4).

SWP/CVP Export Service Areas

Effects of CM1 on boron under Alternative 6A in the Delta would be similar to the effects discussed for Alternative 1A. Under Alternative 6A, long-term average boron concentrations would decrease by as much as 56% at the Banks Pumping Plant and by as much 63% at Jones Pumping Plant relative to Existing Conditions and No Action Alternative (Appendix 8F, Table Bo-16) as a result of export of a greater proportion of low-boron Sacramento River water. Commensurate with the decrease in exported boron concentrations, boron concentrations in the lower San Joaquin River may be reduced and would likely alleviate or lessen any expected increase in boron concentrations at Vernalis associated with flow reductions (see discussion of Upstream of the Delta), as well as locations in the Delta receiving a large fraction of San Joaquin River water. Reduced export boron concentrations also may contribute to reducing the existing 303(d) impairment in the lower San Joaquin River and associated TMDL actions for reducing boron loading.

Maintenance of SWP and CVP facilities under Alternative 6A would not be expected to create new sources of boron or contribute towards a substantial change in existing sources of boron in the affected environment. Maintenance activities would not be expected to cause any substantial increases in boron concentrations or degradation with respect to boron such that objectives would be exceeded more frequently, or any beneficial uses would be adversely affected anywhere in the affected environment.

***NEPA Effects*:** In summary, relative to the No Action Alternative conditions, Alternative 6 would result in relatively small long-term average increases in boron levels in the San Joaquin River and moderate increases in the interior and western Delta locations Delta. However, the predicted changes in the Delta would not be expected to result in exceedances of applicable objectives or further water quality degradation such that objectives would likely be exceeded or there would be substantially increased risk of adverse effects on water quality.

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

Boron is not a constituent of concern in the Sacramento River watershed upstream of the Delta, thus river flow rate and reservoir storage reductions that would occur under the Alternative 6, relative to Existing Conditions, would not be expected to result in a substantial adverse change in boron levels. Additionally, relative to Existing Conditions, Alternative 6A would not result in reductions in river flow rates (i.e., less dilution) or increased boron loading such that there would be any substantial increases in boron concentration upstream of the Delta in the San Joaquin River watershed.

Moderate increased boron levels (i.e., up to 75% increased concentration) and degradation predicted for interior and western Delta locations in response to a shift in the Delta source water percentages and tidal habitat restoration under this alternative would not be expected to cause exceedances of objectives. Alternative 6A maintenance also would not result in any substantial increases in boron concentrations in the affected environment. Boron concentrations would be reduced in water exported from the Delta to the CVP/SWP Export Service Areas, thus reflecting a potential improvement to boron loading in the lower San Joaquin River.

Boron is not a bioaccumulative constituent, thus any increased concentrations under Alternative 6A would not result in adverse boron bioaccumulation effects to aquatic life or humans. Relative to Existing Conditions, Alternative 6A would not result in substantially increased boron concentrations such that frequency of exceedances of municipal and agricultural water supply objectives would increase. The levels of boron degradation that may occur under Alternative 6A, while widespread in particular at interior Delta locations, would not be of sufficient magnitude to cause substantially increased risk for adverse effects to municipal or agricultural beneficial uses within the affected environment. Long-term average boron concentrations would decrease in Delta water exports to the SWP and CVP service area, which may contribute to reducing the existing 303(d) impairment of agricultural beneficial uses in the lower San Joaquin River. Consequently, Alternative 6A would not be expected to cause any substantial increases in boron concentrations or degradation with respect to boron such that objectives would be exceeded more frequently, or any beneficial uses would be adversely affected anywhere in the affected environment. Based on these findings, this impact is determined to be less than significant. No mitigation is required.

Impact WQ-4: Effects on Boron Concentrations Resulting from Implementation of CM2–CM22

***NEPA Effects*:** Effects of CM2–CM22 on boron under Alternative 6A are the same as those discussed for Alternative 1A and are determined to be not adverse.

***CEQA Conclusion*:** Conservation Measures 2–22 proposed under Alternative 6A would be similar to those proposed under Alternative 1A. As such, effects on boron resulting from the implementation of CM2–CM22 would be similar to that previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

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

Upstream of the Delta

Under Alternative 6A there would be no expected change to the sources of bromide in the Sacramento and eastside tributary watersheds. Bromide loading in these watersheds would remain unchanged and resultant changes in flows from altered system-wide operations under Alternative 6A would have negligible, if any, effects on the concentration of bromide in the rivers and reservoirs of these watersheds. Consequently, Alternative 6A would not be expected to adversely affect the MUN beneficial use, or any other beneficial uses, of the Sacramento River, the eastside tributaries, or their associated reservoirs upstream of the Delta.

Under Alternative 6A, modeling indicates that long-term annual average flows on the San Joaquin River would decrease by 6%, relative to Existing Conditions and would remain virtually the same relative to the No Action Alternative (Appendix 5A). These decreases in flow would result in possible increases in long-term average bromide concentrations of about 3%, relative to Existing Conditions and less than <1% relative to the No Action Alternative (Appendix 8E, Bromide Table 22). The small increases in lower San Joaquin River bromide levels that could occur under Alternative 6A, relative to existing and the No Action Alternative conditions would not be expected to adversely affect the MUN beneficial use, or any other beneficial uses, of the lower San Joaquin River.

Delta

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

Using the mass-balance modeling approach for bromide (see Section 8.3.1.3), relative to Existing Conditions, Alternative 6A would result in increases in long-term average bromide concentrations at Staten Island and Barker Slough, while long-term average concentrations would decrease at the other assessment locations (Appendix 8E, *Bromide*, Table 14). At Barker Slough, predicted long-term average bromide concentrations would increase from 51 µg/L to 61 µg/L (19% relative increase) for the modeled 16-year hydrologic period and would increase from 54 µg/L to 92 µg/L (73%

relative increase) for the modeled drought period. At Barker Slough, the predicted 50 μg/L exceedance frequency would decrease from 49% under Existing Conditions to 38% under Alternative 6A, but would increase from 55% to 63% during the drought period. At Barker Slough, the predicted 100 μg/L exceedance frequency would increase from 0% under Existing Conditions to 17% under Alternative 6A, and would increase from 0% to 37% during the drought period. At Staten Island, predicted long-term average bromide concentrations would increase from 50 μg/L to 70 μg/L (41% relative increase) for the modeled 16-year hydrologic period and would increase from 51 μg/L to 70 μg/L (37% relative increase) for the modeled drought period. At Staten Island, increases in average bromide concentrations would correspond to an increased frequency of 50 μg/l threshold exceedance, from 47% under Existing Conditions to 85% under Alternative 6A (52% to 88% for the modeled drought period), and an increase from 1% to 10% (0% to 5% for the modeled drought period) for the 100 μg/L threshold. Changes in exceedance frequency of the 50 μg/L and 100 μg/L concentration thresholds at other assessment locations would be less considerable. This comparison to Existing Conditions reflects changes in bromide due to both Alternative 6A operations (including north Delta intake capacity of 15,000 cfs and numerous other operational components of Scenario D) and climate change/sea level rise.

Due to the relatively small differences between modeled Existing Conditions and No Action baselines, changes in long-term average bromide concentrations and changes in exceedance frequencies relative to the No Action Alternative are generally of similar magnitude to those previously described for the existing condition comparison (Appendix 8E, *Bromide*, Table 14). Modeled long-term average bromide concentration increases at Barker Slough are predicted to increase by 22% (72% for the modeled drought period) relative to the No Action Alternative. Modeled long-term average bromide concentration increases at Staten Island are predicted to increase by 45% (41% for the modeled drought period) relative to the No Action Alternative. However, unlike the Existing Conditions comparison, long-term average bromide concentrations at Buckley Cove would increase relative to the No Action Alternative, although the increases would be relatively small (≤4%). Unlike the comparison to Existing Conditions, this comparison to the No Action Alternative reflects changes in bromide due only to Alternative 6A operations.

At Barker Slough, modeled long-term average bromide concentrations for the two baseline conditions are very similar (Appendix 8E, *Bromide*, Table 14). Such similarity demonstrates that the modeled Alternative 6A change in bromide is almost entirely due to Alternative 6A operations, and not climate change/sea level rise. Therefore, operations are the primary driver of effects on bromide at Barker Slough, regardless whether Alternative 6A is compared to Existing Conditions, or compared to the No Action Alternative.

Results of the modeling approach which used relationships between EC and chloride and between chloride and bromide (see Section 8.3.1.3) differed somewhat from what is presented above for the mass-balance approach (see Appendix 8E, Table 15). For most locations, the frequency of exceedance of the 50 μg/L and 100 μg/L were similar. The greatest difference between the methods was predicted for Barker Slough. The increases in frequency of exceedance of the 100 μg/L threshold, relative to Existing Conditions and the No Action Alternative, were not as great using this alternative EC to chloride and chloride to bromide relationship modeling approach as compared to that presented above from the mass-balance modeling approach. However, there were still substantial increases, resulting in 6% exceedance over the modeled period under Alternative 6A, as compared to 1% under Existing Conditions and 2% under the No Action Alternative. For the drought period, exceedance frequency increased from 0% under Existing Conditions and the No Action

Alternative, to 17% under Alternative 6A. Because the mass-balance approach predicts a greater level of impact at Barker Slough, determination of impacts was based on the mass-balance results.

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

The seasonal intakes at Mallard Slough and City of Antioch are infrequently used due to water quality constraints related to sea water intrusion. On a long-term average basis, bromide at these locations is in excess of 3,000 μg/L, but during seasonal periods of high Delta outflow can be <300 μg/L. Based on modeling using the mass-balance approach, use of the seasonal intakes at Mallard Slough and City of Antioch under Alternative 6A would experience a period average increase in bromide during the months when these intakes would most likely be utilized. For those wet and above normal water year types where mass balance modeling would predict water quality typically suitable for diversion, predicted long-term average bromide would increase from 103 μg/L to 162 μg/L (58% increase) at City of Antioch and would increase from 150 μg/L to 199 μg/L (33% increase) at Mallard Slough relative to Existing Conditions (Appendix 8E, *Bromide*, Table 23). Increases would be similar for the No Action Alternative comparison. Modeling results using the EC to chloride and chloride to bromide relationships show increases during these months, but the relative magnitude of the increases is much lower (Appendix 8E, Bromide Table 24). Regardless of the differences in the data between the two modeling approaches, the decisions surrounding the use of these seasonal intakes is largely driven by acceptable water quality, and thus have historically been opportunistic. Opportunity to use these intakes would remain, and the predicted increases in bromide concentrations at the City of Antioch and Mallard Slough intake would not be expected to adversely affect MUN beneficial uses, or any other beneficial use, at these locations.

Based on modeling using the mass-balance approach, relative to existing and No Action Alternative conditions, Alternative 6A would lead to predicted improvements in long-term average bromide concentrations at Franks Tract, Rock Slough, and Contra Costa PP No. 1, in addition to Banks and Jones (discussed below). At these locations, long-term average bromide concentrations would be predicted to decrease by as much as 41–61%, depending on baseline comparison. Modeling results using the EC to chloride and chloride to bromide relationships generally do not show similar decreases for Rock Slough and Contra Costa PP No. 1, but rather, predict small increases. Based on the small magnitude of increases predicted, these increases would not adversely affect beneficial uses at those locations.

SWP/CVP Export Service Areas

Under Alternative 6A, improvement in long-term average bromide concentrations would occur at the Banks and Jones pumping plants. Long-term average bromide concentrations for the modeled 16-year hydrologic period at these locations would decrease by as much as 96% relative to Existing Conditions and the No Action Alternative (Appendix 8E, *Bromide*, Table 14). As a result, exceedances of the 50 µg/L and 100 µg/L assessment thresholds would be completely eliminated, resulting in considerable overall improvement in Export Service Areas water quality 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 15).

Similar to the discussion pertaining to the No Action Alternative, maintenance of SWP and CVP facilities under Alternative 6A would not be expected to create new sources of bromide or contribute towards a substantial change in existing sources of bromide in the affected environment. Maintenance activities would not be expected to cause any substantial change in bromide such that MUN beneficial uses, or any other beneficial use, would be adversely affected anywhere in the affected environment.

NEPA Effects: In summary, Alternative 6A operations and maintenance, relative to the No Action Alternative, would result in small increases (i.e., <1%) in long-term average bromide concentrations at Vernalis related to relatively small declines in long-term average flow on the San Joaquin River. However, Alternative 6A operation and maintenance activities would cause substantial degradation to water quality with respect to bromide at Barker Slough, source of the North Bay Aqueduct. Resultant substantial change in long-term average bromide at Barker Slough could necessitate changes in water treatment plant operations or require treatment plant upgrades in order to maintain DBP compliance, and thus would constitute an adverse effect on water quality. Mitigation Measure WQ-5 is available to reduce these effects (implementation of this measure along with a separate, non-environmental commitment as set forth in EIR/EIS Appendix 3B, *Environmental Commitments*, relating to the potential increased treatment costs associated with bromide-related changes would reduce these effects).

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

Under Alternative 6A there would be no expected change to the sources of bromide in the Sacramento and eastside tributary watersheds. Bromide loading in these watersheds would remain unchanged and resultant changes in flows from altered system-wide operations under Alternative 6A would have negligible, if any, effects on the concentration of bromide in the rivers and reservoirs of these watersheds. However, south of the Delta, the San Joaquin River is a substantial source of bromide, primarily due to the use of irrigation water imported from the southern Delta. Concentrations of bromide at Vernalis are inversely correlated to net river flow. Under Alternative 6A, long-term average flows at Vernalis would decrease only slightly, resulting in less than substantial predicted increases in long-term average bromide of about 3% relative to Existing Conditions.

Relative to Existing Conditions, Alternative 6A would result in substantial increases in long-term average bromide concentration at Barker Slough and Staten Island. There are no existing or foreseeable municipal drinking water intakes in the vicinity of Staten Island, but Barker Slough is the source of the North Bay Aqueduct. The increase in long-term average bromide concentrations predicted for Barker Slough would result in a substantial change in source water quality to existing drinking water treatment plants drawing water from the North Bay Aqueduct. These modeled increases in bromide at Barker Slough could lead to adverse changes in the formation of disinfection byproducts at drinking water treatment plants such that considerable water treatment plant upgrades would be necessary in order to achieve equivalent levels of drinking water health protection.

The assessment of effects on bromide in the SWP/CVP Export Service Areas is based on assessment of changes in bromide concentrations at Banks and Jones pumping plants. Under Alternative 6A, substantial improvement would occur at the Banks and Jones pumping plants, where predicted long-term average bromide concentrations are predicted to decrease by as much as 96% relative to Existing Conditions. An overall improvement in bromide-related water quality would be predicted in the SWP/CVP Export Service Areas.

Based on the above, Alternative 6A operation and maintenance would not result in any substantial change in long-term average bromide concentration upstream of the Delta. Furthermore, under Alternative 6A, water exported from the Delta to the SWP/CVP service area would be substantially improved relative to bromide. Bromide is not bioaccumulative, therefore change in long-term average bromide concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Additionally, bromide is not a constituent related to any 303(d) listings. Alternative 6A operation and maintenance activities would not cause substantial long-term degradation to water quality respective to bromide with the exception of water quality at Barker Slough and at Staten Island in the eastern Delta. There are no existing or foreseeable municipal intakes in the vicinity of Staten Island, but Barker Slough is the source of the North Bay Aqueduct. At Barker Slough, modeled long-term annual average concentrations of bromide would increase by 19%, and 73% during the modeled drought period. For the modeled 16-year hydrologic period the frequency of predicted bromide concentrations exceeding 100 μg/L would increase from 0% under Existing Conditions to 17% under Alternative 6A, while for the modeled drought period, the frequency would increase from 0% to 37%. Substantial changes in long-term average bromide could necessitate changes in treatment plant operation or require treatment plant upgrades in order to maintain DBP compliance. The model predicted change at Barker Slough is substantial and, therefore, would represent a substantially increased risk for adverse effects on existing MUN beneficial uses should treatment upgrades not be undertaken. The impact is considered significant.

Implementation of Mitigation Measure WQ-5 along with a separate, non-environmental commitment relating to the potential increased treatment costs associated with bromide-related changes would reduce these effects. While mitigation measures to reduce these water quality effects in affected water bodies to less than significant levels are not available, implementation of Mitigation Measure WQ-5 is recommended to attempt to reduce the effect that increased bromide concentrations may have on Delta beneficial uses. However, because the effectiveness of this mitigation measure to result in feasible measures for reducing water quality effects is uncertain, this impact is considered to remain significant and unavoidable. Please see Mitigation Measure WQ-5 under Impact WQ-5 in the discussion of Alternative 1A.

In addition to and to supplement Mitigation Measure WQ-5, the BDCP proponents have incorporated into the BDCP, as set forth in EIR/EIS Appendix 3B, *Environmental Commitments*, a separate, non-environmental commitment to address the potential increased water treatment costs that could result from bromide-related concentration effects on municipal water purveyor operations. Potential options for making use of this financial commitment include funding or providing other assistance towards implementation of the North Bay Aqueduct AIP, acquiring alternative water supplies, or other actions to indirectly reduce the effects of elevated bromide and DOC in existing water supply diversion facilities. Please refer to Appendix 3B, *Environmental Commitments*, for the full list of potential actions that could be taken pursuant to this commitment in order to reduce the water quality treatment costs associated with water quality effects relating to chloride, electrical conductivity, and bromide.

Mitigation Measure WQ-5: Avoid, Minimize, or Offset, as Feasible, Adverse Water Quality Conditions

Please see Mitigation Measure WQ-5 under Impact WQ-5 in the discussion of Alternative 1A.

Impact WQ-6: Effects on Bromide Concentrations Resulting from Implementation of CM2–CM22

***NEPA Effects*:** Conservation Measures 2–22 proposed under Alternative 6A would be the same as those proposed under Alternative 1A. As discussed for Alternative 1A, implementation of the CM2–CM22 would not present new or substantially changed sources of bromide to the study area. Some conservation measures may replace or substitute for existing irrigated agriculture in the Delta. This replacement or substitution is not expected to substantially increase or present new sources of bromide. CM2–CM22 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.

In summary, implementation of CM2–CM22 under Alternative 6A, relative to the No Action Alternative, would have negligible, if any, effects on bromide concentrations. The effects on bromide from implementing CM2–CM22 are determined to not be adverse.

***CEQA Conclusion*:** Conservation Measures 2–22 proposed under Alternative 6A would be similar to those proposed under Alternative 1A. As such, effects on bromide resulting from the implementation of CM2–CM22 would be similar to that previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

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

Upstream of the Delta

Under Alternative 6A there would be no expected change to the sources of chloride in the Sacramento and eastside tributary watersheds. Chloride loading in these watersheds would remain unchanged and resultant changes in flows from altered system-wide operations would have negligible, if any, effects on the concentration of chloride in the rivers and reservoirs of these watersheds. The modeled long-term annual average flows on the lower San Joaquin River at Vernalis would decrease slightly compared to Existing Conditions and be similar compared to the No Action Alternative (as a result of climate change). The reduced flow would result in possible increases in long-term average chloride concentrations of about 2%, relative to the Existing Conditions and no change relative to No Action Alternative (Appendix 8G, Table Cl-62). Consequently, Alternative 6A would not be expected to cause exceedance of chloride objectives/criteria or substantially degrade water quality with respect to chloride, and thus would not adversely affect any beneficial uses of the Sacramento River, the eastside tributaries, associated reservoirs upstream of the Delta, or the San Joaquin River.

Delta

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

Relative to the Existing Conditions and No Action Alternative, the predicted long-term average chloride concentrations under Alternative 6A for the 16-year period modeled would be substantially reduced at most of the assessment locations (Appendix 8G, *Chloride*, Table Cl-37 and Table Cl-38). Moreover, the direction and magnitude of predicted changes for Alternative 6A are similar between the alternatives, thus, the effects relative to Existing Conditions and the No Action Alternative are discussed together. Depending on the modeling approach (see Section 8.3.1.3), the average chloride concentrations would be increased at the North Bay Aqueduct at Barker Slough (i.e., ≤15%) and San Joaquin River at Staten Island (i.e., ≤37%). Additionally, implementation of tidal habitat restoration under CM4 would increase the tidal exchange volume in the Delta, and thus may contribute to increased chloride concentrations in the Bay source water as a result of increased salinity intrusion. More discussion of this phenomenon is included in Section 8.3.1.3. Consequently, while uncertain, the magnitude of chloride increases may be greater than indicated herein and would affect the western Delta assessment locations the most which are influenced to the greatest extent by the Bay source water. The comparison to Existing Conditions reflects changes in chloride due to both Alternative 6A operations (including north Delta intake capacity of 15,000 cfs and numerous other operational components of Scenario D) and climate change/sea level rise. The comparison to the No Action Alternative reflects changes in chloride due only to operations. The following outlines the modeled chloride changes relative to the applicable objectives and beneficial uses of Delta waters.

Municipal Beneficial Uses

Estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3) were used to evaluate the 150 mg/L Bay-Delta WQCP objective for municipal and industrial beneficial uses on a basis of the percent of years the chloride objective is exceeded for the modeled 16-year period. The objective is exceeded if chloride concentrations exceed 150 mg/L for a specified number of days in a given water year at both the Antioch and Contra Costa Pumping Plant #1 locations. For Alternative 6A, the modeled frequency of objective exceedance would increase from 6% of years under Existing Conditions and 6% under the No Action Alternative to 13% of years under Alternative 6A (Appendix 8G, Table Cl-64).

Similarly, estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3) were also used to evaluate the 250 mg/L Bay-Delta WQCP objective for chloride at Contra Costa Pumping Plant #1 where daily average objectives apply. The basis for the evaluation was the predicted number of days the objective was exceeded for the modeled 16-year period. For Alternative 6A, the modeled frequency of objective exceedance would be eliminated, from 6% of modeled days under Existing Conditions and 5% under the No Action Alternative to 0% of modeled days under Alternative 6A (Appendix 8G, Table Cl-63).

Given the limitations inherent to estimating future chloride concentrations (see Section 8.3.1.3), estimation of chloride concentrations through both a mass balance approach and an EC-chloride relationship approach was used to evaluate the 250 mg/L Bay-Delta WQCP objectives in terms of both frequency of exceedance and use of assimilative capacity. When utilizing the mass balance approach to model monthly average chloride concentrations for the 16-year period, the predicted frequency of exceeding the 250 mg/L objective would be eliminated at the Contra Costa Canal at Pumping Plant #1 (24% for Existing Conditions to 0% for Alternative 6A), thus indicating complete compliance with this objective would be achieved (Appendix 8G, Table Cl-39 and Figure Cl-9). The frequency of exceedances at the San Joaquin River at Antioch also would decrease compared to all of the alternative scenarios (i.e., 9% from 66% for Existing Conditions to 57%) with no substantial change predicted for Mallard Island (i.e., maximum increase of 1%) (Appendix 8G, Table Cl-39). However, available assimilative capacity would be reduced relative to Existing Conditions in April (i.e., up to 21%) (Appendix 8G, Table Cl-41) reflecting substantial degradation during a month when average concentrations would be near, or exceed, the objective.

In comparison, when utilizing the chloride-EC relationship to model monthly average chloride concentrations for the 16-year period, trends in frequency of exceedance generally agreed, but use of assimilative capacity were predicted to be larger at some locations (Appendix 8G, Table Cl-40 and Table Cl-42). Specifically, while the model predicted exceedance frequency would decrease at the Contra Costa Canal at Pumping Plant #1 and Rock Slough locations, use of assimilative capacity would increase substantially for the months of February through June. (i.e., maximum of 81% in March for the modeled drought period). Due to such seasonal long-term average water quality degradation at these locations, the potential exists for substantial adverse effects on the municipal and industrial beneficial uses through reduced opportunity for diversion of water with acceptable chloride levels. Moreover, due to the increased frequency of exceeding the 150 mg/L Bay-Delta WQCP objective, the potential exists for additional adverse effects on the municipal and industrial beneficial uses at Contra Costa Pumping Plant #1 and Antioch.

303(d) Listed Water Bodies

With respect to the 303(d) listing for chloride in Tom Paine Slough, the monthly average chloride concentrations for the 16-year period modeled at Old River at Tracy Road would generally be similar compared to Existing Conditions, and thus, would not be further degraded on a long-term basis (Appendix 8G, Figure Cl-10). With respect to Suisun Marsh, the monthly average chloride concentrations for the 16-year period modeled would generally increase compared to Existing Conditions and No Action Alternative in some months during October through May at the Sacramento River at Collinsville (Appendix 8G, Figure Cl-11), Mallard Island (Appendix 8G, Figure Cl-9), and increase substantially at Montezuma Slough at Beldon's Landing (i.e., over a doubling of concentration in December through February) (Appendix 8G, Figure Cl-12), 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.

SWP/CVP Export Service Areas

Under Alternative 6A, long-term average chloride concentrations based on the mass balance analysis of modeling results for the 16-year period modeled at the Banks and Jones pumping plants would decrease by approximately 95% relative to Existing Conditions and No Action Alternative (Appendix 8G, *Chloride*, Table Cl-37). The modeled low-frequency exceedances of objectives present under the Existing Conditions and No Action Alternative would be eliminated under Alternative 6A (Appendix 8G, *Chloride*, Table Cl-39). Consequently, water exported into the SWP/CVP service area would generally be improved with regards to chloride relative to Existing Conditions and No Action Alternative conditions.

Results of the modeling approach which used relationships between EC and chloride (see Section 8.3.1.3) were consistent with the discussion above, and assessment of chloride using these data results in the same conclusions as are presented above for the mass-balance approach (Appendix 8G, Table Cl-38 and Table Cl-40).

Commensurate with the reduced chloride concentrations in water exported to the service area, reduced chloride loading in the lower San Joaquin River would be anticipated which would likely alleviate or lessen any expected increase in chloride at Vernalis related to decreased annual average San Joaquin River flows (see discussion of Upstream of the Delta).

Maintenance of SWP and CVP facilities would not be expected to create new sources of chloride or contribute towards a substantial change in existing sources of chloride in the affected environment. Maintenance activities would not be expected to cause any substantial change in chloride such that any long-term water quality degradation would occur, thus, beneficial uses would not be adversely affected anywhere in the affected environment.

***NEPA Effects*:** In summary, relative to the No Action Alternative conditions, Alternative 6A would result in increased frequency of exceedance of the 150 mg/L Bay-Delta WCCP objective at Contra Costa Pumping Plant #1 and Antioch, substantial seasonal use of assimilative capacity at Contra Costa Pumping Plant #1, Antioch, and Rock Slough, and increased concentrations with respect to the 303(d) impairment in Suisun Marsh. The predicted chloride increases constitute an adverse effect on water quality (see Mitigation Measure WQ-7 below; implementation of this measure along with a separate, non-environmental commitment relating to the potential increased chloride treatment costs would reduce these effects). Additionally, the predicted changes relative to the No Action Alternative conditions indicate that in addition to the effects of climate change/sea level rise, implementation of CM1 and CM4 under Alternative 6A would contribute substantially to the adverse water quality effects.

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

Chloride is not a constituent of concern in the Sacramento River watershed upstream of the Delta, thus river flow rate and reservoir storage reductions that would occur under the Alternative 6A, relative to Existing Conditions, would not be expected to result in a substantial adverse change in chloride levels. Additionally, relative to Existing Conditions, the Alternative 6A would not result in reductions in river flow rates (i.e., less dilution) or increased chloride loading such that there would be any substantial increase in chloride concentrations upstream of the Delta in the San Joaquin River watershed.

Relative to Existing Conditions, Alternative 6A operations would result in substantially reduced chloride concentrations in the Delta such that exceedances of the 250 mg/L Bay-Delta WQCP objective at the San Joaquin River at Antioch and Mallard Slough would be reduced. Nevertheless, due to the predicted increased frequency of exceeding the 150 mg/L Bay-Delta WQCP objective at Contra Costa Pumping Plant #1 and Antioch, and the substantial seasonal use of assimilative capacity at Contra Costa Pumping Plant #1 and Rock Slough, the potential exists for adverse effects on the municipal and industrial beneficial uses at these locations (see Mitigation Measure WQ-7 below; implementation of this measure along with a separate, non-environmental commitment relating to the potential increased chloride treatment costs would reduce these effects). Moreover, the modeled increased chloride concentrations and degradation in the western Delta could still occur and further contribute, at measurable levels (i.e., over a doubling of concentration), to the existing 303(d) listed impairment due to chloride in Suisun Marsh for the protection of fish and wildlife. Based on these findings, this impact is determined to be significant due to increased frequency of exceedance of the 150 mg/L Bay-Delta WQCP objective as well as potential adverse effects on fish and wildlife beneficial uses in Suisun Marsh.

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

Chloride is not a bioaccumulative constituent, thus any increased concentrations under Alternative 6A would not result in substantial chloride bioaccumulation impacts on aquatic life or humans. Alternative 6A maintenance would not result in any substantial changes in chloride concentration upstream of the Delta or in the SWP/CVP Export Service Areas. However, based on these findings, this impact is determined to be significant due to increased chloride concentrations and degradation in Suisun Marsh and its effects on fish and wildlife beneficial uses.

While mitigation measures to reduce these water quality effects in affected water bodies to less than significant levels are not available, implementation of Mitigation Measure WQ-7 is recommended to attempt to reduce the effect that increased chloride concentrations may have on Delta beneficial uses. However, because the effectiveness of this mitigation measure to result in feasible measures for reducing water quality effects is uncertain, this impact is considered to remain significant and unavoidable. Please see Mitigation Measure WQ-7 under Impact WQ-7 in the discussion of Alternative 1A.

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

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

Please see Mitigation Measure WQ-7 under Impact WQ-7 in the discussion of Alternative 1A.

Impact WQ-8: Effects on Chloride Concentrations Resulting from Implementation of CM2–CM22

***NEPA Effects*:** Under Alternative 6A, the types and geographic extent of effects on chloride concentrations in the Delta as a result of implementation of the other conservation measures (i.e., CM2–CM22) would be similar to, and undistinguishable from, those effects previously described for Alternative 1A. The conservation measures would present no new direct sources of chloride to the affected environment. Moreover, some habitat restoration conservation measures (CM4–10) would occur on lands within the Delta currently used for irrigated agriculture, thus replacing agricultural land uses with restored tidal wetlands, floodplain, and related channel margin and off-channel habitats. The potential reduction in irrigated lands within the Delta may result in reduced discharges of agricultural field drainage with elevated chloride concentrations, which would be considered an improvement compared to No Action Alternative conditions.

In summary, based on the discussion above, the effects on chloride from implementing CM2-CM22 are considered to be not adverse.

***CEQA Conclusion*:** Implementation of the CM2–CM22 for Alternative 6A would not present new or substantially changed sources of chloride to the affected environment upstream of the Delta, within Delta, or in the SWP/CVP service area. Replacement of irrigated agricultural land uses in the Delta with habitat restoration conservation measures may result in some reduction in discharge of agricultural field drainage with elevated chloride concentrations, thus resulting in improved water quality conditions. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

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

***NEPA Effects*:** Effects of CM1 on dissolved oxygen under Alternative 6A are the same as those discussed for Alternative 1A and are considered to not be adverse.

CEQA Conclusion**:** Effects of CM1 on DO under Alternative 6A would be similar to those discussed for Alternative 1A, and are summarized here, then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion under the Alternative 1A.

River flow rate and reservoir storage reductions that would occur under Alternative 6A, relative to Existing Conditions, would not be expected to result in a substantial adverse change in DO levels in the reservoirs and rivers upstream of the Delta, given that mean monthly flows would remain within the ranges historically seen under Existing Conditions and the affected river are large and turbulent. Any reduced DO saturation level that may be caused by increased water temperature would not be expected to cause DO levels to be outside of the range seen historically. Finally, amounts of oxygen demanding substances and salinity would not be expected to change sufficiently to affect DO levels.

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

There is not expected to be substantial, if even measurable, changes in DO levels in the SWP/CVP Export Service Areas waters under Alternative 6A, relative to Existing Conditions, because the biochemical oxygen demand of the exported water would not be expected to substantially differ from that under Existing Conditions (due to ever increasing water quality regulations), canal turbulence and exposure of the water to the atmosphere and the algal communities that exist within the canals would establish an equilibrium for DO levels within the canals. The same would occur in downstream reservoirs.

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

Impact WQ-10: Effects on Dissolved Oxygen Resulting from Implementation of CM2–CM22

NEPA Effects**:** Effects of CM2–CM22 on DO under Alternative 6A are the same as those discussed for Alternative 1A and are considered to not be adverse.

CEQA Conclusion**:** Conservation Measures 2–22 proposed under Alternative 6A would be similar to those proposed under Alternative 1A. As such, effects on DO resulting from the implementation of CM2–CM22 would be similar to that previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

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

Upstream of the Delta

For the same reasons stated for the No Action Alternative, EC levels (highs, lows, typical conditions) in the Sacramento River and its tributaries, the eastside tributaries, their associated reservoirs, and the San Joaquin River upstream of the Delta under Alternative 6A are not expected to be outside the ranges occurring under Existing Conditions or would occur under the No Action Alternative. Any minor changes in EC levels that could occur under Alternative 6A in water bodies upstream of the Delta would not be of sufficient magnitude, frequency and geographic extent that would cause adverse effects on beneficial uses or substantially degrade water quality with regard to EC.

Delta

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

Relative to Existing Conditions, Alternative 6A would result in an increase in the number of days the Bay-Delta WQCP EC objectives for fish and wildlife protection (which apply during April and May) would be exceeded in the San Joaquin River at Jersey Point and Prisoners Point (Appendix 8H, Table EC-6), and an increase in exceedance of the agricultural EC objective for the Sacramento River at Emmaton. The percent of days the EC objective would be exceeded at Jersey Point for the entire period modeled (1976–1991) would increase from 0% under Existing Conditions to 3% under Alternative 6A, and the percent of days out of compliance with the EC objective would increase from 0% under Existing Conditions to 5% under Alternative 6A. The percent of days the EC objective would be exceeded at Prisoners Point for the entire period modeled would increase from 6% under Existing Conditions to 34% under Alternative 6A, and the percent of days out of compliance with the EC objective would increase from 10% under Existing Conditions to 34% under Alternative 6A. At Emmaton, the percent of days the EC objective would be exceeded would increase from 6% under Existing Conditions to 28% under Alternative 6A, and the percent of days out of compliance would increase from 11% under Existing Conditions to 40% under Alternative 6A. Average EC levels at the western and southern Delta compliance locations and San Joaquin River at San Andreas Landing (an interior Delta location) would decrease from 2–56% for the entire period modeled and 3–52% during the drought period modeled (1987–1991) (Appendix 8H, Table EC-17). In the S. Fork Mokelumne River at Terminous, average EC would increase 7% for the entire period modeled and 6% during the drought period modeled. Average EC in the S. Fork Mokelumne River at Terminous (an interior Delta location) would increase during all months (Appendix 8H, Table EC-17). The western Delta is Clean Water Act section 303(d) listed as impaired due to elevated EC and there would be an increased exceedance of the EC objective at Emmaton, Thus, relative to Existing Conditions, Alternative 6A could contribute to additional impairment of section 303(d) listed waters. The comparison to Existing Conditions reflects changes in EC due to both Alternative 6A operations (including north Delta intake capacity of 15,000 cfs and numerous other operational components of Scenario D) and climate change/sea level rise.

Relative to the No Action Alternative, the change in percent compliance with Bay-Delta WQCP EC objectives under Alternative 6A would be similar to that described above relative to Existing Conditions for the Sacramento River at Emmaton, and the San Joaquin River at Jersey Point and Prisoners Point. In addition, there would also be a slight increase (<1%) in the percent of days the EC objective would be exceeded in Old River at Tracy Bridge for the entire period modeled. For the entire period modeled, average EC levels would increase at: S. Fork Mokelumne River at Terminous; San Joaquin River at Brandt Bridge and Prisoners Point; and Old River at Tracy Bridge. The greatest average EC increase would occur in the S. Fork Mokelumne River at Terminous (8%); the average EC increase at the other locations would be <1–3% (Appendix 8H, Table EC-17). During the drought period modeled, average EC would increase at the same locations, except San Joaquin River at Prisoners Point. The greatest average EC increase during the drought period modeled would occur in the S. Fork Mokelumne River at Terminous (7%); the increase at the other locations would be 1–2% (Appendix 8H, Table EC-17). Given that the western and southern Delta are Clean Water Act section 303(d) listed as impaired due to elevated EC, the increase in the incidence of exceedance of EC objectives and increase in long-term and drought period average EC under Alternative 6A at southern Delta compliance locations and increase in exceedance of EC objectives at Emmaton, relative to the No Action Alternative, has the potential to contribute to additional impairment and potentially adversely affect beneficial uses. The comparison to the No Action Alternative reflects changes in EC due only to Alternative 6A operations (including north Delta intake capacity of 15,000 cfs and numerous other operational components of Scenario D).

For Suisun Marsh, October–May is the period when Bay-Delta WQCP EC objectives for protection of fish and wildlife apply. Long-term average EC would increase under Alternative 6A, relative to Existing Conditions, during the months of April and May by 0.2–0.4 mS/cm in the Sacramento River at Collinsville (Appendix 8H, Table EC-21). Long-term average EC would decrease relative to Existing Conditions in Montezuma Slough at National Steel during October–May (Appendix 8H, Table EC-22). The most substantial increase would occur near Beldon Landing, with long-term average EC levels increasing by 0.8–2.2 mS/cm, depending on the month, nearly doubling during some months the long-term average EC relative to Existing Conditions (Appendix 8H, Table EC-23). Sunrise Duck Club and Volanti Slough also would have long-term average EC increases during February–May of 0.4–1.7 mS/cm (Appendix 8H, Tables EC-24 and EC-25). The degree to which the long-term average EC increases would cause exceedance of Bay-Delta WQCP objectives is unknown, because objectives are expressed as a monthly average of daily high tide EC, which does not have to be met if it can be demonstrated “equivalent or better protection will be provided at the location” (State Water Resources Control Board 2006:14). 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 be substantial and it is uncertain the degree to which current management plans for the Suisun Marsh would be able to address these substantially higher EC levels and protect beneficial uses. Thus, these increased EC levels in Suisun Marsh are considered to have a potentially adverse effect on marsh beneficial uses. Long-term average EC increases in Suisun Marsh under Alternative 6A relative to the No Action Alternative would be similar to the increases relative to Existing Conditions. Suisun Marsh also is section 303(d) listed as impaired due to elevated EC, and the potential increases in long-term average EC concentrations could contribute to additional impairment, because the increases would be double that relative to Existing Conditions and the No Action Alternative.

SWP/CVP Export Service Areas

At the Banks and Jones pumping plants, Alternative 6A would result in no exceedances of the Bay-Delta WQCP's 1,000 µmhos/cm EC objective for the entire period modeled (Appendix 8H, Table EC-10). Thus, there would be no adverse effect on the beneficial uses in the SWP/CVP Export Service Areas using water pumped at this location under the Alternative 6A.

At the Banks pumping plant, relative to Existing Conditions, average EC levels under Alternative 6A would decrease substantially on average: 67% for the entire period modeled and 73% during the drought period modeled. Relative to the No Action Alternative, average EC levels would decrease by 64% for the entire period modeled and 71% during the drought period modeled. (Appendix 8H, Table EC-17)

At the Jones pumping plant, relative to Existing Conditions, average EC levels under Alternative 6A would also decrease substantially: 68% for the entire period modeled and 74% during the drought period modeled. Relative to the No Action Alternative, average EC levels would decrease by 67% for the entire period modeled and 73% during the drought period modeled. (Appendix 8H, Table EC-17)

Based on the decreases in long-term average EC levels that would occur at the Banks and Jones pumping plants, Alternative 6A would not cause degradation of water quality with respect to EC in the SWP/CVP Export Service Areas; rather, Alternative 6A would improve long-term average EC conditions in the SWP/CVP Export Service Areas.

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

The export area of the Delta is listed on the state's CWA Section 303(d) list as impaired due to elevated EC. Alternative 6A would result in lower average EC levels relative to Existing Conditions and the No Action Alternative and, thus, would not contribute to additional beneficial use impairment related to elevated EC in the SWP/CVP Export Service Areas waters.

NEPA Effects: In summary, the increased frequency of exceedance of EC objectives and increased long-term and drought period average EC levels that would occur at southern Delta compliance locations, and increased exceedance of objectives in the western Delta under Alternative 6A, relative to the No Action Alternative, would contribute to adverse effects on the agricultural beneficial uses. In addition. the increased frequency of exceedance of the San Joaquin River at Prisoners Point and Jersey Point EC objectives and long-term and drought period average EC at Prisoners Point could contribute to adverse effects on fish and wildlife beneficial uses. Given that the western and southern Delta are Clean Water Act section 303(d) listed as impaired due to elevated EC, the increase in the incidence of exceedance of EC objectives and long-term average and drought period average EC in these portions of the Delta has the potential to contribute to additional beneficial use impairment. The increases in long-term average EC levels that would occur in Suisun Marsh would further degrade existing EC levels and could contribute additional to adverse effects on the fish and wildlife beneficial uses. Suisun Marsh is section 303(d) listed as impaired due to elevated EC, and the potential increases in long-term average EC levels could contribute to additional beneficial use impairment. These increases in EC constitute an adverse effect on water quality. Mitigation Measure WQ-11 would be available to reduce these effects (implementation of this measure along with a separate, non-environmental commitment as set forth in EIR/EIS Appendix 3B, *Environmental Commitments*, relating to the potential EC-related changes would reduce these effects).

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

River flow rate and reservoir storage reductions that would occur under Alternative 6A, relative to Existing Conditions, would not be expected to result in a substantial adverse change in EC levels in the reservoirs and rivers upstream of the Delta, given that: changes in the quality of watershed runoff and reservoir inflows would not be expected to occur in the future; the state's aggressive regulation of point-source discharge effects on Delta salinity-elevating parameters and the expected further regulation as salt management plans are developed; the salt-related TMDLs adopted and being developed for the San Joaquin River; and the expected improvement in lower San Joaquin River average EC levels commensurate with the lower EC of the irrigation water deliveries from the Delta.

Relative to Existing Conditions, Alternative 6A would not result in any substantial increases in long-term average EC levels in the SWP/CVP Export Service Areas. There would be no exceedance of the EC objective at the Jones and Banks pumping plants. Average EC levels for the entire period modeled would decrease at both plants and, thus, this alternative would not contribute to additional beneficial use impairment related to elevated EC in the SWP/CVP Export Service Areas waters. Rather, this alternative would improve long-term EC levels in the SWP/CVP Export Service Areas, relative to Existing Conditions.

Alternative 6A would result in an increase in the frequency with which Bay-Delta WQCP EC objectives for fish and wildlife protection are exceeded in the San Joaquin River at Jersey Point (from 0% under Existing Conditions to 3% under Alternative 6A) and Prisoners Point (from 6% under Existing Conditions to 34% under Alternative 6A), and an increase in the EC agricultural objectives at Emmaton for the entire period modeled (1976–1991). Because EC is not bioaccumulative, the increases in long-term average EC levels would not directly cause bioaccumulative problems in aquatic life or humans. Portions of the Delta on the Clean Water Act section 303(d) list as impaired due to elevated EC would not have increased long-term average EC levels relative to Existing Conditions, However, at Emmaton, which is in the western Delta, there would be an increased frequency of exceedance of the EC objective. Thus, Alternative 6A could contribute to additional impairment of section 303(d) listed waters. The increased frequency of exceedance of fish and wildlife EC objectives at Prisoners Point and Jersey Point could adversely affect aquatic life beneficial uses. This impact is considered to be significant.

Further, relative to Existing Conditions, Alternative 6A would result in substantial increases in long-term average EC during the months of October through May in Suisun Marsh, such that EC levels would nearly double that relative to Existing Conditions. The increases in long-term average EC levels that would occur in Suisun Marsh could further degrade existing EC levels and thus contribute additionally to adverse effects on the fish and wildlife beneficial uses. Because EC is not bioaccumulative, the increases in long-term average EC levels would not directly cause bioaccumulative problems in wildlife. Suisun Marsh is Clean Water Act section 303(d) listed for elevated EC and the increases in long-term average EC that would occur in the marsh could make beneficial use impairment measurably worse. This impact is considered to be significant.

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

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

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

Please see Mitigation Measure WQ-11 under Impact WQ-11 in the discussion of Alternative 1A.

Impact WQ-12: Effects on Electrical Conductivity Resulting from Implementation of CM2–CM22

***NEPA Effects*:** Effects of CM2–CM22 on EC under Alternative 6 are the same as those discussed for Alternative 1A and are considered not to be adverse.

***CEQA Conclusion*:** Conservation Measures 2–22 proposed under Alternative 6A would be similar to those proposed under Alternative 1A. As such, effects on EC resulting from the implementation of CM2–CM22 would be similar to that previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

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

Upstream of the Delta

Under the Alternative 6A, the magnitude and timing of reservoir releases and river flows upstream of the Delta in the Sacramento River watershed and east-side tributaries would be altered, relative to Existing Conditions and the No Action Alternative.

The Sacramento River at Freeport and San Joaquin River at Vernalis (as summarized for water quality average concentrations in Tables 8-48 and 8-49) were examined for flow/concentration relationships for mercury and methylmercury. No significant, predictive regression relationships were discovered for mercury or methylmercury, except for total mercury with flow at Freeport (monthly or annual)(Figures 8I-10 through 8I-13, Appendix 8I). Such a positive relationship between total mercury and flow is to be expected based on the association of mercury with suspended sediment and the mobilization of sediments during storm flows. However, the changes in flow in the Sacramento River under Alternative 6A relative to Existing Conditions and the No Action Alternative are not of the magnitude of storm flows, in which substantial sediment-associated mercury is mobilized. Therefore mercury loading should not be substantially different due to changes in flow. In addition, even though it may be flow-affected, total mercury concentrations remain well below criteria at upstream locations. Any negligible changes in mercury concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies as related to mercury. Both waterborne methylmercury concentrations and largemouth bass fillet mercury concentrations are expected to remain above guidance levels at upstream of Delta locations, but will not change substantially relative to Existing Conditions or the No Action Alternative due to changes in flows under Alternative 6A.

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

Delta

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

The water quality impacts of waterborne concentrations of mercury and methylmercury and fish tissue mercury concentrations were evaluated for 9 Delta locations. The analysis of percentage change in assimilative capacity of waterborne total mercury of Alternative 6A relative to the 25 ng/L ecological risk benchmark as compared to Existing Conditions showed the greatest decrease to be 9.2% at the Contra Costa Pumping Plant, 9.1% at the Contra Costa Pumping Plant relative to the No Action Alternative (Figures 8-53 and 8-54). These changes are not expected to result in adverse effects to beneficial use. Similarly, changes in methylmercury concentration are expected to be relatively small. The greatest annual average methylmercury concentration for drought conditions was 0.165 ng/L for the San Joaquin River at Buckley Cove which was slightly higher than Existing Conditions (0.161 ng/L) and slightly lower than the No Action Alternative (0.167 ng/L) (Appendix 8I, Table I-6). All modeled input concentrations exceeded the methylmercury TMDL guidance objective of 0.06 ng/L, therefore percentage change in assimilative capacity was not evaluated for methylmercury.

Fish tissue estimates show substantial percentage increases in concentration and exceedance quotients for mercury at some Delta locations. The greatest increases in exceedance quotients (ranging from 33 to 64%) are expected for Franks Tract and Old River at Rock Slough relative to Existing Conditions and the No Action Alternative (Figure 8-55, Appendix 8I, Table I-13b).

SWP/CVP Export Service Areas

The analysis of mercury and methylmercury in the SWP/CVP Export Service Areas was based on concentrations estimated at the Banks and Jones pumping plants. Both waterborne total and methylmercury concentrations for Alternative 6A are projected to be lower than Existing Conditions and the No Action Alternative (Appendix 8I, Figures 8I-4 and 8I-5). Therefore, mercury shows an increased assimilative capacity at these locations (Figures 8-53 and 8-54).

The largest improvements in bass tissue mercury concentrations and exceedance quotients for Alternative 6A, relative to Existing Conditions and the No Action Alternative at any location within the Delta are expected for the export pump locations (specifically, at Jones Pumping plant, 41% improvement relative to Existing Conditions, 43% relative to the No Action Alternative) (Figure 8-55, Appendix 8I, Table I-13b).

***NEPA Effects*:** Based on the above discussion, the effects of mercury and methylmercury in comparison of Alternative 6A to the No Action Alternative (as waterborne and bioaccumulated forms) are considered to be adverse for the case of fish tissue bioaccumulation at some locations.

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

Under Alternative 6A, greater water demands and climate change would alter the magnitude and timing of reservoir releases and river flows upstream of the Delta in the Sacramento River watershed and east-side tributaries, relative to Existing Conditions. Concentrations of mercury and methylmercury upstream of the Delta will not be substantially different relative to Existing Conditions due to the lack of important relationships between mercury/methylmercury concentrations and flow for the major rivers.

Methylmercury concentrations exceed criteria at all locations in the Delta and no assimilative capacity exists. However, monthly average waterborne concentrations of total and methylmercury, over the period of record, are very similar to Existing Conditions. Similarly, estimates of fish tissue mercury concentrations show almost no differences would occur among sites for Alternative 6A as compared to Existing Conditions for Delta sites.

Assessment of effects of mercury in the SWP and CVP Export Service Areas were based on effects on mercury concentrations and fish tissue mercury concentrations at the Banks and Jones pumping plants. The Banks and Jones pumping plants are expected to show increased assimilative capacity for waterborne mercury and decreased fish tissue concentrations of mercury for Alternative 6A as compared to Existing Conditions.

As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. However, increases in fish tissue mercury concentrations are substantial, and changes in fish tissue mercury concentrations would make existing mercury-related impairment in the Delta measurably worse. In comparison to Existing Conditions, Alternative 6A would increase levels of mercury by frequency, magnitude, and geographic extent such that the affected environment would be expected to have measurably higher body burdens of mercury in aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish) or humans consuming those organisms. This impact is considered to be significant. Feasible or effective actions to reduce the effects on mercury resulting from CM1 are unknown. General mercury management measures through CM12, or actions taken by other entities or programs such as TMDL implementation, may minimize or reduce sources and inputs of mercury to the Delta and methylmercury formation. However, it is uncertain whether this impact would be reduced to a level that would be less than significant as a result of CM12 or other future actions. Therefore, the impact would be significant and unavoidable.

Impact WQ-14: Effects on Mercury Concentrations Resulting from Implementation of CM2–CM22

NEPA Effects**:** Some habitat restoration activities under Alternative 6A would occur on lands in the Delta formerly used for irrigated agriculture. Tidal and other restoration proposed under Alternative 6A have the potential to increase water residence times and increase accumulation of organic sediments that are known to enhance methylmercury bioaccumulation in biota in the restored habitat. Therefore, increases in mercury methylation in the habitat restoration areas is possible but uncertain depending on the specific restoration design implemented at a particular Delta location. Models to estimate the potential for methylmercury formation in restored areas are not currently available. However, DSM2 modeling for Alternative 6A operations does incorporate assumptions for certain habitat restoration activities proposed under CM2 and CM4 (see Section 8.3.1.3) that result in changes to Delta hydrodynamics compared to the No Action Alternative. These modeled restoration assumptions provide some insight into potential hydrodynamic changes that could be expected related to implementing CM2 and CM4 and are considered in the evaluation of the potential for increased mercury and methylmercury concentrations under Alternative 6A.

BDCP Conservation Measure 12 (CM12) addresses the potential for methylmercury bioaccumulation associated with restoration activities and acknowledges the uncertainties associated with mitigating or minimizing this potential effect. CM12 proposes project-specific mercury management plans for restoration actions that will incorporate relevant approaches recommended in Phase 1 Methylmercury TMDL control studies. Specific approaches recommended under CM12 that are intended to minimize or mitigate for potential increases in methylmercury bioaccumulation at future restoration sites include:

- Characterizing mercury, methylmercury, organic carbon, iron, and sulfate concentrations to better inform restoration design,
- Sequestering methylmercury at restoration sites using low intensity chemical dosing techniques,
- Minimizing microbial methylation associated with anoxic conditions by reducing the amount of organic material at a restoration site,
- Designing restoration sites to enhance photo degeneration that converts methylmercury into a biologically unavailable, inorganic form of mercury,
- Remediating restoration site soils with iron to reduce methylation in sulfide rich soils, and

- Considering capping mercury laden sediments, where possible to reduce methylation potential at a site.

Because of the uncertainties associated with site-specific estimates of methylmercury concentrations and the uncertainties in source modeling and tissue modeling, the effectiveness of methylmercury management proposed under CM12 to reduce methylmercury concentrations would need to be evaluated separately for each restoration effort, as part of design and implementation. Because of this uncertainty and the known potential for methylmercury creation in the Delta this potential effect of implementing CM2–CM22 is considered adverse.

***CEQA Conclusion*:** There would be no substantial, long-term increase in mercury or methylmercury concentrations or loads in the rivers and reservoirs upstream of the Delta or the waters exported to the CVP and SWP service areas due to implementation of CM2–CM22 relative to Existing Conditions. However, uptake of mercury from water and/or methylation of inorganic mercury may increase to an unquantified degree as part of the creation of new, marshy, shallow, or organic-rich restoration areas. Methylmercury is 303(d)-listed within the affected environment, and therefore any potential measurable increase in methylmercury concentrations would make existing mercury-related impairment measurably worse. Because mercury is bioaccumulative, increases in water-borne mercury or methylmercury that could occur in some areas could bioaccumulate to somewhat greater levels in aquatic organisms and would, in turn, pose health risks to fish, wildlife, or humans. Design of restoration sites under Alternative 6A would be guided by CM12 which requires development of site specific mercury management plans as restoration actions are implemented. The effectiveness of minimization and mitigation actions implemented according to the mercury management plans is not known at this time although the potential to reduce methylmercury concentrations exists based on current research. Although the BDCP will implement CM12 with the goal to reduce this potential effect the uncertainties related to site specific restoration conditions and the potential for increases in methylmercury concentrations in the Delta result in this potential impact being considered significant. No mitigation measures would be available until specific restoration actions are proposed. Therefore this programmatic impact is considered significant and unavoidable.

Impact WQ-15: Effects on Nitrate Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative, Alternative 6A would have negligible, if any, impact on nitrate concentrations in the rivers and reservoirs upstream of the Delta in the Sacramento River watershed relative to Existing Conditions and the No Action Alternative.

Under Alternative 6A, modeling indicates that long-term annual average flows on the San Joaquin River would decrease by an estimated 6%, relative to Existing Conditions, and would remain virtually the same relative to the No Action Alternative (Appendix 5A). Given these relatively small decreases in flows and the weak correlation between nitrate and flows in the San Joaquin River (see Nitrate Appendix 8J, Figure 2), it is expected that nitrate concentrations in the San Joaquin River would be minimally affected, if at all, by changes in flow rates under Alternative 6A.

Any negligible changes in nitrate-N concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regards to nitrate.

Delta

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

Results of the mixing calculations indicate that under Alternative 6A, relative to Existing Conditions and the No Action Alternative, nitrate concentrations throughout the Delta are anticipated to remain low (<1.4 mg/L-N) relative to adopted objectives (Nitrate Appendix 8J, Table 22 and 23). Long-term average nitrate concentrations are anticipated to increase at most locations in the Delta. The increase would be greatest at Franks Tract, Old River at Rock Slough, and Contra Costa Pumping Plant #1 (all >100% increase). Long-term average concentrations were estimated to increase to 0.78, 1.23 and 1.33 mg/L-N for Franks Tract, Old River at Rock Slough, and Contra Costa Pumping Plant #1, respectively, due primarily to increased San Joaquin River water percentage at these locations (see Fingerprinting Appendix 8D). Although changes at specific Delta locations and for specific months may be substantial on a relative basis, the absolute concentration of nitrate in Delta waters would remain low (<1.4 mg/L-N) in relation to the drinking water MCL of 10 mg/L-N, as well as all other thresholds identified in Table 8-50. No additional exceedances of the MCL are anticipated at any location (Nitrate Appendix 8J, Table 22). On a monthly average basis and on a long term annual average basis, for all modeled years and for the drought period (1987–1991) only, use of assimilative capacity available under Existing Conditions and the No Action Alternative, relative to the drinking water MCL of 10 mg/L-N, was up to approximately 14% at Old River at Rock Slough and Contra Costa Pumping Plant #1, and averaged approximately 8–9% on a long-term average basis (Nitrate Appendix 8J, Table 24). Similarly, the use of available assimilative capacity at Franks Tract was up to approximately 7%, and averaged 3–4% over the long term. The concentrations estimated for these locations would not increase the likelihood of exceeding the 10 mg/L-N MCL, nor would they increase the risk for adverse effects to beneficial uses. At all other locations, use of assimilative capacity was negligible (<5%), except San Joaquin River at Buckley Cove in August, which showed a 7.3% use of the assimilative capacity that was available under the No Action Alternative, for the drought period (1987–1991) (Nitrate Appendix 8J, Table 24).

Nitrate concentrations will likely be higher than the modeling results indicate in certain locations. This includes in the Sacramento River between Freeport and Mallard Island and other areas in the Delta downstream of Freeport that are influenced by Sacramento River water. These increases are associated with ammonia and nitrate that are discharged from the SRWTP, which are not included in the modeling.

- Under Existing Conditions, most of the ammonia discharged from the SRWTP is converted to nitrate downstream of the facility's discharge at Freeport, and thus, nitrate concentrations under Existing Conditions in these areas are expected to be higher than the modeling predicts, the increase becoming greater with increasing distance downstream. However, the increase in nitrate concentrations downstream of the SRWTP is expected to be small—the existing increase appears to be from approximately 0.1 mg/L-N to approximately 0.4–0.5

mg/L-N over this reach, due to approximately a 1:1 conversion of ammonia-N to nitrate-N (Central Valley Water Board 2010a:32).

- Under Alternative 6A, the planned upgrades to the SRWTP, which include nitrification/partial denitrification, would substantially decrease ammonia concentrations in the discharge, but would increase nitrate concentrations in the discharge up to 10 mg/L-N, which is substantially higher than under Existing Conditions.

- Overall, under Alternative 6A, the nitrogen load from the SRWTP discharge is expected to decrease (by up to 50%), relative to Existing Conditions, due to nitrification/partial dentrification ugrades at the SRWTP facility. Thus, while concentrations of nitrate downstream of the facility are expected to be higher than modeling results indicate for both Existing Conditions and Alternative 6A, the increase is expected to be greater under Existing Conditions than for Alternative 6A due to the upgrades that are assumed under Alternative 6A.

The other areas in which nitrate concentrations will be higher than the modeling results indicate are immediately downstream of other wastewater treatment plants that practice nitrification, but not denitrification (e.g., City of Rio Vista Beach WWTF, Town of Discovery Bay WWTF, City of Stockton RWCF). For all such facilities in the Delta, the Regional Water Boards have issued NPDES permits that allow discharge of wastewater containing nitrate into the Delta, and under these permits, the State has determined that no beneficial uses are adversely affected by the discharge, and that the discharger's use of available assimilative capacity of the water body is acceptable. When dilution is necessary in order for the discharge to be in compliance with the Basin Plans (which incorporate the 10 mg/L-N MCL by reference), not all of the assimilative capacity of the receiving water is granted to the discharger. Thus, limited decreases in flows are not anticipated to result in systemic exceedances of the MCLs by these POTWs. Furthermore, NPDES permits are renewed on a 5-year basis, and thus, if under changes in flows, dilution was no longer sufficient to maintain nitrate below the MCL in the receiving water, the NPDES permit renewal process would address such cases.

Therefore, any increases in nitrate-N concentrations that may occur at certain locations within the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to nitrate.

SWP/CVP Export Service Areas

Assessment of effects of nitrate in the SWP and CVP Export Service Areas is based on effects on nitrate-N at the Banks and Jones pumping plants.

Results of the mixing calculations indicate that under Alternative 6A, relative to Existing Conditions and the No Action Alternative, nitrate concentrations at Banks and Jones pumping plants are anticipated to decrease on a long-term average annual basis, and on an average monthly basis for every month of the year (Nitrate Appendix 8J, Table 22 and 23). No additional exceedances of the MCL are anticipated (Nitrate Appendix 8J, Table 22). On a monthly average basis and on a long term annual average basis, for all modeled years and for the drought period (1987–1991) only, there was no use of assimilative capacity available under Existing Conditions and the No Action Alternative, relative to the 10 mg/L-N MCL, for both Banks and Jones pumping plants (Nitrate Appendix 8J, Table 24).

Therefore, implementation of this alternative is not expected to result in adverse effects to beneficial uses or substantially degrade the quality of exported water, with regards to nitrate.

NEPA Effects: In summary, based on the discussion above, the effects on nitrate from implementing CM1 are considered to be not adverse.

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

Nitrate-N concentrations are generally low in the reservoirs and rivers of the watersheds, owing to substantial dilution available for point sources and the lack of substantial nonpoint sources of nitrate-N upstream of the SRWTP in the Sacramento River watershed, and in the watersheds of the eastern tributaries (Cosumnes, Mokelumne, and Calaveras Rivers). Although higher in the San Joaquin River watershed, nitrate-N concentrations are not well-correlated with flow rates. Consequently, any modified reservoir operations and subsequent changes in river flows under Alternative 6A, relative to Existing Conditions, are expected to have negligible, if any, effects on reservoir and river nitrate-N concentrations upstream of Freeport in the Sacramento River watershed and upstream of the Delta in the San Joaquin River watershed.

In the Delta, results of the mixing calculations indicate that under Alternative 6A, relative to Existing Conditions, nitrate concentrations throughout the Delta are anticipated to remain low (<1.4 mg/L-N) relative to adopted objectives. No additional exceedances of the MCL are anticipated at any location, and use of assimilative capacity available under Existing Conditions, relative to the drinking water MCL of 10 mg/L-N, was not of sufficient magnitude to increase the risk of substantially effecting beneficial uses.

Assessment of effects of nitrate in the SWP and CVP Export Service Areas is based on effects on nitrate-N concentrations at the Banks and Jones pumping plants. Results of the mixing calculations indicate that under Alternative 6A, relative to Existing Conditions, long-term average nitrate concentrations at Banks and Jones pumping plants are anticipated to decrease. No additional exceedances of the MCL are anticipated, and there was no use of assimilative capacity available under Existing Conditions, relative to the MCL, for both Banks and Jones pumping plants for all months.

Based on the above, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. No long-term water quality degradation is expected to occur such that exceedance of criteria is more likely or such that there is an increased risk of adverse impacts to beneficial uses. Nitrate is not 303(d) listed within the affected environment and thus any increases that may occur in some areas and months would not make any existing nitrate-related impairment measurably worse because no such impairments currently exist. Because nitrate is not bioaccumulative, increases that may occur in some areas and months would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-16: Effects on Nitrate Concentrations Resulting from Implementation of CM2–CM22

NEPA Effects: Effects of CM2–CM22 on nitrate under Alternative 6A are the same as those discussed for Alternative 1A and are considered not to be adverse.

CEQA Conclusion: Conservation Measures 2–22 proposed under Alternative 6A would be similar to those proposed under Alternative 1A. As such, effects on nitrate resulting from the implementation of CM2–CM22 would be similar to that previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-17: Effects on Dissolved Organic Carbon Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Under Alternative 6A, there would be no substantial change to the sources of DOC within the watersheds upstream of the Delta. Moreover, long-term average flow and DOC levels in the Sacramento River at Hood and San Joaquin River at Vernalis are poorly correlated. Thus changes in system operations and resulting reservoir storage levels and river flows would not be expected to cause a substantial long-term change in DOC concentrations in the water bodies upstream of the Delta. Any negligible changes in DOC levels in water bodies upstream of the Delta under Alternative 6A, relative to Existing Conditions and the No Action Alternative, would not be of sufficient frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regards to DOC.

Delta

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

Under Alternative 6A, the geographic extent of effects pertaining to long-term average DOC concentrations in the Delta would be similar to that previously described for Alternative 1A, although the magnitude of predicted long-term increase and relative frequency of concentration threshold exceedances would be substantially greater. Modeled effects would be greatest at Franks Tract, Rock Slough, and Contra Costa PP No. 1., where for the 16-year hydrologic period and the modeled drought period, long-term average concentration increases ranging from 1.0–1.6 mg/L would be predicted (≤46% net increase) resulting in long-term average DOC concentrations greater than 4 mg/L at all three Delta interior locations (Appendix 8K, DOC Table 7). Long-term average increases of 0.2–0.6 mg/L (≤20% net increase) would also occur at Staten Island, Emmaton, Antioch and Mallard Island. Increases in long-term average concentrations would correspond to more frequent concentration threshold exceedances, with the greatest change occurring at Rock Slough and Contra Costa PP No. 1 locations. For Rock Slough, long-term average DOC concentrations exceeding 3 mg/L would increase from 52% under Existing Conditions to 100% under the Alternative 6A (an increase from 47% to 100% for the drought period), and concentrations exceeding 4 mg/L would increase from 30% to 79% (32% to 95% for the drought period). For

Contra Costa PP No. 1, long-term average DOC concentrations exceeding 3 mg/L would increase from 52% under Existing Conditions to 100% under Alternative 6A (45% to 100% for the drought period), and concentrations exceeding 4 mg/L would increase from 32% to 84% (35% to 95% for the drought period). Relative change in frequency of threshold exceedance for other assessment locations would be similar or less. This comparison to Existing Conditions reflects changes in DOC due to both Alternative 6A operations (including north Delta intake capacity of 15,000 cfs and numerous other operational components of Scenario D) and climate change/sea level rise.

In comparison, Alternative 6A relative to the No Action Alternative N would generally result in a similar magnitude of change to that discussed for the comparison to Existing Conditions. Maximum increases of 1.0 to 1.5 mg/L DOC (i.e., ≤41%) would be predicted at Franks Tract, Rock Slough, and Contra Costa PP No. 1 relative to the No Action Alternative (Appendix 8K, DOC Table 7). Threshold concentration exceedance frequency trends would also be similar to that discussed for the existing condition comparison, with exception to the predicted 4 mg/L exceedance frequency at Buckley Cove. In comparison to the No Action Alternative, the frequency which long-term average DOC concentrations exceeded 4 mg/L at Buckley Cove would increase from 27% to 30% (42% to 53% for the modeled drought period). Unlike the comparison to Existing Conditions, this comparison to the No Action Alternative reflects changes in DOC due only to Alternative 6A operations.

The increases in long-term average DOC concentrations estimated to occur at Franks Tract, Rock Slough, and Contra Costa PP No. 1 are considered substantial and could potentially trigger significant changes in drinking water treatment plant design or operations. In particular, assessment locations at Rock Slough and Contra Costa PP No. 1 represent municipal intakes servicing existing drinking water treatment plants. Under Alternative 6A, drinking water treatment plants obtaining water from these interior Delta locations would likely need to upgrade existing treatment systems in order to achieve EPA Stage 1 Disinfectants and Disinfection Byproduct Rule action thresholds. While treatment technologies sufficient to achieve the necessary DOC removals exist, implementation of such technologies would likely require substantial investment in new or modified infrastructure.

Relative to existing and No Action Alternative conditions, Alternative 6A would lead to predicted improvements in long-term average DOC concentrations at Barker Slough, as well as Banks and Jones pumping plants (discussed below). Predicted long-term average DOC concentrations at Barker Slough would decrease approximately 0.1 mg/L (including the drought period), depending on baseline conditions comparison and modeling period.

SWP/CVP Export Service Areas

Under Alternative 6A, modeled long-term average DOC concentrations would decrease at Banks and Jones pumping plants for both the modeled 16-year hydrologic period and the modeled drought period. Modeled decreases would generally be similar between Existing Conditions and the No Action Alternative. Relative to Existing Conditions, long-term average DOC concentrations at Banks would be predicted to decrease by 1.5 mg/L (1.8 mg/L during drought period) (Appendix 8K, DOC Table 7). At Jones, long-term average DOC concentrations would be predicted to decrease by 1.5 mg/L (1.7 mg/L during drought period). Such substantial improvement in long-term average DOC concentrations would include fewer exceedances of concentration thresholds. At both Banks and Jones, average DOC concentrations exceeding the 2 mg/L concentration threshold would decrease from 100% under Existing Conditions and the No Action Alternative to 39% under Alternative 6A (100% to 33% during the drought period), while concentrations exceeding 4 mg/L would nearly be eliminated (i.e., ≤10% exceedance frequency). Such modeled improvement would correspond to substantial improvement in Export Service Areas water quality, respective to DOC.

Similar to the discussion pertaining to the No Action Alternative, maintenance of SWP and CVP facilities under Alternative 6A would not be expected to create new sources of DOC or contribute towards a substantial change in existing sources of DOC in the affected area. Maintenance activities would not be expected to cause any substantial change in long-term average DOC concentrations such that MUN beneficial uses, or any other beneficial use, would be adversely affected.

NEPA Effects: In summary, Alternative 6A, relative to the No Action Alternative, would not cause a substantial long-term change in DOC concentrations in the water bodies upstream of the Delta. Long-term average DOC concentrations at Banks and Jones pumping plants are predicted to decrease by as much as 1.9 mg/L, while long-term average DOC concentrations for some Delta interior locations, including Franks Tract, Rock Slough and Contra Costa PP #1, are predicted to increase by as much as 1.5 mg/L. Resultant substantial changes in long-term average DOC at these Delta interior locations could necessitate changes in water treatment plant operations or require treatment plant upgrades in order to maintain DBP compliance, and thus would constitute an adverse effect on water quality and MUN beneficial uses. Mitigation Measure WQ-17 is available to reduce these effects.

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

While greater water demands under the Alternative 6A would alter the magnitude and timing of reservoir releases north, south and east of the Delta, these activities would have no substantial effect on the various watershed sources of DOC. Moreover, long-term average flow and DOC at Sacramento River at Hood and San Joaquin River at Vernalis are poorly correlated; therefore, changes in river flows would not be expected to cause a substantial long-term change in DOC concentrations upstream of the Delta.

Relative to Existing Conditions, Alternative 6A would result in substantial increases (i.e., 1.0–1.6 mg/L) in long-term average DOC concentrations at some Delta interior locations, and would be greatest at Franks Tract, Rock Slough, and Contra Costa PP No. 1. At these locations the predicted changes in DOC would substantially increase the frequency with which long-term average concentrations exceeds 2, 3, or 4 mg/L. Drinking water treatment plants obtaining water from these interior Delta locations would likely need to upgrade existing treatment systems in order to achieve EPA Stage 1 Disinfectants and Disinfection Byproduct Rule action thresholds. Such predicted magnitude change in long-term average DOC concentrations would represent a substantially increased risk for adverse effects on existing MUN beneficial.

The assessment of Alternative 6A effects on DOC in the SWP/CVP Export Service Areas is based on assessment of changes in DOC concentrations at Banks and Jones pumping plants. Relative to the existing condition, long-term average DOC concentrations would decrease by as much as 1.8 mg/L at Banks and Jones pumping plants. The frequency with which long-term average DOC concentrations would exceed 2, 3, or 4 mg/L would be substantially reduced, where predicted exceedances of >4 mg/L would be nearly eliminated (i.e., ≤10% exceedance frequency). As a result, substantial improvement in DOC-related water quality would be predicted in the SWP/CVP Export Service Areas.

Based on the above, Alternative 6A operation and maintenance would not result in any substantial change in long-term average DOC concentration upstream of the Delta. Furthermore, under Alternative 6A, water exported from the Delta to the SWP/CVP service area would be substantially improved relative to DOC. DOC is not bioaccumulative, therefore change in long-term average DOC concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Additionally, DOC is not a constituent related to any 303(d) listings. Nevertheless, new and modified conveyance facilities proposed under Alternative 6A would result in a substantial increase in long-term average DOC concentrations (i.e., 1.0–1.6 mg/L, equivalent to ≤46% relative increase) at Franks Tract, Rock Slough, and Contra Costa PP No. 1. In particular, under Alternative 6A, model predicted long-term average DOC concentrations would be greater than 4 mg/L at Rock Slough and Contra Costa PP No. 1 with commensurate substantial increases in the frequency with which average DOC concentrations exceed 2, 3, and 4 mg/L levels. Drinking water treatment plants obtaining water from these interior Delta locations would likely need to upgrade existing treatment systems in order to achieve EPA Stage 1 Disinfectants and Disinfection Byproduct Rule action thresholds. Therefore, such a magnitude change in long-term average DOC concentrations would represent a substantially increased risk for adverse effects on existing MUN beneficial uses at Rock Slough and Contra Costa PP No. 1 should such treatment upgrades not be undertaken. The impact is considered significant and mitigation is required. While Mitigation Measure WQ-17 is available to partially reduce this impact of DOC, the feasibility and effectiveness of this mitigation measure is uncertain and therefore implementation would not necessarily reduce the identified impact to a level that would be less than significant, and therefore it is significant and unavoidable.

Mitigation Measure WQ-17: Consult with Delta Water Purveyors to Identify Means to Avoid, Minimize, or Offset Increases in Long-Term Average DOC Concentrations

To reduce the effect of CM1 operations on increased DOC concentrations specifically predicted to occur at municipal water purveyors obtaining raw source water through south Delta intakes at Rock Slough and those associated with Contra Costa PP No. 1, the BDCP proponents shall consult with the purveyors (i.e., Contra Costa water district and entities to which they supply raw water) to identify the means to either avoid, minimize, or offset increases in long-term average DOC concentrations that affect the beneficial use of the water. The BDCP proponents shall consult with these entities to determine existing DBP concentrations (as system-wide running averages), and then implement any combination of measures sufficient to maintaining these concentrations at existing levels in treated drinking water of affected water purveyors. Such actions may include, but not be limited to: 1) upgrading and maintaining adequate drinking water treatment systems, 2) developing or obtaining replacement surface water supplies from other water rights holders, 3) developing replacement groundwater supplies, or 4) physically routing a portion of the water diverted from the Sacramento River through the associated new conveyance pipelines/tunnel to affected purveyors.

Impact WQ-18: Effects on Dissolved Organic Carbon Concentrations Resulting from Implementation of CM2–CM22

NEPA Effects: Conservation Measures 2–22 proposed under Alternative 6A would be the same as those proposed under Alternative 1A. As such, effects on DOC resulting from the implementation of CM2–CM22 would be similar to that previously discussed for Alternative 1A, although the isolated conveyance facilities of Alternative 6A would effectively isolate SWP and CVP export facilities in the southern Delta from the influence of potential new or modified sources of DOC relative to CM4–CM7 and CM10. However, the potential for CM4–CM7 and CM10 to contribute substantial amounts of DOC to raw drinking water supplies to the other Delta municipal intakes would remain, and could possibly be measurably worse in actual comparison to the dual conveyance project alternatives. With relatively less low DOC Sacramento River water in the Delta, there effectively would be less dilution of interior Delta DOC sources, leading to effectively higher long-term average DOC concentrations. Substantially increased long-term average DOC in raw water supplies could lead to a need for treatment plant upgrades in order to appropriately manage DBP formation in treated drinking water. This potential for future DOC increases would lead to substantially greater associated risk of long-term adverse effects on the MUN beneficial use.

In summary, the habitat restoration elements of CM4–CM7 and CM10 under Alternative 6A would present new localized sources of DOC to the study area, and in some circumstances would substitute for existing sources related to replaced agriculture. Depending on localized hydrodynamics and proximity to municipal drinking water intakes, such restoration activities could contribute substantial amounts of DOC to municipal raw water. Substantial increases in municipal raw water DOC could necessitate changes in water treatment plant operations or require treatment plant upgrades in order to maintain DBP compliance, and thus would constitute an adverse effect on water quality. Mitigation Measure WQ-18 is available to reduce these effects.

***CEQA Conclusion*:** Effects of CM4–CM7 and CM10 on DOC under Alternative 6A would be similar, and possibly greater, to those discussed for Alternative 1A, except that SWP and CVP export facilities would be isolated from these effects by Alternative 6A design. Similar to the discussion for Alternative 1A, this impact is considered to be significant and mitigation is required. It is uncertain whether implementation of Mitigation Measure WQ-18 would reduce identified impacts to a less-than-significant level. Hence, this impact remains significant and unavoidable.

In addition to and to supplement Mitigation Measure WQ-18, the BDCP proponents have incorporated into the BDCP, as set forth in EIR/EIS Appendix 3B, *Environmental Commitments*, a separate, non-environmental commitment to address the potential increased water treatment costs that could result from DOC concentration effects on municipal and industrial water purveyor operations. Potential options for making use of this financial commitment include funding or providing other assistance towards implementing treatment for DOC and/or DBPs or DOC source control strategies. Please refer to Appendix 3B, *Environmental Commitments*, for the full list of potential actions that could be taken pursuant to this commitment in order to reduce the water quality treatment costs associated with water quality effects relating to DOC.

Mitigation Measure WQ-18: Design Wetland and Riparian Habitat Features to Minimize Effects on Municipal Intakes

Please see Mitigation Measure WQ-18 under Impact WQ-18 in the discussion of Alternative 1A.

Impact WQ-19: Effects on Pathogens Resulting from Facilities Operations and Maintenance (CM1)

***NEPA Effects*:** Effects of CM1 on pathogens under Alternative 6A are the same as those discussed for Alternative 1A and are considered to not be adverse.

CEQA Conclusion: Effects of CM1 on pathogens under Alternative 6A are the same as those discussed for Alternative 1A, and are summarized here, then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion under Alternative 1A.

River flow rate and reservoir storage reductions that would occur due to implementation of CM1 (water facilities and operations) under Alternative 6A, relative to Existing Conditions, would not be expected to result in a substantial adverse change in pathogen concentrations in the reservoirs and rivers upstream of the Delta, given the small magnitude of urban runoff contributions relative to the magnitude of river flows, that pathogen concentrations in the rivers have a minimal relationship to river flow rate, and the expected reduced pollutant loadings in response to NPDES stormwater-related regulations.

It is expected there would be no substantial change in Delta pathogen concentrations in response to a shift in the Delta source water percentages under this alternative or substantial degradation of these water bodies, with regard to pathogens. This conclusion is based on the Pathogens Conceptual Model, which found that pathogen sources in close proximity to a Delta site appear to have the greatest influence on pathogen levels at the site, rather than the primary source(s) of water to the site. In-Delta potential pathogen sources, including water-based recreation, tidal habitat, wildlife, and livestock-related uses, would continue under this alternative.

In the SWP/CVP Export Service Areas waters, relative to Existing Conditions, an increased proportion of water coming from the Sacramento River would not adversely affect beneficial uses in the SWP/CVP Export Service Areas. The pathogen levels in the Sacramento River are similar to or lower than the water diverted at the Delta export pumps. Further, it is localized sources of pathogens that appear to have the greatest influence on concentrations. Thus, an increased proportion of Sacramento River water diverted to the SWP/CVP Export Service Areas would result in minimal changes in pathogen levels in the SWP/CVP Export Service Areas waters.

Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because pathogen concentrations are not expected to increase substantially, no long-term water quality degradation for pathogens is expected to occur and, thus, no adverse effects on beneficial uses would occur. The San Joaquin River in the Stockton Deep Water Ship Channel is Clean Water Act section 303(d) listed for pathogens. Because no measurable increase in Deep Water Ship Channel pathogen concentrations are expected to occur on a long-term basis, further degradation and impairment of this area is not expected to occur. Finally, pathogens are not bioaccumulative constituents. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-20: Effects on Pathogens Resulting from Implementation of CM2–CM22

NEPA Effects: Effects of CM2–CM22 on pathogens under Alternative 6A are the same as those discussed for Alternative 1A and are considered to not be adverse.

CEQA Conclusion: Conservation Measures 2–22 proposed under Alternative 6A would be similar to those proposed under Alternative 1A. As such, effects on pathogens resulting from the implementation of CM2–CM22 would be similar to that previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-21: Effects on Pesticide Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative, under Alternative 6A no specific operations or maintenance activity of the SWP or CVP would substantially drive a change in pesticide use, and thus pesticide sources would remain unaffected upstream of the Delta. Nevertheless, changes in the timing and magnitude of reservoir releases could have an effect on available dilution capacity along river segments such as the Sacramento, Feather, American, and San Joaquin Rivers.

Under Alternative 6A, winter (November–March) and summer (April–October) season average flow rates on the Sacramento River at Freeport, American River at Nimbus, Feather River at Thermalito and the San Joaquin River at Vernalis would change. Relative to existing condition and the No Action Alternative, seasonal average flow rates on the Sacramento would decrease no more than 6% during the summer and 3% during the winter (Appendix 8L, Seasonal average flows Tables 1-4). On the Feather River, average flow rates would decrease no more than 7% during the summer, but would increase by as much as 9% in the winter. American River average flow rates would decrease by as much as 17% in the summer but would increase by as much as 7% in the winter. Seasonal average flow rates on the San Joaquin River would decrease by as much as 12% in the summer, but increase by as much as 1% in the winter. For the same reasons stated for the No Action Alternative, decreased seasonal average flow of ≤17% is not considered to be of sufficient magnitude to substantially increase pesticide concentrations or alter the long-term risk of pesticide-related toxicity to aquatic life, nor adversely affect other beneficial uses of water bodies upstream of the Delta.

Delta

Sources of diuron, OP and pyrethroid insecticides to the Plan Area include direct input of surface runoff from in-Delta agriculture and Delta urbanized areas as well as inputs from rivers upstream of the Delta. Similar to Upstream of the Delta, CVP/SWP operations would not affect these sources.

Under Alternative 6A, the distribution and mixing of Delta source waters would change. Percent change in monthly average source water fraction were evaluated for the modeled 16-year (1976–1991) hydrologic period and a representative drought period (1987–1991), with special attention given to changes in San Joaquin River, Sacramento River and Delta Agriculture sources water fractions. Relative to Existing Conditions, under Alternative 6A modeled San Joaquin River fractions would increase greater than 10% at Buckley Cove (drought period only), Franks Tract, Rock Slough, Contra Costa PP No. 1, and the San Joaquin River at Antioch (Appendix 8D, Source Water Fingerprinting). At Buckley Cove, San Joaquin River source water fractions when modeled for the drought period would increase by 13% in July and 19% in August. At Antioch, San Joaquin River source water fractions when modeled for the 16-year hydrologic period would increase by 11–19% from October through June (11% for January through March of the modeled drought period). While these changes at Buckley Cove and Antioch are not considered substantial, changes in San Joaquin River source water fraction in the Delta interior would be considerable. At Franks Tract, modeled San Joaquin River source water fractions would increase between 14–34% for the entire calendar year of January through December (12–28% for October through June of the modeled drought period). Changes at Rock Slough and Contra Costa PP No. 1 would be very similar, where modeled San Joaquin River source water fractions would increase from 26–76% (11–74% for the modeled drought period) for the entire calendar year. Relative to Existing Conditions, there would be no modeled increases in Sacramento River fractions greater than 14% (with exception to Banks and Jones which are discussed below) and Delta agricultural fractions greater than 19%. Increases in San Joaquin River source water fraction at Franks Tract, Rock Slough, and Contra Costa PP No. 1 would primarily balance through decreases in Sacramento River water, and as a result the San Joaquin River would account for greater than 50% of the total source water volume at Franks Tract between March through May (<50% for all months during the modeled drought period), and would be 50%, and as much as 80% during October through May at Rock Slough and Contra Costa PP No. 1 for both the modeled drought and 16-year hydrologic periods. While the source water and potential pesticide related toxicity co-occurrence predictions do not mean adverse effects would occur, such considerable modeled increases in early summer source water fraction at Franks Tract and winter and summer source water fractions at Rock Slough and Contra Costa PP No. 1 could substantially alter the long-term risk of pesticide-related toxicity to aquatic life, given the apparent greater incidence of pesticides in the San Joaquin River.

When compared to the No Action Alternative, changes in source water fractions would be similar in season, geographic extent, and magnitude to those discussed for Existing Conditions with exception to Buckley Cove. Relative to the No Action Alternative, on a source water basis Buckley Cove is comprised predominantly of water of San Joaquin River origin (i.e., typically >80% San Joaquin River) for all months of the year but July and August. In July and August, the combined operational effects on Delta hydrodynamics of the Delta Cross Channel being open, the absence of a barrier at Head of Old River, and seasonally high exports from south Delta pumps results in substantially lower San Joaquin River source water fraction at Buckley Cove relative to all other months of the year. Under the operational scenarios of Alternative 2A, however, modeled July and August San Joaquin River fractions at Buckley Cove would increase relative to the No Action Alternative, with increases of 20% in July (36% for the modeled drought period) and 27% in August (52% for the modeled drought period) (Appendix 8D, Source Water Fingerprinting). Despite these San Joaquin River increases, the resulting net San Joaquin River source water fraction for July and August would remain less than all other months. Although these modeled changes in the source water fractions at Buckley Cover are not of sufficient magnitude to substantially alter the long-term risk of pesticide-related toxicity to aquatic life, relative to the No Action Alternative, changes in source water fractions at Rock Slough, Contra Costa PP No. 1 and Franks Tract could substantially alter the long-term risk of pesticide-related toxicity to aquatic life, given the apparent greater incidence of pesticides in the San Joaquin River.

These predicted adverse effects on pesticides at Delta interior locations relative to Existing Conditions and the No Action Alternative fundamentally assume that the present pattern of pesticide incidence in surface water will occur at similar levels into the future. In reality, however, the makeup and character of the pesticide use market in the late long-term (i.e., the year 2060) will not be exactly as it is today. Current use of chlorpyrifos and diazinon is on the decline with their replacement by pyrethroids on the rise, yet in this assessment it is the apparent greater incidence of diazinon and chlorpyrifos on the San Joaquin River that serves as the basis for concluding that substantially increased San Joaquin River source water fraction would correspond to an increased risk of pesticide-related toxicity to aquatic life. By 2060, however, alternative pesticides, such as neonicitinoids and biologicals, will likely be a more substantial contributing part of the existing mix of pesticides, and perhaps more prominent. The trend in the development of future-use pesticides is towards reduced risk pesticides, including more biopesticides, with greater targeted specificity, fewer residues, and lower overall non-target toxicity. By 2060 existing chlorpyrifos and diazinon

TMDLs for the Sacramento and San Joaquin Rivers will have been in effect for more than 50 years. Moreover, it is reasonable to expect that CWA section 303(d) listings and future additional listings will have developed TMDLs by 2060. To the extent these existing and future TMDL's address current and future-use pesticides, a greater degree of pesticide related source control can be anticipated. Nevertheless, forecasting whether these various efforts will ultimately be successful at resolving current pesticide related impairments requires considerable speculation. While the fundamental assumptions that have guided this assessment of pesticides may be somewhat altered by 2060, these assumptions are informed by actual studies and monitoring data collected from the recent past and, therefore, judging project alternative effects in the future remain most accurate through use of these informed assumptions rather than based on assumptions founded upon future speculative conditions.

SWP/CVP Export Service Areas

Assessment of effects in SWP/CVP Export Service Areas is based on effects seen in the Plan Area at the Banks and Jones pumping plants. Under Alternative 6A, Sacramento River source water fractions would increase substantially at both Banks and Jones pumping plants relative to Existing Conditions and the No Action Alternative (Appendix 8D, Source Water Fingerprinting). At Banks pumping plant, Sacramento source water fractions would generally increase from 19–79% for the entire period of January through December (12–56% for January through December of the modeled drought period) and at Jones pumping plant Sacramento source water fractions would generally increase from 33–96% for the entire period of January through December (17–89% for January through December of the modeled drought period). These increases in Sacramento source water fraction would primarily balance through equivalent decreases in San Joaquin River water. Based on the general observation that San Joaquin River, in comparison to the Sacramento River, is a greater contributor of OP insecticides in terms of greater frequency of incidence and presence at concentrations exceeding water quality benchmarks, modeled increases in Sacramento River fraction at Banks and Jones would generally represent an improvement in export water quality respective to pesticides.

***NEPA Effects*:** In summary, the changes in long-term average flows on the Sacramento, Feather, American, and San Joaquin Rivers, under Alternative 6A relative to the No Action Alternative, are of insufficient magnitude to substantially increase the long-term risk of pesticide-related water quality degradation and related toxicity to aquatic life in these water bodies upstream of the Delta. However, modeled increases in San Joaquin River fraction at Franks Tract, Rock Slough, and Contra Costa PP No. 1 are of sufficient magnitude to substantially alter the long-term risk of pesticide-related water quality degradation and related toxicity to aquatic life in the Delta. The effects on pesticides from operations and maintenance (CM1) are determined to be adverse and unavoidable.

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

Sources of pesticides upstream of the Delta include direct input of pesticide containing surface runoff from agriculture and urbanized areas. Flows in rivers receiving these discharges dilute these pesticide inputs. Relative to Existing Conditions, however, modeled changes in long-term average flows on the Sacramento, Feather, American, and San Joaquin Rivers are of insufficient magnitude to substantially increase the long-term risk of pesticide-related water quality degradation and related toxicity to aquatic life in these water bodies upstream of the Delta.

In the Delta, sources of pesticides include direct input of surface runoff from Delta agriculture and Delta urbanized areas as well as inputs from rivers upstream of the Delta. While facilities operations and maintenance activities would not affect these sources, changes in Delta source water fraction could change the relative risk associated with pesticide related toxicity to aquatic life. Under Alternative 6A, modeled long-term average San Joaquin River source water fractions at Franks Tract, Rock Slough and Contra Costa PP No. 1 locations would increase considerably for some months such that the long-term risk of pesticide-related toxicity to aquatic life could substantially increase.

The assessment of Alternative 6A effects on pesticides in the SWP/CVP Export Service Areas is based on assessment of changes predicted at Banks and Jones pumping plants. Sacramento River source water fractions would increase substantially at both Banks and Jones pumping plants and would generally represent an improvement in export water quality respective to pesticides.

Based on the above, Alternative 6A would not result in any substantial change in long-term average pesticide concentration or result in substantial increase in the anticipated frequency with which long-term average pesticide concentrations would exceed aquatic life toxicity thresholds or other beneficial use effect thresholds upstream of the Delta or the SWP/CVP service area. Numerous pesticides are currently used throughout the affected environment, and while some of these pesticides may be bioaccumulative, those present-use pesticides for which there is sufficient evidence for their presence in waters affected by SWP and CVP operations (i.e., diazinon, chlorpyrifos, diuron, and pyrethroids) are not considered bioaccumulative, and thus changes in their concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Furthermore, while there are numerous 303(d) listings throughout the affected environment that name pesticides as the cause for beneficial use impairment, the modeled changes in upstream river flows and Delta source water fractions would not be expected to make any of these beneficial use impairments measurably worse, with principal exception to locations in the Delta that would receive a substantially greater fraction San Joaquin River water under Alternative 6A. Long-term average San Joaquin River source water fractions at Franks Tract, Rock Slough and Contra Costa PP No. 1 locations would change considerably for some months such that the long-term risk of pesticide-related toxicity to aquatic life could substantially increase. Additionally, the potential for increased incidence of pesticide related toxicity could include pesticides such as chlorpyrifos and diazinon for which existing 303(d) listings exist for the Delta, and thus existing beneficial use impairment could be made discernibly worse. The impact is considered to be significant and unavoidable. There is no feasible mitigation available to reduce the effect of this significant impact.

Impact WQ-22: Effects on Pesticide Concentrations Resulting from Implementation of CM2–CM22

***NEPA Effects*:** Conservation Measures 2–22 proposed under Alternative 6A would be the same as those proposed under Alternative 1A. As such, effects on pesticides resulting from the implementation of CM2–CM22 would be similar to that previously discussed for Alternative 1A. In summary, CM13 proposes the use of herbicides to control invasive aquatic vegetation around habitat restoration sites. Herbicides directly applied to water could include adverse effects on non-target aquatic life, such as aquatic invertebrates and beneficial aquatic plants. As such, aquatic life toxicity objectives could be exceeded with sufficient frequency and magnitude such that beneficial uses would be impacted, thus constituting an adverse effect on water quality.

In summary, based on the discussion above, the effects on pesticides from implementing CM2-CM22 are considered to be adverse. Mitigation Measure WQ-22 would be available to reduce this adverse effect.

CEQA Conclusion**:** Effects of CM2–CM22 on pesticides under Alternative 6A are similar to those discussed for Alternative 1A. Potential environmental effects related only to CM13 are considered to be significant. Mitigation is required. While Mitigation Measure WQ-22 is available to partially reduce this impact of pesticides, no feasible mitigation is available that would reduce it to a level that would be less than significant.

Mitigation Measure WQ-22: Implement Least Toxic Integrated Pest Management Strategies

Please see Mitigation Measure WQ-22 under Impact WQ-22 in the discussion of Alternative 1A.

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

NEPA Effects**:** Effects of water facilities and operations (CM1) on phosphorus levels in water bodies of the affected environment under Alternative 6A would be very similar (i.e., nearly the same) to those discussed for Alternative 1A. Consequently, the environmental consequences to phosphorus levels discussed in detail for Alternative 1A also adequately represent the effects under Alternative 6A, which are considered to be not adverse.

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

Because phosphorus loading to waters upstream of the Delta is not anticipated to change, and because changes in flows do not necessarily result in changes in concentrations or loading of phosphorus to these water bodies, substantial changes in phosphorus concentration upstream of the Delta are not anticipated for Alternative 6A, relative to Existing Conditions.

Because phosphorus concentrations in the major source waters to the Delta are similar for much of the year, phosphorus concentrations in the Delta are not anticipated to change substantially on a long term-average basis under Alternative 6A, relative to Existing Conditions. Algal growth rates are limited by availability of light in the Delta, and therefore any minor increases in phosphorus levels that may occur at some locations and times within the Delta would be expected to have little effect on primary productivity in the Delta.

The assessment of effects of phosphorus under Alternative 6A in the SWP and CVP Export Service Areas is based on effects on phosphorus at the Banks and Jones pumping plants. As noted above, phosphorus concentrations in the Delta (including Banks and Jones pumping plants) are not anticipated to change substantially on a long term-average basis.

Based on the above, there would be no substantial, long-term increase in phosphorus concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the waters exported to the CVP and SWP service areas under Alternative 6A relative to Existing Conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because phosphorus concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Phosphorus is not 303(d) listed within the affected environment and thus any minor increases that may occur in some areas would not make any existing phosphorus-related impairment measurably worse because no such impairments currently exist. Because phosphorus is not bioaccumulative, minor increases that may occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-24: Effects on Phosphorus Concentrations Resulting from Implementation of CM2–CM22

NEPA Effects: Effects of CM2–CM22 on phosphorus levels in water bodies of the affected environment under Alternative 6A would be very similar (i.e., nearly the same) to those discussed for Alternative 1A. Consequently, the environmental consequences to phosphorus levels from implementing CM2–CM22 discussed in detail for Alternative 1A also adequately represent the effects of these same actions under Alternative 6A, which are considered to be not adverse.

CEQA Conclusion: Conservation Measures 2–22 proposed under Alternative 6A would be similar to those proposed under Alternative 1A. As such, effects on phosphorus resulting from the implementation of CM2–CM22 would be similar to that previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

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

Upstream of the Delta

For the same reasons stated for the No Action Alternative, Alternative 6A would have negligible, if any, effect on selenium concentrations in the rivers and reservoirs upstream of the Delta relative to Existing Conditions and the No Action Alternative. Any negligible increases in selenium concentrations that could occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regard to selenium.

Delta

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

Alternative 6A would result in small to moderate changes in average selenium concentrations in water at all modeled Delta assessment locations relative to Existing Conditions and the No Action Alternative (Appendix 8M, Table M-10A). These changes in selenium concentrations in water are reflected in small (10% or less) to moderate (between 11% and 50%) percent changes in available assimilative capacity for selenium (based on 2 µg/L ecological risk benchmark) for all years. Relative to Existing Conditions, Alternative 6A would result in the largest modeled increase in available assimilative capacity at Buckley Cove (2%); relative to the No Action Alternative, the largest increase would be at Staten Island (1%), and the largest decreases relative to Existing Conditions and the No Action Alternative would be at Contra Costa PP (16% and 15%, respectively) (Figures 8-59 and 8-60). Although there would be moderate negative changes in assimilative capacity at two locations (Contra Costa PP and Rock Slough [15% decrease in available assimilative capacity for Existing Conditions and the No Action Alternative]), the changes are small (10% or less decrease) at the other locations and the available assimilative capacity at all locations would remain substantial; therefore, the effect of Alternative 6A is generally minimal for the Delta. Furthermore, the modeled selenium concentrations in water (Appendix 8M, Table M-19) for Alternative 6A (range 0.24–0.74 µg/L), Existing Conditions (range 0.21–0.76 µg/L), and the No Action Alternative (range 0.21–0.69 µg/L) are generally similar, and all would be below the ecological risk benchmark (2 µg/L).

Relative to Existing Conditions and the No Action Alternative, Alternative 6A would generally result in small changes in estimated selenium concentrations in biota (whole-body fish, bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets) (Appendix 8M, Table M-17 and Addendum M.A to Appendix 8M, Table M.A-2). Relative to Existing Conditions and the No Action Alternative, the largest increase of selenium concentrations in biota would be at Contra Costa PP for drought years and in sturgeon at the two western Delta locations in all as well as drought years. Relative to Existing Conditions, the largest decrease in selenium concentrations in biota would be at Buckley Cove for drought years; relative to the No Action Alternative, the largest decrease would be at Staten Island for drought years. Except for sturgeon in the western Delta, concentrations of selenium in whole-body fish and bird eggs (invertebrate and fish diets) would exceed only the lower benchmarks (4 and 6 mg/kg dry weight, respectively, indicating a low potential for effects), under drought conditions, at Buckley Cove for Alternative 6A and for Existing Conditions and the No Action Alternative (Figures 8-61 through 8-63). However, Exceedance Quotients for these exceedances of the lower benchmarks are between 1.0 and 1.5, indicating a low risk to biota in the Delta, with Alternative 6A being similar to Existing Conditions and the No Action Alternative. Selenium concentrations in fish fillets would not exceed the screening value for protection of human health (Figure 8-64). For sturgeon in the western Delta, whole-body selenium concentrations would increase from 12.3 mg/kg under Existing Conditions and the No Action Alternative to 15.1 mg/kg under Alternative 6A, a 23% increase (Table M.A-2). All of these values exceed both the low and high toxicity benchmarks. The predicted increases are high enough that they may represent a measurable increase in body burdens of sturgeon, which would constitute an adverse impact.

SWP/CVP Export Service Areas

Alternative 6A would result in small to moderate changes in average selenium concentrations relative to Existing Conditions and the No Action Alternative (Appendix 8M, Table M-10A). These changes are reflected in small (10% or less) to moderate (between 11% and 50%) percent changes in available assimilative capacity for selenium for all years. Relative to Existing Conditions and the No Action Alternative, Alternative 6A would result in increases in available assimilative capacity at Banks PP (10% and 9%, respectively) and at Jones PP (18% and 19%, respectively) (Figures 8-59 and 8-60), and would have a positive effect at the Export Service Area locations. The modeled selenium concentrations in water (Appendix 8M, Table M-10A) for Alternative 6A (0.32 μg/L) would be lower than the ranges for Existing Conditions (range 0.37–0.58 μg/L) and the No Action Alternative (range 0.37–0.59 μg/L), and all would be below the ecological risk benchmark (2 μg/L).

Relative to Existing Conditions and the No Action Alternative, Alternative 6A would result in small changes in estimated selenium concentrations in biota (Appendix 8M, Table M-17). Relative to Existing Conditions, the largest increase of selenium concentrations in biota would be at Banks PP for drought years (except for bird eggs [assuming a fish diet] at Banks PP for all years), and relative to the No Action Alternative, the largest increase would be at Banks PP for drought years. Relative to Existing Conditions and the No Action Alternative, the largest decrease of selenium concentration in biota would be at Jones PP for drought years. However, concentrations in biota would not exceed any benchmarks for Alternative 6A (Figures 8-61 through 8-64).

Thus, relative to Existing Conditions and the No Action Alternative, Alternative 6A would result in small to moderate changes in selenium concentrations in water and minimal changes in selenium concentrations in biota at the Export Service Area locations. Selenium concentrations in water and biota would generally decrease under Alternative 6A and would not exceed ecological benchmarks at either location, whereas the lower benchmark for bird eggs (fish diet) would be exceeded under Existing Conditions and the No Action Alternative at Jones PP for drought years. This small positive change in selenium concentrations under Alternative 6A would be expected to slightly decrease the frequency with which applicable benchmarks would be exceeded or slightly improve the quality of water at the Export Service Area locations, with regard to selenium.

***NEPA Effects*:** Based on the discussion above, the effects on selenium from Alternative 6A are considered to be adverse. This determination is reached because selenium concentrations in whole-body sturgeon modeled at two western Delta locations would increase by an estimated 23%, which may represent a measurable increase in the environment. Because both low and high toxicity benchmarks are already exceeded under the No Action Alternative, these potentially measurable increases represent an adverse impact.

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

There are no substantial point sources of selenium in watersheds upstream of the Delta, and no substantial nonpoint sources of selenium in the watersheds of the Sacramento River and the eastern tributaries. Nonpoint sources in the San Joaquin Valley that contribute selenium to the Delta will be controlled through a TMDL developed by the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the Grassland Bypass Project, and Basin Plan objectives (Central Valley Water Board 2010c) and State Water Board (2010d, 2010e) that are expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta. Consequently, any modified reservoir operations and subsequent changes in river flows under Alternative 6A, relative to Existing Conditions, are expected to cause negligible changes in selenium concentrations in water. Any negligible changes in selenium concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies as related to selenium.

Relative to Existing Conditions, modeling estimates indicate that Alternative 6A would increase selenium concentrations in whole-body sturgeon modeled at two western Delta locations by an estimated 23%, which may represent a measurable increase in the environment. Because both low and high toxicity benchmarks are already exceeded under Existing Conditions, these potentially measurable increases represent a potential impact to aquatic life beneficial uses.

Assessment of effects of selenium in the SWP and CVP Export Service Areas is based on effects on selenium concentrations at the Banks and Jones pumping plants. Relative to Existing Conditions, Alternative 6A would slightly decrease the frequency with which applicable benchmarks would be exceeded and 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, significant impacts on some beneficial uses of waters in the Delta could occur because both low and high toxicity benchmarks are already exceeded under Existing Conditions, and uptake of selenium from water to biota may measurably increase. In comparison to Existing Conditions, water quality conditions under this alternative would increase levels of selenium (a bioaccumulative pollutant) by frequency, magnitude, and geographic extent such that the affected environment may have measurably higher body burdens of selenium in aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish); however, impacts to humans consuming those organisms are not expected to occur. Water quality conditions under this alternative with respect to selenium would cause long-term degradation of water quality in the western Delta. Except in the vicinity of the western Delta for sturgeon, water quality conditions under this alternative would not increase levels of selenium by frequency, magnitude, and geographic extent such that the affected environment would be expected to have measurably higher body burdens of selenium in aquatic organisms. The greater level of selenium bioaccumulation in the western Delta would further degrade water quality by measurable levels, on a long-term basis, for selenium and, thus, cause the 303(d)-listed impairment of beneficial use to be made discernibly worse. This impact is considered significant.

The need for, and the feasibility and effectiveness of, post-operation mitigation for the predicted level of selenium bioaccumulation is uncertain. The first step shall be to determine the reliability of the model in predicting biota selenium concentrations in the affected environment where effects are predicted but selenium data are lacking. For that reason, the model shall be validated with site-specific sampling before extensive mitigation measures relative to CM1 operations are developed and evaluated for feasibility, as the measures and their evaluation for feasibility are likely to be complex. Specifically, it remains to be determined whether the available existing data for transfer of selenium from water to particulates and through different trophic levels of the food chain are representative of conditions that may occur from implementation of Alternative 6A. Therefore, the proposed mitigation measure requires that sampling be conducted to characterize each step of data inputs needed for the model, and then the refined model be validated for local conditions. This impact is considered significant and unavoidable.

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

NEPA Effects: In general, with the possible exception of changes in Delta hydrodynamics resulting from habitat restoration, CM2–CM11 would not substantially increase selenium concentrations in the water bodies of the affected environment. Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, and thus such effects of these restoration measures were included in the assessment of CM1 facilities operations and maintenance (see Impact WQ-25).

However, implementation of these conservation measures may increase water residence time within the restoration areas. Increased restoration area water residence times could potentially increase the bioaccumulation of selenium in biota, thereby potentially increasing fish tissue and bird egg concentrations of selenium, but models are not available to quantitatively estimate the level of changes in residence time and the associated selenium bioavailability. If increases in fish tissue or bird egg selenium were to occur, the increases would likely be of concern only where fish tissues or bird eggs are already elevated in selenium to near or above thresholds of concern. That is, where biota concentrations are currently low and not approaching thresholds of concern, changes in residence time alone would not be expected to cause them to then approach or exceed thresholds of concern. In consideration of this factor, although the Delta as a whole is a 303(d)-listed water body for selenium, and although monitoring data of fish tissue or bird eggs in the Delta are sparse, the most likely areas in which biota tissues would be at levels high enough that additional bioaccumulation due to increased residence time from restoration areas would be a concern are the western Delta and Suisun Bay, and the South Delta in areas that receive San Joaquin River water.

The western Delta and Suisun Bay receive elevated selenium loads from North San Francisco Bay (including San Pablo Bay, Carquinez Strait, and Suisun Bay) and from the San Joaquin River. Point sources of selenium in North San Francisco Bay (i.e., refineries) that contribute selenium to Suisun Bay are expected to be reduced through a TMDL under development by the San Francisco Bay Water Board (San Francisco Bay Water Board 2012) that is expected to result in decreasing discharges of selenium. Nonpoint sources of selenium in the San Joaquin Valley that contribute selenium to the San Joaquin River, and thus the Delta and Suisun Bay, will be controlled through a TMDL developed by the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the Grassland Bypass Project, and Basin Plan objectives (Central Valley Water Board 2010c, d) that are expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta. If selenium levels are not sufficiently reduced via these efforts, it is expected that the State Water Board and the San Francisco Bay and Central Valley Water Boards would initiate additional actions to further control sources of selenium.

The South Delta receives elevated selenium loads from the San Joaquin River. In contrast to Suisun Bay and possibly the western Delta in the future, the South Delta lacks the overbite clam (*Corbula* [*Potamocorbula*] *amurensis*), which is considered a key driver of selenium bioaccumulation in Suisun Bay, due to its high bioaccumulation of selenium and its role in the benthic food web that includes long-lived sturgeon. The South Delta does have *Corbicula fluminea*, another bivalve that bioaccumulates selenium, but it is not as invasive as the overbite clam and thus likely makes up a smaller fraction of sturgeon diet. Also, as mentioned above, nonpoint sources of selenium in the San Joaquin Valley that contribute selenium to the Delta will be controlled through a TMDL developed by the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the Grassland Bypass Project, and Basin Plan objectives (Central Valley Water Board 2010c, d) that are expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta. Further, if selenium levels in the San Joaquin River are not sufficiently reduced via these efforts, it is expected that the State Water Board and Central Valley Water Board would initiate additional TMDLs to further control nonpoint sources of selenium.

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

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

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

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

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

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

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

Impact WQ-27: Effects on Trace Metal Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative, Alternative 6A would result in negligible, and likely immeasurable, increases in trace metal concentrations in the rivers and reservoirs upstream of the Delta, relative to Existing Conditions and the No Action Alternative. Effects due to the operation and maintenance of the conveyance facilities are expected to be immeasurable, on an annual and long-term average basis. As such, Alternative 6A would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or CTR criteria would be exceeded in water bodies of the affected environment located upstream of the Delta or substantially degrade the quality of these water bodies, with regard to trace metals.

Delta

For the same reasons stated for the No Action Alternative, Alternative 6A would not result in substantial increases in trace metal concentrations in the Delta relative to Existing Conditions and the No Action Alternative. However, substantial changes in source water fraction would occur in the south Delta (Appendix 8D, Source Water Fingerprinting). Throughout much of the south Delta, San Joaquin River water would replace Sacramento River water, with the future trace metals profile largely reflecting that of the San Joaquin River. As discussed for the No Action Alternative, trace metal concentration profiles between the San Joaquin and Sacramento Rivers are very similar and currently meet Basin Plan objectives and CTR criteria. While the change in trace metal concentrations in the south Delta would likely be measurable, Alternative 6A 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 Delta waters with regard to trace metals.

SWP/CVP Export Service Areas

For the same reasons stated for the No Action Alternative, Alternative 6A would not result in substantial increases in trace metal concentrations in SWP/CVP export service area waters under Alternative 6A, relative to Existing Conditions and the No Action Alternative. Unlike current conditions, however, water delivered to the SWP and CVP export service area would be entirely sourced to the Sacramento River, and thus the future trace metals profile would reflect that of the Sacramento River. While the change in trace metal concentrations in SWP and CVP export service area would likely be measurable, Alternative 6A would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or CTR criteria would be exceeded in the water bodies of the affected environment in the SWP/CVP service area or substantially degrade the quality of these water bodies, with regard to trace metals.

NEPA Effects: In summary, Alternative 6A, relative to the No Action Alternative, would not cause a substantial increase in long-term average trace metals concentrations within the affected environment, nor would it cause an increased frequency of water quality objective/criteria exceedances within the affected environment. The effect on trace metals is determined not to be adverse.

CEQA Conclusion: Effects of CM1 on trace metals under Alternative 6A would be similar to those discussed for Alternative 1A, and are summarized here, then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion under Alternative 1A.

While greater water demands under the Alternative 6A would alter the magnitude and timing of reservoir releases north, south and east of the Delta, these activities would have no substantial effect on the various watershed sources of trace metals. Moreover, long-term average flow and trace metals at Sacramento River at Hood and San Joaquin River at Vernalis are poorly correlated; therefore, changes in river flows would not be expected to cause a substantial long-term change in trace metal concentrations upstream of the Delta.

Average and 95^{th} percentile trace metal concentrations are very similar across the primary source waters to the Delta. Given this similarity, very large changes in source water fraction would be necessary to effect a relatively small change in trace metal concentration at a particular Delta location. Moreover, average and 95^{th} percentile trace metal concentrations for these primary source waters are all below their respective water quality criteria, including those that are hardness-based without a WER adjustment. No mixing of these three source waters could result in a metal concentration greater than the highest source water concentration, and given that trace metals do not already exceed water quality criteria, more frequent exceedances of criteria in the Delta would not be expected to occur under the Alternative 6A.

The assessment of the Alternative 6A effects on trace metals in the SWP/CVP Export Service Areas is based on assessment of changes in trace metal concentrations at Banks and Jones pumping plants. As just discussed regarding similarities in Delta source water trace metal concentrations, the Alternative 6A is not expected to result in substantial changes in trace metal concentrations in Delta waters, including Banks and Jones pumping plants, therefore effects on trace metal concentrations in the SWP/CVP Export Service Area are expected to be negligible.

Based on the above, there would be no substantial long-term increase in trace metal concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the SWP/CVP export service area waters under Alternative 6A relative to Existing Conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because trace metal concentrations are not expected to increase substantially, no long-term water quality degradation for trace metals is expected to occur and, thus, no adverse effects to beneficial uses would occur. Furthermore, any negligible changes in long-term trace metal concentrations that may occur in water bodies of the affected environment would not be expected to make any existing beneficial use impairments measurably worse. The trace metals discussed in this assessment are not considered bioaccumulative, and thus would not directly cause bioaccumulative problems in aquatic life or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-28: Effects on Trace Metal Concentrations Resulting from Implementation of CM2–CM22

NEPA Effects: Conservation Measures 2–22 proposed under Alternative 6A would be the same as those proposed under Alternative 1A. As such, effects on trace metals resulting from the implementation of CM2–CM22 would be similar to that previously discussed for Alternative 1A. As they pertain to trace metals, implementation of CM2–CM22 would not be expected to adversely affect beneficial uses of the affected environment or substantially degrade water quality with respect to trace metals.

In summary, implementation of CM2–CM22 under Alternative 6A, relative to the No Action Alternative, would have negligible, if any, effect on trace metals concentrations. The effect on trace metals from implementing CM2–CM22 is determined not to be adverse.

CEQA Conclusion: Implementation of CM2–CM22 under Alternative 6A would not cause substantial long-term increase in trace metal concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the SWP/CVP export service area. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because trace metal concentrations are not expected to increase substantially, no long-term water quality degradation for trace metals is expected to occur and, thus, no adverse effects to beneficial uses would occur. Furthermore, any negligible changes in long-term trace metal concentrations that may occur throughout the affected environment would not be expected to make any existing beneficial use impairments measurably worse. The trace metals discussed in this assessment are not considered bioaccumulative, and thus would not directly cause bioaccumulative problems in aquatic life or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-29: Effects on TSS and Turbidity Resulting from Facilities Operations and Maintenance (CM1)

NEPA Effects: Effects of CM1 on TSS and turbidity under Alternative 6A are the same as those discussed for Alternative 1A. The effects on TSS and turbidity from implementing CM1 is determined to not be adverse.

CEQA Conclusion: Effects of CM1 on TSS and turbidity under Alternative 6A would be similar to those discussed for Alternative 1A, and are summarized here, then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion under Alternative 1A.

Changes river flow rate and reservoir storage that would occur under Alternative 6A, relative to Existing Conditions, would not be expected to result in a substantial adverse change in TSS concentrations and turbidity levels in the reservoirs and rivers upstream of the Delta, given that suspended sediment concentrations are more affected by season than flow. Site-specific and temporal exceptions may occur due to localized temporary construction activities, dredging activities, development, or other land use changes would be site-specific and temporal, which would be regulated to limit both their short-term and long-term effects on TSS and turbidity levels to less than substantial levels.

Within the Delta, geomorphic changes associated with sediment transport and deposition are usually gradual, occurring over years, and high storm event inflows would not be substantially affected. Thus, it is expected that the TSS concentrations and turbidity levels in the affected channels would not be substantially different from the levels under Existing Conditions. Consequently, this alternative is expected to have minimal effect on TSS concentrations and turbidity levels in the Delta region, relative to Existing Conditions.

There is not expected to be substantial, if even measurable, changes in TSS concentrations and turbidity levels in the SWP/CVP Export Service Areas waters under Alternative 6A, relative to Existing Conditions, because as stated above, this alternative is not expected to result in substantial changes in TSS concentrations and turbidity levels at the south Delta export pumps, relative to Existing Conditions.

Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives where such objectives are not exceeded under Existing Conditions. Because TSS concentrations and turbidity levels are not expected to be substantially different, long-term water quality degradation is not expected, and, thus, beneficial uses are not expected to be adversely affected. Finally, TSS and turbidity are neither bioaccumulative nor Clean Water Act section 303(d) listed constituents. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-30: Effects on TSS and Turbidity Resulting from Implementation of CM2–CM22

NEPA Effects**:** Effects of CM2–CM22 on TSS and turbidity under Alternative 6A are the same as those discussed for Alternative 1A. The effects on TSS and turbidity from implementing CM2–CM22 is determined to not be adverse.

CEQA Conclusion**:** Conservation Measures 2–22 proposed under Alternative 6A would be similar to those proposed under Alternative 1A. As such, effects on TSS and turbidity resulting from the implementation of CM2–CM22 would be similar to that previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-31: Water Quality Effects Resulting from Construction-Related Activities (CM1–CM22)

The conveyance features for CM1 under Alternative 6A would be very similar to those discussed for Alternative 1A. The primary difference between Alternative 6A and Alternative 1A is that under Alternative 6A, there would be additional features constructed to create the isolated conveyance system. As such, construction techniques and locations of major features of the conveyance system within the Delta would be similar. The remainder of the facilities constructed under Alternative 6A, including CM2–CM22, would be very similar to, or the same as, those to be constructed for Alternative 1A.

NEPA Effects**:** The types and magnitude of potential construction-related water quality effects associated with implementation of CM1–CM22 under Alternative 6A would be very similar to the effects discussed for Alternative 1A, and the effects anticipated with implementation of CM2–CM22 would be essentially identical. Nevertheless, the construction of CM1, and any individual components necessitated by CM2, and CM4–CM10, with the implementation of the BMPs specified in Appendix 3B*, Environmental Commitments,* and other agency permitted construction requirements would result in the potential water quality effects being largely avoided and minimized. The specific environmental commitments that would be implemented under Alternative 6A would be similar to those described for Alternative 1A (refer to Chapter 3, *Description of Alternatives*, and Appendix 3B, *Environmental Commitments,* for additional information regarding the environmental commitments and environmental permits). Consequently, relative to Existing Conditions, Alternative 6A would not be expected to cause exceedance of applicable water quality objectives/criteria or substantial water quality degradation with respect to constituents of concern, and thus would not adversely affect any beneficial uses upstream of the Delta, in the Delta, or in the SWP and CVP service area.

In summary, with implementation of environmental commitments in Appendix 3B, the potential construction-related water quality effects are considered to be not adverse.

***CEQA Conclusion*:** Because environmental commitments would be implemented under Alternative 6A for construction-related activities along with agency-issued permits that also contain construction requirements to protect water quality, the construction-related effects, relative to Existing Conditions, would not be expected to cause or contribute to substantial alteration of existing drainage patterns which would result in substantial erosion or siltation on- or off-site, substantial increased frequency of exceedances of water quality objectives/criteria, or substantially degrade water quality with respect to the constituents of concern on a long-term average basis, and thus would not adversely affect any beneficial uses in water bodies upstream of the Delta, within the Delta, or in the SWP and CVP service area. Moreover, because the construction-related activities would be temporary and intermittent in nature, the construction would involve negligible discharges, if any, of bioaccumulative or 303(d) listed constituents to water bodies of the affected environment. As such, construction activities would not contribute measurably to bioaccumulation of contaminants in organisms or humans or cause 303(d) impairments to be discernibly worse. Based on these findings, this impact is determined to be less than significant. No mitigation is required.

8.4.3.12 Alternative 6B—Isolated Conveyance with East Alignment and Intakes 1–5 (15,000 cfs; Operational Scenario D)

Alternative 6B would comprise physical/structural components similar to those under Alternative 1B with the principal exception that Alternative 6B would be an "isolated" conveyance, no longer involving operation of the existing SWP and CVP south Delta export facilities for Clifton Court Forebay and Jones Pumping Plant. Alternative 6B would utilize five screened intakes (i.e., Intakes 1 through 5) to convey up to 15,000 cfs of water from the north Delta to the south Delta through a canal along the east side of the Delta. An intermediate pumping plant north of the town of Holt would be constructed as well as a new 600 acre Byron Tract Forebay located adjacent to Clifton Court Forebay. Water supply and conveyance operations would follow the guidelines described as Scenario D, which includes fall X2. CM2–CM22 would be implemented under this alternative, and these conservation measures would be the same as those under Alternative 1A. See Chapter 3, *Description of Alternatives,* Section 3.5.12, for additional details on Alternative 6B.

Water Quality Effects Resulting from Facilities Operations and Maintenance (CM1)

Alternative 6B has the same diversion and conveyance operations as Alternative 6A. The primary difference between the two alternatives is that conveyance under Alternative 6B would be in a lined or unlined canal, instead of pipeline. Because there would be no difference in conveyance capacity or operations, there would be no differences between these two alternatives in upstream of Delta river flows or reservoir operations, Delta inflow, source fractions to various Delta locations, and hydrodynamics in the Delta. Conveyance of water in an open channel instead of a pipeline may result in differing physical properties (e.g., DO, pH, temperature) of the water upon reaching the south Delta export pumps than if the water was conveyed in a pipeline. However, the physical properties of water arriving at the south Delta export pumps would continue to change and would equilibrate to similar levels as Alternative 6A as it is conveyed throughout the SWP/CVP Export Service Areas. Because no substantial differences in water quality effects are anticipated anywhere in the affected environment under Alternative 6B compared to those described in detail for Alternative 6A, the water quality effects described for Alternative 6A also appropriately characterize effects under Alternative 6B.

Water Quality Effects Resulting from Implementation of CM2–CM22

Alternative 6B has the same conservation measures as Alternative 6A. Because no substantial differences in water quality effects are anticipated anywhere in the affected environment under Alternative 6B compared to those described in detail for Alternative 6A, the water quality effects described for Alternative 6A also appropriately characterize effects under Alternative 6B.

Impact WQ-31: Water Quality Effects Resulting from Construction-Related Activities (CM1–CM22)

NEPA Effects: The primary difference between Alternative 6B and Alternative 1A is that under Alternative 6B, a canal would be constructed for conservation measure CM1 along the eastern side of the Delta to convey the Sacramento River water south, rather than the tunnel/pipeline features. As such, construction techniques and locations of major features of the conveyance system within the Delta would be different (see Chapter 3, *Description of Alternatives,* Section 3.5.12). The remainder of the facilities constructed under Alternative 6B, including CM2–CM22, would be very similar to, or the same as, those to be constructed for Alternative 1A.

The types of potential construction-related water quality effects associated with implementation of CM1 under Alternative 6B would be very similar to the effects discussed for Alternative 1A, and the effects anticipated with implementation of CM2–CM22 would be essentially identical. However, given the substantial differences in the conveyance features under CM1 with construction of a canal, there could be differences in the location, magnitude, duration, and frequency of construction activities and related water quality effects. In particular, relative to the Existing Conditions and No Action Alternative conditions, construction of the major intakes and canal features for CM1 under Alternative 6B would involve extensive general construction activities, material handling/storage/placement activities, surface soil grading/excavation/disposal and associated exposure of disturbed sites to erosion and runoff, and construction site dewatering operations. Nevertheless, the construction of CM1, and any individual components necessitated by CM2, and CM4–CM10, with the implementation of the BMPs specified in Appendix 3B*, Environmental Commitments,* and other agency permitted construction requirements would result in the potential water quality effects being largely avoided and minimized. The specific environmental commitments that would be implemented under Alternative 6B would be similar to those described for Alternative 1A with the exception that Category "B" BMPs for RTM dewatering basin construction and operations, if necessary at all, would be much reduced. Consequently, relative to Existing Conditions, Alternative 6B would not be expected to cause exceedance of applicable water quality objectives/criteria or substantial water quality degradation with respect to constituents of concern, and thus would not adversely affect any beneficial uses upstream of the Delta, in the Delta, or in the SWP and CVP service area.

In summary, with implementation of environmental commitments in Appendix 3B, the potential construction-related water quality effects are considered to be not adverse.

CEQA Conclusion**:** Construction-related contaminant discharges would be temporary and intermittent in nature and would involve negligible, if any, discharges of bioaccumulative or 303(d) listed constituents to water bodies of the affected environment. As such, construction activities would not contribute measurably to bioaccumulation of contaminants in organisms or humans or cause 303(d) impairments to be discernibly worse. Because environmental commitments would be implemented under Alternative 6B for construction-related activities along with agency-issued permits that also contain construction related mitigation requirements to protect water quality, the construction-related effects, relative to Existing Conditions, would not be expected to cause or contribute to substantial alteration of existing drainage patterns which would result in substantial erosion or siltation on- or off-site, substantial increased frequency of exceedances of water quality objectives/criteria, or substantially degrade water quality with respect to the constituents of concern on a long-term average basis, and thus would not adversely affect any beneficial uses in water bodies upstream of the Delta, within the Delta, or in the SWP and CVP service area. Based on these findings, this impact is determined to be less than significant. No mitigation is required.

8.4.3.13 Alternative 6C—Isolated Conveyance with West Alignment and Intakes W1–W5 (15,000 cfs; Operational Scenario D)

Alternative 6C would comprise physical/structural components similar to those under Alternative 1C with the principal exception that Alternative 6B would be an "isolated" conveyance, no longer involving operation of the existing SWP and CVP south Delta export facilities for Clifton Court Forebay and Jones Pumping Plant. Alternative 6C would utilize five screened intakes (i.e., Intakes 1 through 5) to convey up to 15,000 cfs of water from the north Delta to the south Delta through a series of canals and tunnels along the west side of the Delta. An intermediate pumping plant would be utilized and a new 600 acre forebay at Byron Tract would be constructed adjacent Clifton Court Forebay. There would be no intermediate forebay. Water supply and conveyance operations would follow the guidelines described as Scenario D, which includes fall X2. CM2–CM22 would be implemented under this alternative, and these conservation measures would be the same as those under Alternative 1A. See Chapter 3, *Description of Alternatives,* Section 3.5.13, for additional details on Alternative 6C.

Water Quality Effects Resulting from Facilities Operations and Maintenance (CM1)

Alternative 6C has the same diversion and conveyance operations as Alternative 6A. The primary differences between the two alternatives are that conveyance under Alternative 6C would be in a lined or unlined canal, instead of pipeline, and the alignment of the canal would be along the western side of the Delta, rather than the eastern side. Because there would be no difference in conveyance capacity or operations, there would be no differences between these two alternatives in upstream of Delta river flows or reservoir operations, Delta inflow, source fractions to various Delta locations, and hydrodynamics in the Delta. Conveyance of water in an open channel instead of a pipeline may result in differing physical properties (e.g., DO, pH, temperature) of the water upon reaching the south Delta export pumps than if the water was conveyed in a pipeline. However, the physical properties of water arriving at the south Delta export pumps would continue to change and would equilibrate to similar levels as Alternative 6A as it is conveyed throughout the SWP/CVP Export Service Areas. Because no substantial differences in water quality effects are anticipated anywhere in the affected environment under Alternative 6C compared to those described in detail for Alternative 6A, the water quality effects described for Alternative 6A also appropriately characterize effects under Alternative 6C.

Water Quality Effects Resulting from Implementation of CM2–CM22

Alternative 6C has the same conservation measures as Alternative 6A. Because no substantial differences in water quality effects are anticipated anywhere in the affected environment under Alternative 6C compared to those described in detail for Alternative 6A, the water quality effects described for Alternative 6A also appropriately characterize effects under Alternative 6C.

Impact WQ-31: Water Quality Effects Resulting from Construction-Related Activities (CM1–CM22)

NEPA Effects: The primary difference between Alternative 6C and Alternative 1A is that under Alternative 6C, a canal would be constructed for CM1 along the western side of the Delta to convey the Sacramento River water south, in addition to the tunnel/pipeline features. As such, construction techniques and locations of major features of the conveyance system within the Delta would be different (see Chapter 3, *Description of Alternatives,* Section 3.5.13). The remainder of the facilities constructed under Alternative 6C, including CM2–CM22, would be very similar to, or the same as, those to be constructed for Alternative 1A.

The types of potential construction-related water quality effects associated with implementation of CM1 under Alternative 6C would be very similar to the effects discussed for Alternative 1A, and the effects anticipated with implementation of CM2–CM22 would be essentially identical. Given the substantial differences in the conveyance features under CM1 with construction of a canal in addition to the tunnel/pipeline features, there could be differences in the location, magnitude, duration, and frequency of construction activities and related water quality effects. In particular, relative to the Existing Conditions and No Action Alternative conditions, construction of the major intakes and canal features for CM1 under Alternative 6C would involve extensive general construction activities, material handling/storage/placement activities, surface soil grading/excavation/disposal and associated exposure of disturbed sites to erosion and runoff, and construction site dewatering operations. Nevertheless, the construction of CM1, and any individual components necessitated by CM2, and CM4–CM10, with the implementation of the BMPs specified in Appendix 3B*, Environmental Commitments,* and other agency permitted construction requirements would result in the potential water quality effects being largely avoided and minimized. The specific environmental commitments that would be implemented under Alternative 6C would be similar to those described for Alternative 1A. However, this alternative would involve environmental commitments associated with both tunnel/pipeline and canal construction activities. Consequently, relative to Existing Conditions, Alternative 6C would not be expected to cause exceedance of applicable water quality objectives/criteria or substantial water quality degradation with respect to constituents of concern, and thus would not adversely affect any beneficial uses upstream of the Delta, in the Delta, or in the SWP and CVP service area.

In summary, with implementation of environmental commitments in Appendix 3B, the potential construction-related water quality effects are considered to be not adverse.

***CEQA Conclusion*:** Construction-related contaminant discharges would be temporary and intermittent in nature and would involve negligible, if any, discharges of bioaccumulative or 303(d) listed constituents to water bodies of the affected environment. As such, construction activities would not contribute measurably to bioaccumulation of contaminants in organisms or humans or cause 303(d) impairments to be discernibly worse. Because environmental commitments would be implemented under Alternative 6C for construction-related activities along with agency-issued permits that also contain construction related mitigation requirements to protect water quality, the construction-related effects, relative to Existing Conditions, would not be expected to cause or contribute to substantial alteration of existing drainage patterns which would result in substantial erosion or siltation on- or off-site, substantial increased frequency of exceedances of water quality objectives/criteria, or substantially degrade water quality with respect to the constituents of concern on a long-term average basis, and thus would not adversely affect any beneficial uses in water bodies upstream of the Delta, within the Delta, or in the SWP and CVP service area. Based on these findings, this impact is determined to be less than significant. No mitigation is required.

8.4.3.14 Alternative 7—Dual Conveyance with Pipeline/Tunnel, Intakes 2, 3, and 5, and Enhanced Aquatic Conservation (9,000 cfs; Operational Scenario E)

Alternative 7 would comprise physical/structural components similar to those under Alternative 1A with the principal exception that Alternative 7 would construct only three intakes and intake pumping plants (i.e., Intakes 2, 3, and 5). Alternative 7 would convey up to 9,000 cfs of water from the north Delta to the south Delta through pipelines/tunnels from three screened intakes on the east bank of the Sacramento River between Clarksburg and Walnut Grove. A 750 acre intermediate forebay and pumping plant would be constructed near Hood. A new 600 acre Byron Tract Forebay, adjacent to and south of Clifton Court Forebay, would be constructed which would provide water to the south Delta pumping plants. Water supply and conveyance operations would follow the guidelines described as Scenario E, which includes fall X2. The modifications under this enhanced aquatic alternative are intended to further improve fish and wildlife habitat, especially along the San Joaquin River. Conservation Measures 2–22 (CM2–22) would be implemented under this alternative, and would be the same as those under Alternative 1A, except that 40 linear miles rather than 20 linear miles of channel margin habitat would be enhanced, and 20,000 acres rather than 10,000 acres of seasonally inundated floodplain would be restored. See Chapter 3, *Description of Alternatives*, Section 3.5.14, for additional details on Alternative 7.

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 7, over the long term, average annual delta exports are anticipated to decrease by 1,389 TAF relative to Existing Conditions, and by 682 TAF relative to the No Action Alternative. Since, over the long-term, approximately 62% 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 greatly 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 7–Old River at Rock Slough for ALL years (1976–1991), which shows increased San Joaquin River (SJR) percentage and decreased Sacramento River (SAC) percentage under the alternative, relative to Existing Conditions and the No Action Alternative.

Under Alternative 7, long-term average annual Delta outflow is anticipated to increase 1,383 TAF relative to Existing Conditions, due to both changes in operations (including north Delta intake capacity of 9,000 cfs and numerous other operational components of Scenario E) and climate change/sea level rise (see Chapter 5, *Water Supply*, for more information). The result of this is decreased sea water intrusion in the west Delta. The decrease of sea water intrusion in the west Delta under Alternative 7 is greater relative to the Existing Conditions because it does not include operations to meet Fall X2, whereas the No Action alternative and Alternative 7 do. Long-term average annual Delta outflow is anticipated to increase under Alternative 7 by 683 TAF relative to the No Action Alternative, due only to changes in operations. The decreases in sea water intrusion (represented by an decrease in San Francisco Bay (BAY) percentage) can be seen, for example, in Appendix 8D, ALT 7–Sacramento River at Mallard Island for ALL years (1976–1991).

Impact WQ-1: Effects on Ammonia Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative, Alternative 7 would have negligible, if any, effect on ammonia concentrations in the rivers and reservoirs upstream of the Delta relative to Existing Conditions and the No Action Alternative. Any negligible increases in ammonia-N concentrations that could occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regard to ammonia.

Delta

Assessment of effects of ammonia under Alternative 7 is the same as discussed under Alternative 1A, except that because flows in the Sacramento River at Freeport are different between the two alternatives, estimated monthly average and long term annual average predicted ammonia-N concentrations in the Sacramento River downstream of Freeport are different.

As Table 8-70 shows, estimated ammonia-N concentrations in the Sacramento River downstream of Freeport (upon full mixing of the SRWTP discharge with river water) under Alternative 7 and the No Action Alternative are expected to be similar. Minor increases in ammonia-N concentrations would occur during January through March, July through September, November, and December, and remaining months would be unchanged or have a minor decrease. A minor increase in the annual average concentration would occur under Alternative 7, compared to the No Action Alternative. Moreover, the estimated concentrations downstream of Freeport under Alternative 7 would be similar to existing source water concentrations for the San Francisco Bay and San Joaquin River. Consequently, changes in source water fraction anticipated under Alternative 7, relative to the No Action Alternative, are not expected to substantially increase ammonia concentrations at any Delta locations.

Table 8-70. Estimated Ammonia-N (mg-L as N) Concentrations in the Sacramento River Downstream of the Sacramento Regional Wastewater Treatment Plant for the No Action Alternative and Alternative 7

	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
Alternative 7	0.073	0.086	0.070	0.061	0.058	0.061	0.058	0.064	0.065	0.061	0.069	0.066	0.066

Any negligible increases in ammonia-N concentrations that could occur at certain locations in the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to ammonia.

SWP/CVP Export Service Areas

The assessment of effects on ammonia in the SWP/CVP Export Service Area is based on assessment of ammonia-N concentrations at Banks and Jones pumping plants. Similar to the discussion for Alternative 1A, under Alternative 7 for areas of the Delta that are influenced by Sacramento River water, including Banks and Jones pumping plants, ammonia-N concentrations are expected to decrease, relative to Existing Conditions (in association with less diversion of water influenced by the SRWTP). This decrease in ammonia-N concentrations for water exported via the south Delta pumps is not expected to result in adverse effects on beneficial uses or substantially degrade water quality of exported water, with regards to ammonia.

Furthermore, as discussed above for the Plan Area, for all areas of the Delta, including Banks and Jones pumping plants, ammonia-N concentrations are not expected to be substantially different under Alternative 7, relative to No Action Alternative. Any negligible increases in ammonia-N concentrations that could occur at Banks and Jones pumping plants would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to ammonia.

NEPA Effects: In summary, based on the discussion above, effects on ammonia from implementation of CM1 are considered to be not adverse.

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

Ammonia-N concentrations are generally low in the reservoirs and rivers of the watersheds, owing to the lack of substantial point and nonpoint sources of ammonia-N upstream of the SRWTP in the Sacramento River watershed, in the watersheds of the eastern tributaries (Cosumnes, Mokelumne, and Calaveras Rivers), or upstream of the Delta in the San Joaquin River watershed. Consequently, any modified reservoir operations and subsequent changes in river flows under Alternative 7, relative to Existing Conditions, are expected to have negligible, if any, effects on reservoir and river ammonia-N concentrations upstream of Freeport in the Sacramento River watershed and upstream of the Delta in the San Joaquin River watershed.

Ammonia-N concentrations in the Sacramento River downstream of the SRWTP would be substantially lower under Alternative 7, relative to Existing Conditions, due to upgrades to the SRWTP that are assumed to be in place, and thus, ammonia concentrations for all areas of the Delta that are influenced by Sacramento River water are expected to decrease. At locations which are not influenced notably by Sacramento River water, concentrations are expected to remain relatively unchanged, due to the similarity in SJR and BAY concentrations and the lack of expected changes in either of these concentrations.

The assessment of effects on ammonia in the SWP/CVP Export Service Areas is based on assessment of ammonia-N concentrations at Banks and Jones pumping plants. As discussed above for the Plan Area, for areas of the Delta that are influenced by Sacramento River water, including Banks and Jones pumping plants, ammonia-N concentrations are expected to decrease under Alternative 7, relative to Existing Conditions.

There would be no substantial, long-term increase in ammonia-N concentrations in the rivers and reservoirs upstream of the Delta, in the Plan Area, or the waters exported to the CVP and SWP service areas under Alternative 7 relative to Existing Conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because ammonia concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects on beneficial uses would occur. Ammonia is not 303(d) listed within the affected environment and thus any minor increases that could occur in some areas would not make any existing ammonia-related impairment measurably worse because no such impairments currently exist. Because ammonia-N is not bioaccumulative, minor increases that could occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-2: Effects on Ammonia Concentrations Resulting from Implementation of CM2–CM22

NEPA Effects: Effects of CM2–CM22 on ammonia under Alternative 7 are the same as those discussed for Alternative 1A and are considered to be not adverse.

CEQA Conclusion: Conservation Measures 2–22 proposed under Alternative 7 would be similar to those proposed under Alternative 1A. As such, effects on ammonia resulting from the implementation of CM2–CM22 would be similar to that previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-3: Effects on Boron Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Effects of CM1 on boron under Alternative 7 in areas upstream of the Delta would be very similar to the effects discussed for Alternative 1A. There would be no expected change to the sources of boron in the Sacramento and east-side tributary watersheds, and resultant changes in flows from altered system-wide operations would have negligible, if any, effects on the concentration of boron in the rivers and reservoirs of these watersheds. The modeled long-term annual average lower San Joaquin River flow at Vernalis would decrease slightly compared to Existing Conditions (in association with project operations, climate change, and increased water demands) and would be similar compared to the No Action Alternative considering only changes due to Alternative 7 operations. The reduced flow would result in possible increases in long-term average boron concentrations of up to about 3% relative to the Existing Conditions (Appendix 8F, Table 24). The increased boron concentrations would not increase the frequency of exceedances of any applicable objectives or criteria and would not be expected to cause further degradation at measurable levels in the lower San Joaquin River, and thus would not cause the existing impairment there to be discernibly worse. Consequently, Alternative 7 would not be expected to cause exceedance of boron objectives/criteria or substantially degrade water quality with respect to boron, and thus would not adversely affect any beneficial uses of the Sacramento River, the east-side tributaries, associated reservoirs upstream of the Delta, or the San Joaquin River.

Delta

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

Effects of CM1 on boron under Alternative 7 in the Delta would be similar to the effects discussed for Alternative 1A. Relative to the Existing Conditions and No Action Alternative, Alternative 7 would result in increased long-term average boron concentrations for the 16-year period modeled at interior and western Delta locations (by as much as 10% at the SF Mokelumne River at Staten Island, 33% at Franks Tract, and 56% at Old River at Rock Slough) (Appendix 8F, Table Bo-18). The comparison to Existing Conditions reflects changes due to both Alternative 7 operations (including north Delta intake capacity of 9,000 cfs and numerous other operational components of Scenario E) and climate change/sea level rise. The comparison to the No Action Alternative reflects changes due only to operations.

Implementation of tidal habitat restoration under CM4 also may contribute to increased boron concentrations at western Delta assessment locations (more discussion of this phenomenon is included in Section 8.3.1.3), and thus would not be anticipated to substantially affect agricultural diversions which occur primarily at interior Delta locations. The long-term annual average and monthly average boron concentrations, for either the 16-year period or drought period modeled, would never exceed the 2,000 µg/L human health advisory objective (i.e., for children) or 500 µg/L agricultural objective at any of the eleven Delta assessment locations, which represents no change from the Existing Conditions and the No Action Alternative (Appendix 8F, Table Bo-3A). The increased concentrations at interior Delta locations would result in moderate reductions in the long-term average assimilative capacity of up to 33% at Franks Tract and up to 56% at Old River at Rock Slough locations (Appendix 8F, Table Bo-19). However, because the absolute boron concentrations would still be well below the lowest 500 µg/L objective for the protection of the agricultural beneficial use under Alternative 7, the levels of boron degradation would not be of sufficient magnitude to substantially increase the risk of exceeding objectives or cause adverse effects to municipal and agricultural water supply beneficial uses, or any other beneficial uses, in the Delta (Appendix 8F, Figure Bo-5).

SWP/CVP Export Service Areas

Effects of CM1 on boron under Alternative 7 in the Delta would be similar to the effects discussed for Alternative 1A. Under Alternative 7, long-term average boron concentrations would decrease by as much as 41% at the Banks Pumping Plant and by as much as 48% at Jones Pumping Plant relative to Existing Conditions and No Action Alternative (Appendix 8F, Table Bo-18) as a result of export of a greater proportion of low-boron Sacramento River water. Commensurate with the decrease in exported boron concentrations, boron concentrations in the lower San Joaquin River may be reduced and would likely alleviate or lessen any expected increase in boron concentrations at Vernalis associated with flow reductions (see discussion of Upstream of the Delta), as well as locations in the Delta receiving a large fraction of San Joaquin River water. Reduced export boron concentrations also may contribute to reducing the existing 303(d) impairment in the lower San Joaquin River and associated TMDL actions for reducing boron loading.

Maintenance of SWP and CVP facilities under Alternative 7 would not be expected to create new sources of boron or contribute towards a substantial change in existing sources of boron in the affected environment. Maintenance activities would not be expected to cause any substantial increases in boron concentrations or degradation with respect to boron such that objectives would be exceeded more frequently, or any beneficial uses would be adversely affected anywhere in the affected environment.

NEPA Effects: In summary, relative to the No Action Alternative conditions, Alternative 7 would result in relatively small long-term average increases in boron levels in the San Joaquin River and moderate increases in the interior and western Delta locations Delta. However, the predicted changes in the Delta would not be expected to result in exceedances of applicable objectives or further water quality degradation such that objectives would likely be exceeded or there would be substantially increased risk of adverse effects on water quality.

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

Boron is not a constituent of concern in the Sacramento River watershed upstream of the Delta, thus river flow rate and reservoir storage reductions that would occur under the Alternative 7, relative to Existing Conditions, would not be expected to result in a substantial adverse change in boron levels. Additionally, relative to Existing Conditions, Alternative 7 would not result in reductions in river flow rates (i.e., less dilution) or increased boron loading such that there would be any substantial increases in boron concentration upstream of the Delta in the San Joaquin River watershed.

Moderate increased boron levels (i.e., up to 56% increased concentration) and degradation predicted for interior and western Delta locations in response to a shift in the Delta source water percentages and tidal habitat restoration under this alternative would not be expected to cause exceedances of objectives. Alternative 7 maintenance also would not result in any substantial increases in boron concentrations in the affected environment. Boron concentrations would be reduced in water exported from the Delta to the CVP/SWP Export Service Areas, thus reflecting a potential improvement to boron loading in the lower San Joaquin River.

Boron is not a bioaccumulative constituent, thus any increased concentrations under Alternative 7 would not result in adverse boron bioaccumulation effects to aquatic life or humans. Relative to Existing Conditions, Alternative 7 would not result in substantially increased boron concentrations such that frequency of exceedances of municipal and agricultural water supply objectives would increase. The levels of boron degradation that may occur under Alternative 7, while widespread in particular at interior Delta locations, would not be of sufficient magnitude to cause substantially increased risk for adverse effects to municipal or agricultural beneficial uses within the affected environment. Long-term average boron concentrations would decrease in Delta water exports to the SWP and CVP service area, which may contribute to reducing the existing 303(d) impairment of agricultural beneficial uses in the lower San Joaquin River. Consequently, Alternative 7 would not be expected to cause any substantial increases in boron concentrations or degradation with respect to boron such that objectives would be exceeded more frequently, or any beneficial uses would be adversely affected anywhere in the affected environment. Based on these findings, this impact is determined to be less than significant. No mitigation is required.

Impact WQ-4: Effects on Boron Concentrations Resulting from Implementation of CM2–CM22

***NEPA Effects*:** Effects of CM2–CM22 on boron under Alternative 7 are the same as those discussed for Alternative 1A and are determined to be not adverse.

***CEQA Conclusion*:** Conservation Measures 2–22 proposed under Alternative 7 would be similar to those proposed under Alternative 1A. As such, effects on boron resulting from the implementation of CM2–CM22 would be similar to that previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

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

Upstream of the Delta

Under Alternative 7 there would be no expected change to the sources of bromide in the Sacramento and eastside tributary watersheds. Bromide loading in these watersheds would remain unchanged and resultant changes in flows from altered system-wide operations under Alternative 7 would have negligible, if any, effects on the concentration of bromide in the rivers and reservoirs of these watersheds. Consequently, Alternative 7 would not be expected to adversely affect the MUN beneficial use, or any other beneficial uses, of the Sacramento River, the eastside tributaries, or their associated reservoirs upstream of the Delta.

Under Alternative 7, modeling indicates that long-term annual average flows on the San Joaquin River would decrease by 6%, relative to Existing Conditions, and would remain virtually the same relative to the No Action Alternative (Appendix 5A). Similar to the No Action Alternative, these decreases in flow would result in possible increases in long-term average bromide concentrations of about 3%, relative to Existing Conditions and less than <1% relative to No Action Alternative (Appendix 8E, Bromide Table 22). The small increases in lower San Joaquin River bromide levels that could occur under Alternative 7, relative to existing and the No Action Alternative conditions would not be expected to adversely affect the MUN beneficial use, or any other beneficial uses, of the lower San Joaquin River.

Delta

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

Using the mass-balance modeling approach for bromide (see Section 8.3.1.3), relative to Existing Conditions, Alternative 7 would result in increases in long-term average bromide concentrations at Staten Island and Barker Slough (for the modeled drought period only), while long-term average concentrations would decrease at the other assessment locations (Appendix 8E, *Bromide*, Table 16). At Barker Slough, predicted long-term average bromide concentrations would decrease from 51 μg/L to 50 μg/L (2% relative decrease) for the modeled 16-year hydrologic period, but would increase from 54 μg/L to 72 μg/L (34% relative increase) for the modeled drought period. At Barker Slough, the predicted 50 μg/L exceedance frequency would decrease from 49% under Existing Conditions to 29% under Alternative 7, but would increase slightly from 55% to 57% during the drought period. At Barker Slough, the predicted 100 μg/L exceedance frequency would increase from 0% under Existing Conditions to 8% under Alternative 7, and would increase from 0% to 22% during the drought period. At Staten Island, predicted long-term average bromide concentrations would increase from 50 μg/L to 63 μg/L (27% relative increase) for the modeled 16-year hydrologic period and would increase from 51 μg/L to 64 μg/L (25% relative increase) for the modeled drought period. At Staten Island, increases in average bromide concentrations would correspond to an increased frequency of 50 μg/l threshold exceedance, from 47% under Existing Conditions to 80% under Alternative 7 (52% to 88% for the modeled drought period), and an increase from 1% to 2% (0% to 0% for the modeled drought period) for the 100 μg/L threshold. Changes in exceedance frequency of the 50 μg/L and 100 μg/L concentration thresholds at other assessment locations would be less considerable, with exception to Franks Tract. Although long-term average bromide concentrations were modeled to decrease at Franks Tract, exceedances of the 100 μg/L threshold would increase slightly, from 82% under Existing Conditions to 99% under Alternative 7 (78% to 97% for the modeled drought period). This comparison to Existing Conditions reflects changes in bromide due to both Alternative 7 operations (including north Delta intake capacity of 9,000 cfs and numerous other operational components of Scenario E) and climate change/sea level rise.

Due to the relatively small differences between modeled Existing Conditions and No Action baselines, changes in long-term average bromide concentrations and changes in exceedance frequencies relative to the No Action Alternative are generally of similar magnitude to those previously described for the existing condition comparison (Appendix 8E, *Bromide*, Table 16). Modeled long-term average bromide concentration at Barker Slough is predicted to increase by 1% (34% for the modeled drought period) relative to the No Action Alternative. Modeled long-term average bromide concentration increases at Staten Island are predicted to increase by 31% (29% for the modeled drought period) relative to the No Action Alternative. However, unlike the Existing Conditions comparison, long-term average bromide concentrations at Buckley Cove would increase relative to the No Action Alternative, although the increases would be relatively small (≤9%). Unlike the comparison to Existing Conditions, this comparison to the No Action Alternative reflects changes in bromide due only to Alternative 7 operations.

At Barker Slough, modeled long-term average bromide concentrations for the two baseline conditions are very similar (Appendix 8E, *Bromide*, Table 16). Such similarity demonstrates that the modeled Alternative 7 change in bromide is almost entirely due to Alternative 7 operations, and not climate change/sea level rise. Therefore, operations are the primary driver of effects on bromide at Barker Slough, regardless whether Alternative 7 is compared to Existing Conditions, or compared to the No Action Alternative.

Results of the modeling approach which used relationships between EC and chloride and between chloride and bromide (see Section 8.3.1.3) differed somewhat from what is presented above for the mass-balance approach (see Appendix 8E, *Bromide*, Table 17). For most locations, the frequency of exceedance of the 50 μg/L and 100 μg/L were similar. The greatest difference between the methods was predicted for Barker Slough. The increases in frequency of exceedance of the 100 μg/L threshold, relative to Existing Conditions and the No Action Alternative, were not as great using this alternative EC to chloride and chloride to bromide relationship modeling approach as compared to that presented above from the mass-balance modeling approach. Results indicate 2% exceedance over the modeled period under Alternative 7, as compared to 1% under Existing Conditions and 2% under the No Action Alternative. For the drought period, exceedance frequency increased from 0% under Existing Conditions and the No Action Alternative, to 7% under Alternative 7. Because the mass-balance approach predicts a greater level of impact at Barker Slough, determination of impacts was based on the mass-balance results.

While the increase in long-term average bromide concentrations at Barker Slough are relatively small when modeled over a representative 16-year hydrologic period, increases during the modeled drought period, principally the relative increase in 100 μg/L exceedance frequency, would represent a substantial change in source water quality during a season of drought. As discussed for Alternative 1A, drinking water treatment plants obtaining water via the North Bay Aqueduct utilize a variety of conventional and enhanced treatment technologies in order to achieve DBP drinking water criteria. While the implications of such a modeled drought period change in bromide concentrations at

Barker Slough is difficult to predict, the substantial modeled increases could lead to adverse changes in the formation of disinfection byproducts such that considerable treatment plant upgrades may be necessary in order to achieve equivalent levels of health protection during seasons of drought. Increases at Staten Island are also considerable, although there are no existing or foreseeable municipal intakes in the immediate vicinity. Because many of the other modeled locations already frequently exceed the 100 µg/L threshold under Existing Conditions and the No Action Alternative, these locations likely already require treatment plant technologies to achieve equivalent levels of health protection, and thus no additional treatment technologies would be triggered by the small increases in the frequency of exceeding the 100 µg/L threshold. Hence, no further impact on the drinking water beneficial use would be expected at these locations.

The seasonal intakes at Mallard Slough and City of Antioch are infrequently used due to water quality constraints related to sea water intrusion. On a long-term average basis, bromide at these locations is in excess of 3,000 µg/L, but during seasonal periods of high Delta outflow can be <300 µg/L. Based on modeling using the mass-balance approach, use of the seasonal intakes at Mallard Slough and City of Antioch under Alternative 7 would experience a period average increase in bromide during the months when these intakes would most likely be utilized. For those wet and above normal water year types where mass balance modeling would predict water quality typically suitable for diversion, predicted long-term average bromide would increase from 103 µg/L to 152 µg/L (48% increase) at City of Antioch and would increase from 150 µg/L to 204 µg/L (36% increase) at Mallard Slough relative to Existing Conditions (Appendix 8E, *Bromide*, Table 23). Increases would be similar for the No Action Alternative comparison. Modeling results using the EC to chloride and chloride to bromide relationships show increases during these months, but the relative magnitude of the increases is much lower (Appendix 8E, *Bromide*, Table 24). Regardless of the differences in the data between the two modeling approaches, the decisions surrounding the use of these seasonal intakes is largely driven by acceptable water quality, and thus have historically been opportunistic. Opportunity to use these intakes would remain, and the predicted increases in bromide concentrations at the City of Antioch and Mallard Slough intake would not be expected to adversely affect MUN beneficial uses, or any other beneficial use, at these locations.

Based on modeling using the mass-balance approach, relative to existing and No Action Alternative conditions, Alternative 7 would lead to predicted improvements in long-term average bromide concentrations at Franks Tract, Rock Slough, and Contra Costa PP No. 1, in addition to Banks and Jones (discussed below). At these locations, long-term average bromide concentrations would be predicted to decrease by as much as 16–32%, depending on baseline comparison. Modeling results using the EC to chloride and chloride to bromide relationships generally do not show similar decreases for Rock Slough and Contra Costa PP No. 1, but rather, predict small increases. Based on the small magnitude of increases predicted, these increases would not adversely affect beneficial uses at those locations.

SWP/CVP Export Service Areas

Under Alternative 7, improvement in long-term average bromide concentrations would occur at the Banks and Jones pumping plants. Long-term average bromide concentrations for the modeled 16-year hydrologic period at these locations would decrease by as much as 71% relative to Existing Conditions and 67% relative to the No Action Alternative (Appendix 8E, Bromide Table 16). As a result, exceedances of the 50 µg/L and 100 µg/L assessment thresholds would be substantially reduced, resulting in considerable overall improvement in Export Service Areas water quality 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, *Bromide*, Table 17).

Similar to the discussion pertaining to the No Action Alternative, maintenance of SWP and CVP facilities under Alternative 7 would not be expected to create new sources of bromide or contribute towards a substantial change in existing sources of bromide in the affected environment. Maintenance activities would not be expected to cause any substantial change in bromide such that MUN beneficial uses, or any other beneficial use, would be adversely affected anywhere in the affected environment.

NEPA Effects: In summary, Alternative 7 operations and maintenance, relative to the No Action Alternative, would result in small increases (i.e., <1%) in long-term average bromide concentrations at Vernalis related to relatively small declines in long-term average flow on the San Joaquin River. However, Alternative 7 operation and maintenance activities would cause substantial degradation to water quality with respect to bromide at Barker Slough, source of the North Bay Aqueduct. Resultant substantial change in long-term average bromide at Barker Slough could necessitate changes in water treatment plant operations or require treatment plant upgrades in order to maintain DBP compliance, and thus would constitute an adverse effect on water quality. Mitigation Measure WQ-5 is available to reduce these effects (implementation of this measure along with a separate, non-environmental commitment as set forth in EIR/EIS Appendix 3B, *Environmental Commitments*, relating to the potential increased treatment costs associated with bromide-related changes would reduce these effects).

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

Under Alternative 7 there would be no expected change to the sources of bromide in the Sacramento and eastside tributary watersheds. Bromide loading in these watersheds would remain unchanged and resultant changes in flows from altered system-wide operations under Alternative 7 would have negligible, if any, effects on the concentration of bromide in the rivers and reservoirs of these watersheds. However, south of the Delta, the San Joaquin River is a substantial source of bromide, primarily due to the use of irrigation water imported from the southern Delta. Concentrations of bromide at Vernalis are inversely correlated to net river flow. Under Alternative 7, long-term average flows at Vernalis would decrease only slightly, resulting in less than substantial predicted increases in long-term average bromide of about 3% relative to Existing Conditions.

Relative to Existing Conditions, Alternative 7 would result in substantial increases in long-term average bromide concentration at Staten Island and Barker Slough (for the modeled drought period only). There are no existing or foreseeable municipal drinking water intakes in the vicinity of Staten Island, but Barker Slough is the source of the North Bay Aqueduct. While the increase in long-term average bromide concentrations at Barker Slough are predicted to be relatively small when modeled over a representative 16-year hydrologic period, increases during the modeled drought period would represent a substantial change in source water quality during a season of drought. These predicted drought season related increases in bromide at Barker Slough could lead to adverse changes in the formation of disinfection byproducts at drinking water treatment plants such that considerable water treatment plant upgrades would be necessary in order to achieve equivalent levels of drinking water health protection.

The assessment of effects on bromide in the SWP/CVP Export Service Areas is based on assessment of changes in bromide concentrations at Banks and Jones pumping plants. Under Alternative 7, substantial improvement would occur at the Banks and Jones pumping plants, where predicted long-term average bromide concentrations are predicted to decrease by as much as 71% relative to Existing Conditions. An overall improvement in bromide-related water quality would be predicted in the SWP/CVP Export Service Areas.

Based on the above, Alternative 7 operation and maintenance would not result in any substantial change in long-term average bromide concentration upstream of the Delta. Furthermore, under Alternative 7, water exported from the Delta to the SWP/CVP service area would be substantially improved relative to bromide. Bromide is not bioaccumulative, therefore change in long-term average bromide concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Additionally, bromide is not a constituent related to any 303(d) listings. Alternative 7 operation and maintenance activities would not cause substantial long-term degradation to water quality respective to bromide with the exception of water quality at Barker Slough (drought period only) and at Staten Island in the eastern Delta. There are no existing or foreseeable municipal intakes in the vicinity of Staten Island, but Barker Slough is the source of the North Bay Aqueduct. At Barker Slough, modeled long-term annual average concentrations of bromide would increase by 34% during the modeled drought period. For the modeled 1 drought period the frequency of predicted bromide concentrations exceeding 100 μg/L would increase from 0% under Existing Conditions to 22% under Alternative 7. Substantial changes in long-term average bromide during seasons of drought could necessitate changes in treatment plant operation or require treatment plant upgrades in order to maintain DBP compliance. The model predicted change at Barker Slough during the drought period is substantial and, therefore, would represent a substantially increased risk for adverse effects on existing MUN beneficial uses should treatment upgrades not be undertaken. The impact is considered significant.

Implementation of Mitigation Measure WQ-5 along with a separate, non-environmental commitment relating to the potential increased treatment costs associated with bromide-related changes would reduce these effects. While mitigation measures to reduce these water quality effects in affected water bodies to less than significant levels are not available, implementation of Mitigation Measure WQ-5 is recommended to attempt to reduce the effect that increased bromide concentrations may have on Delta beneficial uses. However, because the effectiveness of this mitigation measure to result in feasible measures for reducing water quality effects is uncertain, this impact is considered to remain significant and unavoidable. Please see Mitigation Measure WQ-5 under Impact WQ-5 in the discussion of Alternative 1A.

In addition to and to supplement Mitigation Measure WQ-5, the BDCP proponents have incorporated into the BDCP, as set forth in EIR/EIS Appendix 3B, *Environmental Commitments*, a separate, non-environmental commitment to address the potential increased water treatment costs that could result from bromide-related concentration effects on municipal water purveyor operations. Potential options for making use of this financial commitment include funding or providing other assistance towards implementation of the North Bay Aqueduct AIP, acquiring alternative water supplies, or other actions to indirectly reduce the effects of elevated bromide and DOC in existing water supply diversion facilities. Please refer to Appendix 3B, *Environmental Commitments*, for the full list of potential actions that could be taken pursuant to this commitment in order to reduce the water quality treatment costs associated with water quality effects relating to chloride, electrical conductivity, and bromide.

Mitigation Measure WQ-5: Avoid, Minimize, or Offset, as Feasible, Adverse Water Quality Conditions

Please see Mitigation Measure WQ-5 under Impact WQ-5 in the discussion of Alternative 1A.

Impact WQ-6: Effects on Bromide Concentrations Resulting from Implementation of CM2–CM22

***NEPA Effects*:** Conservation Measures 2–22 under Alternative 7 would be similar to those under Alternative 1A, but 40 linear miles rather than 20 linear miles of channel margin habitat would be enhanced, and 20,000 acres rather than 10,000 acres of seasonally inundated floodplain would be restored. As discussed for Alternative 1A, implementation of the CM2–CM22 would not present new or substantially changed sources of bromide to the study area. Some conservation measures may replace or substitute for existing irrigated agriculture in the Delta. This replacement or substitution is not expected to substantially increase or present new sources of bromide. CM2–CM22 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.

In summary, implementation of CM2–CM22 under Alternative 7, relative to the No Action Alternative, would have negligible, if any, effects on bromide concentrations. The effects on bromide from implementing CM2–CM22 are determined to not be adverse.

***CEQA Conclusion*:** Conservation Measures 2–22 proposed under Alternative 7 would be similar to those proposed under Alternative 1A. As discussed for Alternative 1A, implementation of CM2–CM22 would not present new or substantially changed sources of bromide to the study area. As such, effects on bromide resulting from the implementation of CM2–CM22 would be similar to that previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

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

Upstream of the Delta

Under Alternative 7 there would be no expected change to the sources of chloride in the Sacramento and eastside tributary watersheds. Chloride loading in these watersheds would remain unchanged and resultant changes in flows from altered system-wide operations would have negligible, if any, effects on the concentration of chloride in the rivers and reservoirs of these watersheds. The modeled long-term annual average flows on the lower San Joaquin River at Vernalis would decrease slightly compared to Existing Conditions and be similar compared to the No Action Alternative (as a result of climate change). The reduced flow would result in possible increases in long-term average chloride concentrations of about 2%, relative to the Existing Conditions and no change relative to No Action Alternative (Appendix 8G, Table Cl-62). Consequently, Alternative 7 would not be expected to cause exceedance of chloride objectives/criteria or substantially degrade water quality with respect to chloride, and thus would not adversely affect any beneficial uses of the Sacramento River, the eastside tributaries, associated reservoirs upstream of the Delta, or the San Joaquin River.

Delta

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

Relative to the Existing Conditions and No Action Alternative, Alternative 7 would result in similar or reduced long-term average chloride concentrations for the 16-year period modeled at most of the assessment locations, and, depending on modeling approach (see Section 8.3.1.3) increased concentrations at the Contra Costa Canal at Pumping Plant #1 (i.e., up to 29% compared to No Action Alternative), Rock Slough (i.e., up to 22% compared to No Action Alternative), and the San Joaquin River at Staten Island (i.e., up to 28% compared to Existing Conditions and No Action Alternative) (Appendix 8G, *Chloride*, Table Cl-43 and Table Cl-44). Moreover, the direction and magnitude of predicted changes for Alternative 7 are similar between the alternatives, thus, the effects relative to Existing Conditions and the No Action Alternative are discussed together. Additionally, implementation of tidal habitat restoration under CM4 would increase the tidal exchange volume in the Delta, and thus may contribute to increased chloride concentrations in the Bay source water as a result of increased salinity intrusion. More discussion of this phenomenon is included in Section 8.3.1.3. Consequently, while uncertain, the magnitude of chloride increases may be greater than indicated herein and would affect the western Delta assessment locations the most which are influenced to the greatest extent by the Bay source water. The comparison to Existing Conditions reflects changes in chloride due to both Alternative 7 operations (including north Delta intake capacity of 9,000 cfs and numerous other operational components of Scenario E) and climate change/sea level rise. The comparison to the No Action Alternative reflects changes in chloride due only to operations. The following outlines the modeled chloride changes relative to the applicable objectives and beneficial uses of Delta waters.

Municipal Beneficial Uses

Estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3) were used to evaluate the 150 mg/L Bay-Delta WQCP objective for municipal and industrial beneficial uses on a basis of the percent of years the chloride objective is exceeded for the modeled 16-year period. The objective is exceeded if chloride concentrations exceed 150 mg/L for a specified number of days in a given water year at both the Antioch and Contra Costa Pumping Plant #1 locations. For Alternative 7, the modeled frequency of objective exceedance would increase from 6% of years under Existing Conditions and 6% under the No Action Alternative to 25% of years under Alternative 7 (Appendix 8G, Table Cl-64).

Similarly, estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3) were also used to evaluate the 250 mg/L Bay-Delta WQCP objective for chloride at Contra Costa Pumping Plant #1 where daily average objectives apply. The basis for the evaluation was the predicted number of days the objective was exceeded for the modeled 16-year period. For Alternative 7, the modeled frequency of objective exceedance would decrease, from 6% of modeled days under Existing Conditions and 5% under the No Action Alternative to 1% of modeled days under Alternative 7 (Appendix 8G, Table Cl-63).

Given the limitations inherent to estimating future chloride concentrations (see Section 8.3.1.3), estimation of chloride concentrations through both a mass balance approach and an EC-chloride relationship approach was used to evaluate the 250 mg/L Bay-Delta WQCP objectives in terms of both frequency of exceedance and use of assimilative capacity. When utilizing the mass balance approach to model monthly average chloride concentrations for the 16-year period, the predicted frequency of exceeding the 250 mg/L objective would decrease up to 12% (i.e., 24% for Existing Conditions to 12%) at the Contra Costa Canal at Pumping Plant #1 (Appendix 8G, Table Cl-45 and Figure Cl-13). The frequency of exceedances would decrease at the San Joaquin River at Antioch (i.e., from 66% under Existing Conditions to 60%) with no substantial change predicted for Mallard Island (i.e., maximum increase of 1%) (Appendix 8G, Table Cl-45) and no substantial long-term degradation (Appendix 8G, Table Cl-47). However, relative to the No Action conditions, available assimilative capacity for chloride at the Contra Costa Canal at Pumping Plant #1 would be substantially reduced in August through October (i.e., reduction ranging from 35% to 74% for the 16 year period modeled, and 100% in August and September [i.e., eliminated]) (Appendix 8G, Table Cl-47), thus reflecting substantial degradation when concentrations would be near, or exceed, the objective.

In comparison, when utilizing the chloride-EC relationship to model monthly average chloride concentrations for the 16-year period, trends in frequency of exceedance generally agreed, but use of assimilative capacity were predicted to be larger at some locations (Appendix 8G, Table Cl-46 and Table Cl-48). Specifically, while the model predicted exceedance frequency would decrease at the Contra Costa Canal at Pumping Plant #1 and Rock Slough locations, use of assimilative capacity would increase substantially for the months of February through June as well as September (i.e., maximum of 82% in March for the modeled drought period). Due to such seasonal long-term average water quality degradation at these locations, the potential exists for substantial adverse effects on the municipal and industrial beneficial uses through reduced opportunity for diversion of water with acceptable chloride levels. Moreover, due to the increased frequency of exceeding the 150 mg/L Bay-Delta WQCP objective, the potential exists for adverse effects on the municipal and industrial beneficial uses at Contra Costa Pumping Plant #1 and Antioch.

303(d) Listed Water Bodies

With respect to the 303(d) listing for chloride in Tom Paine Slough, the monthly average chloride concentrations for the 16-year period modeled at Old River at Tracy Road would generally be similar compared to Existing Conditions, and thus, would not be further degraded on a long-term basis (Appendix 8G, Figure Cl-14. With respect to Suisun Marsh, the monthly average chloride concentrations for the 16-year period modeled would generally increase compared to Existing Conditions in some months during October through May at the Sacramento River at Collinsville (Appendix 8G, Figure Cl-15), Mallard Island (Appendix 8G, Figure Cl-13), and increase substantially at Montezuma Slough at Beldon's Landing (i.e., over a doubling of concentration in December through February) (Appendix 8G, Figure Cl-16), 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.

SWP/CVP Export Service Areas

Under Alternative 7, long-term average chloride concentrations based on the mass balance analysis of modeling results for the 16-year period modeled at the Banks and Jones pumping plants would decrease by as much as 70% relative to Existing Conditions and 66% compared to No Action Alternative (Appendix 8G, *Chloride*, Table Cl-43). The modeled frequency of exceedances of applicable water quality objectives/criteria would decrease relative to Existing Conditions and No Action Alternative, for both the 16-year period and the drought period modeled (Appendix 8G, *Chloride*, Table Cl-45). Consequently, water exported into the SWP/CVP service area would generally be of similar or better quality with regards to chloride relative to Existing Conditions and the No Action Alternative conditions.

Results of the modeling approach which used relationships between EC and chloride (see Section 8.3.1.3) were consistent with the discussion above, and assessment of chloride using these data results in the same conclusions as are presented above for the mass-balance approach (Appendix 8G, Table Cl-44 and Table Cl-46).

Commensurate with the reduced chloride concentrations in water exported to the service area, reduced chloride loading in the lower San Joaquin River would be anticipated which would likely alleviate or lessen any expected increase in chloride at Vernalis related to decreased annual average San Joaquin River flows (see discussion of Upstream of the Delta).

Maintenance of SWP and CVP facilities would not be expected to create new sources of chloride or contribute towards a substantial change in existing sources of chloride in the affected environment. Maintenance activities would not be expected to cause any substantial change in chloride such that any long-term water quality degradation would occur, thus, beneficial uses would not be adversely affected anywhere in the affected environment.

***NEPA Effects*:** In summary, relative to the No Action Alternative conditions, Alternative 7 would result in substantial increased water quality degradation relative to the 150 mg/L Bay-Delta WCCP objective at Contra Costa Pumping Plant #1 and Antioch, substantial seasonal use of assimilative capacity at Contra Costa Pumping Plant #1 and Rock Slough, and measureable water quality degradation relative to the 303(d) impairment in Suisun Marsh. The predicted chloride increases constitute an adverse effect on water quality (see Mitigation Measure WQ-7 below; implementation of this measure along with a separate, non-environmental commitment relating to the potential increased chloride treatment costs would reduce these effects). Additionally, the predicted changes relative to the No Action Alternative conditions indicate that in addition to the effects of climate change/sea level rise, implementation of CM1 and CM4 under Alternative 7 would contribute substantially to the adverse water quality effects.

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

Chloride is not a constituent of concern in the Sacramento River watershed upstream of the Delta, thus river flow rate and reservoir storage reductions that would occur under the Alternative 7, relative to Existing Conditions, would not be expected to result in a substantial adverse change in chloride levels. Additionally, relative to Existing Conditions, the Alternative 7 would not result in reductions in river flow rates (i.e., less dilution) or increased chloride loading such that there would be any substantial increase in chloride concentrations upstream of the Delta in the San Joaquin River watershed.

Relative to Existing Conditions, Alternative 7 operations would result in reduced chloride concentrations in the Delta such that exceedances of the 250 mg/L Bay-Delta WQCP objective at the San Joaquin River at Antioch and Mallard Slough would be reduced. Nevertheless, due to the predicted increased frequency of exceeding the 150 mg/L Bay-Delta WQCP objective at Contra Costa Pumping Plant #1 and Antioch as well as substantial seasonal use of assimilative capacity at Contra Costa Pumping Plant #1 and Rock Slough, the potential exists for adverse effects on the municipal and industrial beneficial uses at Contra Costa Pumping Plant #1 and Antioch (see Mitigation Measure WQ-7 below; implementation of this measure along with a separate, non-environmental commitment relating to the potential increased chloride treatment costs would reduce these effects). Moreover, the modeled increased chloride concentrations and degradation in the western Delta could further contribute, at measurable levels (i.e., over a doubling of concentration), to the existing 303(d) listed impairment due to chloride in Suisun Marsh for the protection of fish and wildlife. Also, relative to the Existing Conditions, long-term degradation at interior Delta locations could still occur and may increase the risk of exceeding aquatic life criteria.

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

Chloride is not a bioaccumulative constituent, thus any increased concentrations under Alternative 7 would not result in substantial chloride bioaccumulation impacts on aquatic life or humans. Alternative 7 maintenance would not result in any substantial changes in chloride concentration upstream of the Delta or in the SWP/CVP Export Service Areas. However, based on these findings, this impact is determined to be significant due to increased chloride concentrations and frequency of objective exceedance in the western Delta, as well as potential adverse effects on aquatic life beneficial uses in the interior Delta and fish and wildlife beneficial uses in Suisun Marsh.

While mitigation measures to reduce these water quality effects in affected water bodies to less than significant levels are not available, implementation of Mitigation Measure WQ-7 is recommended to attempt to reduce the effect that increased chloride concentrations may have on Delta beneficial uses. However, because the effectiveness of this mitigation measure to result in feasible measures for reducing water quality effects is uncertain, this impact is considered to remain significant and unavoidable. Please see Mitigation Measure WQ-7 under Impact WQ-7 in the discussion of Alternative 1A.

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

Commitments, for the full list of potential actions that could be taken pursuant to this commitment in order to reduce the water quality treatment costs associated with water quality effects relating to chloride, electrical conductivity, and bromide.

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

Please see Mitigation Measure WQ-7 under Impact WQ-7 in the discussion of Alternative 1A.

Impact WQ-8: Effects on Chloride Concentrations Resulting from Implementation of CM2–CM22

NEPA Effects: Under Alternative 7, the types and geographic extent of effects on chloride concentrations in the Delta as a result of implementation of the other conservation measures (i.e., CM2–CM22) would be similar to, and undistinguishable from, those effects previously described for Alternative 1A. The conservation measures would present no new direct sources of chloride to the affected environment. Moreover, some habitat restoration conservation measures (CM4-10) would occur on lands within the Delta currently used for irrigated agriculture, thus replacing agricultural land uses with restored tidal wetlands, floodplain, and related channel margin and off-channel habitats. The potential reduction in irrigated lands within the Delta may result in reduced discharges of agricultural field drainage with elevated chloride concentrations, which would be considered an improvement compared to Existing Conditions and No Action Alternative conditions.

In summary, based on the discussion above, the effects on chloride from implementing CM2-CM22 are considered to be not adverse.

CEQA Conclusion: Implementation of the CM2–CM22 for Alternative 7 would not present new or substantially changed sources of chloride to the affected environment upstream of the Delta, within Delta, or in the SWP/CVP service area. Replacement of irrigated agricultural land uses in the Delta with habitat restoration conservation measures may result in some reduction in discharge of agricultural field drainage with elevated chloride concentrations, thus resulting in improved water quality conditions. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

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

NEPA Effects: Effects of CM1 on dissolved oxygen under Alternative 7 are the same as those discussed for Alternative 1A and are considered to not be adverse.

CEQA Conclusion: Effects of CM1 on DO under Alternative 7 would be similar to those discussed for Alternative 1A, and are summarized here, then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion under Alternative 1A.

River flow rate and reservoir storage reductions that would occur under Alternative 7, relative to Existing Conditions, would not be expected to result in a substantial adverse change in DO levels in the reservoirs and rivers upstream of the Delta, given that mean monthly flows would remain within the ranges historically seen under Existing Conditions and the affected river are large and turbulent. Any reduced DO saturation level that may be caused by increased water temperature would not be expected to cause DO levels to be outside of the range seen historically. Finally, amounts of oxygen demanding substances and salinity would not be expected to change sufficiently to affect DO levels.

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

There is not expected to be substantial, if even measurable, changes in DO levels in the SWP/CVP Export Service Areas waters under Alternative 7, relative to Existing Conditions, because the biochemical oxygen demand of the exported water would not be expected to substantially differ from that under Existing Conditions (due to ever increasing water quality regulations), canal turbulence and exposure of the water to the atmosphere and the algal communities that exist within the canals would establish an equilibrium for DO levels within the canals. The same would occur in downstream reservoirs.

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

Impact WQ-10: Effects on Dissolved Oxygen Resulting from Implementation of CM2–CM22

***NEPA Effects*:** Effects of CM2–CM22 on DO under Alternative 7 are the same as those discussed for Alternative 1A and are considered to not be adverse.

***CEQA Conclusion*:** Conservation Measures 2–22 proposed under Alternative 7 would be similar to those proposed under Alternative 1A. As such, effects on DO resulting from the implementation of CM2–CM22 would be similar to that previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

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

Upstream of the Delta

For the same reasons stated for the No Action Alternative, EC levels (highs, lows, typical conditions) in the Sacramento River and its tributaries, the eastside tributaries, their associated reservoirs, and the San Joaquin River upstream of the Delta under Alternative 7 are not expected to be outside the ranges occurring under Existing Conditions or would occur under the No Action Alternative. Any minor changes in EC levels that could occur under Alternative 7 in water bodies upstream of the Delta would not be of sufficient magnitude, frequency and geographic extent that would cause adverse effects on beneficial uses or substantially degrade water quality with regard to EC.

Delta

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

Relative to Existing Conditions, Alternative 7 would result in an increase in the number of days the Bay-Delta WQCP EC objectives would be exceeded in the Sacramento River at Emmaton, and the San Joaquin River at San Andreas Landing, Prisoners Point, and Brandt Bridge (Appendix 8H, Table EC-7). The percent of days the Emmaton EC objective would be exceeded for the entire period modeled (1976–1991) would increase from 6% under Existing Conditions to 16% under Alternative 7, and the percent of days out of compliance would increase from 11% under Existing Conditions to 26% under Alternative 7. The percent of days the San Andreas Landing EC objective would be exceeded would increase from 1% under Existing Conditions to 3% under Alternative 7, and the percent of days out of compliance with the EC objective would increase from 1% under Existing Conditions to 6% under Alternative 7. The percent of days the Prisoners Point EC objective would be exceeded for the entire period modeled would increase from 6% under Existing Conditions to 35% under Alternative 7, and the percent of days out of compliance with the EC objective would increase from 10% under Existing Conditions to 35% under Alternative 7. In the San Joaquin River at Brandt Bridge, the percent of days exceeding the EC objective would increase from 3% under Existing Conditions to 4% under Alternative 7; the percent of days out of compliance would increase from 8% under Existing Conditions to 9% under Alternative 7. Average EC levels at the western and southern Delta compliance locations and San Joaquin River at San Andreas Landing (an interior Delta location) would decrease from 0–46% for the entire period modeled and 2–45% during the drought period modeled (1987–1991) (Appendix 8H, Table EC-18). In the S. Fork Mokelumne River at Terminous, average EC would increase 6% for the entire period modeled and 5% during the drought period modeled. Average EC in the S. Fork Mokelumne River at Terminous would increase during all months (Appendix 8H, Table EC-18). Average EC in the San Joaquin River at Prisoners Point would increase by 1% during the drought period (Appendix 8H, Table EC-18). Given that the western and southern Delta are Clean Water Act section 303(d) listed as impaired due to elevated EC, the increase in the incidence of exceedance of EC objectives under Alternative 7, relative to Existing Conditions, has the potential to contribute to additional impairment and potentially adversely affect beneficial uses. The comparison to Existing Conditions reflects changes in EC due to both Alternative 7 operations (including north Delta intake capacity of 9,000 cfs and numerous other operational components of Scenario E) and climate change/sea level rise.

Relative to the No Action Alternative, the percent of days exceeding EC objectives and percent of days out of compliance would increase at: Sacramento River at Emmaton, San Joaquin River at Jersey Point, San Andreas Landing, Vernalis, Brandt Bridge, and Prisoners Point; and Old River near Middle River and at Tracy Bridge (Appendix 8H, Table EC-7). The increase in percent of days exceeding the EC objective would be 34% at Prisoners Point and 10% or less at the remaining locations. The increase in percent of days out of compliance would be 34% at Prisoners Point and 15% or less at the remaining locations. For the entire period modeled, average EC levels would increase at: S. Fork Mokelumne River (6%), Old River at Tracy Bridge (1%), and San Joaquin River at Prisoners Point (10%) (Appendix 8H, Table EC-18). During the drought period modeled, average EC would increase at: S. Fork Mokelumne River (6%), San Joaquin River at Brandt Bridge (1%) and

Prisoners Point (8%), and Old River at Tracy Bridge 1%) (Appendix 8H, Table EC-18). Given that the western and southern Delta are Clean Water Act section 303(d) listed as impaired due to elevated EC, the increase in the incidence of exceedance of EC objectives under Alternative 7, relative to the No Action Alternative, has the potential to contribute to additional impairment and potentially adversely affect beneficial uses. The comparison to the No Action Alternative reflects changes in EC due only to Alternative 7 operations (including north Delta intake capacity of 9,000 cfs and numerous other operational components of Scenario E).

For Suisun Marsh, October–May is the period when Bay-Delta WQCP EC objectives for protection of fish and wildlife apply. Long-term average EC would increase under Alternative 7, relative to Existing Conditions, during the months of April and May by 0.2 mS/cm in the Sacramento River at Collinsville (Appendix 8H, Table EC-21). Long-term average EC would decrease relative to Existing Conditions in Montezuma Slough at National Steel during October–May (Appendix 8H, Table EC-22). The most substantial increase would occur near Beldon Landing, with long-term average EC levels increasing by 0.8–3.3 mS/cm, depending on the month, nearly doubling during some months the long-term average EC relative to Existing Conditions (Appendix 8H, Table EC-23). Sunrise Duck Club and Volanti Slough also would have long-term average EC increases of 0.1–1.6 mS/cm (Appendix 8H, Tables EC-24 and EC-25). The degree to which the long-term average EC increases would cause exceedance of Bay-Delta WQCP objectives is unknown, because objectives are expressed as a monthly average of daily high tide EC, which does not have to be met if it can be demonstrated "equivalent or better protection will be provided at the location" (State Water Resources Control Board 2006:14). 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 be substantial and it is uncertain the degree to which current management plans for the Suisun Marsh would be able to address these substantially higher EC levels and protect beneficial uses. Thus, these increased EC levels in Suisun Marsh are considered to have a potentially adverse effect on marsh beneficial uses. Long-term average EC increases in Suisun Marsh under Alternative 7 relative to the No Action Alternative would be similar to the increases relative to Existing Conditions. Suisun Marsh is section 303(d) listed as impaired due to elevated EC, and the potential increases in long-term average EC concentrations could contribute to additional impairment, because the increases would be double that relative to Existing Conditions and the No Action Alternative.

SWP/CVP Export Service Areas

At the Banks and Jones pumping plants, Alternative 7 would result in no exceedances of the Bay-Delta WQCP's 1,000 µmhos/cm EC objective for the entire period modeled (Appendix 8H, Table EC-10). Thus, there would be no adverse effect on the beneficial uses in the SWP/CVP Export Service Areas using water pumped at this location under the Alternative 7.

At the Banks pumping plant, relative to Existing Conditions, average EC levels under Alternative 7 would decrease substantially: 47% for the entire period modeled and 51% during the drought period modeled. Relative to the No Action Alternative, average EC levels would decrease by 43% for the entire period modeled and 46% during the drought period modeled. (Appendix 8H, Table EC-18)

At the Jones pumping plant, relative to Existing Conditions, average EC levels under Alternative 7 would also decrease substantially: 52% for the entire period modeled and 59% during the drought period modeled. Relative to the No Action Alternative, average EC levels would decrease by 50% for the entire period modeled and 57% during the drought period modeled. (Appendix 8H, Table EC-18)

Based on the decreases in long-term average EC levels that would occur at the Banks and Jones pumping plants, Alternative 7 would not cause degradation of water quality with respect to EC in the SWP/CVP Export Service Areas; rather, Alternative 7 would improve long-term average EC conditions in the SWP/CVP Export Service Areas.

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

The export area of the Delta is listed on the state's CWA Section 303(d) list as impaired due to elevated EC. Alternative 7 would result in lower average EC levels relative to Existing Conditions and the No Action Alternative and, thus, would not contribute to additional beneficial use impairment related to elevated EC in the SWP/CVP Export Service Areas waters.

NEPA Effects: In summary, the increased frequency of exceedance of EC objectives and increased long-term and drought period average EC levels that would occur at interior and southern Delta compliance locations, and increased frequency of exceedance of EC objectives in the western Delta under Alternative 7, relative to the No Action Alternative, would contribute to adverse effects on the agricultural beneficial uses. In addition. the increased frequency of exceedance of the San Joaquin River at Prisoners Point EC objective and long-term and drought period average EC could contribute to adverse effects on fish and wildlife beneficial uses. Given that the western and southern Delta are Clean Water Act section 303(d) listed as impaired due to elevated EC, the increase in the incidence of exceedance of EC objectives and long-term average and drought period average EC in these portions of the Delta has the potential to contribute to additional beneficial use impairment. The increases in long-term average EC levels that would occur in Suisun Marsh would further degrade existing EC levels and could contribute additional to adverse effects on the fish and wildlife beneficial uses. Suisun Marsh is section 303(d) listed as impaired due to elevated EC, and the potential increases in long-term average EC levels could contribute to additional beneficial use impairment. These increases in EC constitute an adverse effect on water quality. Mitigation Measure WQ-11 would be available to reduce these effects (implementation of this measure along with a separate, non-environmental commitment as set forth in EIR/EIS Appendix 3B, *Environmental Commitments*, relating to the potential EC-related changes would reduce these effects).

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

River flow rate and reservoir storage reductions that would occur under Alternative 7, relative to Existing Conditions, would not be expected to result in a substantial adverse change in EC levels in the reservoirs and rivers upstream of the Delta, given that: changes in the quality of watershed runoff and reservoir inflows would not be expected to occur in the future; the state's aggressive regulation of point-source discharge effects on Delta salinity-elevating parameters and the expected further regulation as salt management plans are developed; the salt-related TMDLs adopted and being developed for the San Joaquin River; and the expected improvement in lower San Joaquin River average EC levels commensurate with the lower EC of the irrigation water deliveries from the Delta.

Relative to Existing Conditions, Alternative 7 would not result in any substantial increases in long-term average EC levels in the SWP/CVP Export Service Areas. There would be no exceedance of the EC objective at the Jones and Banks pumping plants. Average EC levels for the entire period modeled would decrease at both plants and, thus, this alternative would not contribute to additional beneficial use impairment related to elevated EC in the SWP/CVP Export Service Areas waters. Rather, this alternative would improve long-term EC levels in the SWP/CVP Export Service Areas, relative to Existing Conditions.

In the Plan Area, Alternative 7 would result in an increase in the frequency with which Bay-Delta WQCP EC objectives are exceeded in the Sacramento River at Emmaton (agricultural objective; 10% increase), San Joaquin River at San Andreas Landing (agricultural objective; 2% increase) and Brandt Bridge (agricultural objective; 1% increase) in the southern Delta, and San Joaquin River at Prisoners Point (fish and wildlife objective; 29% increase) in the interior Delta for the entire period modeled (1976–1991). The increased frequency of exceedance of the fish and wildlife objective at Prisoners Point could contribute to adverse effects on aquatic life, and the increased frequency of the EC exceedance at Emmaton could contribute to adverse effects on agricultural uses. Because EC is not bioaccumulative, the increases in long-term average EC levels would not directly cause bioaccumulative problems in aquatic life or humans. The western and southern Delta are Clean Water Act section 303(d) listed for elevated EC and the increased frequency of exceedance of EC objectives that would occur in these portions of the Delta could make beneficial use impairment measurably worse. This impact is considered to be significant.

Further, relative to Existing Conditions, Alternative 7 would result in substantial increases in long-term average EC during the months of October through May in Suisun Marsh, such that EC levels would be double that relative to Existing Conditions. The increases in long-term average EC levels that would occur in Suisun Marsh could further degrade existing EC levels and thus contribute additionally to adverse effects on the fish and wildlife beneficial uses. Because EC is not bioaccumulative, the increases in long-term average EC levels would not directly cause bioaccumulative problems in 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.

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

Please see Mitigation Measure WQ-11 under Impact WQ-11 in the discussion of Alternative 1A.

Impact WQ-12: Effects on Electrical Conductivity Resulting from Implementation of CM2–CM22

***NEPA Effects*:** Effects of CM2–CM22 on EC under Alternative 7 are the same as those discussed for Alternative 1A and are considered not to be adverse.

***CEQA Conclusion*:** Conservation Measures 2–22 proposed under Alternative 7 would be similar to those proposed under Alternative 1A. As such, effects on EC resulting from the implementation of CM2–CM22 would be similar to that previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

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

Upstream of the Delta

Under Alternative 7, the magnitude and timing of reservoir releases and river flows upstream of the Delta in the Sacramento River watershed and east-side tributaries would be altered, relative to Existing Conditions and the No Action Alternative.

The Sacramento River at Freeport and San Joaquin River at Vernalis (as summarized for water quality average concentrations in Tables 8-48 and 8-49) were examined for flow/concentration relationships for mercury and methylmercury. No significant, predictive regression relationships were discovered for mercury or methylmercury, except for total mercury with flow at Freeport (monthly or annual)(Figures 8I-10 through 8I-13, Appendix 8I). Such a positive relationship between total mercury and flow is to be expected based on the association of mercury with suspended sediment and the mobilization of sediments during storm flows. However, the changes in flow in the Sacramento River under Alternative 7 relative to Existing Conditions and the No Action Alternative are not of the magnitude of storm flows, in which substantial sediment-associated mercury is mobilized. Therefore mercury loading should not be substantially different due to changes in flow. In addition, even though it may be flow-affected, total mercury concentrations remain well below criteria at upstream locations. Any negligible changes in mercury concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies as related to mercury. Both waterborne methylmercury concentrations and largemouth bass fillet mercury concentrations are expected to remain above guidance levels at upstream of Delta locations, but will not change substantially relative to Existing Conditions or the No Action Alternative due to changes in flows under Alternative 7.

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

Delta

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

The water quality impacts of waterborne concentrations of mercury and methylmercury and fish tissue mercury concentrations were evaluated for 9 Delta locations. The analysis of percentage change in assimilative capacity of waterborne total mercury of Alternative 7 relative to the 25 ng/L ecological risk benchmark as compared to Existing Conditions showed a 6.7% reduction at Old River at Rock Slough and Contra Costa Pumping Plant, and a 6.6% reduction at those same locations relative to the No Action Alternative. These changes are not expected to result in adverse effects to beneficial use (Figures 8-53 and 8-54). Similarly, changes in methylmercury concentration are expected to be relatively small. The greatest annual average methylmercury concentration for drought conditions was 0.164 ng/L for the San Joaquin River at Buckley Cove which was slightly higher than Existing Conditions (0.161 ng/L), and slightly lower than the No Action Alternative (0.167 ng/L) (Appendix 8I, Table I-6). All modeled input concentrations exceeded the methylmercury TMDL guidance objective of 0.06 ng/L, therefore percentage change in assimilative capacity was not evaluated for methylmercury.

Fish tissue estimates show substantial percentage increases in concentration and exceedance quotients for mercury at some Delta locations. The greatest changes in exceedance quotients relative to Existing Conditions and the No Action Alternative are 30 - 39% at the Contra Costa Pumping Plant and 32–45% for Old River at Rock Slough (Figure 8-55, Appendix 8I, Table I-14b).

SWP/CVP Export Service Areas

The analysis of mercury and methylmercury in the SWP/CVP Export Service Areas was based on concentrations estimated at the Banks and Jones pumping plants. Both waterborne total and methylmercury concentrations for Alternative 7 are projected to be lower than Existing Conditions and the No Action Alternative (Appendix 8I, Figures 8I-8 and 8I-9). Therefore, mercury shows an increased assimilative capacity at these locations (Figures 8-53 and 8-54).

The largest improvements in bass tissue mercury concentrations and exceedance quotients for Alternative 7, relative to Existing Conditions and the No Action Alternative at any location within the Delta are expected for the export pump locations (specifically, at Jones Pumping plant, 30% improvement relative to Existing Conditions, 32% relative to the No Action Alternative) (Figure 8-55, Appendix 8I, Table I-14b).

***NEPA Effects*:** Based on the above discussion, the effects of mercury and methylmercury in comparison of Alternative 7 to the No Action Alternative (as waterborne and bioaccumulated forms) are considered to be adverse for the case of fish tissue bioaccumulation at some locations.

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

Under Alternative 7, greater water demands and climate change would alter the magnitude and timing of reservoir releases and river flows upstream of the Delta in the Sacramento River watershed and east-side tributaries, relative to Existing Conditions. Concentrations of mercury and methylmercury upstream of the Delta will not be substantially different relative to Existing Conditions due to the lack of important relationships between mercury/methylmercury concentrations and flow for the major rivers.

Methylmercury concentrations exceed criteria at all locations in the Delta and no assimilative capacity exists. However, monthly average waterborne concentrations of total and methylmercury, over the period of record, are very similar to Existing Conditions. Similarly, estimates of fish tissue mercury concentrations show almost no differences would occur among sites for Alternative 7 as compared to Existing Conditions for Delta sites.

Assessment of effects of mercury in the SWP and CVP Export Service Areas were based on effects on mercury concentrations and fish tissue mercury concentrations at the Banks and Jones pumping plants. The Banks and Jones pumping plants are expected to show increased assimilative capacity for waterborne mercury and decreased fish tissue concentrations of mercury for Alternative 7 as compared to Existing Conditions.

As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. However, increases in fish tissue mercury concentrations are substantial, and changes in fish tissue mercury concentrations would make existing mercury-related impairment in the Delta measurably worse. In comparison to Existing Conditions, Alternative 7 would increase levels of mercury by frequency, magnitude, and geographic extent such that the affected environment would be expected to have measurably higher body burdens of mercury in aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish) or humans consuming those organisms. This impact is considered to be significant. Feasible or effective actions to reduce the effects on mercury resulting from CM1 are unknown. General mercury management measures through CM12, or actions taken by other entities or programs such as TMDL implementation, may minimize or reduce sources and inputs of mercury to the Delta and methylmercury formation. However, it is uncertain whether this impact would be reduced to a level that would be less than significant as a result of CM12 or other future actions. Therefore, the impact would be significant and unavoidable.

Impact WQ-14: Effects on Mercury Concentrations Resulting from Implementation of CM2–CM22

***NEPA Effects*:** Some habitat restoration activities under Alternative 7 would occur on lands in the Delta formerly used for irrigated agriculture. Tidal and other restoration proposed under Alternative 7 have the potential to increase water residence times and increase accumulation of organic sediments that are known to enhance methylmercury bioaccumulation in biota in the restored habitat. Therefore, increases in mercury methylation in the habitat restoration areas is possible but uncertain depending on the specific restoration design implemented at a particular Delta location. Models to estimate the potential for methylmercury formation in restored areas are not currently available. However, DSM2 modeling for Alternative 7 operations does incorporate assumptions for certain habitat restoration activities proposed under CM2 and CM4 (see Section 8.3.1.3) that result in changes to Delta hydrodynamics compared to the No Action Alternative. These modeled restoration assumptions provide some insight into potential hydrodynamic changes that could be expected related to implementing CM2 and CM4 and are considered in the evaluation of the potential for increased mercury and methylmercury concentrations under Alternative 7.

BDCP Conservation Measure 12 (CM12) addresses the potential for methylmercury bioaccumulation associated with restoration activities and acknowledges the uncertainties associated with mitigating or minimizing this potential effect. CM12 proposes project-specific mercury management plans for restoration actions that will incorporate relevant approaches recommended in Phase 1 Methylmercury TMDL control studies. Specific approaches recommended under CM12 that are intended to minimize or mitigate for potential increases in methylmercury bioaccumulation at future restoration sites include:

- Characterizing mercury, methylmercury, organic carbon, iron, and sulfate concentrations to better inform restoration design,
- Sequestering methylmercury at restoration sites using low intensity chemical dosing techniques,
- Minimizing microbial methylation associated with anoxic conditions by reducing the amount of organic material at a restoration site,
- Designing restoration sites to enhance photo degeneration that converts methylmercury into a biologically unavailable, inorganic form of mercury,
- Remediating restoration site soils with iron to reduce methylation in sulfide rich soils, and
- Considering capping mercury laden sediments, where possible to reduce methylation potential at a site.

Because of the uncertainties associated with site-specific estimates of methylmercury concentrations and the uncertainties in source modeling and tissue modeling, the effectiveness of methylmercury management proposed under CM12 to reduce methylmercury concentrations would need to be evaluated separately for each restoration effort, as part of design and implementation. Because of this uncertainty and the known potential for methylmercury creation in the Delta this potential effect of implementing CM2–CM22 is considered adverse.

***CEQA Conclusion*:** There would be no substantial, long-term increase in mercury or methylmercury concentrations or loads in the rivers and reservoirs upstream of the Delta or the waters exported to the CVP and SWP service areas due to implementation of CM2–CM22 relative to Existing Conditions.

However, uptake of mercury from water and/or methylation of inorganic mercury may increase to an unquantified degree as part of the creation of new, marshy, shallow, or organic-rich restoration areas. Methylmercury is 303(d)-listed within the affected environment, and therefore any potential measurable increase in methylmercury concentrations would make existing mercury-related impairment measurably worse. Because mercury is bioaccumulative, increases in water-borne mercury or methylmercury that could occur in some areas could bioaccumulate to somewhat greater levels in aquatic organisms and would, in turn, pose health risks to fish, wildlife, or humans. Design of restoration sites under Alternative 7 would be guided by CM12 which requires development of site specific mercury management plans as restoration actions are implemented. The effectiveness of minimization and mitigation actions implemented according to the mercury management plans is not known at this time although the potential to reduce methylmercury concentrations exists based on current research. Although the BDCP will implement CM12 with the goal to reduce this potential effect the uncertainties related to site specific restoration conditions and the potential for increases in methylmercury concentrations in the Delta result in this potential impact being considered significant. No mitigation measures would be available until specific restoration actions are proposed. Therefore this programmatic impact is considered significant and unavoidable.

Impact WQ-15: Effects on Nitrate Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative, Alternative 7 would have negligible, if any, impact on nitrate concentrations in the rivers and reservoirs upstream of the Delta in the Sacramento River watershed relative to Existing Conditions and the No Action Alternative.

Under Alternative 7, modeling indicates that long-term annual average flows on the San Joaquin River would decrease by an estimated 6%, relative to Existing Conditions, and would remain virtually the same relative to the No Action Alternative (Appendix 5A). Given these relatively small decreases in flows and the weak correlation between nitrate and flows in the San Joaquin River (see Nitrate Appendix 8J, Figure 2), it is expected that nitrate concentrations in the San Joaquin River would be minimally affected, if at all, by changes in flow rates under Alternative 7.

Any negligible changes in nitrate-N concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regards to nitrate.

Delta

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

Results of the mixing calculations indicate that under Alternative 7, relative to Existing Conditions and the No Action Alternative, nitrate concentrations throughout the Delta are anticipated to remain low (<1.4 mg/L-N) relative to adopted objectives (Nitrate Appendix 8J, Table 25 and 26). Long-term average nitrate concentrations are anticipated to increase at most locations in the Delta. The increase would be greatest at Franks Tract, Old River at Rock Slough, and Contra Costa Pumping Plant #1 (all >85% increase). Long-term average concentrations were estimated to increase to 0.67, 1.04 and 1.10 mg/L-N for Franks Tract, Old River at Rock Slough, and Contra Costa Pumping Plant #1, respectively, due primarily to increased San Joaquin River water percentage at these locations (see Fingerprinting Appendix 8D). Although changes at specific Delta locations and for specific months may be substantial on a relative basis, the absolute concentration of nitrate in Delta waters would remain low (<1.4 mg/L-N) in relation to the drinking water MCL of 10 mg/L-N, as well as all other thresholds identified in Table 8-50. No additional exceedances of the MCL are anticipated at any location (Nitrate Appendix 8J, Table 25). On a monthly average basis and on a long term annual average basis, for all modeled years and for the drought period (1987–1991) only, use of assimilative capacity available under Existing Conditions and the No Action Alternative, relative to the drinking water MCL of 10 mg/L-N, was up to approximately 13% at Old River at Rock Slough and Contra Costa Pumping Plant #1, and averaged approximately 6% on a long-term average basis (Nitrate Appendix 8J, Table 27). Similarly, the use of available assimilative capacity at Franks Tract was up to approximately 6%, and averaged 3% over the long term. The concentrations estimated for these locations would not increase the likelihood of exceeding the 10 mg/L-N MCL, nor would they increase the risk for adverse effects to beneficial uses. At all other locations, use of assimilative capacity was negligible (<5%) (Nitrate Appendix 8J, Table 27).

Nitrate concentrations will likely be higher than the modeling results indicate in certain locations. This includes in the Sacramento River between Freeport and Mallard Island and other areas in the Delta downstream of Freeport that are influenced by Sacramento River water. These increases are associated with ammonia and nitrate that are discharged from the SRWTP, which are not included in the modeling.

- Under Existing Conditions, most of the ammonia discharged from the SRWTP is converted to nitrate downstream of the facility's discharge at Freeport, and thus, nitrate concentrations under Existing Conditions in these areas are expected to be higher than the modeling predicts, the increase becoming greater with increasing distance downstream. However, the increase in nitrate concentrations downstream of the SRWTP is expected to be small—the existing increase appears to be from approximately 0.1 mg/L-N to approximately 0.4–0.5 mg/L-N over this reach, due to approximately a 1:1 conversion of ammonia-N to nitrate-N (Central Valley Water Board 2010a:32).

- Under Alternative 7, the planned upgrades to the SRWTP, which include nitrification/partial denitrification, would substantially decrease ammonia concentrations in the discharge, but would increase nitrate concentrations in the discharge up to 10 mg/L-N, which is substantially higher than under Existing Conditions.

- Overall, under Alternative 7, the nitrogen load from the SRWTP discharge is expected to decrease (by up to 50%), relative to Existing Conditions, due to nitrification/partial dentrification ugrades at the SRWTP facility. Thus, while concentrations of nitrate downstream of the facility are expected to be higher than modeling results indicate for both Existing Conditions and Alternative 7, the increase is expected to be greater under Existing Conditions than for Alternative 7 due to the upgrades that are assumed under Alternative 7.

The other areas in which nitrate concentrations will be higher than the modeling results indicate are immediately downstream of other wastewater treatment plants that practice nitrification, but not denitrification (e.g., City of Rio Vista Beach WWTF, Town of Discovery Bay WWTF, City of Stockton RWCF). For all such facilities in the Delta, the Regional Water Boards have issued NPDES permits that allow discharge of wastewater containing nitrate into the Delta, and under these permits, the State has determined that no beneficial uses are adversely affected by the discharge, and that the discharger's use of available assimilative capacity of the water body is acceptable. When dilution is necessary in order for the discharge to be in compliance with the Basin Plans (which incorporate the 10 mg/L-N MCL by reference), not all of the assimilative capacity of the receiving water is granted to the discharger. Thus, limited decreases in flows are not anticipated to result in systemic exceedances of the MCLs by these POTWs. Furthermore, NPDES permits are renewed on a 5-year basis, and thus, if under changes in flows, dilution was no longer sufficient to maintain nitrate below the MCL in the receiving water, the NPDES permit renewal process would address such cases.

Therefore, any increases in nitrate-N concentrations that may occur at certain locations within the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to nitrate.

SWP/CVP Export Service Areas

Assessment of effects of nitrate in the SWP and CVP Export Service Areas is based on effects on nitrate-N at the Banks and Jones pumping plants.

Results of the mixing calculations indicate that under Alternative 7, relative to Existing Conditions and the No Action Alternative, nitrate concentrations at Banks and Jones pumping plants are anticipated to decrease on a long-term average annual basis (Nitrate Appendix 8J, Table 25 and 26). During the late summer, particularly in the drought period assessed, concentrations are expected to increase substantially on a relative basis (i.e., >50%), but the absolute value of these changes (i.e., in mg/L-N) is small. Additionally, given the many factors that contribute to potential algal blooms in the SWP and CVP canals within the Export Service Area, and the lack of studies that have shown a direct relationship between nutrient concentrations in the canals and reservoirs and problematic algal blooms in these water bodies, there is no basis to conclude that these small (i.e., generally <0.3 mg/L-N), seasonal increases in nitrate concentrations would increase the potential for problem algal blooms in the SWP and CVP Export Service Area. No additional exceedances of the MCL are anticipated (Nitrate Appendix 8J, Table 25). On a monthly average basis and on a long term annual average basis, for all modeled years and for the drought period (1987–1991) only, use of assimilative capacity available under Existing Conditions and the No Action Alternative, relative to the 10 mg/L-N MCL, was negligible for both Banks and Jones pumping plants (Nitrate Appendix 8J, Table 27).

Any increases in nitrate-N concentrations that may occur in water exported via Banks and Jones pumping plants are not expected to result in adverse effects to beneficial uses or substantially degrade the quality of exported water, with regards to nitrate.

NEPA Effects: In summary, based on the discussion above, the effects on nitrate from implementing CM1 are considered to be not adverse.

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

Nitrate-N concentrations are generally low in the reservoirs and rivers of the watersheds, owing to substantial dilution available for point sources and the lack of substantial nonpoint sources of nitrate-N upstream of the SRWTP in the Sacramento River watershed, and in the watersheds of the eastern tributaries (Cosumnes, Mokelumne, and Calaveras Rivers). Although higher in the San Joaquin River watershed, nitrate-N concentrations are not well-correlated with flow rates. Consequently, any modified reservoir operations and subsequent changes in river flows under Alternative 7, relative to Existing Conditions, are expected to have negligible, if any, effects on reservoir and river nitrate-N concentrations upstream of Freeport in the Sacramento River watershed and upstream of the Delta in the San Joaquin River watershed.

In the Delta, results of the mixing calculations indicate that under Alternative 7, relative to Existing Conditions, long-term average nitrate concentrations are anticipated to increase at most locations. The increase would be greatest at Franks Tract, Old River at Rock Slough, and Contra Costa Pumping Plant #1 (all >85% increase), due primarily to increased San Joaquin River water percentage at these locations. However, nitrate concentrations throughout the Delta are anticipated to remain low (<1.4 mg/L-N) relative to adopted objectives, and no additional exceedances of the MCL are anticipated at any location. Use of assimilative capacity at locations throughout the Delta (up to 13%) did not result in concentrations that would increase the likelihood of exceeding the 10 mg/L-N MCL, nor would they increase the risk for adverse effects to beneficial uses.

Assessment of effects of nitrate in the SWP and CVP Export Service Areas is based on effects on nitrate-N concentrations at the Banks and Jones pumping plants. Results of the mixing calculations indicate that under Alternative 7, relative to Existing Conditions, long-term average nitrate concentrations at Banks and Jones pumping plants are anticipated to decrease. No additional exceedances of the MCL are anticipated. Monthly average use of assimilative capacity available under Existing Conditions, relative to the MCL, for both Banks and Jones pumping plants in drought conditions was at times >50%, but the absolute value of these changes (i.e., in mg/L-N) was small. Additionally, given the many factors that contribute to potential algal blooms in the SWP and CVP canals within the Export Service Area, and the lack of studies that have shown a direct relationship between nutrient concentrations in the canals and reservoirs and problematic algal blooms in these water bodies, there is no basis to conclude that these small (i.e., generally <0.3 mg/L-N), seasonal increases in nitrate concentrations would increase the potential for problem algal blooms in the SWP and CVP Export Service Area.

Based on the above, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. No long-term water quality degradation is expected to occur such that exceedance of criteria is more likely or such that there is an increased risk of adverse impacts to beneficial uses. Nitrate is not 303(d) listed within the affected environment and thus any increases that may occur in some areas and months would not make any existing nitrate-related impairment measurably worse because no such impairments currently exist. Because nitrate is not bioaccumulative, increases that may occur in some areas and months would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-16: Effects on Nitrate Concentrations Resulting from Implementation of CM2–CM22

***NEPA Effects*:** Effects of CM2–CM22 on nitrate under Alternative 7 are the same as those discussed for Alternative 1A and are considered not to be adverse.

***CEQA Conclusion*:** Conservation Measures 2–22 proposed under Alternative 7 would be similar to those proposed under Alternative 1A. As such, effects on nitrate resulting from the implementation of CM2–CM22 would be similar to that previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-17: Effects on Dissolved Organic Carbon Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Under Alternative 7, there would be no substantial change to the sources of DOC within the watersheds upstream of the Delta. Moreover, long-term average flow and DOC levels in the Sacramento River at Hood and San Joaquin River at Vernalis are poorly correlated. Thus changes in system operations and resulting reservoir storage levels and river flows would not be expected to cause a substantial long-term change in DOC concentrations in the water bodies upstream of the Delta. Any negligible changes in DOC levels in water bodies upstream of the Delta under Alternative 7, relative to Existing Conditions and the No Action Alternative, would not be of sufficient frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regards to DOC.

Delta

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

Under Alternative 7, the geographic extent of effects pertaining to long-term average DOC concentrations in the Delta would be similar to that previously described for Alternative 1A, although the magnitude of predicted long-term increase and relative frequency of concentration threshold exceedances would be substantially greater. Modeled effects would be greatest at Franks Tract, Rock Slough, and Contra Costa PP No. 1., where for the 16-year hydrologic period and the modeled drought period, long-term average concentration increases ranging from 0.7–1.1 mg/L would be predicted (≤30% net increase), resulting in long-term average DOC concentrations greater than 4 mg/L at Rock Slough and Contra Costa PP No. 1 (Appendix 8K, DOC Table 8). Increases in long-term average concentrations would correspond to more frequent concentration threshold exceedances, with the greatest change occurring at Rock Slough and Contra Costa PP No. 1 locations. For Rock Slough, long-term average DOC concentrations exceeding 3 mg/L would increase from 52% under Existing Conditions to 85% under the Alternative 7 (an increase from 47% to 82% for the drought period), and concentrations exceeding 4 mg/L would increase from 30% to 47% (32% to 57% for the drought period). For Contra Costa PP No. 1, long-term average DOC concentrations exceeding 3 mg/L would increase from 52% under Existing Conditions to 85% under Alternative 7

(45% to 88% for the drought period), and concentrations exceeding 4 mg/L would increase from 32% to 52% (35% to 58% for the drought period). Relative change in frequency of threshold exceedance for other assessment locations would be similar or less. This comparison to Existing Conditions reflects changes in DOC due to both Alternative 7 operations (including north Delta intake capacity of 9,000 cfs and numerous other operational components of Scenario E) and climate change/sea level rise.

In comparison, Alternative 7 relative to the No Action Alternative would generally result in a similar magnitude of change to that discussed for the comparison to Existing Conditions. Maximum increases of 0.7–1.0 mg/L DOC (i.e., ≤26%) would be predicted at Franks Tract, Rock Slough, and Contra Costa PP No. 1 relative to No Action Alternative) (Appendix 8K, DOC Table 8). Threshold concentration exceedance frequency trends would also be similar to that discussed for the existing condition comparison, with exception to the predicted 4 mg/L exceedance frequency at Buckley Cove. In comparison to the No Action Alternative, the frequency which long-term average DOC concentrations exceeded 4 mg/L at Buckley Cove would increase from 27% to 33% (42% to 57% for the modeled drought period). Unlike the comparison to Existing Conditions, this comparison to the No Action Alternative reflects changes in DOC due only to Alternative 7 operations.

The increases in long-term average DOC concentrations estimated to occur at Franks Tract, Rock Slough, and Contra Costa PP No. 1 are considered substantial and could potentially trigger significant changes in drinking water treatment plant design or operations. In particular, assessment locations at Rock Slough and Contra Costa PP No. 1 represent municipal intakes servicing existing drinking water treatment plants. Under Alternative 7, drinking water treatment plants obtaining water from these interior Delta locations would likely need to upgrade existing treatment systems in order to achieve EPA Stage 1 Disinfectants and Disinfection Byproduct Rule action thresholds. While treatment technologies sufficient to achieve the necessary DOC removals exist, implementation of such technologies would likely require substantial investment in new or modified infrastructure.

Relative to existing and No Action Alternative conditions, Alternative 7 would lead to predicted improvements in long-term average DOC concentrations at Barker Slough, as well as Banks and Jones pumping plants (discussed below). Predicted long-term average DOC concentrations at Barker Slough would decrease <0.1–0.2 mg/L, depending on baseline conditions comparison and modeling period.

SWP/CVP Export Service Areas

Under Alternative 7, modeled long-term average DOC concentrations would decrease at Banks and Jones pumping plants for both the modeled 16-year hydrologic period and the modeled drought period. Modeled decreases would generally be similar between Existing Conditions and the No Action Alternative. Relative to Existing Conditions, long-term average DOC concentrations at Banks would be predicted to decrease by 1.1 mg/L (1.3 mg/L during drought period) (Appendix 8K, DOC Table 8). At Jones, long-term average DOC concentrations would be predicted to decrease by 1.0 mg/L (1.2 mg/L during drought period). Such substantial improvement in long-term average DOC concentrations would include fewer exceedances of concentration thresholds. Average DOC concentrations exceeding the 2 mg/L concentration threshold would decrease from 100% under Existing Conditions and the No Action Alternative to 67% at Banks and 61% at Jones under Alternative 7 (60% and 57%, respectively during the drought period), while concentrations exceeding 4 mg/L would nearly be eliminated (i.e., ≤15% exceedance frequency). Such modeled improvement would correspond to substantial improvement in Export Service Areas water quality, respective to DOC.

Similar to the discussion pertaining to the No Action Alternative, maintenance of SWP and CVP facilities under Alternative 7 would not be expected to create new sources of DOC or contribute towards a substantial change in existing sources of DOC in the affected area. Maintenance activities would not be expected to cause any substantial change in long-term average DOC concentrations such that MUN beneficial uses, or any other beneficial use, would be adversely affected.

NEPA Effects: In summary, Alternative 7, relative to the No Action Alternative, would not cause a substantial long-term change in DOC concentrations in the water bodies upstream of the Delta. Long-term average DOC concentrations at Banks and Jones pumping plants are predicted to decrease by as much as 1.4 mg/L, while long-term average DOC concentrations for some Delta interior locations, including Franks Tract, Rock Slough and Contra Costa PP #1, are predicted to increase by as much as 1.0 mg/L. Resultant substantial changes in long-term average DOC at these Delta interior locations could necessitate changes in water treatment plant operations or require treatment plant upgrades in order to maintain DBP compliance, and thus would constitute an adverse effect on water quality and MUN beneficial uses. Mitigation Measure WQ-17 is available to reduce these effects.

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

While greater water demands under the Alternative 7 would alter the magnitude and timing of reservoir releases north, south and east of the Delta, these activities would have no substantial effect on the various watershed sources of DOC. Moreover, long-term average flow and DOC at Sacramento River at Hood and San Joaquin River at Vernalis are poorly correlated; therefore, changes in river flows would not be expected to cause a substantial long-term change in DOC concentrations upstream of the Delta.

Relative to Existing Conditions, Alternative 7 would result in substantial increases (i.e., 0.7–1.1 mg/L) in long-term average DOC concentrations at some Delta interior locations, and would be greatest at Franks Tract, Rock Slough, and Contra Costa PP No. 1. At these locations the predicted changes in DOC would substantially increase the frequency with which long-term average concentrations exceeds 2, 3, or 4 mg/L. Drinking water treatment plants obtaining water from these interior Delta locations would likely need to upgrade existing treatment systems in order to achieve EPA Stage 1 Disinfectants and Disinfection Byproduct Rule action thresholds. Such predicted magnitude change in long-term average DOC concentrations would represent a substantially increased risk for adverse effects on existing MUN beneficial.

The assessment of Alternative 7 effects on DOC in the SWP/CVP Export Service Areas is based on assessment of changes in DOC concentrations at Banks and Jones pumping plants. Relative to the existing condition, long-term average DOC concentrations would decrease by as much as 1.3 mg/L at Banks and Jones pumping plants. The frequency with which long-term average DOC concentrations would exceed 2, 3, or 4 mg/L would be substantially reduced, where predicted exceedances of >4 mg/L would be nearly eliminated (i.e., ≤15% exceedance frequency). As a result, substantial improvement in DOC-related water quality would be predicted in the SWP/CVP Export Service Areas.

Based on the above, Alternative 7 operation and maintenance would not result in any substantial change in long-term average DOC concentration upstream of the Delta. Furthermore, under Alternative 7, water exported from the Delta to the SWP/CVP service area would be substantially improved relative to DOC. DOC is not bioaccumulative, therefore change in long-term average DOC concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Additionally, DOC is not a constituent related to any 303(d) listings. Nevertheless, new and modified conveyance facilities proposed under Alternative 7 would result in a substantial increase in long-term average DOC concentrations (i.e., 0.7–1.1 mg/L, equivalent to ≤30% relative increase) at Franks Tract, Rock Slough, and Contra Costa PP No. 1. In particular, under Alternative 7, model predicted long-term average DOC concentrations would be greater than 4 mg/L at Rock Slough and Contra Costa PP No. 1 with commensurate substantial increases in the frequency with which average DOC concentrations exceed 2, 3, and 4 mg/L levels. Drinking water treatment plants obtaining water from these interior Delta locations would likely need to upgrade existing treatment systems in order to achieve EPA Stage 1 Disinfectants and Disinfection Byproduct Rule action thresholds. Therefore, such a magnitude change in long-term average DOC concentrations would represent a substantially increased risk for adverse effects on existing MUN beneficial uses at Rock Slough and Contra Costa PP No. 1 should such treatment upgrades not be undertaken. The impact is considered significant and mitigation is required. While Mitigation Measure WQ-17 is available to partially reduce this impact of DOC, the feasibility and effectiveness of this mitigation measure is uncertain and implementation would not necessarily reduce the identified impact to a level that would be less than significant, and therefore it is significant and unavoidable.

Mitigation Measure WQ-17: Consult with Delta Water Purveyors to Identify Means to Avoid, Minimize, or Offset Increases in Long-Term Average DOC Concentrations

Please see Mitigation Measure WQ-17 under Impact WQ-17 in the discussion of Alternative 6A.

Impact WQ-18: Effects on Dissolved Organic Carbon Concentrations Resulting from Implementation of CM2–CM22

NEPA Effects**:** Conservation Measures 2–22 under Alternative 7 would be similar to those under Alternative 1A, but 40 linear miles rather than 20 linear miles of channel margin habitat would be enhanced, and 20,000 acres rather than 10,000 acres of seasonally inundated floodplain would be restored. Effects on DOC resulting from the implementation of CM2–CM22 would be similar to that previously discussed for Alternative 1A, except that the increased linear miles of channel margin habitat enhancement and increased acreage of seasonally inundated floodplain would increase the overall Alternative 7 DOC loading to the Delta. In total, CM4–CM7 and CM10 could contribute substantial amounts of DOC to raw drinking water supplies, largely depending on final design and operational criteria for the related restoration activities. Substantially increased long-term average DOC in raw water supplies could lead to a need for treatment plant upgrades in order to appropriately manage DBP formation in treated drinking water. This potential for future DOC increases would lead to substantially greater associated risk of long-term adverse effects on the MUN beneficial use.

In summary, the habitat restoration elements of CM4–CM7 and CM10 under Alternative 7 would present new localized sources of DOC to the study area, and in some circumstances would substitute for existing sources related to replaced agriculture. Depending on localized hydrodynamics and proximity to municipal drinking water intakes, such restoration activities could contribute substantial amounts of DOC to municipal raw water. Substantial increases in municipal raw water DOC could necessitate changes in water treatment plant operations or require treatment plant upgrades in order to maintain DBP compliance, and thus would constitute an adverse effect on water quality. Mitigation Measure WQ-18 is available to reduce these effects.

***CEQA Conclusion*:** Effects of CM4–CM7 and CM10 on DOC under Alternative 7 are similar to, and possibly greater than, those discussed for Alternative 1A. Similar to the discussion for Alternative 1A, this impact is considered to be significant. It is uncertain whether implementation of Mitigation Measure WQ-18 would reduce identified impacts to a less-than-significant level. Hence, this impact remains significant and unavoidable.

In addition to and to supplement Mitigation Measure WQ-18, the BDCP proponents have incorporated into the BDCP, as set forth in EIR/EIS Appendix 3B, *Environmental Commitments*, a separate, non-environmental commitment to address the potential increased water treatment costs that could result from DOC concentration effects on municipal and industrial water purveyor operations. Potential options for making use of this financial commitment include funding or providing other assistance towards implementing treatment for DOC and/or DBPs or DOC source control strategies. Please refer to Appendix 3B, *Environmental Commitments*, for the full list of potential actions that could be taken pursuant to this commitment in order to reduce the water quality treatment costs associated with water quality effects relating to DOC.

Mitigation Measure WQ-18: Design Wetland and Riparian Habitat Features to Minimize Effects on Municipal Intakes

Please see Mitigation Measure WQ-18 under Impact WQ-18 in the discussion of Alternative 1A.

Impact WQ-19: Effects on Pathogens Resulting from Facilities Operations and Maintenance (CM1)

***NEPA Effects*:** Effects of CM1 on pathogens under Alternative 7 are the same as those discussed for Alternative 1A and are considered to not be adverse.

***CEQA Conclusion*:** Effects of CM1 on pathogens under Alternative 7 are the same as those discussed for Alternative 1A, and are summarized here, then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion under Alternative 1A.

River flow rate and reservoir storage reductions that would occur due to implementation of CM1 (water facilities and operations) under Alternative 7, relative to Existing Conditions, would not be expected to result in a substantial adverse change in pathogen concentrations in the reservoirs and rivers upstream of the Delta, given the small magnitude of urban runoff contributions relative to the magnitude of river flows, that pathogen concentrations in the rivers have a minimal relationship to river flow rate, and the expected reduced pollutant loadings in response to NPDES stormwater-related regulations.

It is expected there would be no substantial change in Delta pathogen concentrations in response to a shift in the Delta source water percentages under this alternative or substantial degradation of these water bodies, with regard to pathogens. This conclusion is based on the Pathogens Conceptual

Model, which found that pathogen sources in close proximity to a Delta site appear to have the greatest influence on pathogen levels at the site, rather than the primary source(s) of water to the site. In-Delta potential pathogen sources, including water-based recreation, tidal habitat, wildlife, and livestock-related uses, would continue under this alternative.

In the SWP/CVP Export Service Areas waters, relative to Existing Conditions, an increased proportion of water coming from the Sacramento River would not adversely affect beneficial uses in the SWP/CVP Export Service Areas. The pathogen levels in the Sacramento River are similar to or lower than the water diverted at the Delta export pumps. Further, it is localized sources of pathogens that appear to have the greatest influence on concentrations. Thus, an increased proportion of Sacramento River water diverted to the SWP/CVP Export Service Areas would result in minimal changes in pathogen levels in the SWP/CVP Export Service Areas waters.

Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because pathogen concentrations are not expected to increase substantially, no long-term water quality degradation for pathogens is expected to occur and, thus, no adverse effects on beneficial uses would occur. The San Joaquin River in the Stockton Deep Water Ship Channel is Clean Water Act section 303(d) listed for pathogens. Because no measurable increase in Deep Water Ship Channel pathogen concentrations are expected to occur on a long-term basis, further degradation and impairment of this area is not expected to occur. Finally, pathogens are not bioaccumulative constituents. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-20: Effects on Pathogens Resulting from Implementation of CM2–CM22

***NEPA Effects*:** Effects of CM2–CM22 on pathogens under Alternative 7 are the same as those discussed for Alternative 1A and are considered to not be adverse.

***CEQA Conclusion*:** Conservation Measures 2–22 proposed under Alternative 7 would be similar to those proposed under Alternative 1A. As such, effects on pathogens resulting from the implementation of CM2–CM22 would be similar to that previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-21: Effects on Pesticide Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative, under Alternative 7 no specific operations or maintenance activity of the SWP or CVP would substantially drive a change in pesticide use, and thus pesticide sources would remain unaffected upstream of the Delta. Nevertheless, changes in the timing and magnitude of reservoir releases could have an effect on available dilution capacity along river segments such as the Sacramento, Feather, American, and San Joaquin Rivers.

Under Alternative 7, winter (November–March) and summer (April–October) season average flow rates on the Sacramento River at Freeport, American River at Nimbus, Feather River at Thermalito and the San Joaquin River at Vernalis would change. Relative to existing condition and the No Action Alternative, seasonal average flow rates on the Sacramento would decrease no more than 3% during the summer and 4% during the winter (Appendix 8L, Seasonal average flows Tables 1-4). On the

Feather River, average flow rates would decrease no more than 5% during the summer, but would increase as much as 7% in the winter. American River average flow rates would decrease by as much as 15% in the summer but would increase by as much as 6% in the winter. Seasonal average flow rates on the San Joaquin River would decrease by as much as 12% in the summer, but increase by as much as 1% in the winter. For the same reasons stated for the No Action Alternative, decreased seasonal average flow of ≤15% is not considered to be of sufficient magnitude to substantially increase pesticide concentrations or alter the long-term risk of pesticide-related toxicity to aquatic life, nor adversely affect other beneficial uses of water bodies upstream of the Delta.

Delta

Sources of diuron, OP and pyrethroid insecticides to the Plan Area include direct input of surface runoff from in-Delta agriculture and Delta urbanized areas as well as inputs from rivers upstream of the Delta. Similar to Upstream of the Delta, CVP/SWP operations would not affect these sources.

Under Alternative 7, the distribution and mixing of Delta source waters would change. Percent change in monthly average source water fraction were evaluated for the modeled 16-year (1976–1991) hydrologic period and a representative drought period (1987–1991), with special attention given to changes in San Joaquin River, Sacramento River and Delta Agriculture sources water fractions. Relative to Existing Conditions, under Alternative 7 modeled San Joaquin River fractions would increase greater than 10% at Franks Tract, Rock Slough, Contra Costa PP No. 1, and the San Joaquin River at Antioch (Appendix 8D, Source Water Fingerprinting). At Antioch, San Joaquin River source water fractions when modeled for the 16-year hydrologic period would increase by 11–14% from November through May (no increase >10% for the modeled drought period). While this change at Antioch is not considered substantial, changes in San Joaquin River source water fraction in the Delta interior would be considerable. At Franks Tract, San Joaquin River source water fractions would increase between 18–28% for October through June (12–25% for November through June of the modeled drought period). Changes at Rock Slough and Contra Costa PP No. 1 would be very similar, where modeled San Joaquin River source water fractions would increase from 27–71% (11–70% for the modeled drought period) for October through June. Relative to Existing Conditions, there would be no modeled increases in Sacramento River fractions greater than 16% (with exception to Banks and Jones which are discussed below) and Delta agricultural fractions greater than 6%. Increases in San Joaquin River source water fraction at Franks Tract, Rock Slough, and Contra Costa PP NO. 1 would primarily balance through decreases in Sacramento River water, and as a result the San Joaquin River would account for greater than 50% of the total source water volume at Franks Tract between March through May (<50% for all months during the modeled drought period), and would be 50%, and as much as 81% during November through May at Rock Slough and Contra Costa PP No. 1 for both the modeled drought and 16-year hydrologic periods. While the source water and potential pesticide related toxicity co-occurrence predictions do not mean adverse effects would occur, such considerable modeled increases in early summer source water fraction at Franks Tract and winter and summer source water fractions at Rock Slough and Contra Costa PP No. 1 could substantially alter the long-term risk of pesticide-related toxicity to aquatic life, given the apparent greater incidence of pesticides in the San Joaquin River.

When compared to the No Action Alternative, changes in source water fractions would be similar in season, geographic extent, and magnitude to those discussed for Existing Conditions with exception to Buckley Cove during the modeled drought period. At Buckley Cove, modeled drought period San Joaquin River fractions would increase 15% in July and 14% in August when compared to No Action

Alternative (Appendix 8D, Source Water Fingerprinting). These increases would primarily balance through decreases in Sacramento River water and eastside tributary waters. Nevertheless, the San Joaquin River at Buckley Cove during the modeled drought period would only account for 36% of the total source water volume in July and 26% in August. These changes at Buckley Cove are not considered substantial, however, as discussed for Existing Conditions, under the No Action Alternative the similar magnitude change at Franks Tract, Rock Slough, and Contra Costa PP No. 1 would be considered substantial and could substantially alter the long-term risk of pesticide-related toxicity to aquatic life.

These predicted adverse effects on pesticides relative to Existing Conditions and the No Action Alternative fundamentally assume that the present pattern of pesticide incidence in surface water will occur at similar levels into the future. In reality, however, the makeup and character of the pesticide use market in the late long-term (i.e., the year 2060) will not be exactly as it is today. Current use of chlorpyrifos and diazinon is on the decline with their replacement by pyrethroids on the rise, yet in this assessment it is the apparent greater incidence of diazinon and chlorpyrifos on the San Joaquin River that serves as the basis for concluding that substantially increased San Joaquin River source water fraction would correspond to an increased risk of pesticide-related toxicity to aquatic life. By 2060, however, alternative pesticides, such as neonicitinoids and biologicals, will likely be a more substantial contributing part of the existing mix of pesticides, and perhaps more prominent. The trend in the development of future-use pesticides is towards reduced risk pesticides, including more biopesticides, with greater targeted specificity, fewer residues, and lower overall non-target toxicity. By 2060 existing chlorpyrifos and diazinon TMDLs for the Sacramento and San Joaquin Rivers will have been in effect for more than 50 years. Moreover, it is reasonable to expect that CWA section 303(d) listings and future additional listings will have developed TMDLs by 2060. To the extent these existing and future TMDL's address current and future-use pesticides, a greater degree of pesticide related source control can be anticipated. Nevertheless, forecasting whether these various efforts will ultimately be successful at resolving current pesticide related impairments requires considerable speculation. While the fundamental assumptions that have guided this assessment of pesticides may be somewhat altered by 2060, these assumptions are informed by actual studies and monitoring data collected from the recent past and, therefore, judging project alternative effects in the future remain most accurate through use of these informed assumptions rather than based on assumptions founded upon future speculative conditions.

SWP/CVP Export Service Areas

Assessment of effects in SWP/CVP Export Service Areas is based on effects seen in the Plan Area at the Banks and Jones pumping plants. Under Alternative 7, Sacramento River source water fractions would increase substantially at both Banks and Jones pumping plants relative to Existing Conditions and the No Action Alternative (Appendix 8D, Source Water Fingerprinting). At Banks pumping plant, Sacramento source water fractions would generally increase from 27–79% for October through June (13–32% for December through March of the modeled drought period) and at Jones pumping plant Sacramento source water fractions would generally increase from 43–96% for October through June (37–89% for October through June of the modeled drought period). These increases in Sacramento source water fraction would primarily balance through equivalent decreases in San Joaquin River water. Based on the general observation that San Joaquin River, in comparison to the Sacramento River, is a greater contributor of OP insecticides in terms of greater frequency of incidence and presence at concentrations exceeding water quality benchmarks, modeled increases in Sacramento River fraction at Banks and Jones would generally represent an improvement in export water quality respective to pesticides.

NEPA Effects: In summary, the changes in long-term average flows on the Sacramento, Feather, American, and San Joaquin Rivers, under Alternative 7 relative to the No Action Alternative, are of insufficient magnitude to substantially increase the long-term risk of pesticide-related water quality degradation and related toxicity to aquatic life in these water bodies upstream of the Delta. However, modeled increases in San Joaquin River fraction at Franks Tract, Rock Slough, and Contra Costa PP No. 1 are of sufficient magnitude to substantially alter the long-term risk of pesticide-related water quality degradation and related toxicity to aquatic life in the Delta. The effects on pesticides from operations and maintenance (CM1) are determined to be adverse and unavoidable.

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

Sources of pesticides upstream of the Delta include direct input of pesticide containing surface runoff from agriculture and urbanized areas. Flows in rivers receiving these discharges dilute these pesticide inputs. Relative to Existing Conditions, however, modeled changes in long-term average flows on the Sacramento, Feather, American, and San Joaquin Rivers are of insufficient magnitude to substantially increase the long-term risk of pesticide-related water quality degradation and related toxicity to aquatic life in these water bodies upstream of the Delta.

In the Delta, sources of pesticides include direct input of surface runoff from Delta agriculture and Delta urbanized areas as well as inputs from rivers upstream of the Delta. While facilities operations and maintenance activities would not affect these sources, changes in Delta source water fraction could change the relative risk associated with pesticide related toxicity to aquatic life. Under Alternative 7, modeled long-term average San Joaquin River source water fractions at Franks Tract, Rock Slough and Contra Costa PP No. 1 locations would increase considerably for some months such that the long-term risk of pesticide-related toxicity to aquatic life could substantially increase.

The assessment of Alternative 7 effects on pesticides in the SWP/CVP Export Service Areas is based on assessment of changes predicted at Banks and Jones pumping plants. Sacramento River source water fractions would increase substantially at both Banks and Jones pumping plants and would generally represent an improvement in export water quality respective to pesticides.

Based on the above, Alternative 7 would not result in any substantial change in long-term average pesticide concentration or result in substantial increase in the anticipated frequency with which long-term average pesticide concentrations would exceed aquatic life toxicity thresholds or other beneficial use effect thresholds upstream of the Delta or the SWP/CVP service area. Numerous pesticides are currently used throughout the affected environment, and while some of these pesticides may be bioaccumulative, those present-use pesticides for which there is sufficient evidence for their presence in waters affected by SWP and CVP operations (i.e., diazinon, chlorpyrifos, diuron, and pyrethroids) are not considered bioaccumulative, and thus changes in their concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Furthermore, while there are numerous 303(d) listings throughout the affected environment that name pesticides as the cause for beneficial use impairment, the modeled changes in upstream river flows and Delta source water fractions would not be expected to make any of these beneficial use impairments measurably worse, with principal exception to locations in the Delta that would receive a substantially greater fraction San Joaquin River water under Alternative 7. Long-term average San

Joaquin River source water fractions at Franks Tract, Rock Slough and Contra Costa PP No. 1 locations would change considerably for some months such that the long-term risk of pesticide-related toxicity to aquatic life could substantially increase. Additionally, the potential for increased incidence of pesticide related toxicity could include pesticides such as chlorpyrifos and diazinon for which existing 303(d) listings exist for the Delta, and thus existing beneficial use impairment could be made discernibly worse. The impact is considered to be significant and unavoidable. There is no feasible mitigation available to reduce the effect of this significant impact.

Impact WQ-22: Effects on Pesticide Concentrations Resulting from Implementation of CM2–CM22

NEPA Effects: Conservation Measures 2–22 under Alternative 7 would be similar to those under Alternative 1A, but 40 linear miles rather than 20 linear miles of channel margin habitat would be enhanced, and 20,000 acres rather than 10,000 acres of seasonally inundated floodplain would be restored. Effects on pesticides resulting from the implementation of CM2–CM22 would be similar to that previously discussed for Alternative 1A. In summary, CM13 proposes the use of herbicides to control invasive aquatic vegetation around habitat restoration sites. Herbicides directly applied to water could include adverse effects on non-target aquatic life, such as aquatic invertebrates and beneficial aquatic plants. As such, aquatic life toxicity objectives could be exceeded with sufficient frequency and magnitude such that beneficial uses would be impacted, thus constituting an adverse effect on water quality.

In summary, based on the discussion above, the effects on pesticides from implementing CM2-CM22 are considered to be adverse. Mitigation Measure WQ-22 would be available to reduce this adverse effect.

CEQA Conclusion: Effects of CM2–CM22 on pesticides under Alternative 7 are similar to those discussed for Alternative 1A. Potential environmental effects related only to CM13 are considered to be significant. Mitigation is required. While Mitigation Measure WQ-22 is available to partially reduce this impact of pesticides, no feasible mitigation is available that would reduce it to a level that would be less than significant.

Mitigation Measure WQ-22: Implement Least Toxic Integrated Pest Management Strategies

Please see Mitigation Measure WQ-22 under Impact WQ-22 in the discussion of Alternative 1A.

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

NEPA Effects: Effects of water facilities and operations (CM1) on phosphorus levels in water bodies of the affected environment under Alternative 7 would be very similar (i.e., nearly the same) to those discussed for Alternative 1A. Consequently, the environmental consequences to phosphorus levels discussed in detail for Alternative 1A also adequately represent the effects under Alternative 7, which are considered to be not adverse.

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

Because phosphorus loading to waters upstream of the Delta is not anticipated to change, and because changes in flows do not necessarily result in changes in concentrations or loading of phosphorus to these water bodies, substantial changes in phosphorus concentration upstream of the Delta are not anticipated for Alternative 7, relative to Existing Conditions.

Because phosphorus concentrations in the major source waters to the Delta are similar for much of the year, phosphorus concentrations in the Delta are not anticipated to change substantially on a long term-average basis under Alternative 7, relative to Existing Conditions. Algal growth rates are limited by availability of light in the Delta, and therefore any minor increases in phosphorus levels that may occur at some locations and times within the Delta would be expected to have little effect on primary productivity in the Delta.

The assessment of effects of phosphorus under Alternative 7 in the SWP and CVP Export Service Areas is based on effects on phosphorus at the Banks and Jones pumping plants. As noted above, phosphorus concentrations in the Delta (including Banks and Jones pumping plants) are not anticipated to change substantially on a long term-average basis.

Based on the above, there would be no substantial, long-term increase in phosphorus concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the waters exported to the CVP and SWP service areas under Alternative 7 relative to Existing Conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/ criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because phosphorus concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Phosphorus is not 303(d) listed within the affected environment and thus any minor increases that may occur in some areas would not make any existing phosphorus-related impairment measurably worse because no such impairments currently exist. Because phosphorus is not bioaccumulative, minor increases that may occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-24: Effects on Phosphorus Concentrations Resulting from Implementation of CM2–CM22

***NEPA Effects*:** Effects of CM2–CM22 on phosphorus levels in water bodies of the affected environment under Alternative 7 would be very similar (i.e., nearly the same) to those discussed for Alternative 1A. Consequently, the environmental consequences to phosphorus levels from implementing CM2–CM22 discussed in detail for Alternative 1A also adequately represent the effects of these same actions under Alternative 7, which are considered to be not adverse.

***CEQA Conclusion*:** Conservation Measures 2–22 proposed under Alternative 7 would be similar to those proposed under Alternative 1A. As such, effects on phosphorus resulting from the implementation of CM2–CM22 would be similar to that previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

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

Upstream of the Delta

For the same reasons stated for the No Action Alternative, Alternative 7 would have negligible, if any, effect on selenium concentrations in the rivers and reservoirs upstream of the Delta relative to Existing Conditions and the No Action Alternative. Any negligible increases in selenium concentrations that could occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regard to selenium.

Delta

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

Alternative 7 would result in small to moderate changes in average selenium concentrations in water at all modeled Delta assessment locations relative to Existing Conditions and the No Action Alternative (Appendix 8M, Table M-10A). Changes in selenium concentrations in water are reflected in small (10% or less) to moderate (between 11% and 50%) percent changes in available assimilative capacity for selenium (based on 2 µg/L ecological risk benchmark) for all years. Relative to Existing Conditions, Alternative 7 would result in the largest modeled increases in available assimilative capacity at Buckley Cove (4%); relative to the No Action Alternative, the largest increase would be at Staten Island (1%), and the largest decreases for Existing Conditions and the No Action Alternative would be at Rock Slough and Contra Costa PP (12%) (Figures 8-59 and 8-60). Although moderate negative changes in assimilative capacity would occur at two locations (Rock Slough and Contra Costa PP), the changes are minimal at the other locations and the available assimilative capacity at all locations would remain substantial; therefore, the effect of Alternative 7 is generally minimal for the Delta. Furthermore, the ranges of modeled selenium concentrations in water (Appendix 8M, Table M-10A) for Alternative 7 (range 0.24–0.71 µg/L), Existing Conditions (range 0.21–0.76 µg/L), and the No Action Alternative (range 0.21–0.69 µg/L) are similar, and would be well below the ecological risk benchmark (2 µg/L).

Relative to Existing Conditions and the No Action Alternative, Alternative 7 would generally result in small changes in estimated selenium concentrations in biota (whole-body fish, bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets) (Appendix 8M, Table M-18 and Addendum M.A to Appendix 8M, Table M.A-2). Relative to Existing Conditions and the No Action Alternative, the largest increase of selenium concentrations in biota would be at Contra Costa PP for drought years and in sturgeon at the two western Delta locations in all as well as drought years. Relative to Existing Conditions, the largest decrease would be at Buckley Cove for drought years. Relative to the No Action Alternative, the largest decrease would be at Staten Island for drought years (except for bird eggs [assuming a fish diet] at Buckley Cove for drought years). Except for sturgeon in the western Delta, concentrations of selenium in whole-body fish and bird eggs (invertebrate and fish diets) would exceed only the lower benchmarks (4 and 6 mg/kg dry weight, respectively, indicating a low potential for effects), under drought conditions, at Buckley Cove for Alternative 7 and Existing Conditions and the No Action Alternative (Figures 8-61 through 8-63). Exceedance Quotients for these exceedances of the lower benchmarks are between 1.0 and 1.5, indicating a low risk to biota in the Delta and no substantial difference for Alternative 7 from Existing Conditions and the No Action Alternative. Selenium concentrations in fish fillets would not exceed the screening value for protection of human health (Figure 8-64). For sturgeon in the western Delta, whole-body selenium concentrations would increase from 12.3 mg/kg under Existing Conditions and the No Action Alternative to 14.7 mg/kg under Alternative 7, a 20% increase (Table M.A-2). All of these values exceed both the low and high toxicity benchmarks. These increases are high enough that they may represent a measurable increase in body burdens of sturgeon, which would constitute an adverse impact (see also the discussion of results provided in Addendum M.A to Appendix 8M).

SWP/CVP Export Service Areas

Alternative 7 would result in small to moderate changes in average selenium concentrations relative to the Existing Conditions and the No Action Alternative (Appendix 8M, Table M-10A). These changes in selenium concentrations in water are reflected in small (10% or less) to moderate (between 11% and 50%) percent changes in available assimilative capacity for selenium for all years. Relative to Existing Conditions and the No Action Alternative, Alternative 7 would result in modeled increases in available assimilative capacity at Jones PP (14% and 15%, respectively) and at Banks PP (8%) (Figures 8-59 and 8-60) and would have a positive effect at the Export Service Area locations. The ranges of modeled selenium concentrations in water (Appendix 8M, Table M-10A) for Alternative 7 (range 0.32–0.37 μg/L), Existing Conditions (range 0.37–0.58 μg/L), and the No Action Alternative (range 0.37–0.59 μg/L) are similar, and all would be well below the ecological risk benchmark (2 μg/L).

Relative to Existing Conditions and the No Action Alternative, Alternative 7 would result in small changes in estimated selenium concentrations in biota (Appendix 8M, Table M-18). Relative to Existing Conditions and the No Action Alternative, the largest increase of selenium concentrations in biota would be at Banks PP for drought years (except for bird eggs [assuming a fish diet] at Banks PP for all years), and the largest decrease would be at Jones PP for drought years. However, concentrations in biota would not exceed any benchmarks for Alternative 7 (Figures 8-61 through 8-64).

Thus, relative to Existing Conditions and the No Action Alternative, Alternative 7 would result in small to moderate changes in selenium concentrations in water and minimal changes in selenium concentrations in biota at the Export Service Area locations. Selenium concentrations in water and biota generally would decrease under Alternative 7 and would not exceed ecological benchmarks at either location, whereas the lower benchmark for bird eggs (fish diet) would be exceeded under Existing Conditions and the No Action Alternative at Jones PP for drought years. This small positive change in selenium concentrations under Alternative 7 would be expected to slightly decrease the frequency with which applicable benchmarks would be exceeded or slightly improve the quality of water in the Export Services Areas, with regard to selenium.

NEPA Effects: Based on the discussion above, the effects on selenium from Alternative 7 are considered to be adverse. This determination is reached because selenium concentrations in whole-body sturgeon modeled at two western Delta locations would increase by an estimated 20%, which may represent a measurable increase in the environment. Because both low and high toxicity benchmarks are already exceeded under the No Action Alternative, these potentially measurable increases represent an adverse impact.

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

There are no substantial point sources of selenium in watersheds upstream of the Delta, and no substantial nonpoint sources of selenium in the watersheds of the Sacramento River and the eastern tributaries. Nonpoint sources in the San Joaquin Valley that contribute selenium to the Delta will be controlled through a TMDL developed by the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the Grassland Bypass Project, and Basin Plan objectives (Central Valley Water Board 2010c) and State Water Board (2010d, 2010e) that are expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta. Consequently, any modified reservoir operations and subsequent changes in river flows under Alternative 7, relative to Existing Conditions, are expected to cause negligible changes in selenium concentrations in water. Any negligible changes in selenium concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies as related to selenium.

Relative to Existing Conditions, modeling estimates indicate that Alternative 7 would 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.

Assessment of effects of selenium in the SWP and CVP Export Service Areas is based on effects on selenium concentrations at the Banks and Jones pumping plants. Relative to Existing Conditions, Alternative 7 would slightly decrease the frequency with which applicable benchmarks would be exceeded 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, significant impacts on some beneficial uses of waters in the Delta could occur because both low and high toxicity benchmarks are already exceeded under Existing Conditions, and uptake of selenium from water to biota may measurably increase. In comparison to Existing Conditions, water quality conditions under this alternative would increase levels of selenium (a bioaccumulative pollutant) by frequency, magnitude, and geographic extent such that the affected environment may have measurably higher body burdens of selenium in aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish); however, impacts to humans consuming those organisms are not expected to occur. Water quality conditions under this alternative with respect to selenium would cause long-term degradation of water quality in the western Delta. Except in the vicinity of the western Delta for sturgeon, water quality conditions under this alternative would not increase levels of selenium by frequency, magnitude, and geographic extent such that the affected environment would be expected to have measurably higher body burdens of selenium in aquatic organisms. The greater level of selenium bioaccumulation in the western Delta would further degrade water quality by measurable levels, on a long-term basis, for selenium and, thus, cause the 303(d)-listed impairment of beneficial use to be made discernibly worse. This impact is considered significant.

The need for, and the feasibility and effectiveness of, post-operation mitigation for the predicted level of selenium bioaccumulation is uncertain. The first step shall be to determine the reliability of the model in predicting biota selenium concentrations in the affected environment where effects are predicted but selenium data are lacking. For that reason, the model shall be validated with site-specific sampling before extensive mitigation measures relative to CM1 operations are developed and evaluated for feasibility, as the measures and their evaluation for feasibility are likely to be complex. Specifically, it remains to be determined whether the available existing data for transfer of selenium from water to particulates and through different trophic levels of the food chain are representative of conditions that may occur from implementation of Alternative 7. Therefore, the proposed mitigation measure requires that sampling be conducted to characterize each step of data inputs needed for the model, and then the refined model be validated for local conditions. This impact is considered significant and unavoidable.

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

NEPA Effects**:** In general, with the possible exception of changes in Delta hydrodynamics resulting from habitat restoration, CM2–CM11 would not substantially increase selenium concentrations in the water bodies of the affected environment. Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, and thus such effects of these restoration measures were included in the assessment of CM1 facilities operations and maintenance (see Impact WQ-25).

However, implementation of these conservation measures may increase water residence time within the restoration areas. Increased restoration area water residence times could potentially increase the bioaccumulation of selenium in biota, thereby potentially increasing fish tissue and bird egg concentrations of selenium, but models are not available to quantitatively estimate the level of changes in residence time and the associated selenium bioavailability. If increases in fish tissue or bird egg selenium were to occur, the increases would likely be of concern only where fish tissues or bird eggs are already elevated in selenium to near or above thresholds of concern. That is, where biota concentrations are currently low and not approaching thresholds of concern, changes in residence time alone would not be expected to cause them to then approach or exceed thresholds of concern. In consideration of this factor, although the Delta as a whole is a 303(d)-listed water body for selenium, and although monitoring data of fish tissue or bird eggs in the Delta are sparse, the most likely areas in which biota tissues would be at levels high enough that additional bioaccumulation due to increased residence time from restoration areas would be a concern are the western Delta and Suisun Bay, and the South Delta in areas that receive San Joaquin River water.

The western Delta and Suisun Bay receive elevated selenium loads from North San Francisco Bay (including San Pablo Bay, Carquinez Strait, and Suisun Bay) and from the San Joaquin River. Point sources of selenium in North San Francisco Bay (i.e., refineries) that contribute selenium to Suisun Bay are expected to be reduced through a TMDL under development by the San Francisco Bay Water Board (San Francisco Bay Water Board 2012) that is expected to result in decreasing discharges of selenium. Nonpoint sources of selenium in the San Joaquin Valley that contribute selenium to the San Joaquin River, and thus the Delta and Suisun Bay, will be controlled through a TMDL developed by the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the Grassland Bypass Project, and Basin Plan objectives (Central Valley Water Board 2010c, d) that are expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta. If selenium levels are not sufficiently reduced via these efforts, it is expected that the State Water Board and the San Francisco Bay and Central Valley Water Boards would initiate additional actions to further control sources of selenium.

The South Delta receives elevated selenium loads from the San Joaquin River. In contrast to Suisun Bay and possibly the western Delta in the future, the South Delta lacks the overbite clam (*Corbula* [*Potamocorbula*] *amurensis*), which is considered a key driver of selenium bioaccumulation in Suisun Bay, due to its high bioaccumulation of selenium and its role in the benthic food web that includes long-lived sturgeon. The South Delta does have *Corbicula fluminea*, another bivalve that bioaccumulates selenium, but it is not as invasive as the overbite clam and thus likely makes up a smaller fraction of sturgeon diet. Also, as mentioned above, nonpoint sources of selenium in the San Joaquin Valley that contribute selenium to the Delta will be controlled through a TMDL developed by the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the Grassland Bypass Project, and Basin Plan objectives (Central Valley Water Board 2010c, d) that are expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta. Further, if selenium levels in the San Joaquin River are not sufficiently reduced via these efforts, it is expected that the State Water Board and Central Valley Water Board would initiate additional TMDLs to further control nonpoint sources of selenium.

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

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

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

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

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

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

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

Impact WQ-27: Effects on Trace Metal Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative, Alternative 7 would result in negligible, and likely immeasurable, increases in trace metal concentrations in the rivers and reservoirs upstream of the Delta, relative to Existing Conditions and the No Action Alternative. Effects due to the operation and maintenance of the conveyance facilities are expected to be immeasurable, on an annual and long-term average basis. As such, Alternative 7 would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or CTR criteria would be exceeded in water bodies of the affected environment located upstream of the Delta or substantially degrade the quality of these water bodies, with regard to trace metals.

Delta

For the same reasons stated for the No Action Alternative, Alternative 7 would not result in substantial increases in trace metal concentrations in the Delta relative to Existing Conditions and the No Action Alternative. However, substantial changes in source water fraction would occur in the south Delta (Appendix 8D, Source Water Fingerprinting). Throughout much of the south Delta, San Joaquin River water would replace Sacramento River water, with the future trace metals profile largely reflecting that of the San Joaquin River. As discussed for the No Action Alternative, trace metal concentration profiles between the San Joaquin and Sacramento Rivers are very similar and currently meet Basin Plan objectives and CTR criteria. While the change in trace metal concentrations in the south Delta would likely be measurable, Alternative 7 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 Delta waters with regard to trace metals.

SWP/CVP Export Service Areas

For the same reasons stated for the No Action Alternative, Alternative 7 would not result in substantial increases in trace metal concentrations in the water exported from the Delta or diverted from the Sacramento River through the proposed conveyance facilities. As such, there is not expected to be substantial changes in trace metal concentrations in the SWP/CVP export service area waters under Alternative 7, relative to Existing Conditions and the No Action Alternative. As such, Alternative 7 would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or CTR criteria would be exceeded in the water bodies of the affected environment in the SWP and CVP Service Area or substantially degrade the quality of these water bodies, with regard to trace metals.

NEPA Effects: In summary, Alternative 7, relative to the No Action Alternative, would not cause a substantial increase in long-term average trace metals concentrations within the affected environment, nor would it cause an increased frequency of water quality objective/criteria exceedances within the affected environment. The effect on trace metals is determined not to be adverse.

CEQA Conclusion: Effects of CM1 on trace metals under Alternative 7 would be similar to those discussed for Alternative 1A, and are summarized here, then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion under Alternative 1A.

While greater water demands under the Alternative 7 would alter the magnitude and timing of reservoir releases north, south and east of the Delta, these activities would have no substantial effect on the various watershed sources of trace metals. Moreover, long-term average flow and trace metals at Sacramento River at Hood and San Joaquin River at Vernalis are poorly correlated; therefore, changes in river flows would not be expected to cause a substantial long-term change in trace metal concentrations upstream of the Delta.

Average and 95th percentile trace metal concentrations are very similar across the primary source waters to the Delta. Given this similarity, very large changes in source water fraction would be necessary to effect a relatively small change in trace metal concentration at a particular Delta location. Moreover, average and 95th percentile trace metal concentrations for these primary source waters are all below their respective water quality criteria, including those that are hardness-based without a WER adjustment. No mixing of these three source waters could result in a metal concentration greater than the highest source water concentration, and given that trace metals do not already exceed water quality criteria, more frequent exceedances of criteria in the Delta would not be expected to occur under the Alternative 7.

The assessment of the Alternative 7 effects on trace metals in the SWP/CVP Export Service Areas is based on assessment of changes in trace metal concentrations at Banks and Jones pumping plants. As just discussed regarding similarities in Delta source water trace metal concentrations, the Alternative 7 is not expected to result in substantial changes in trace metal concentrations in Delta waters, including Banks and Jones pumping plants, therefore effects on trace metal concentrations in the SWP/CVP Export Service Area are expected to be negligible.

Based on the above, there would be no substantial long-term increase in trace metal concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the SWP/CVP export service area waters under Alternative 7 relative to Existing Conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because trace metal concentrations are not expected to increase substantially, no long-term water quality degradation for trace metals is expected to occur and, thus, no adverse effects to beneficial uses would occur. Furthermore, any negligible changes in long-term trace metal concentrations that may occur in water bodies of the affected environment would not be expected to make any existing beneficial use impairments measurably worse. The trace metals discussed in this assessment are not considered bioaccumulative, and thus would not directly cause bioaccumulative problems in aquatic life or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-28: Effects on Trace Metal Concentrations Resulting from Implementation of CM2–CM22

***NEPA Effects*:** Conservation Measures 2–22 under Alternative 7 would be similar to those under Alternative 1A, but 40 linear miles rather than 20 linear miles of channel margin habitat would be enhanced, and 20,000 acres rather than 10,000 acres of seasonally inundated floodplain would be restored. Effects on trace metals resulting from the implementation of CM2–CM22 would be similar to that previously discussed for Alternative 1A. As they pertain to trace metals, implementation of CM2–CM22 would not be expected to adversely affect beneficial uses of the affected environment or substantially degrade water quality with respect to trace metals.

In summary, implementation of CM2–CM22 under Alternative 7, relative to the No Action Alternative, would have negligible, if any, effect on trace metals concentrations. The effect on trace metals from implementing CM2–CM22 is determined not to be adverse.

CEQA Conclusion: Implementation of CM2–CM22 under Alternative 7 would not cause substantial long-term increase in trace metal concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the SWP/CVP export service area. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because trace metal concentrations are not expected to increase substantially, no long-term water quality degradation for trace metals is expected to occur and, thus, no adverse effects to beneficial uses would occur. Furthermore, any negligible changes in long-term trace metal concentrations that may occur throughout the affected environment would not be expected to make any existing beneficial use impairments measurably worse. The trace metals discussed in this assessment are not considered bioaccumulative, and thus would not directly cause bioaccumulative problems in aquatic life or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-29: Effects on TSS and Turbidity Resulting from Facilities Operations and Maintenance (CM1)

***NEPA Effects*:** Effects of CM1 on TSS and turbidity under Alternative 7 are the same as those discussed for Alternative 1A. The effects on TSS and turbidity from implementing CM1 is determined to not be adverse.

***CEQA Conclusion*:** Effects of CM1 on TSS and turbidity under Alternative 7 would be similar to those discussed for Alternative 1A, and are summarized here, then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion under Alternative 1A.

Changes river flow rate and reservoir storage that would occur under Alternative 7, relative to Existing Conditions, would not be expected to result in a substantial adverse change in TSS concentrations and turbidity levels in the reservoirs and rivers upstream of the Delta, given that suspended sediment concentrations are more affected by season than flow. Site-specific and temporal exceptions may occur due to localized temporary construction activities, dredging activities, development, or other land use changes would be site-specific and temporal, which would be regulated to limit both their short-term and long-term effects on TSS and turbidity levels to less than substantial levels.

Within the Delta, geomorphic changes associated with sediment transport and deposition are usually gradual, occurring over years, and high storm event inflows would not be substantially affected. Thus, it is expected that the TSS concentrations and turbidity levels in the affected channels would not be substantially different from the levels under Existing Conditions. Consequently, this alternative is expected to have minimal effect on TSS concentrations and turbidity levels in the Delta region, relative to Existing Conditions.

There is not expected to be substantial, if even measurable, changes in TSS concentrations and turbidity levels in the SWP/CVP Export Service Areas waters under Alternative 7, relative to Existing Conditions, because as stated above, this alternative is not expected to result in substantial changes in TSS concentrations and turbidity levels at the south Delta export pumps, relative to Existing Conditions.

Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives where such objectives are not exceeded under Existing Conditions. Because TSS concentrations and turbidity levels are not expected to be substantially different, long-term water quality degradation is not expected, and, thus, beneficial uses are not expected to be adversely affected. Finally, TSS and turbidity are neither bioaccumulative nor Clean Water Act section 303(d) listed constituents. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-30: Effects on TSS and Turbidity Resulting from Implementation of CM2–CM22

NEPA Effects: Effects of CM2–CM22 on TSS and turbidity under Alternative 7 are the same as those discussed for Alternative 1A. The effects on TSS and turbidity from implementing CM2–CM22 is determined to not be adverse.

CEQA Conclusion: Conservation Measures 2–22 proposed under Alternative 7 would be similar to those proposed under Alternative 1A. As such, effects on TSS and turbidity resulting from the implementation of CM2–CM22 would be similar to that previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-31: Water Quality Effects Resulting from Construction-Related Activities (CM1–CM22)

The conveyance features for CM1 under Alternative 7 would be very similar to those discussed for Alternative 1A. The primary difference between Alternative 7 and Alternative 1A is that under Alternative 7, there would be two fewer intakes and two fewer pumping plant locations, which would result in a reduced level of construction activity. Additional construction activity also would occur to restore channel margin and seasonally inundated floodplain habitats. However, construction techniques and locations of major features of the conveyance system within the Delta would be similar. The remainder of the facilities constructed under Alternative 7, including CM2–CM22, would be very similar to, or the same as, those to be constructed for Alternative 1A. However, under Alternative 7, there would be up to 20,000 acres of inundated floodplain habitat restored (as opposed to 10,000 acres under the majority of the other alternatives), thus resulting in increased construction-related disturbances.

NEPA Effects: The types and magnitude of potential construction-related water quality effects associated with implementation of CM1–CM22 under Alternative 7 would be very similar to the effects discussed for Alternative 1A, and the effects anticipated with implementation of CM2–CM22 would be essentially identical. Nevertheless, the construction of CM1, and any individual components necessitated by CM2, and CM4–CM10, with the implementation of the BMPs specified in Appendix 3B*, Environmental Commitments,* and other agency permitted construction requirements would result in the potential water quality effects being largely avoided and minimized. The specific environmental commitments that would be implemented under Alternative 7 would be similar to those described for Alternative 1A. Consequently, relative to Existing Conditions, Alternative 7 would not be expected to cause exceedance of applicable water quality objectives/criteria or substantial water quality degradation with respect to constituents of concern, and thus would not adversely affect any beneficial uses upstream of the Delta, in the Delta, or in the SWP and CVP service area.

In summary, with implementation of environmental commitments in Appendix 3B, the potential construction-related water quality effects are considered to be not adverse.

CEQA Conclusion: Because environmental commitments would be implemented under Alternative 7 for construction-related activities along with agency-issued permits that also contain construction requirements to protect water quality, the construction-related effects, relative to Existing Conditions, would not be expected to cause or contribute to substantial alteration of existing drainage patterns which would result in substantial erosion or siltation on- or off-site, substantial increased frequency of exceedances of water quality objectives/criteria, or substantially degrade water quality with respect to the constituents of concern on a long-term average basis, and thus would not adversely affect any beneficial uses in water bodies upstream of the Delta, within the Delta, or in the SWP and CVP service area. Moreover, because the construction-related activities would be temporary and intermittent in nature, the construction would involve negligible discharges, if any, of bioaccumulative or 303(d) listed constituents to water bodies of the affected environment. As such, construction activities would not contribute measurably to bioaccumulation of contaminants in organisms or humans or cause 303(d) impairments to be discernibly worse. Based on these findings, this impact is determined to be less than significant. No mitigation is required.

8.4.3.15 Alternative 8—Dual Conveyance with Pipeline/Tunnel, Intakes 2, 3, and 5 and Increased Delta Outflow (9,000 cfs; Operational Scenario F)

Alternative 8 would comprise physical/structural components similar to those under Alternative 1A with the principal exceptions that Alternative 8 would construct only three intakes and intake pumping plants (i.e., Intakes 2, 3, and 5). Alternative 8 would convey up to 9,000 cfs of water from the north Delta to the south Delta through pipelines/tunnels from three screened intakes on the east bank of the Sacramento River between Clarksburg and Walnut Grove. A 750 acre intermediate forebay and pumping plant would be constructed near Hood. A new 600 acre Byron Tract Forebay, adjacent to and south of Clifton Court Forebay, would be constructed which would provide water to the south Delta pumping plants. Water supply and conveyance operations would follow the guidelines described as Scenario F, which includes fall X2. The alternative would provide up to 1.5 MAF in increased Delta outflow. Conservation Measures 2–22 (CM2–22) would be implemented under this alternative, and would be the same as those under Alternative 1A. See Chapter 3, *Description of Alternatives,* Section 3.5.15, for additional details on Alternative 8.

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 8, over the long term, average annual delta exports are anticipated to decrease by 2,046 TAF relative to Existing Conditions, and by 1,342 TAF relative to the No Action Alternative. Since, over the long-term, approximately 70% 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 greatly 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 8–Old River at Rock Slough for ALL years (1976–1991), which shows increased San Joaquin River (SJR) percentage and decreased Sacramento River (SAC) percentage under the alternative, relative to Existing Conditions and the No Action Alternative.

Under Alternative 8, long-term average annual Delta outflow is anticipated to increase 2,195 TAF relative to Existing Conditions, due to both changes in operations (including north Delta intake capacity of 9,000 cfs and numerous other operational components of Scenario F) and climate change/sea level rise (see Chapter 5, *Water Supply*, for more information). The result of this is decreased sea water intrusion in the west Delta. The decrease of sea water intrusion in the west Delta under Alternative 8 is greater relative to the Existing Conditions because it does not include operations to meet Fall X2, whereas the No Action alternative and Alternative 8 do. Long-term average annual Delta outflow is anticipated to increase under Alternative 8 by 1,445 TAF relative to the No Action Alternative, due only to changes in operations. The decreases in sea water intrusion (represented by an decrease in San Francisco Bay (BAY) percentage) can be seen, for example, in Appendix 8D, ALT 8–Sacramento River at Mallard Island for ALL years (1976–1991).

Impact WQ-1: Effects on Ammonia Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative, Alternative 8 would have negligible, if any, effect on ammonia concentrations in the rivers and reservoirs upstream of the Delta relative to Existing Conditions and the No Action Alternative. Any negligible increases in ammonia-N concentrations that could occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regard to ammonia.

Delta

Assessment of effects of ammonia under Alternative 8 is the same as discussed under Alternative 1A, except that because flows in the Sacramento River at Freeport are different between the two alternatives, estimated monthly average and long term annual average predicted ammonia-N concentrations in the Sacramento River downstream of Freeport are different.

As Table 8-71 shows, estimated ammonia-N concentrations in the Sacramento River downstream of Freeport (upon full mixing of the SRWTP discharge with river water) under Alternative 8 and the No Action Alternative are expected to be similar. Minor increases in ammonia-N concentrations would occur during July through December, and remaining months would be unchanged or have a minor decrease. A minor increase in the annual average concentration would occur under Alternative 8, compared to the No Action Alternative. Moreover, the estimated concentrations downstream of Freeport under Alternative 8 would be similar to existing source water concentrations for the San Francisco Bay and San Joaquin River. Consequently, changes in source water fraction anticipated under Alternative 8, relative to the No Action Alternative, are not expected to substantially increase ammonia concentrations at any Delta locations.

Table 8-71. Estimated Ammonia-N (mg-L as N) Concentrations in the Sacramento River Downstream of the Sacramento Regional Wastewater Treatment Plant for the No Action Alternative and Alternative 8

	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
Alternative 8	0.081	0.089	0.070	0.060	0.057	0.059	0.055	0.059	0.066	0.072	0.078	0.070	0.068

Any negligible increases in ammonia-N concentrations that could occur at certain locations in the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to ammonia.

SWP/CVP Export Service Areas

The assessment of effects on ammonia in the SWP/CVP Export Service Area is based on assessment of ammonia-N concentrations at Banks and Jones pumping plants. Similar to the discussion for Alternative 1A, under Alternative 8 for areas of the Delta that are influenced by Sacramento River water, including Banks and Jones pumping plants, ammonia-N concentrations are expected to decrease, relative to Existing Conditions (in association with less diversion of water influenced by the SRWTP). This decrease in ammonia-N concentrations for water exported via the south Delta pumps is not expected to result in adverse effects on beneficial uses or substantially degrade water quality of exported water, with regards to ammonia.

Furthermore, as discussed above for the Plan Area, for all areas of the Delta, including Banks and Jones pumping plants, ammonia-N concentrations are not expected to be substantially different under Alternative 8, relative to the No Action Alternative. Any negligible increases in ammonia-N concentrations that could occur at Banks and Jones pumping plants would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to ammonia.

NEPA Effects**:** In summary, based on the discussion above, effects on ammonia from implementation of CM1 are considered to be not adverse.

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

Ammonia-N concentrations are generally low in the reservoirs and rivers of the watersheds, owing to the lack of substantial point and nonpoint sources of ammonia-N upstream of the SRWTP in the Sacramento River watershed, in the watersheds of the eastern tributaries (Cosumnes, Mokelumne, and Calaveras Rivers), or upstream of the Delta in the San Joaquin River watershed. Consequently, any modified reservoir operations and subsequent changes in river flows under Alternative 8, relative to Existing Conditions, are expected to have negligible, if any, effects on reservoir and river ammonia-N concentrations upstream of Freeport in the Sacramento River watershed and upstream of the Delta in the San Joaquin River watershed.

Ammonia-N concentrations in the Sacramento River downstream of the SRWTP would be substantially lower under Alternative 8, relative to Existing Conditions, due to upgrades to the SRWTP that are assumed to be in place, and thus, ammonia concentrations for all areas of the Delta that are influenced by Sacramento River water are expected to decrease. At locations which are not influenced notably by Sacramento River water, concentrations are expected to remain relatively unchanged, due to the similarity in SJR and BAY concentrations and the lack of expected changes in either of these concentrations.

The assessment of effects on ammonia in the SWP/CVP Export Service Areas is based on assessment of ammonia-N concentrations at Banks and Jones pumping plants. As discussed above for the Plan Area, for areas of the Delta that are influenced by Sacramento River water, including Banks and Jones pumping plants, ammonia-N concentrations are expected to decrease under Alternative 8, relative to Existing Conditions.

Based on the above, there would be no substantial, long-term increase in ammonia-N concentrations in the rivers and reservoirs upstream of the Delta, in the Plan Area, or the waters exported to the CVP and SWP service areas under Alternative 8 relative to Existing Conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because ammonia concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects on beneficial uses would occur. Ammonia is not 303(d) listed within the affected environment and thus any minor increases that could occur in some areas would not make any existing ammonia-related impairment measurably worse because no such impairments currently exist. Because ammonia-N is not bioaccumulative, minor increases that could occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-2: Effects on Ammonia Concentrations Resulting from Implementation of CM2–CM22

NEPA Effects**:** Effects of CM2–CM22 on ammonia under Alternative 8 are the same as those discussed for Alternative 1A and are considered to be not adverse.

CEQA Conclusion**:** Conservation Measures 2–22 proposed under Alternative 8 would be similar to those proposed under Alternative 1A. As such, effects on ammonia resulting from the implementation of CM2–CM22 would be similar to that previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-3: Effects on Boron Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Effects of CM1 on boron under Alternative 8 in areas upstream of the Delta would be very similar to the effects discussed for Alternative 1A. There would be no expected change to the sources of boron in the Sacramento and east-side tributary watersheds, and resultant changes in flows from altered system-wide operations would have negligible, if any, effects on the concentration of boron in the rivers and reservoirs of these watersheds. The modeled long-term annual average lower San Joaquin

River flow at Vernalis would decrease slightly compared to Existing Conditions (in association with project operations, climate change, and increased water demands) and the No Action Alternative considering only changes due to Alternative 8 operations. The reduced flow would result in possible increases in long-term average boron concentrations of up to about 3% relative to the Existing Conditions (Appendix 8F, Table 24). The increased boron concentrations would not increase the frequency of exceedances of any applicable objectives or criteria and would not be expected to cause further degradation at measurable levels in the lower San Joaquin River, and thus would not cause the existing impairment there to be discernibly worse. Consequently, Alternative 8 would not be expected to cause exceedance of boron objectives/criteria or substantially degrade water quality with respect to boron, and thus would not adversely affect any beneficial uses of the Sacramento River, the east-side tributaries, associated reservoirs upstream of the Delta, or the San Joaquin River.

Delta

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

Effects of CM1 on boron under Alternative 8 in the Delta would be similar to the effects discussed for Alternative 1A. Relative to the Existing Conditions and No Action Alternative, Alternative 8 would result in increased long-term average boron concentrations for the 16-year period modeled at interior Delta locations (by as much as 10% at the SF Mokelumne River at Staten Island, 35% at Franks Tract, 58% at Old River at Rock Slough) (Appendix 8F, Table Bo-20). The comparison to Existing Conditions reflects changes due to both Alternative 8 operations (including north Delta intake capacity of 9,000 cfs and numerous other operational components of Scenario E) and climate change/sea level rise. The comparison to the No Action Alternative reflects changes due only to operations.

Implementation of tidal habitat restoration under CM4 also may contribute to increased boron concentrations at western Delta assessment locations (more discussion of this phenomenon is included in Section 8.3.1.3), and thus would not be anticipated to substantially affect agricultural diversions which occur primarily at interior Delta locations.

The long-term annual average and monthly average boron concentrations, for either the 16-year period or drought period modeled, would never exceed the 2,000 μg/L human health advisory objective (i.e., for children) or 500 μg/L agricultural objective at any of the eleven Delta assessment locations, which represents no change from the Existing Conditions and No Action Alternative (Appendix 8F, Table Bo-3A). The increased concentrations at interior Delta locations would result in moderate reductions in the long-term average assimilative capacity of up to 16% at Franks Tract and up to 34% at Old River at Rock Slough locations (Appendix 8F, Table Bo-21). However, because the absolute boron concentrations would still be well below the lowest 500 μg/L objective for the protection of the agricultural beneficial use under Alternative 8, the levels of boron degradation would not be of sufficient magnitude to substantially increase the risk of exceeding objectives or cause adverse effects to municipal and agricultural water supply beneficial uses, or any other beneficial uses, in the Delta (Appendix 8F, Figure Bo-5).

SWP/CVP Export Service Areas

Effects of CM1 on boron under Alternative 8 in the Delta would be similar to the effects discussed for Alternative 1A. Under Alternative 8, long-term average boron concentrations would decrease by as much as 37% at the Banks Pumping Plant and by as much as 47% at Jones Pumping Plant relative to Existing Conditions and No Action Alternative (Appendix 8F, Table Bo-20) as a result of export of a greater proportion of low-boron Sacramento River water. Commensurate with the decrease in exported boron concentrations, boron concentrations in the lower San Joaquin River may be reduced and would likely alleviate or lessen any expected increase in boron concentrations at Vernalis associated with flow reductions (see discussion of Upstream of the Delta), as well as locations in the Delta receiving a large fraction of San Joaquin River water. Reduced export boron concentrations also may contribute to reducing the existing 303(d) impairment in the lower San Joaquin River and associated TMDL actions for reducing boron loading.

Maintenance of SWP and CVP facilities under Alternative 8 would not be expected to create new sources of boron or contribute towards a substantial change in existing sources of boron in the affected environment. Maintenance activities would not be expected to cause any substantial increases in boron concentrations or degradation with respect to boron such that objectives would be exceeded more frequently, or any beneficial uses would be adversely affected anywhere in the affected environment.

***NEPA Effects*: In summary, relative to the No Action Alternative conditions, Alternative 8 would result in relatively small long-term average increases in boron levels in the San Joaquin River and moderate increases in the interior and western Delta locations Delta. However, the predicted changes in the Delta would not be expected to result in exceedances of applicable objectives or further water quality degradation such that objectives would likely be exceeded or there would be substantially increased risk of adverse effects on water quality.

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

Boron is not a constituent of concern in the Sacramento River watershed upstream of the Delta, thus river flow rate and reservoir storage reductions that would occur under the Alternative 8, relative to Existing Conditions, would not be expected to result in a substantial adverse change in boron levels. Additionally, relative to Existing Conditions, Alternative 8 would not result in reductions in river flow rates (i.e., less dilution) or increased boron loading such that there would be any substantial increases in boron concentration upstream of the Delta in the San Joaquin River watershed.

Moderate increased boron levels (i.e., up to 58% increased concentration) and degradation predicted for interior and western Delta locations in response to a shift in the Delta source water percentages and tidal habitat restoration under this alternative would not be expected to cause exceedances of objectives. Alternative 8 maintenance also would not result in any substantial increases in boron concentrations in the affected environment. Boron concentrations would be reduced in water exported from the Delta to the CVP/SWP Export Service Areas, thus reflecting a potential improvement to boron loading in the lower San Joaquin River.

Boron is not a bioaccumulative constituent, thus any increased concentrations under Alternative 8 would not result in adverse boron bioaccumulation effects to aquatic life or humans. Relative to Existing Conditions, Alternative 8 would not result in substantially increased boron concentrations such that frequency of exceedances of municipal and agricultural water supply objectives would increase. The levels of boron degradation that may occur under Alternative 8, while widespread in particular at interior Delta locations, would not be of sufficient magnitude to cause substantially increased risk for adverse effects to municipal or agricultural beneficial uses within the affected environment. Long-term average boron concentrations would decrease in Delta water exports to the SWP and CVP service area, which may contribute to reducing the existing 303(d) impairment of agricultural beneficial uses in the lower San Joaquin River. Consequently, Alternative 8 would not be expected to cause any substantial increases in boron concentrations or degradation with respect to boron such that objectives would be exceeded more frequently, or any beneficial uses would be adversely affected anywhere in the affected environment. Based on these findings, this impact is determined to be less than significant. No mitigation is required.

Impact WQ-4: Effects on Boron Concentrations Resulting from Implementation of CM2–CM22

***NEPA Effects*:** Effects of CM2–CM22 on boron under Alternative 8 are the same as those discussed for Alternative 1A and are determined to be not adverse.

***CEQA Conclusion*:** Conservation Measures 2–22 proposed under Alternative 8 would be similar to those proposed under Alternative 1A. As such, effects on boron resulting from the implementation of CM2–CM22 would be similar to that previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

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

Upstream of the Delta

Under Alternative 8 there would be no expected change to the sources of bromide in the Sacramento and eastside tributary watersheds. Bromide loading in these watersheds would remain unchanged and resultant changes in flows from altered system-wide operations under Alternative 8 would have negligible, if any, effects on the concentration of bromide in the rivers and reservoirs of these watersheds. Consequently, Alternative 8 would not be expected to adversely affect the MUN beneficial use, or any other beneficial uses, of the Sacramento River, the eastside tributaries, or their associated reservoirs upstream of the Delta.

Under Alternative 8, modeling indicates that long-term annual average flows on the San Joaquin River would decrease by 6%, relative to Existing Conditions, and would remain virtually the same relative to No Action Alternative (Appendix 5A). These decreases in flow would result in possible increases in long-term average bromide concentrations of about 3%, relative to Existing Conditions and less than <1% relative to the No Action Alternative (Appendix 8E, Bromide Table 22). The small increases in lower San Joaquin River bromide levels that could occur under Alternative 8, relative to existing and No Action Alternative conditions would not be expected to adversely affect the MUN beneficial use, or any other beneficial uses, of the lower San Joaquin River.

Delta

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

Using the mass-balance modeling approach for bromide (see Section 8.3.1.3), relative to Existing Conditions, Alternative 8 would result in increases in long-term average bromide concentrations at Staten Island and Barker Slough, while long-term average concentrations would decrease at the other assessment locations (Appendix 8E, *Bromide*, Table 18). At Barker Slough, predicted long-term average bromide concentrations would increase from 51 µg/L to 54 µg/L (4% relative increase) for the modeled 16-year hydrologic period, and would increase from 54 µg/L to 80 µg/L (50% relative increase) for the modeled drought period. At Barker Slough, the predicted 50 µg/L exceedance frequency would decrease from 49% under Existing Conditions to 34% under Alternative 8, but would increase slightly from 55% to 62% during the drought period. At Barker Slough, the predicted 100 µg/L exceedance frequency would increase from 0% under Existing Conditions to 10% under Alternative 8, and would increase from 0% to 27% during the drought period. At Staten Island, predicted long-term average bromide concentrations would increase from 50 µg/L to 64 µg/L (29% relative increase) for the modeled 16-year hydrologic period and would increase from 51 µg/L to 65 µg/L (26% relative increase) for the modeled drought period. At Staten Island, increases in average bromide concentrations would correspond to an increased frequency of 50 µg/l threshold exceedance, from 47% under Existing Conditions to 80% under Alternative 8 (52% to 87% for the modeled drought period), and an increase from 1% to 2% (0% to 0% for the modeled drought period) for the 100 µg/L threshold. Changes in exceedance frequency of the 50 µg/L and 100 µg/L concentration thresholds at other assessment locations would be less considerable, with exception to Franks Tract. Although long-term average bromide concentrations were modeled to decrease at Franks Tract, exceedances of the 100 µg/L threshold would increase slightly, from 82% under Existing Conditions to 98% under Alternative 8 (78% to 93% for the modeled drought period). This comparison to Existing Conditions reflects changes in bromide due to both Alternative 8 operations (including north Delta intake capacity of 9,000 cfs and numerous other operational components of Scenario F) and climate change/sea level rise.

Due to the relatively small differences between modeled Existing Conditions and the No Action baseline, changes in long-term average bromide concentrations and changes in exceedance frequencies relative to the No Action Alternative are generally of similar magnitude to those previously described for the existing condition comparison (Appendix 8E, *Bromide*, Table 18). Modeled long-term average bromide concentration at Barker Slough is predicted to increase by 8% (50% for the modeled drought period) relative to the No Action Alternative. Modeled long-term average bromide concentration increases at Staten Island are predicted to increase by 33% (30% for the modeled drought period) relative to the No Action Alternative. However, unlike the Existing Conditions comparison, long-term average bromide concentrations at Buckley Cove would increase relative to the No Action Alternative, although the increases would be relatively small (≤2%). Unlike the comparison to Existing Conditions, this comparison to the No Action Alternative reflects changes in bromide due only to Alternative 8 operations.

At Barker Slough, modeled long-term average bromide concentrations for the two baseline conditions are very similar (Appendix 8E, *Bromide*, Table 18). Such similarity demonstrates that the modeled Alternative 8 change in bromide is almost entirely due to Alternative 8 operations, and not climate change/sea level rise. Therefore, operations are the primary driver of effects on bromide at Barker Slough, regardless whether Alternative 8 is compared to Existing Conditions, or compared to the No Action Alternative.

Results of the modeling approach which used relationships between EC and chloride and between chloride and bromide (see Section 8.3.1.3) differed somewhat from what is presented above for the mass-balance approach (see Appendix 8E, *Bromide*, Table 19). For most locations, the frequency of exceedance of the 50 μg/L and 100 μg/L were similar. The greatest difference between the methods was predicted for Barker Slough. The increases in frequency of exceedance of the 100 μg/L threshold, relative to Existing Conditions and the No Action Alternative, were not as great using this alternative EC to chloride and chloride to bromide relationship modeling approach as compared to that presented above from the mass-balance modeling approach. Results indicate 4% exceedance over the modeled period under Alternative 8, as compared to 1% under Existing Conditions and 2% under the No Action Alternative. For the drought period, exceedance frequency increased from 0% under Existing Conditions and the No Action Alternative, to 12% under Alternative 8. Because the mass-balance approach predicts a greater level of impact at Barker Slough, determination of impacts was based on the mass-balance results.

While the increase in long-term average bromide concentrations at Barker Slough are relatively small when modeled over a representative 16-year hydrologic period, increases during the modeled drought period, principally the relative increase in 100 μg/L exceedance frequency, would represent a substantial change in source water quality during a season of drought. As discussed for Alternative 1A, drinking water treatment plants obtaining water via the North Bay Aqueduct utilize a variety of conventional and enhanced treatment technologies in order to achieve DBP drinking water criteria. While the implications of such a modeled drought period change in bromide concentrations at Barker Slough is difficult to predict, the substantial modeled increases could lead to adverse changes in the formation of disinfection byproducts such that considerable treatment plant upgrades may be necessary in order to achieve equivalent levels of health protection during seasons of drought. Increases at Staten Island are also considerable, although there are no existing or foreseeable municipal intakes in the immediate vicinity. Because many of the other modeled locations already frequently exceed the 100 μg/L threshold under Existing Conditions and the No Action Alternative, these locations likely already require treatment plant technologies to achieve equivalent levels of health protection, and thus no additional treatment technologies would be triggered by the small increases in the frequency of exceeding the 100 μg/L threshold. Hence, no further impact on the drinking water beneficial use would be expected at these locations.

The seasonal intakes at Mallard Slough and City of Antioch are infrequently used due to water quality constraints related to sea water intrusion. On a long-term average basis, bromide at these locations is in excess of 3,000 μg/L, but during seasonal periods of high Delta outflow can be <300 μg/L. Based on modeling using the mass-balance approach, use of the seasonal intakes at Mallard Slough and City of Antioch under Alternative 8 would experience a period average increase in bromide during the months when these intakes would most likely be utilized. For those wet and above normal water year types where mass balance modeling would predict water quality typically suitable for diversion, predicted long-term average bromide would increase from 103 μg/L to 146 μg/L (42% increase) at City of Antioch and would increase from 150 μg/L to 193 μg/L (29% increase) at Mallard Slough relative to Existing Conditions (Appendix 8E, *Bromide*, Table 23).

Increases would be similar for the No Action Alternative comparison. Modeling results using the EC to chloride and chloride to bromide relationships show increases during these months, but the relative magnitude of the increases is much lower (Appendix 8E, Bromide Table 24). Regardless of the differences in the data between the two modeling approaches, the decisions surrounding the use of these seasonal intakes is largely driven by acceptable water quality, and thus have historically been opportunistic. Opportunity to use these intakes would remain, and the predicted increases in bromide concentrations at the City of Antioch and Mallard Slough intake would not be expected to adversely affect MUN beneficial uses, or any other beneficial use, at these locations.

Based on modeling using the mass-balance approach, relative to existing and No Action Alternative conditions, Alternative 8 would lead to predicted improvements in long-term average bromide concentrations at Franks Tract, Rock Slough, and Contra Costa PP No. 1, in addition to Banks and Jones (discussed below). At these locations, long-term average bromide concentrations would be predicted to decrease by as much as 11–37%, depending on baseline comparison. Modeling results using the EC to chloride and chloride to bromide relationships generally do not show similar decreases for Rock Slough and Contra Costa PP No. 1, but rather, predict small increases. Based on the small magnitude of increases predicted, these increases would not adversely affect beneficial uses at those locations.

SWP/CVP Export Service Areas

Under Alternative 8, improvement in long-term average bromide concentrations would occur at the Banks and Jones pumping plants. Long-term average bromide concentrations for the modeled 16-year hydrologic period at these locations would decrease by as much as 75% relative to Existing Conditions and 69% relative to the No Action Alternative (Appendix 8E, *Bromide*, Table 18). As a result, exceedances of the 50 μg/L and 100 μg/L assessment thresholds would be substantially reduced, resulting in considerable overall improvement in Export Service Areas water quality 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, *Bromide*, Table 19).

Similar to the discussion pertaining to the No Action Alternative, maintenance of SWP and CVP facilities under Alternative 8 would not be expected to create new sources of bromide or contribute towards a substantial change in existing sources of bromide in the affected environment. Maintenance activities would not be expected to cause any substantial change in bromide such that MUN beneficial uses, or any other beneficial use, would be adversely affected anywhere in the affected environment.

NEPA Effects: In summary, Alternative 8 operations and maintenance, relative to the No Action Alternative, would result in small increases (i.e., <1%) in long-term average bromide concentrations at Vernalis related to relatively small declines in long-term average flow on the San Joaquin River. However, Alternative 8 operation and maintenance activities would cause substantial degradation to water quality with respect to bromide at Barker Slough, source of the North Bay Aqueduct. Resultant substantial change in long-term average bromide at Barker Slough could necessitate changes in water treatment plant operations or require treatment plant upgrades in order to maintain DBP compliance, and thus would constitute an adverse effect on water quality. Mitigation Measure WQ-5 is available to reduce these effects (implementation of this measure along with a separate, non-environmental commitment as set forth in EIR/EIS Appendix 3B, *Environmental Commitments*, relating to the potential increased treatment costs associated with bromide-related changes would reduce these effects).

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

Under Alternative 8 there would be no expected change to the sources of bromide in the Sacramento and eastside tributary watersheds. Bromide loading in these watersheds would remain unchanged and resultant changes in flows from altered system-wide operations under Alternative 8 would have negligible, if any, effects on the concentration of bromide in the rivers and reservoirs of these watersheds. However, south of the Delta, the San Joaquin River is a substantial source of bromide, primarily due to the use of irrigation water imported from the southern Delta. Concentrations of bromide at Vernalis are inversely correlated to net river flow. Under Alternative 8, long-term average flows at Vernalis would decrease only slightly, resulting in less than substantial predicted increases in long-term average bromide of about 3% relative to Existing Conditions.

Relative to Existing Conditions, Alternative 8 would result in increases in long-term average bromide concentration at Staten Island and Barker Slough. There are no existing or foreseeable municipal drinking water intakes in the vicinity of Staten Island, but Barker Slough is the source of the North Bay Aqueduct. While the increase in long-term average bromide concentrations at Barker Slough are predicted to be relatively small when modeled over a representative 16-year hydrologic period, increases during the modeled drought period would represent a substantial change in source water quality during a season of drought. These predicted drought season related increases in bromide at Barker Slough could lead to adverse changes in the formation of disinfection byproducts at drinking water treatment plants such that considerable water treatment plant upgrades would be necessary in order to achieve equivalent levels of drinking water health protection.

The assessment of effects on bromide in the SWP/CVP Export Service Areas is based on assessment of changes in bromide concentrations at Banks and Jones pumping plants. Under Alternative 8, substantial improvement would occur at the Banks and Jones pumping plants, where predicted long-term average bromide concentrations are predicted to decrease by as much as 75% relative to Existing Conditions. An overall improvement in bromide-related water quality would be predicted in the SWP/CVP Export Service Areas.

Based on the above, Alternative 8 operation and maintenance would not result in any substantial change in long-term average bromide concentration upstream of the Delta. Furthermore, under Alternative 8, water exported from the Delta to the SWP/CVP service area would be substantially improved relative to bromide. Bromide is not bioaccumulative, therefore change in long-term average bromide concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Additionally, bromide is not a constituent related to any 303(d) listings. Alternative 8 operation and maintenance activities would not cause substantial long-term degradation to water quality respective to bromide with the exception of water quality at Barker Slough (drought period only) and at Staten Island in the eastern Delta. There are no existing or foreseeable municipal intakes in the vicinity of Staten Island, but Barker Slough is the source of the North Bay Aqueduct. At Barker Slough, modeled long-term annual average concentrations of bromide would increase by 50% during the modeled drought period. For the modeled drought period the frequency of predicted bromide concentrations exceeding 100 µg/L would increase from 0% under Existing Conditions to 27% under Alternative 8. Substantial changes in long-term average bromide during seasons of drought could necessitate changes in treatment plant operation or require treatment plant upgrades in order to maintain DBP compliance. The model predicted change at Barker Slough during the drought period is substantial and, therefore, would represent a substantially increased risk for adverse effects on existing MUN beneficial uses should treatment upgrades not be undertaken. The impact is considered significant.

Implementation of Mitigation Measure WQ-5 along with a separate, non-environmental commitment relating to the potential increased treatment costs associated with bromide-related changes would reduce these effects. While mitigation measures to reduce these water quality effects in affected water bodies to less than significant levels are not available, implementation of Mitigation Measure WQ-5 is recommended to attempt to reduce the effect that increased bromide concentrations may have on Delta beneficial uses. However, because the effectiveness of this mitigation measure to result in feasible measures for reducing water quality effects is uncertain, this impact is considered to remain significant and unavoidable. Please see Mitigation Measure WQ-5 under Impact WQ-5 in the discussion of Alternative 1A.

In addition to and to supplement Mitigation Measure WQ-5, the BDCP proponents have incorporated into the BDCP, as set forth in EIR/EIS Appendix 3B, *Environmental Commitments*, a separate, non-environmental commitment to address the potential increased water treatment costs that could result from bromide-related concentration effects on municipal water purveyor operations. Potential options for making use of this financial commitment include funding or providing other assistance towards implementation of the North Bay Aqueduct AIP, acquiring alternative water supplies, or other actions to indirectly reduce the effects of elevated bromide and DOC in existing water supply diversion facilities. Please refer to Appendix 3B, *Environmental Commitments*, for the full list of potential actions that could be taken pursuant to this commitment in order to reduce the water quality treatment costs associated with water quality effects relating to chloride, electrical conductivity, and bromide.

Mitigation Measure WQ-5: Avoid, Minimize, or Offset, as Feasible, Adverse Water Quality Conditions

Please see Mitigation Measure WQ-5 under Impact WQ-5 in the discussion of Alternative 1A.

Impact WQ-6: Effects on Bromide Concentrations Resulting from Implementation of CM2–CM22

NEPA Effects: Conservation Measures 2–22 under Alternative 8 would be similar to those under Alternative 1A. As discussed for Alternative 1A, implementation of the CM2–CM22 would not present new or substantially changed sources of bromide to the study area. Some conservation measures may replace or substitute for existing irrigated agriculture in the Delta. This replacement or substitution is not expected to substantially increase or present new sources of bromide. CM2–CM22 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.

In summary, implementation of CM2–CM22 under Alternative 8, relative to the No Action Alternative, would have negligible, if any, effects on bromide concentrations. The effects on bromide from implementing CM2–CM22 are determined to not be adverse.

CEQA Conclusion: Conservation Measures 2–22 proposed under Alternative 8 would be similar to those proposed under Alternative 1A. As discussed for Alternative 1A, implementation of CM2–CM22 would not present new or substantially changed sources of bromide to the study area. As such, effects on bromide resulting from the implementation of CM2–CM22 would be similar to that previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

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

Upstream of the Delta

Under Alternative 8 there would be no expected change to the sources of chloride in the Sacramento and eastside tributary watersheds. Chloride loading in these watersheds would remain unchanged and resultant changes in flows from altered system-wide operations would have negligible, if any, effects on the concentration of chloride in the rivers and reservoirs of these watersheds. The modeled long-term annual average flows on the lower San Joaquin River at Vernalis would decrease slightly compared to Existing Conditions and be similar compared to the No Action Alternative (as a result of climate change). The reduced flow would result in possible increases in long-term average chloride concentrations of about 2%, relative to the Existing Conditions and no change relative to No Action Alternative (Appendix 8G, Table Cl-62). Consequently, Alternative 8 would not be expected to cause exceedance of chloride objectives/criteria or substantially degrade water quality with respect to chloride, and thus would not adversely affect any beneficial uses of the Sacramento River, the eastside tributaries, associated reservoirs upstream of the Delta, or the San Joaquin River.

Delta

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

Relative to the Existing Conditions and No Action Alternative, Alternative 8 would result in similar or reduced long-term average chloride concentrations for the 16-year period modeled at most of the assessment locations, and, depending on the modeling approach (see Section 8.3.1.3), increased concentrations at the North Bay Aqueduct at Barker Slough (i.e., up to 6% compared to No Action Alternative), Contra Costa Canal at Pumping Plant #1 (i.e., up to 24% compared to No Action Alternative), Rock Slough (i.e., up to 18% compared to No Action Alternative), and the San Joaquin River at Staten Island (i.e., up to 29% compared to No Action Alternative) (Appendix 8G, *Chloride*, Table Cl-49 and Table Cl-50). Moreover, the direction and magnitude of predicted changes for Alternative 8 are similar between the alternatives, thus, the effects relative to Existing Conditions and the No Action Alternative are discussed together. Additionally, implementation of tidal habitat restoration under CM4 would increase the tidal exchange volume in the Delta, and thus may contribute to increased chloride concentrations in the Bay source water as a result of increased salinity intrusion. More discussion of this phenomenon is included in Section 8.3.1.3. Consequently, while uncertain, the magnitude of chloride increases may be greater than indicated herein and would affect the western Delta assessment locations the most which are influenced to the greatest extent by the Bay source water. The comparison to Existing Conditions reflects changes in chloride due to both Alternative 8 operations (including north Delta intake capacity of 9,000 cfs and numerous other operational components of Scenario E) and climate change/sea level rise. The comparison to the No Action Alternative reflects changes in chloride due only to operations. The following outlines the modeled chloride changes relative to the applicable objectives and beneficial uses of Delta waters.

Municipal Beneficial Uses

Estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3) were used to evaluate the 150 mg/L Bay-Delta WQCP objective for municipal and industrial beneficial uses on a basis of the percent of years the chloride objective is exceeded for the modeled 16-year period. The objective is exceeded if chloride concentrations exceed 150 mg/L for a specified number of days in a given water year at both the Antioch and Contra Costa Pumping Plant #1 locations. For Alternative 8, the modeled frequency of objective exceedance would increase from 6% of years under Existing Conditions and 6% under the No Action Alternative to 19% of years under Alternative 8 (Appendix 8G, Table Cl-64).

Similarly, estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3) were also used to evaluate the 250 mg/L Bay-Delta WQCP objective for chloride at Contra Costa Pumping Plant #1 where daily average objectives apply. The basis for the evaluation was the predicted number of days the objective was exceeded for the modeled 16-year period. For Alternative 8, the modeled frequency of objective exceedance would decrease, from 6% of modeled days under Existing Conditions and 5% under the No Action Alternative to 1% of modeled days under Alternative 8 (Appendix 8G, Table Cl-63).

Given the limitations inherent to estimating future chloride concentrations (see Section 8.3.1.3), estimation of chloride concentrations through both a mass balance approach and an EC-chloride relationship approach was used to evaluate the 250 mg/L Bay-Delta WQCP objectives in terms of both frequency of exceedance and use of assimilative capacity. When utilizing the mass balance approach to model monthly average chloride concentrations for the 16-year period, the predicted frequency of exceeding the 250 mg/L objective would decrease up to 15% (i.e., 24% for Existing Conditions to 9%) at the Contra Costa Canal at Pumping Plant #1 (Appendix 8G, Table Cl-51 and Figure Cl-13). The frequency of exceedances would decrease at the San Joaquin River at Antioch (i.e., from 66% under Existing Conditions to 58%) with no substantial change predicted for Mallard Island (i.e., maximum increase of 1%) (Appendix 8G, Table Cl-51) and no substantial long-term degradation (Appendix 8G, Table Cl-53). However, relative to the No Action conditions, available assimilative capacity for chloride at the Contra Costa Canal at Pumping Plant #1 would be substantially reduced in September and October (i.e., up to 100%, or eliminated, for the drought period modeled) (Appendix 8G, Table Cl-53), reflecting substantial degradation when concentrations would be near, or exceed, the objective.

In comparison, when utilizing the chloride-EC relationship to model monthly average chloride concentrations for the 16-year period, trends in frequency of exceedance generally agreed, but use of assimilative capacity were predicted to be larger at some locations (Appendix 8G, Table Cl-52 and Table Cl-54). Specifically, while the model predicted exceedance frequency would decrease at the Contra Costa Canal at Pumping Plant #1 and Rock Slough locations, use of assimilative capacity would increase substantially for the months of February through June as well as September (i.e., maximum of 82% in March for the modeled drought period). Due to such seasonal long-term average water quality degradation at these locations, the potential exists for substantial adverse effects on the municipal and industrial beneficial uses through reduced opportunity for diversion of water with acceptable chloride levels. Moreover, due to the increased frequency of exceeding the 150 mg/L Bay-Delta WQCP objective, the potential exists for adverse effects on the municipal and industrial beneficial uses at Contra Costa Pumping Plant #1 and Antioch.

303(d) Listed W*ater Bodies*

With respect to the 303(d) listing for chloride in Tom Paine Slough, the monthly average chloride concentrations for the 16-year period modeled at Old River at Tracy Road would generally be similar compared to Existing Conditions, and thus, would not be further degraded on a long-term basis (Appendix 8G, Figure Cl-14). With respect to Suisun Marsh, the monthly average chloride concentrations for the 16-year period modeled would generally be similar, or decrease, compared to Existing Conditions in some months during October through May at the Sacramento River at Collinsville (Appendix 8G, Figure Cl-15), Mallard Island (Appendix 8G, Figure Cl-13). However, chloride concentrations would increase substantially at Montezuma Slough at Beldon's Landing (i.e., over a doubling of concentration in December through February) (Appendix 8G, Figure Cl-16), 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.

SWP/CVP Export Service Areas

Under Alternative 8, long-term average chloride concentrations based on the mass balance analysis of modeling results for the 16-year period modeled at the Banks and Jones pumping plants would decrease by as much as 73% relative to Existing Conditions and 70% compared to No Action Alternative (Appendix 8G, *Chloride*, Table Cl-49). The modeled frequency of exceedances of applicable water quality objectives/criteria would decrease relative to Existing Conditions and No Action Alternative, for both the 16-year period and the drought period modeled (Appendix 8G, *Chloride*, Table Cl-51). Consequently, water exported into the SWP/CVP service area would generally be of similar or better quality with regards to chloride relative to Existing Conditions and the No Action Alternative conditions.

Results of the modeling approach which used relationships between EC and chloride (see Section 8.3.1.3) were consistent with the discussion above, and assessment of chloride using these data results in the same conclusions as are presented above for the mass-balance approach (Appendix 8G, Table Cl-50 and Table Cl-52).

Commensurate with the reduced chloride concentrations in water exported to the service area, reduced chloride loading in the lower San Joaquin River would be anticipated which would likely alleviate or lessen any expected increase in chloride at Vernalis related to decreased annual average San Joaquin River flows (see discussion of Upstream of the Delta).

Maintenance of SWP and CVP facilities would not be expected to create new sources of chloride or contribute towards a substantial change in existing sources of chloride in the affected environment. Maintenance activities would not be expected to cause any substantial change in chloride such that any long-term water quality degradation would occur, thus, beneficial uses would not be adversely affected anywhere in the affected environment.

NEPA Effects: In summary, relative to the No Action Alternative conditions, Alternative 8 would result in substantial increased water quality degradation relative to the 150 mg/L Bay-Delta WCCP objective at Contra Costa Pumping Plant #1 and Antioch, substantial seasonal use of assimilative capacity at Contra Costa Pumping Plant #1 and Rock Slough, and measureable water quality degradation relative to the 303(d) impairment in Suisun Marsh. The predicted chloride increases constitute an adverse effect on water quality (see Mitigation Measure WQ-7 below; implementation of this measure along with a separate, non-environmental commitment relating to the potential increased chloride treatment costs would reduce these effects). Additionally, the predicted changes relative to the No Action Alternative conditions indicate that in addition to the effects of climate change/sea level rise, implementation of CM1 and CM4 under Alternative 8 would contribute substantially to the adverse water quality effects.

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

Chloride is not a constituent of concern in the Sacramento River watershed upstream of the Delta, thus river flow rate and reservoir storage reductions that would occur under the Alternative 8, relative to Existing Conditions, would not be expected to result in a substantial adverse change in chloride levels. Additionally, relative to Existing Conditions, the Alternative 8 would not result in reductions in river flow rates (i.e., less dilution) or increased chloride loading such that there would be any substantial increase in chloride concentrations upstream of the Delta in the San Joaquin River watershed.

Relative to Existing Conditions, Alternative 8 operations would result in reduced chloride concentrations in the Delta such that exceedances of the 250 mg/L Bay-Delta WQCP objective at interior and western Delta locations would be reduced. Nevertheless, due to the predicted increased frequency of exceeding the 150 mg/L Bay-Delta WQCP objective at Contra Costa Pumping Plant #1 and Antioch as well as substantial seasonal use of assimilative capacity at Contra Costa Pumping Plant #1, the potential exists for adverse effects on the municipal and industrial beneficial uses at Contra Costa Pumping Plant #1 and Antioch (see Mitigation Measure WQ-7 below; implementation of this measure along with a separate, non-environmental commitment relating to the potential increased chloride treatment costs would reduce these effects). Moreover, the modeled increased chloride concentrations and degradation in the western Delta could further contribute, at measurable levels (i.e., over a doubling of concentration), to the existing 303(d) listed impairment due to chloride in Suisun Marsh for the protection of fish and wildlife.

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

Chloride is not a bioaccumulative constituent, thus any increased concentrations under Alternative 8 would not result in substantial chloride bioaccumulation impacts on aquatic life or humans. Alternative 8 maintenance would not result in any substantial changes in chloride concentration upstream of the Delta or in the SWP/CVP Export Service Areas. However, based on these findings, this impact is determined to be significant due to increased chloride concentrations and frequency of objective exceedance in the western Delta, as well as potential adverse effects on fish and wildlife beneficial uses in Suisun Marsh.

While mitigation measures to reduce these water quality effects in affected water bodies to less than significant levels are not available, implementation of Mitigation Measure WQ-7 is recommended to attempt to reduce the effect that increased chloride concentrations may have on Delta beneficial uses. However, because the effectiveness of this mitigation measure to result in feasible measures for reducing water quality effects is uncertain, this impact is considered to remain significant and unavoidable. Please see Mitigation Measure WQ-7 under Impact WQ-7 in the discussion of Alternative 1A.

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

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

Please see Mitigation Measure WQ-7 under Impact WQ-7 in the discussion of Alternative 1A.

Impact WQ-8: Effects on Chloride Concentrations Resulting from Implementation of CM2–CM22

NEPA Effects: Under Alternative 8, the types and geographic extent of effects on chloride concentrations in the Delta as a result of implementation of the other conservation measures (i.e., CM2–CM22) would be similar to, and undistinguishable from, those effects previously described for Alternative 1A. The conservation measures would present no new direct sources of chloride to the affected environment. Moreover, some habitat restoration conservation measures (CM4–10) would occur on lands within the Delta currently used for irrigated agriculture, thus replacing agricultural land uses with restored tidal wetlands, floodplain, and related channel margin and off-channel habitats. The potential reduction in irrigated lands within the Delta may result in reduced discharges of agricultural field drainage with elevated chloride concentrations, which would be considered an improvement compared to Existing Conditions and No Action Alternative conditions.

In summary, based on the discussion above, the effects on chloride from implementing CM2-CM22 are considered to be not adverse.

CEQA Conclusion: Implementation of the CM2–CM22 for Alternative 8 would not present new or substantially changed sources of chloride to the affected environment upstream of the Delta, within Delta, or in the SWP/CVP service area. Replacement of irrigated agricultural land uses in the Delta with habitat restoration conservation measures may result in some reduction in discharge of agricultural field drainage with elevated chloride concentrations, thus resulting in improved water quality conditions. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

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

NEPA Effects: Effects of CM1 on dissolved oxygen under Alternative 8 are the same as those discussed for Alternative 1A and are considered not to be adverse.

CEQA Conclusion: Effects of CM1 on DO under Alternative 8 would be similar to those discussed for Alternative 1A, and are summarized here, then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion under Alternative 1A.

River flow rate and reservoir storage reductions that would occur under Alternative 8, relative to Existing Conditions, would not be expected to result in a substantial adverse change in DO levels in the reservoirs and rivers upstream of the Delta, given that mean monthly flows would remain within the ranges historically seen under Existing Conditions and the affected river are large and turbulent. Any reduced DO saturation level that may be caused by increased water temperature would not be expected to cause DO levels to be outside of the range seen historically. Finally, amounts of oxygen demanding substances and salinity would not be expected to change sufficiently to affect DO levels.

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

There is not expected to be substantial, if even measurable, changes in DO levels in the SWP/CVP Export Service Areas waters under Alternative 8, relative to Existing Conditions, because the biochemical oxygen demand of the exported water would not be expected to substantially differ from that under Existing Conditions (due to ever increasing water quality regulations), canal turbulence and exposure of the water to the atmosphere and the algal communities that exist within the canals would establish an equilibrium for DO levels within the canals. The same would occur in downstream reservoirs.

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

Impact WQ-10: Effects on Dissolved Oxygen Resulting from Implementation of CM2–CM22

NEPA Effects**:** Effects of CM2–CM22 on DO under Alternative 8 are the same as those discussed for Alternative 1A and are considered not to be adverse.

CEQA Conclusion**:** Conservation Measures 2–22 proposed under Alternative 8 would be similar to those proposed under Alternative 1A. As such, effects on DO resulting from the implementation of CM2–CM22 would be similar to that previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

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

Upstream of the Delta

For the same reasons stated for the No Action Alternative, EC levels (highs, lows, typical conditions) in the Sacramento River and its tributaries, the eastside tributaries, their associated reservoirs, and the San Joaquin River upstream of the Delta under Alternative 8 are not expected to be outside the ranges occurring under Existing Conditions or would occur under the No Action Alternative. Any minor changes in EC levels that could occur under Alternative 8 in water bodies upstream of the Delta would not be of sufficient magnitude, frequency and geographic extent that would cause adverse effects on beneficial uses or substantially degrade water quality with regard to EC.

Delta

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

Relative to Existing Conditions, Alternative 8 would result in an increase in the number of days the Bay-Delta WQCP EC objectives would be exceeded in the Sacramento River at Emmaton, and the San Joaquin River at Vernalis, Prisoners Point, and Brandt Bridge, and in the Old River near Middle River (Appendix 8H, Table EC-8). The percent of days the Emmaton EC objective would be exceeded for the entire period modeled (1976–1991) would increase from 6% under Existing Conditions to 16% under Alternative 8, and the percent of days out of compliance would increase from 11% under Existing Conditions to 28% under Alternative 7. The increase in the percent of days the Vernalis EC objective would be exceeded would be <1%, and the percent of days out of compliance with the EC objective would increase from 7% under Existing Conditions to 8% under Alternative 8. The percent of days the Prisoners Point EC objective would be exceeded for the entire period modeled would increase from 6% under Existing Conditions to 32% under Alternative 8, and the percent of days out of compliance with the EC objective would increase from 10% under Existing Conditions to 32%

under Alternative 8. In the San Joaquin River at Brandt Bridge, the percent of days exceeding the EC objective would increase from 3% under Existing Conditions to 4% under Alternative 8; the percent of days out of compliance would increase from 8% under Existing Conditions to 9% under Alternative 8. The increase in the percent of days the Old River EC objective would be exceeded and out of compliance for the entire period modeled (1976–1991) would be <1%. Average EC levels at the western and southern Delta compliance locations and San Joaquin River at San Andreas Landing (an interior Delta location) would decrease from 0–44% for the entire period modeled and 2–43% during the drought period modeled (1987–1991) (Appendix 8H, Table EC-19). In the S. Fork Mokelumne River at Terminous, average EC would increase 5% for the entire period modeled and drought period modeled. Average EC in the S. Fork Mokelumne River at Terminous would increase during all months (Appendix 8H, Table EC-19). Given that the western and southern Delta are Clean Water Act section 303(d) listed as impaired due to elevated EC, the increase in the incidence of exceedance of EC objectives under Alternative 8, relative to Existing Conditions has the potential to contribute to additional impairment and potentially adversely affect beneficial uses. The comparison to Existing Conditions reflects changes in EC due to both Alternative 8 operations (including north Delta intake capacity of 9,000 cfs and numerous other operational components of Scenario F) and climate change/sea level rise.

Relative to the No Action Alternative, the change in percent compliance with Bay-Delta WQCP EC objectives under Alternative 8 would be similar to that described above relative to Existing Conditions. The exception is that there would also be a slight increase (<1%) in the percent of days the EC objective would be exceeded in the Old River at Tracy for the entire period modeled. Also, Old River at Tracy also would have an increase in the number of days out of compliance with the EC objectives. The percent of days out of compliance with Tracy Bridge EC objectives would increase from 8% to 9% for the entire period modeled. For the entire period modeled, average EC levels would increase at all Delta compliance locations relative to the No Action Alternative, except in Three Mile Slough near the Sacramento River, and the San Joaquin River at San Andreas Landing and Jersey Point. The greatest average EC increase would occur in the San Joaquin River at Prisoners Point (7%); the increase at the other locations would be <1–6% (Appendix 8H, Table EC-19). Similarly, during the drought period modeled, average EC would increase at all locations, except Three Mile Slough and San Joaquin River at San Andreas Landing and Jersey Point. The greatest average EC increase during the drought period modeled would occur in the S. Fork Mokelumne River at Terminous (6%); the increases at the other locations would be 1–4% (Appendix 8H, Table EC-19). Given that the western and southern Delta are Clean Water Act section 303(d) listed as impaired due to elevated EC, the increase in the incidence of exceedance of EC objectives under Alternative 7, relative to the No Action Alternative, has the potential to contribute to additional impairment and potentially adversely affect beneficial uses. The comparison to the No Action Alternative reflects changes in EC due only to Alternative 8 operations (including north Delta intake capacity of 9,000 cfs and numerous other operational components of Scenario F).

For Suisun Marsh, October–May is the period when Bay-Delta WQCP EC objectives for protection of fish and wildlife apply. Long-term average EC would decrease under Alternative 8, relative to Existing Conditions, during October–May in the Sacramento River at Collinsville and Montezuma Slough at National Steel (Appendix 8H, Table EC-21). The most substantial increase would occur near Beldon Landing, with long-term average EC levels increasing by 0.1–3.5 mS/cm, depending on the month (Appendix 8H, Table EC-23). Sunrise Duck Club would have long-term average EC increases of 0.2–0.8 mS/cm (Appendix 8H, Table EC-24) and Volanti Slough would have long-term average EC increases of 0.1–1.1 mS/cm. The degree to which the long-term average EC increases would cause exceedance of Bay-Delta WQCP objectives is unknown, because objectives are expressed as a monthly average of daily high tide EC, which does not have to be met if it can be demonstrated "equivalent or better protection will be provided at the location" (State Water Resources Control Board 2006:14). 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 be substantial and it is uncertain the degree to which current management plans for the Suisun Marsh would be able to address these substantially higher EC levels and protect beneficial uses. Thus, these increased EC levels in Suisun Marsh are considered to have a potentially adverse effect on marsh beneficial uses. Long-term average EC increases in Suisun Marsh under Alternative 8 relative to the No Action Alternative would be similar to the increases relative to Existing Conditions. Suisun Marsh is section 303(d) listed as impaired due to elevated EC, and the potential increases in long-term average EC concentrations could contribute to additional impairment relative to Existing Conditions and the No Action Alternative.

SWP/CVP Export Service Areas

At the Banks and Jones pumping plants, Alternative 8 would result in no exceedances of the Bay-Delta WQCP's 1,000 µmhos/cm EC objective for the entire period modeled (Appendix 8H, Table EC-10). Thus, there would be no adverse effect on the beneficial uses in the SWP/CVP Export Service Areas using water pumped at this location under the Alternative 8.

At the Banks pumping plant, relative to Existing Conditions, average EC levels under Alternative 8 would decrease substantially: 49% for the entire period modeled and 53% during the drought period modeled. Relative to the No Action Alternative, average EC levels would decrease by 45% for the entire period modeled and 50% during the drought period modeled. (Appendix 8H, Table EC-19)

At the Jones pumping plant, relative to Existing Conditions, average EC levels under Alternative 8 would also decrease substantially: 53% for the entire period modeled and 62% during the drought period modeled. Relative to the No Action Alternative, average EC levels would decrease by 51% for the entire period modeled and 60% during the drought period modeled. (Appendix 8H, Table EC-19)

Based on the decreases in long-term average EC levels that would occur at the Banks and Jones pumping plants, Alternative 8 would not cause degradation of water quality with respect to EC in the SWP/CVP Export Service Areas; rather, Alternative 8 would improve long-term average EC conditions in the SWP/CVP Export Service Areas.

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

The export area of the Delta is listed on the state's CWA Section 303(d) list as impaired due to elevated EC. Alternative 8 would result in lower average EC levels relative to Existing Conditions and the No Action Alternative and, thus, would not contribute to additional beneficial use impairment related to elevated EC in the SWP/CVP Export Service Areas waters.

NEPA Effects: In summary, the increased frequency of exceedance of EC objectives and increased long-term and drought period average EC levels that would occur at southern Delta compliance locations, and increased frequency of exceedance of EC objectives in the western Delta under Alternative 8, relative to the No Action Alternative, would contribute to adverse effects on the agricultural beneficial uses. In addition. the increased frequency of exceedance of the San Joaquin River at Prisoners Point EC objective and long-term and drought period average EC could contribute to adverse effects on fish and wildlife beneficial uses. Given that the western and southern Delta are Clean Water Act section 303(d) listed as impaired due to elevated EC, the increase in the incidence of exceedance of EC objectives and long-term average and drought period average EC in these portions of the Delta has the potential to contribute to additional beneficial use impairment. The increases in long-term average EC levels that would occur in Suisun Marsh would further degrade existing EC levels and could contribute additional to adverse effects on the fish and wildlife beneficial uses. Suisun Marsh is section 303(d) listed as impaired due to elevated EC, and the potential increases in long-term average EC levels could contribute to additional beneficial use impairment. These increases in EC constitute an adverse effect on water quality. Mitigation Measure WQ-11 would be available to reduce these effects (implementation of this measure along with a separate, non-environmental commitment as set forth in EIR/EIS Appendix 3B, *Environmental Commitments*, relating to the potential EC-related changes would reduce these effects).

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

River flow rate and reservoir storage reductions that would occur under Alternative 8, relative to Existing Conditions, would not be expected to result in a substantial adverse change in EC levels in the reservoirs and rivers upstream of the Delta, given that: changes in the quality of watershed runoff and reservoir inflows would not be expected to occur in the future; the state's aggressive regulation of point-source discharge effects on Delta salinity-elevating parameters and the expected further regulation as salt management plans are developed; the salt-related TMDLs adopted and being developed for the San Joaquin River; and the expected improvement in lower San Joaquin River average EC levels commensurate with the lower EC of the irrigation water deliveries from the Delta.

Relative to Existing Conditions, Alternative 8 would not result in any substantial increases in long-term average EC levels in the SWP/CVP Export Service Areas. There would be no exceedance of the EC objective at the Jones and Banks pumping plants. Average EC levels for the entire period modeled would decrease at both plants and, thus, this alternative would not contribute to additional beneficial use impairment related to elevated EC in the SWP/CVP Export Service Areas waters. Rather, this alternative would improve long-term EC levels in the SWP/CVP Export Service Areas, relative to Existing Conditions.

In the Plan Area, Alternative 8 would result in an increase in the frequency with which Bay-Delta WQCP EC objectives are exceeded in the Sacramento River at Emmaton (agricultural objective; 10% increase),San Joaquin River at Vernalis (agricultural objective; <1% increase) and Brandt Bridge (agricultural objective; 1% increase), and in the Old River near Middle River (agricultural objective: <1% increase), all in the southern Delta, and Prisoners Point (fish and wildlife objective; 26% increase) in the interior Delta for the entire period modeled (1976–1991). The increased frequency of exceedance of the fish and wildlife objective at Prisoners Point could contribute to adverse effects on aquatic life, and the increased frequency of the EC exceedance at Emmaton could contribute to adverse effects on agricultural uses. Because EC is not bioaccumulative, the increases in long-term average EC levels would not directly cause bioaccumulative problems in aquatic life or humans. The western and southern Delta are Clean Water Act section 303(d) listed for elevated EC and the increased frequency of exceedance of EC objectives that would occur in these portions of the Delta could make beneficial use impairment measurably worse. This impact is considered to be significant.

Further, relative to Existing Conditions, Alternative 8 would result in substantial increases in long-term average EC during the months of October through May in Suisun Marsh. The increases in long-term average EC levels that would occur in Suisun Marsh could further degrade existing EC levels and thus contribute additionally to adverse effects on the fish and wildlife beneficial uses. Because EC is not bioaccumulative, the increases in long-term average EC levels would not directly cause bioaccumulative problems in wildlife. Suisun Marsh is Clean Water Act section 303(d) listed for elevated EC and the increases in long-term average EC that would occur in the marsh could make beneficial use impairment measurably worse. This impact is considered to be significant.

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

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

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

Please see Mitigation Measure WQ-11 under Impact WQ-11 in the discussion of Alternative 1A.

Impact WQ-12: Effects on Electrical Conductivity Resulting from Implementation of CM2–CM22

NEPA Effects: Effects of CM2–CM22 on EC under Alternative 8 are the same as those discussed for Alternative 1A and are considered not to be adverse.

CEQA Conclusion: Conservation Measures 2–22 proposed under Alternative 8 would be similar to those proposed under Alternative 1A. As such, effects on EC resulting from the implementation of CM2–CM22 would be similar to that previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

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

Upstream of the Delta

Under Alternative 8, the magnitude and timing of reservoir releases and river flows upstream of the Delta in the Sacramento River watershed and east-side tributaries would be altered, relative to Existing Conditions and the No Action Alternative.

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

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

Delta

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

The water quality impacts of waterborne concentrations of mercury and methylmercury and fish tissue mercury concentrations were evaluated for 9 Delta locations. The analysis of percentage change in assimilative capacity of waterborne total mercury of Alternative 8 relative to the 25 ng/L ecological risk benchmark as compared to Existing Conditions showed the greatest decrease of 7% for the Contra Costa Pumping Plant, and 6.9% at the same location for the No Action Alternative (Figures 8-53 and 8-54). Similarly, changes in methylmercury concentration are expected to be relatively small The highest methylmercury concentration is 0.229 ng/L at the North Bay Aqueduct at Barker Slough, which is about 100% greater than Existing Conditions or the No Action Alternative (Appendix 8I, Figure I-9). All modeled input concentrations exceeded the methylmercury TMDL guidance objective of 0.06 ng/L, therefore percentage change in assimilative capacity was not evaluated for methylmercury.

Fish tissue estimates show more substantial percentage increases in concentration and exceedance quotients for mercury at some Delta locations. The highest exceedance quotients for any modeled location are predicted for the North Bay Aqueduct pump site at Barker Slough (EQ = 7.6), with an increase relative to Existing Conditions, and the No Action Alternative ranging from 221 to 224% at that location (Figure 8-55, Appendix 8I, Table I-15b). As mentioned above, these changes mirror and enhance the pattern of increased concentrations in methylmercury projected for that location. The Sacramento River at Emmaton site also shows a relatively large percentage increase in tissue concentrations over Existing Conditions and the No Action Alternative (122 to 124%) and a relatively elevated exceedance quotient of 4.6 (Appendix 8I, Table I-15b).

SWP/CVP Export Service Areas

The analysis of mercury and methylmercury in the SWP/CVP Export Service Areas was based on concentrations estimated at the Banks and Jones pumping plants. Both waterborne total and methylmercury concentrations for Alternative 8 are projected to be lower than Existing Conditions and the No Action Alternative at the Jones and Banks pumping plants (Appendix 8I, Figures 8I-8 and 8I-9). Therefore, mercury shows an increased assimilative capacity at these locations (Figures 8-53 and 8-54).

The largest improvements in bass tissue mercury concentrations and exceedance quotients for Alternative 8, relative to Existing Conditions and the No Action Alternative at any location within the Delta are expected for the export pump locations (specifically, at Jones Pumping plant, 27% improvement relative to Existing Conditions, 31% relative to the No Action Alternative) (Figure 8-55, Appendix 8I, Table I-15b).

***NEPA Effects*:** Based on the above discussion, the effects of mercury and methylmercury in comparison of Alternative 8 to the No Action Alternative (as waterborne and bioaccumulated forms) are considered to be adverse for the case of fish tissue bioaccumulation at some locations.

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

Under Alternative 8, greater water demands and climate change would alter the magnitude and timing of reservoir releases and river flows upstream of the Delta in the Sacramento River watershed and east-side tributaries, relative to Existing Conditions. Concentrations of mercury and methylmercury upstream of the Delta will not be substantially different relative to Existing Conditions due to the lack of important relationships between mercury/methylmercury concentrations and flow for the major rivers.

Methylmercury concentrations exceed criteria at all locations in the Delta and no assimilative capacity exists. However, monthly average waterborne concentrations of total and methylmercury, over the period of record, are very similar to Existing Conditions. Estimates of fish tissue mercury concentrations show substantial increases under Alternative 8, relative to Existing Conditions, particularly at North Bay Aqueduct and Sacramento River at Emmaton.

Assessment of effects of mercury in the SWP and CVP Export Service Areas were based on effects on mercury concentrations and fish tissue mercury concentrations at the Banks and Jones pumping plants. The Banks and Jones pumping plants are expected to show increased assimilative capacity for waterborne mercury and decreased fish tissue concentrations of mercury for Alternative 8 as compared to Existing Conditions.

As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. However, increases in fish tissue mercury concentrations are substantial, and changes in fish tissue mercury concentrations would make existing mercury-related impairment in the Delta measurably worse. In comparison to Existing Conditions, Alternative 8 would increase levels of mercury by frequency, magnitude, and geographic extent such that the affected environment would be expected to have measurably higher body burdens of mercury in aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish) or humans consuming those organisms.

This impact is considered to be significant. Feasible or effective actions to reduce the effects on mercury resulting from CM1 are unknown. General mercury management measures through CM12, or actions taken by other entities or programs such as TMDL implementation, may minimize or reduce sources and inputs of mercury to the Delta and methylmercury formation. However, it is uncertain whether this impact would be reduced to a level that would be less than significant as a result of CM12 or other future actions. Therefore, the impact would be significant and unavoidable.

Impact WQ-14: Effects on Mercury Concentrations Resulting from Implementation of CM2–CM22

***NEPA Effects*:** Some habitat restoration activities under Alternative 8 would occur on lands in the Delta formerly used for irrigated agriculture. Tidal and other restoration proposed under Alternative 8 have the potential to increase water residence times and increase accumulation of organic sediments that are known to enhance methylmercury bioaccumulation in biota in the restored habitat. Therefore, increases in mercury methylation in the habitat restoration areas is possible but uncertain depending on the specific restoration design implemented at a particular Delta location. Models to estimate the potential for methylmercury formation in restored areas are not currently available. However, DSM2 modeling for Alternative 8 operations does incorporate assumptions for certain habitat restoration activities proposed under CM2 and CM4 (see Section 8.3.1.3) that result in changes to Delta hydrodynamics compared to the No Action Alternative. These modeled restoration assumptions provide some insight into potential hydrodynamic changes that could be expected related to implementing CM2 and CM4 and are considered in the evaluation of the potential for increased mercury and methylmercury concentrations under Alternative 8.

BDCP Conservation Measure 12 (CM12) addresses the potential for methylmercury bioaccumulation associated with restoration activities and acknowledges the uncertainties associated with mitigating or minimizing this potential effect. CM12 proposes project-specific mercury management plans for restoration actions that will incorporate relevant approaches recommended in Phase 1 Methylmercury TMDL control studies. Specific approaches recommended under CM12 that are intended to minimize or mitigate for potential increases in methylmercury bioaccumulation at future restoration sites include:

- Characterizing mercury, methylmercury, organic carbon, iron, and sulfate concentrations to better inform restoration design,
- Sequestering methylmercury at restoration sites using low intensity chemical dosing techniques,
- Minimizing microbial methylation associated with anoxic conditions by reducing the amount of organic material at a restoration site,
- Designing restoration sites to enhance photo degeneration that converts methylmercury into a biologically unavailable, inorganic form of mercury,
- Remediating restoration site soils with iron to reduce methylation in sulfide rich soils, and
- Considering capping mercury laden sediments, where possible to reduce methylation potential at a site.

Because of the uncertainties associated with site-specific estimates of methylmercury concentrations and the uncertainties in source modeling and tissue modeling, the effectiveness of methylmercury management proposed under CM12 to reduce methylmercury concentrations would need to be evaluated separately for each restoration effort, as part of design and implementation. Because of this uncertainty and the known potential for methylmercury creation in the Delta this potential effect of implementing CM2–CM22 is considered adverse.

***CEQA Conclusion*:** There would be no substantial, long-term increase in mercury or methylmercury concentrations or loads in the rivers and reservoirs upstream of the Delta or the waters exported to the CVP and SWP service areas due to implementation of CM2–CM22 relative to Existing Conditions. However, uptake of mercury from water and/or methylation of inorganic mercury may increase to an unquantified degree as part of the creation of new, marshy, shallow, or organic-rich restoration areas. Methylmercury is 303(d)-listed within the affected environment, and therefore any potential measurable increase in methylmercury concentrations would make existing mercury-related impairment measurably worse. Because mercury is bioaccumulative, increases in water-borne mercury or methylmercury that could occur in some areas could bioaccumulate to somewhat greater levels in aquatic organisms and would, in turn, pose health risks to fish, wildlife, or humans. Design of restoration sites under Alternative 8 would be guided by CM12 which requires development of site specific mercury management plans as restoration actions are implemented. The effectiveness of minimization and mitigation actions implemented according to the mercury management plans is not known at this time although the potential to reduce methylmercury concentrations exists based on current research. Although the BDCP will implement CM12 with the goal to reduce this potential effect the uncertainties related to site specific restoration conditions and the potential for increases in methylmercury concentrations in the Delta result in this potential impact being considered significant. No mitigation measures would be available until specific restoration actions are proposed. Therefore this programmatic impact is considered significant and unavoidable.

Impact WQ-15: Effects on Nitrate Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative, Alternative 8 would have negligible, if any, impact on nitrate concentrations in the rivers and reservoirs upstream of the Delta in the Sacramento River watershed relative to Existing Conditions and the No Action Alternative.

Under Alternative 8, modeling indicates that long-term annual average flows on the San Joaquin River would decrease by an estimated 6%, relative to Existing Conditions, and would remain virtually the same relative to No Action (Appendix 5A). Given these relatively small decreases in flows and the weak correlation between nitrate and flows in the San Joaquin River (see Nitrate Appendix 8J, Figure 2), it is expected that nitrate concentrations in the San Joaquin River would be minimally affected, if at all, by changes in flow rates under Alternative 8.

Any negligible changes in nitrate-N concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regards to nitrate.

Delta

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

Results of the mixing calculations indicate that under Alternative 8, relative to Existing Conditions and the No Action Alternative, nitrate concentrations throughout the Delta are anticipated to remain low (<1.4 mg/L-N) relative to adopted objectives (Nitrate Appendix 8J, Table 28 and 29). Long-term average nitrate concentrations are anticipated to increase at most locations in the Delta. The increase would be greatest at Franks Tract, Old River at Rock Slough, and Contra Costa Pumping Plant #1 (all >85% increase). Long-term average concentrations were estimated to increase to 0.68, 1.06 and 1.13 mg/L-N for Franks Tract, Old River at Rock Slough, and Contra Costa Pumping Plant #1, respectively, due primarily to increased San Joaquin River water percentage at these locations (see Fingerprinting Appendix 8D). Although changes at specific Delta locations and for specific months may be substantial on a relative basis, the absolute concentration of nitrate in Delta waters would remain low (<1.4 mg/L-N) in relation to the drinking water MCL of 10 mg/L-N, as well as all other thresholds identified in Table 8-50. No additional exceedances of the MCL are anticipated at any location (Nitrate Appendix 8J, Table 28). On a monthly average basis and on a long term annual average basis, for all modeled years and for the drought period (1987–1991) only, use of assimilative capacity available under Existing Conditions and the No Action Alternative, relative to the drinking water MCL of 10 mg/L-N, was up to approximately 13% at Old River at Rock Slough and Contra Costa Pumping Plant #1, and averaged approximately 6% on a long-term average basis (Nitrate Appendix 8J, Table 30). Similarly, the use of available assimilative capacity at Franks Tract was up to approximately 6%, and averaged 3% over the long term. The concentrations estimated for these locations would not increase the likelihood of exceeding the 10 mg/L-N MCL, nor would they increase the risk for adverse effects to beneficial uses. At all other locations, use of assimilative capacity was negligible (<5%) (Nitrate Appendix 8J, Table 30).

Nitrate concentrations will likely be higher than the modeling results indicate in certain locations. This includes in the Sacramento River between Freeport and Mallard Island and other areas in the Delta downstream of Freeport that are influenced by Sacramento River water. These increases are associated with ammonia and nitrate that are discharged from the SRWTP, which are not included in the modeling.

- Under Existing Conditions, most of the ammonia discharged from the SRWTP is converted to nitrate downstream of the facility's discharge at Freeport, and thus, nitrate concentrations under Existing Conditions in these areas are expected to be higher than the modeling predicts, the increase becoming greater with increasing distance downstream. However, the increase in nitrate concentrations downstream of the SRWTP is expected to be small—the existing increase appears to be from approximately 0.1 mg/L-N to approximately 0.4–0.5 mg/L-N over this reach, due to approximately a 1:1 conversion of ammonia-N to nitrate-N (Central Valley Water Board 2010a:32).

- Under Alternative 8, the planned upgrades to the SRWTP, which include nitrification/partial denitrification, would substantially decrease ammonia concentrations in the discharge, but would increase nitrate concentrations in the discharge up to 10 mg/L-N, which is substantially higher than under Existing Conditions.

- Overall, under Alternative 8, the nitrogen load from the SRWTP discharge is expected to decrease (by up to 50%), relative to Existing Conditions, due to nitrification/partial dentrification ugrades at the SRWTP facility. Thus, while concentrations of nitrate downstream of the facility are expected to be higher than modeling results indicate for both Existing Conditions and Alternative 8, the increase is expected to be greater under Existing Conditions than for Alternative 8 due to the upgrades that are assumed under Alternative 8.

The other areas in which nitrate concentrations will be higher than the modeling results indicate are immediately downstream of other wastewater treatment plants that practice nitrification, but not denitrification (e.g., City of Rio Vista Beach WWTF, Town of Discovery Bay WWTF, City of Stockton RWCF). For all such facilities in the Delta, the Regional Water Boards have issued NPDES permits that allow discharge of wastewater containing nitrate into the Delta, and under these permits, the State has determined that no beneficial uses are adversely affected by the discharge, and that the discharger's use of available assimilative capacity of the water body is acceptable. When dilution is necessary in order for the discharge to be in compliance with the Basin Plans (which incorporate the 10 mg/L-N MCL by reference), not all of the assimilative capacity of the receiving water is granted to the discharger. Thus, limited decreases in flows are not anticipated to result in systemic exceedances of the MCLs by these POTWs. Furthermore, NPDES permits are renewed on a 5-year basis, and thus, if under changes in flows, dilution was no longer sufficient to maintain nitrate below the MCL in the receiving water, the NPDES permit renewal process would address such cases.

Therefore, any increases in nitrate-N concentrations that may occur at certain locations within the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to nitrate.

SWP/CVP Export Service Areas

Assessment of effects of nitrate in the SWP and CVP Export Service Areas is based on effects on nitrate-N at the Banks and Jones pumping plants.

Results of the mixing calculations indicate that under Alternative 8, relative to Existing Conditions and the No Action Alternative, nitrate concentrations at Banks and Jones pumping plants are anticipated to decrease on a long-term average annual basis (Nitrate Appendix 8J, Table 28 and 29). During the late summer, particularly in the drought period assessed, concentrations are expected to increase substantially on a relative basis (i.e., >50%), but the absolute value of these changes (i.e., in mg/L-N) is small. Additionally, given the many factors that contribute to potential algal blooms in the SWP and CVP canals within the Export Service Area, and the lack of studies that have shown a direct relationship between nutrient concentrations in the canals and reservoirs and problematic algal blooms in these water bodies, there is no basis to conclude that these small (i.e., generally <0.5 mg/L-N), seasonal increases in nitrate concentrations would increase the potential for problem algal blooms in the SWP and CVP Export Service Area. No additional exceedances of the MCL are anticipated (Nitrate Appendix 8J, Table 28). On a monthly average basis and on a long term annual average basis, for all modeled years and for the drought period (1987–1991) only, use of assimilative capacity available under Existing Conditions and the No Action Alternative, relative to the 10 mg/L-N MCL, was negligible for both Banks and Jones pumping plants (Nitrate Appendix 8J, Table 30).

Any increases in nitrate-N concentrations that may occur in water exported via Banks and Jones pumping plants are not expected to result in adverse effects to beneficial uses or substantially degrade the quality of exported water, with regards to nitrate.

NEPA Effects: In summary, based on the discussion above, the effects on nitrate from implementing CM1 are considered to be not adverse.

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

Nitrate-N concentrations are generally low in the reservoirs and rivers of the watersheds, owing to substantial dilution available for point sources and the lack of substantial nonpoint sources of nitrate-N upstream of the SRWTP in the Sacramento River watershed, and in the watersheds of the eastern tributaries (Cosumnes, Mokelumne, and Calaveras Rivers). Although higher in the San Joaquin River watershed, nitrate-N concentrations are not well-correlated with flow rates. Consequently, any modified reservoir operations and subsequent changes in river flows under Alternative 8, relative to Existing Conditions, are expected to have negligible, if any, effects on reservoir and river nitrate-N concentrations upstream of Freeport in the Sacramento River watershed and upstream of the Delta in the San Joaquin River watershed.

In the Delta, results of the mixing calculations indicate that under Alternative 8, relative to Existing Conditions, long-term average nitrate concentrations are anticipated to increase at most locations. The increase would be greatest at Franks Tract, Old River at Rock Slough, and Contra Costa Pumping Plant #1 (all >85% increase), due primarily to increased San Joaquin River water percentage at these locations. However, nitrate concentrations throughout the Delta are anticipated to remain low

(<1.4 mg/L-N) relative to adopted objectives, and no additional exceedances of the MCL are anticipated at any location. Use of assimilative capacity at locations throughout the Delta (up to 13%) did not result in concentrations that would increase the likelihood of exceeding the 10 mg/L-N MCL, nor would they increase the risk for adverse effects to beneficial uses.

Assessment of effects of nitrate in the SWP and CVP Export Service Areas is based on effects on nitrate-N concentrations at the Banks and Jones pumping plants. Results of the mixing calculations indicate that under Alternative 8, relative to Existing Conditions, long-term average nitrate concentrations at Banks and Jones pumping plants are anticipated to decrease. No additional exceedances of the MCL are anticipated. Monthly average use of assimilative capacity available under Existing Conditions, relative to the MCL, for both Banks and Jones pumping plants in drought conditions was at times >50%, but the absolute value of these changes (i.e., in mg/L-N) was small. Additionally, given the many factors that contribute to potential algal blooms in the SWP and CVP canals within the Export Service Area, and the lack of studies that have shown a direct relationship between nutrient concentrations in the canals and reservoirs and problematic algal blooms in these water bodies, there is no basis to conclude that these small (i.e., generally <0.3 mg/L-N), seasonal increases in nitrate concentrations would increase the potential for problem algal blooms in the SWP and CVP Export Service Area.

Based on the above, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. No long-term water quality degradation is expected to occur such that exceedance of criteria is more likely or such that there is an increased risk of adverse impacts to beneficial uses. Nitrate is not 303(d) listed within the affected environment and thus any increases that may occur in some areas and months would not make any existing nitrate-related impairment measurably worse because no such impairments currently exist. Because nitrate is not bioaccumulative, increases that may occur in some areas and months would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-16: Effects on Nitrate Concentrations Resulting from Implementation of CM2–CM22

NEPA Effects: Effects of CM2–CM22 on nitrate under Alternative 8 are the same as those discussed for Alternative 1A and are considered not to be adverse.

CEQA Conclusion: Conservation Measures 2–22 proposed under Alternative 8 would be similar to those proposed under Alternative 1A. As such, effects on nitrate resulting from the implementation of CM2–CM22 would be similar to that previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-17: Effects on Dissolved Organic Carbon Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Under Alternative 8, there would be no substantial change to the sources of DOC within the watersheds upstream of the Delta. Moreover, long-term average flow and DOC levels in the Sacramento River at Hood and San Joaquin River at Vernalis are poorly correlated. Thus changes in system operations and resulting reservoir storage levels and river flows would not be expected to cause a substantial long-term change in DOC concentrations in the water bodies upstream of the Delta. Any negligible changes in DOC levels in water bodies upstream of the Delta under Alternative 8, relative to Existing Conditions and the No Action Alternative, would not be of sufficient frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regards to DOC.

Delta

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

Under Alternative 8 relative to Existing Conditions, the geographic extent of effects pertaining to long-term average DOC concentrations in the Delta would be similar to that previously described for Alternative 1A, although the magnitude of predicted long-term increase and relative frequency of concentration threshold exceedances would be substantially greater. Modeled effects would be greatest at Franks Tract, Rock Slough, and Contra Costa PP No. 1., where for the 16-year hydrologic period and the modeled drought period, long-term average concentration increases ranging from 0.7–1.1 mg/L would be predicted (≤32% net increase), resulting in long-term average DOC concentrations greater than 4 mg/L at Rock Slough and Contra Costa PP No. 1 (Appendix 8K, DOC Table 9). Increases in long-term average concentrations would correspond to more frequent concentration threshold exceedances, with the greatest change occurring at Rock Slough and Contra Costa PP No. 1 locations. For Rock Slough, long-term average DOC concentrations exceeding 3 mg/L would increase from 52% under Existing Conditions to 90% under the Alternative 8 (an increase from 47% to 88% for the drought period), and concentrations exceeding 4 mg/L would increase from 30% to 48% (32% to 57% for the drought period). For Contra Costa PP No. 1, long-term average DOC concentrations exceeding 3 mg/L would increase from 52% under Existing Conditions to 93% under Alternative 8 (45% to 95% for the drought period), and concentrations exceeding 4 mg/L would increase from 32% to 55% (35% to 60% for the drought period). Relative change in frequency of threshold exceedance for other assessment locations would be similar or less. This comparison to Existing Conditions reflects changes in DOC 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.

In comparison, Alternative 8 relative to the No Action Alternative would generally result in a similar magnitude of change to that discussed for the comparison to Existing Conditions. Maximum increases of 0.7–1.0 mg/L DOC (i.e., ≤27%) would be predicted at Franks Tract, Rock Slough, and Contra Costa PP No. 1 relative to No Action Alternative (Appendix 8K, DOC Table 9). Threshold concentration exceedance frequency trends would also be similar to that discussed for the existing condition comparison, with exception to the predicted 4 mg/L exceedance frequency at Buckley Cove. In comparison to the No Action Alternative, the frequency which long-term average DOC concentrations exceeded 4 mg/L at Buckley Cove would increase from 27% to 32% (42% to 58% for the modeled drought period). Unlike the comparison to Existing Conditions, this comparison to the No Action Alternative reflects changes in DOC due only to Alternative 8 operations.

The increases in long-term average DOC concentrations estimated to occur at Franks Tract, Rock Slough, and Contra Costa PP No. 1 are considered substantial and could potentially trigger significant changes in drinking water treatment plant design or operations. In particular, assessment locations at Rock Slough and Contra Costa PP No. 1 represent municipal intakes servicing existing drinking water treatment plants. Under Alternative 8, drinking water treatment plants obtaining water from these interior Delta locations would likely need to upgrade existing treatment systems in order to achieve EPA Stage 1 Disinfectants and Disinfection Byproduct Rule action thresholds. While treatment technologies sufficient to achieve the necessary DOC removals exist, implementation of such technologies would likely require substantial investment in new or modified infrastructure.

Relative to existing and No Action Alternative conditions, Alternative 8 would lead to predicted improvements in long-term average DOC concentrations at Barker Slough, as well as Banks and Jones pumping plants (discussed below). Predicted long-term average DOC concentrations at Barker Slough would decrease ≤0.1 mg/L, depending on baseline conditions comparison and modeling period.

SWP/CVP Export Service Areas

Under Alternative 8, modeled long-term average DOC concentrations would decrease at Banks and Jones pumping plants for both the modeled 16-year hydrologic period and the modeled drought period. Modeled decreases would generally be similar between Existing Conditions and the No Action Alternative. Relative to Existing Conditions, long-term average DOC concentrations at Banks would be predicted to decrease by 1.0 mg/L (1.2 mg/L during drought period) (Appendix 8K, DOC Table 9). At Jones, long-term average DOC concentrations would be predicted to decrease by 1.0 mg/L (1.1 mg/L during drought period). Such substantial improvement in long-term average DOC concentrations would include fewer exceedances of concentration thresholds. Average DOC concentrations exceeding the 2 mg/L concentration threshold would decrease from 100% under Existing Conditions and the No Action Alternative to 63% at Banks and 61% at Jones under Alternative 8 (62% and 57%, respectively during the drought period), while concentrations exceeding 4 mg/L would nearly be eliminated (i.e., ≤17% exceedance frequency). Such modeled improvement would correspond to substantial improvement in Export Service Areas water quality, respective to DOC.

Similar to the discussion pertaining to the No Action Alternative, maintenance of SWP and CVP facilities under Alternative 8 would not be expected to create new sources of DOC or contribute towards a substantial change in existing sources of DOC in the affected area. Maintenance activities would not be expected to cause any substantial change in long-term average DOC concentrations such that MUN beneficial uses, or any other beneficial use, would be adversely affected.

NEPA Effects: In summary, Alternative 8, relative to the No Action Alternative, would not cause a substantial long-term change in DOC concentrations in the water bodies upstream of the Delta. Long-term average DOC concentrations at Banks and Jones pumping plants are predicted to decrease by as much as 1.3 mg/L, while long-term average DOC concentrations for some Delta interior locations, including Franks Tract, Rock Slough and Contra Costa PP #1, are predicted to increase by as much as 1.0 mg/L. Resultant substantial changes in long-term average DOC at these Delta interior locations could necessitate changes in water treatment plant operations or require treatment plant upgrades in order to maintain DBP compliance, and thus would constitute an adverse effect on water quality and MUN beneficial uses. Mitigation Measure WQ-17 is available to reduce these effects.

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

While greater water demands under the Alternative 8 would alter the magnitude and timing of reservoir releases north, south and east of the Delta, these activities would have no substantial effect on the various watershed sources of DOC. Moreover, long-term average flow and DOC at Sacramento River at Hood and San Joaquin River at Vernalis are poorly correlated; therefore, changes in river flows would not be expected to cause a substantial long-term change in DOC concentrations upstream of the Delta.

Relative to Existing Conditions, Alternative 8 would result in substantial increases (i.e., 0.7–1.1 mg/L) in long-term average DOC concentrations at some Delta interior locations, and would be greatest at Franks Tract, Rock Slough, and Contra Costa PP No. 1. At these locations the predicted changes in DOC would substantially increase the frequency with which long-term average concentrations exceeds 2, 3, or 4 mg/L. Drinking water treatment plants obtaining water from these interior Delta locations would likely need to upgrade existing treatment systems in order to achieve EPA Stage 1 Disinfectants and Disinfection Byproduct Rule action thresholds. Such predicted magnitude change in long-term average DOC concentrations would represent a substantially increased risk for adverse effects on existing MUN beneficial.

The assessment of Alternative 8 effects on DOC in the SWP/CVP Export Service Areas is based on assessment of changes in DOC concentrations at Banks and Jones pumping plants. Relative to the existing condition, long-term average DOC concentrations would decrease by as much as 1.2 mg/L at Banks and Jones pumping plants. The frequency with which long-term average DOC concentrations would exceed 2, 3, or 4 mg/L would be substantially reduced, where predicted exceedances of >4 mg/L would be nearly eliminated (i.e., ≤17% exceedance frequency). As a result, substantial improvement in DOC-related water quality would be predicted in the SWP/CVP Export Service Areas.

Based on the above, Alternative 8 operation and maintenance would not result in any substantial change in long-term average DOC concentration upstream of the Delta. Furthermore, under Alternative 8, water exported from the Delta to the SWP/CVP service area would be substantially improved relative to DOC. DOC is not bioaccumulative, therefore change in long-term average DOC concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Additionally, DOC is not a constituent related to any 303(d) listings. Nevertheless, new and modified conveyance facilities proposed under Alternative 8 would result in a substantial increase in long-term average DOC concentrations (i.e., 0.7–1.1 mg/L, equivalent to ≤32% relative increase) at Franks Tract, Rock Slough, and Contra Costa PP No. 1. In particular, under Alternative 8, model predicted long-term average DOC concentrations would be greater than 4 mg/L at Rock Slough and Contra Costa PP No. 1 with commensurate substantial increases in the frequency with which average DOC concentrations exceed 2, 3, and 4 mg/L levels. Drinking water treatment plants obtaining water from these interior Delta locations would likely need to upgrade existing treatment systems in order to achieve EPA Stage 1 Disinfectants and Disinfection Byproduct Rule action thresholds. Therefore, such a magnitude change in long-term average DOC concentrations would represent a substantially increased risk for adverse effects on existing MUN beneficial uses at Rock Slough and Contra Costa PP No. 1 should such treatment upgrades not be undertaken. The impact is considered significant and mitigation is required. While Mitigation Measure WQ-17 is available to partially reduce this impact of DOC, the feasibility and effectiveness of this mitigation measure is uncertain and implementation would not necessarily reduce the identified impact to a level that would be less than significant, and therefore it is significant and unavoidable.

Mitigation Measure WQ-17: Consult with Delta Water Purveyors to Identify Means to Avoid, Minimize, or Offset Increases in Long-Term Average DOC Concentrations

Please see Mitigation Measure WQ-17 under Impact WQ-17 in the discussion of Alternative 6A.

Impact WQ-18: Effects on Dissolved Organic Carbon Concentrations Resulting from Implementation of CM2–CM22

***NEPA Effects*:** Conservation Measures 2–22 under Alternative 8 would be similar to those under Alternative 1A. Effects on DOC resulting from the implementation of CM2–CM22 would be similar to that previously discussed for Alternative 1A. In total, CM4–CM7 and CM10 could contribute substantial amounts of DOC to raw drinking water supplies, largely depending on final design and operational criteria for the related restoration activities. Substantially increased long-term average DOC in raw water supplies could lead to a need for treatment plant upgrades in order to appropriately manage DBP formation in treated drinking water. This potential for future DOC increases would lead to substantially greater associated risk of long-term adverse effects on the MUN beneficial use.

In summary, the habitat restoration elements of CM4–CM7 and CM10 under Alternative 8 would present new localized sources of DOC to the study area, and in some circumstances would substitute for existing sources related to replaced agriculture. Depending on localized hydrodynamics and proximity to municipal drinking water intakes, such restoration activities could contribute substantial amounts of DOC to municipal raw water. Substantial increases in municipal raw water DOC could necessitate changes in water treatment plant operations or require treatment plant upgrades in order to maintain DBP compliance, and thus would constitute an adverse effect on water quality. Mitigation Measure WQ-18 is available to reduce these effects.

***CEQA Conclusion*:** Effects of CM4–CM7 and CM10 on DOC under Alternative 8 are similar to, and possibly greater than, those discussed for Alternative 1A. Similar to the discussion for Alternative 1A, this impact is considered to be significant. It is uncertain whether implementation of Mitigation Measure WQ-18 would reduce identified impacts to a less-than-significant level. Hence, this impact remains significant and unavoidable.

In addition to and to supplement Mitigation Measure WQ-18, the BDCP proponents have incorporated into the BDCP, as set forth in EIR/EIS Appendix 3B, *Environmental Commitments*, a separate, non-environmental commitment to address the potential increased water treatment costs that could result from DOC concentration effects on municipal and industrial water purveyor operations. Potential options for making use of this financial commitment include funding or providing other assistance towards implementing treatment for DOC and/or DBPs or DOC source control strategies. Please refer to Appendix 3B, *Environmental Commitments*, for the full list of potential actions that could be taken pursuant to this commitment in order to reduce the water quality treatment costs associated with water quality effects relating to DOC.

Mitigation Measure WQ-18: Design Wetland and Riparian Habitat Features to Minimize Effects on Municipal Intakes

Please see Mitigation Measure WQ-18 under Impact WQ-18 in the discussion of Alternative 1A.

Impact WQ-19: Effects on Pathogens Resulting from Facilities Operations and Maintenance (CM1)

***NEPA Effects*:** Effects of CM1 on pathogens under Alternative 8 are the same as those discussed for Alternative 1A and are considered to not be adverse.

***CEQA Conclusion*:** Effects of CM1 on pathogens under Alternative 8 are the same as those discussed for Alternative 1A, and are summarized here, then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion under Alternative 1A.

River flow rate and reservoir storage reductions that would occur due to implementation of CM1 (water facilities and operations) under Alternative 8, relative to Existing Conditions, would not be expected to result in a substantial adverse change in pathogen concentrations in the reservoirs and rivers upstream of the Delta, given the small magnitude of urban runoff contributions relative to the magnitude of river flows, that pathogen concentrations in the rivers have a minimal relationship to river flow rate, and the expected reduced pollutant loadings in response to NPDES stormwater-related regulations.

It is expected there would be no substantial change in Delta pathogen concentrations in response to a shift in the Delta source water percentages under this alternative or substantial degradation of these water bodies, with regard to pathogens. This conclusion is based on the Pathogens Conceptual Model, which found that pathogen sources in close proximity to a Delta site appear to have the greatest influence on pathogen levels at the site, rather than the primary source(s) of water to the site. In-Delta potential pathogen sources, including water-based recreation, tidal habitat, wildlife, and livestock-related uses, would continue under this alternative.

In the SWP/CVP Export Service Areas waters, relative to Existing Conditions, an increased proportion of water coming from the Sacramento River would not adversely affect beneficial uses in the SWP/CVP Export Service Areas. The pathogen levels in the Sacramento River are similar to or lower than the water diverted at the Delta export pumps. Further, it is localized sources of pathogens that appear to have the greatest influence on concentrations. Thus, an increased proportion of Sacramento River water diverted to the SWP/CVP Export Service Areas would result in minimal changes in pathogen levels in the SWP/CVP Export Service Areas waters.

Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because pathogen concentrations are not expected to increase substantially, no long-term water quality degradation for pathogens is expected to occur and, thus, no adverse effects on beneficial uses would occur. The San Joaquin River in the Stockton Deep Water Ship Channel is Clean Water Act section 303(d) listed for pathogens. Because no measurable increase in Deep Water Ship Channel pathogen concentrations are expected to occur on a long-term basis, further degradation and impairment of this area is not expected to occur. Finally, pathogens are not bioaccumulative constituents. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-20: Effects on Pathogens Resulting from Implementation of CM2–CM22

***NEPA Effects*:** Effects of CM2–CM22 on pathogens under Alternative 8 are the same as those discussed for Alternative 1A and are considered to not be adverse.

***CEQA Conclusion*:** Conservation Measures 2–22 proposed under Alternative 8 would be similar to those proposed under Alternative 1A. As such, effects on pathogens resulting from the implementation of CM2–CM22 would be similar to that previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-21: Effects on Pesticide Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative, under Alternative 8 no specific operations or maintenance activity of the SWP or CVP would substantially drive a change in pesticide use, and thus pesticide sources would remain unaffected upstream of the Delta. Nevertheless, changes in the timing and magnitude of reservoir releases could have an effect on available dilution capacity along river segments such as the Sacramento, Feather, American, and San Joaquin Rivers.

Under Alternative 8, winter (November–March) and summer (April–October) season average flow rates on the Sacramento River at Freeport, American River at Nimbus, Feather River at Thermalito and the San Joaquin River at Vernalis would change. Relative to existing condition and the No Action Alternative, seasonal average flow rates on the Sacramento would decrease no more than 8% during the summer and 1% during the winter (Appendix 8L, Seasonal average flows Tables 1-4). On the Feather River, average flow rates would decrease no more than 18% during the summer, but would increase as much as 30% in the winter. American River average flow rates would decrease by as much as 15% in the summer but would increase by as much as 5% in the winter. Seasonal average flow rates on the San Joaquin River would decrease by as much as 12% in the summer, but increase by as much as 1% in the winter. For the same reasons stated for the No Action Alternative, decreased seasonal average flow of ≤18% is not considered to be of sufficient magnitude to substantially increase pesticide concentrations or alter the long-term risk of pesticide-related toxicity to aquatic life, nor adversely affect other beneficial uses of water bodies upstream of the Delta.

Delta

Sources of diuron, OP and pyrethroid insecticides to the Plan Area include direct input of surface runoff from in-Delta agriculture and Delta urbanized areas as well as inputs from rivers upstream of the Delta. Similar to Upstream of the Delta, CVP/SWP operations would not affect these sources.

Under Alternative 8, the distribution and mixing of Delta source waters would change. Percent change in monthly average source water fraction were evaluated for the modeled 16-year (1976–1991) hydrologic period and a representative drought period (1987–1991), with special attention given to changes in San Joaquin River, Sacramento River and Delta Agriculture sources water fractions. Relative to Existing Conditions, under Alternative 8 modeled San Joaquin River fractions would increase greater than 10% at Franks Tract, Rock Slough, Contra Costa PP No. 1, and the San

Joaquin River at Antioch (Appendix 8D, Source Water Fingerprinting). At Antioch, San Joaquin River source water fractions when modeled for the 16-year hydrologic period would increase by 11–14% from November through May (no increase >10% for the modeled drought period). While this change at Antioch is not considered substantial, changes in San Joaquin River source water fraction in the Delta interior would be considerable. At Franks Tract, San Joaquin River source water fractions would increase between 18–29% for October through June (11–25% for November through June of the modeled drought period). Changes at Rock Slough and Contra Costa PP No. 1 would be very similar, where modeled San Joaquin River source water fractions would increase from 28–72% (15–71% for the modeled drought period) for October through June. Relative to Existing Conditions, there would be no modeled increases in Sacramento River fractions greater than 15% (with exception to Banks and Jones which are discussed below) and Delta agricultural fractions greater than 8%. Increases in San Joaquin River source water fraction at Franks Tract, Rock Slough, and Contra Costa PP NO. 1 would primarily balance through decreases in Sacramento River water, and as a result the San Joaquin River would account for greater than 50% of the total source water volume at Franks Tract between March through May (<50% for all months during the modeled drought period), and would be ≥50%, and as much as 81% during November through May at Rock Slough and Contra Costa PP No. 1 for both the modeled drought and 16-year hydrologic periods. While the source water and potential pesticide related toxicity co-occurrence predictions do not mean adverse effects would occur, such considerable modeled increases in early summer source water fraction at Franks Tract and winter and summer source water fractions at Rock Slough and Contra Costa PP No. 1 could substantially alter the long-term risk of pesticide-related toxicity to aquatic life, given the apparent greater incidence of pesticides in the San Joaquin River.

When compared to the No Action Alternative, changes in source water fractions would be similar in season, geographic extent, and magnitude to those discussed for Existing Conditions with exception to Buckley Cove during the modeled drought period. At Buckley Cove, modeled drought period San Joaquin River fractions would increase 23% in July and 28% in August when compared to No Action Alternative (Appendix 8D, Source Water Fingerprinting). These increases would primarily balance through decreases in Sacramento River water and eastside tributary waters. Nevertheless, the San Joaquin River at Buckley Cove during the modeled drought period would only account for 44% of the total source water volume in July and 39% in August. These changes at Buckley Cove are not considered substantial, however, as discussed for Existing Conditions, under the No Action Alternative the similar magnitude change at Franks Tract, Rock Slough, and Contra Costa PP No. 1 would be considered substantial and could substantially alter the long-term risk of pesticide-related toxicity to aquatic life.

These predicted adverse effects on pesticides relative to Existing Conditions and the No Action Alternative fundamentally assume that the present pattern of pesticide incidence in surface water will occur at similar levels into the future. In reality, however, the makeup and character of the pesticide use market in the late long-term (i.e., the year 2060) will not be exactly as it is today. Current use of chlorpyrifos and diazinon is on the decline with their replacement by pyrethroids on the rise, yet in this assessment it is the apparent greater incidence of diazinon and chlorpyrifos on the San Joaquin River that serves as the basis for concluding that substantially increased San Joaquin River source water fraction would correspond to an increased risk of pesticide-related toxicity to aquatic life. By 2060, however, alternative pesticides, such as neonicitinoids and biologicals, will likely be a more substantial contributing part of the existing mix of pesticides, and perhaps more prominent. The trend in the development of future-use pesticides is towards reduced risk pesticides, including more biopesticides, with greater targeted specificity, fewer residues, and lower overall non-target toxicity. By 2060 existing chlorpyrifos and diazinon TMDLs for the Sacramento and San Joaquin Rivers will have been in effect for more than 50 years. Moreover, it is reasonable to expect that CWA section 303(d) listings and future additional listings will have developed TMDLs by 2060. To the extent these existing and future TMDL's address current and future-use pesticides, a greater degree of pesticide related source control can be anticipated. Nevertheless, forecasting whether these various efforts will ultimately be successful at resolving current pesticide related impairments requires considerable speculation. While the fundamental assumptions that have guided this assessment of pesticides may be somewhat altered by 2060, these assumptions are informed by actual studies and monitoring data collected from the recent past and, therefore, judging project alternative effects in the future remain most accurate through use of these informed assumptions rather than based on assumptions founded upon future speculative conditions.

SWP/CVP Export Service Areas

Assessment of effects in SWP/CVP Export Service Areas is based on effects seen in the Plan Area at the Banks and Jones pumping plants. Under Alternative 8, Sacramento River source water fractions would increase substantially at both Banks and Jones pumping plants relative to Existing Conditions and the No Action Alternative (Appendix 8D, Source Water Fingerprinting). At Banks pumping plant, Sacramento source water fractions would generally increase from 26–78% for October through June (6–45% for December through March of the modeled drought period) and at Jones pumping plant Sacramento source water fractions would generally increase from 42–95% for October through June (37–88% for October through June of the modeled drought period). These increases in Sacramento source water fraction would primarily balance through equivalent decreases in San Joaquin River water. Based on the general observation that San Joaquin River, in comparison to the Sacramento River, is a greater contributor of OP insecticides in terms of greater frequency of incidence and presence at concentrations exceeding water quality benchmarks, modeled increases in Sacramento River fraction at Banks and Jones would generally represent an improvement in export water quality respective to pesticides.

NEPA Effects**:** In summary, the changes in long-term average flows on the Sacramento, Feather, American, and San Joaquin Rivers, under Alternative 8 relative to the No Action Alternative, are of insufficient magnitude to substantially increase the long-term risk of pesticide-related water quality degradation and related toxicity to aquatic life in these water bodies upstream of the Delta. However, modeled increases in San Joaquin River fraction at Franks Tract, Rock Slough, and Contra Costa PP No. 1 are of sufficient magnitude to substantially alter the long-term risk of pesticide-related water quality degradation and related toxicity to aquatic life in the Delta. The effects on pesticides from operations and maintenance (CM1) are determined to be adverse and unavoidable.

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

Sources of pesticides upstream of the Delta include direct input of pesticide containing surface runoff from agriculture and urbanized areas. Flows in rivers receiving these discharges dilute these pesticide inputs. Relative to Existing Conditions, however, modeled changes in long-term average flows on the Sacramento, Feather, American, and San Joaquin Rivers are of insufficient magnitude to substantially increase the long-term risk of pesticide-related water quality degradation and related toxicity to aquatic life in these water bodies upstream of the Delta.

In the Delta, sources of pesticides include direct input of surface runoff from Delta agriculture and Delta urbanized areas as well as inputs from rivers upstream of the Delta. While facilities operations and maintenance activities would not affect these sources, changes in Delta source water fraction could change the relative risk associated with pesticide related toxicity to aquatic life. Under Alternative 8, modeled long-term average San Joaquin River source water fractions at Franks Tract, Rock Slough and Contra Costa PP No. 1 locations would increase considerably for some months such that the long-term risk of pesticide-related toxicity to aquatic life could substantially increase.

The assessment of Alternative 8 effects on pesticides in the SWP/CVP Export Service Areas is based on assessment of changes predicted at Banks and Jones pumping plants. Sacramento River source water fractions would increase substantially at both Banks and Jones pumping plants and would generally represent an improvement in export water quality respective to pesticides.

Based on the above, Alternative 8 would not result in any substantial change in long-term average pesticide concentration or result in substantial increase in the anticipated frequency with which long-term average pesticide concentrations would exceed aquatic life toxicity thresholds or other beneficial use effect thresholds upstream of the Delta or the SWP/CVP service area. Numerous pesticides are currently used throughout the affected environment, and while some of these pesticides may be bioaccumulative, those present-use pesticides for which there is sufficient evidence for their presence in waters affected by SWP and CVP operations (i.e., diazinon, chlorpyrifos, diuron, and pyrethroids) are not considered bioaccumulative, and thus changes in their concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Furthermore, while there are numerous 303(d) listings throughout the affected environment that name pesticides as the cause for beneficial use impairment, the modeled changes in upstream river flows and Delta source water fractions would not be expected to make any of these beneficial use impairments measurably worse, with principal exception to locations in the Delta that would receive a substantially greater fraction San Joaquin River water under Alternative 8. Long-term average San Joaquin River source water fractions at Franks Tract, Rock Slough and Contra Costa PP No. 1 locations would change considerably for some months such that the long-term risk of pesticide-related toxicity to aquatic life could substantially increase. Additionally, the potential for increased incidence of pesticide related toxicity could include pesticides such as chlorpyrifos and diazinon for which existing 303(d) listings exist for the Delta, and thus existing beneficial use impairment could be made discernibly worse. The impact is considered to be significant and unavoidable. There is no feasible mitigation available to reduce the effect of this significant impact.

Impact WQ-22: Effects on Pesticide Concentrations Resulting from Implementation of CM2–CM22

***NEPA Effects*:** Conservation Measures 2–22 under Alternative 8 would be similar to those under Alternative 1A. Effects on pesticides resulting from the implementation of CM2–CM22 would be similar to that previously discussed for Alternative 1A. In summary, CM13 proposes the use of herbicides to control invasive aquatic vegetation around habitat restoration sites. Herbicides directly applied to water could include adverse effects on non-target aquatic life, such as aquatic invertebrates and beneficial aquatic plants. As such, aquatic life toxicity objectives could be exceeded with sufficient frequency and magnitude such that beneficial uses would be impacted, thus constituting an adverse effect on water quality.

In summary, based on the discussion above, the effects on pesticides from implementing CM2-CM22 are considered to be adverse. Mitigation Measure WQ-22 would be available to reduce this adverse effect.

***CEQA Conclusion*:** Effects of CM2–CM22 on pesticides under Alternative 8 are similar to those discussed for Alternative 1A. Potential environmental effects related only to CM13 are considered to be significant. Mitigation is required. While Mitigation Measure WQ-22 is available to partially reduce this impact of pesticides, no feasible mitigation is available that would reduce it to a level that would be less than significant.

Mitigation Measure WQ-22: Implement Least Toxic Integrated Pest Management Strategies

Please see Mitigation Measure WQ-22 under Impact WQ-22 in the discussion of Alternative 1A.

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

***NEPA Effects*:** Effects of water facilities and operations (CM1) on phosphorus levels in water bodies of the affected environment under Alternative 8 would be very similar (i.e., nearly the same) to those discussed for Alternative 1A. Consequently, the environmental consequences to phosphorus levels discussed in detail for Alternative 1A also adequately represent the effects under Alternative 8, which are considered to be not adverse.

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

Because phosphorus loading to waters upstream of the Delta is not anticipated to change, and because changes in flows do not necessarily result in changes in concentrations or loading of phosphorus to these water bodies, substantial changes in phosphorus concentration upstream of the Delta are not anticipated for Alternative 8, relative to Existing Conditions.

Because phosphorus concentrations in the major source waters to the Delta are similar for much of the year, phosphorus concentrations in the Delta are not anticipated to change substantially on a long term-average basis under Alternative 8, relative to Existing Conditions. Algal growth rates are limited by availability of light in the Delta, and therefore any minor increases in phosphorus levels that may occur at some locations and times within the Delta would be expected to have little effect on primary productivity in the Delta.

The assessment of effects of phosphorus under Alternative 8 in the SWP and CVP Export Service Areas is based on effects on phosphorus at the Banks and Jones pumping plants. As noted above, phosphorus concentrations in the Delta (including Banks and Jones pumping plants) are not anticipated to change substantially on a long term-average basis.

Based on the above, there would be no substantial, long-term increase in phosphorus concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the waters exported to the CVP and SWP service areas under Alternative 8 relative to Existing Conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because phosphorus concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Phosphorus is not 303(d) listed within the affected environment and thus any minor increases that may occur in some areas would not make any existing phosphorus-related impairment measurably worse because no such impairments currently exist. Because phosphorus is not bioaccumulative, minor increases that may occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-24: Effects on Phosphorus Concentrations Resulting from Implementation of CM2–CM22

NEPA Effects**:** Effects of CM2–CM22 on phosphorus levels in water bodies of the affected environment under Alternative 8 would be very similar (i.e., nearly the same) to those discussed for Alternative 1A. Consequently, the environmental consequences to phosphorus levels from implementing CM2–CM22 discussed in detail for Alternative 1A also adequately represent the effects of these same actions under Alternative 8, which are considered to be not adverse.

CEQA Conclusion**:** Conservation Measures 2–22 proposed under Alternative 8 would be similar to those proposed under Alternative 1A. As such, effects on phosphorus resulting from the implementation of CM2–CM22 would be similar to that previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

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

Upstream of the Delta

For the same reasons stated for the No Action Alternative, Alternative 8 would have negligible, if any, effect on selenium concentrations in the rivers and reservoirs upstream of the Delta relative to Existing Conditions and the No Action Alternative. Any negligible increases in selenium concentrations that could occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regard to selenium.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2-22 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for CM2-22. See section 8.3.1.3 for more information.

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, Table M-10A). The changes in selenium concentrations in water are reflected in small (10% or less) to moderate (between 11% and 50%) changes in available assimilative capacity for selenium (based on 2 μg/L ecological risk benchmark) for all years. Relative to Existing Conditions, Alternative 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 selenium concentrations in water (Appendix 8M, Table M-10A) for Alternative 8 (range 0.24–0.72 μg/L), Existing Conditions (range 0.21–0.76 μg/L), and the No Action Alternative (range 0.21–0.69 μg/L) are similar, and all would be below the ecological risk benchmark (2 μg/L).

Relative to Existing Conditions and the No Action Alternative, Alternative 8 would generally result in small changes in estimated selenium concentrations in biota (whole-body fish, bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets) (Appendix 8M, Table M-19 and Addendum M.A to Appendix 8M, Table M.A-2). Relative to Existing Conditions and the No Action Alternative, the largest increase of selenium concentrations in biota would be at Contra Costa PP for drought years and in sturgeon at the two western Delta locations in all as well as drought years. Relative to Existing Conditions, the largest decrease in selenium concentration in biota would be at Buckley Cove for drought years; relative to the No Action Alternative, the largest decrease would be at Staten Island for drought years. Except for sturgeon in the western Delta, concentrations of selenium in whole-body fish and bird eggs (invertebrate and fish diets) would exceed only the lower benchmarks (4 and 6 mg/kg dry weight, respectively, indicating a low potential for effects), under drought conditions, at Buckley Cove for Alternative 8 and Existing Conditions and the No Action Alternative (Figures 8-61 through 8-63). Exceedance Quotients for these exceedances of the lower benchmarks are all between 1.0 and 1.5, indicating a low risk to biota in the Delta and the similarity of Alternative 8 to Existing Conditions and the No Action Alternative. Selenium concentrations in fish fillets would not exceed the screening value for protection of human health (Figure 8-64). For sturgeon in the western Delta, whole-body selenium concentrations would increase from 12.3 mg/kg under Existing Conditions and the No Action Alternative to 14.7 mg/kg under Alternative 8, a 20% increase (Table M.A-2). All of these values exceed both the low and high toxicity benchmarks. The predicted increases are high enough that they may represent a measurable increase in body burdens of sturgeon, which would constitute an adverse impact (see also the discussion of results provided in Addendum M.A to Appendix 8M). Relative to Existing Conditions and the No Action Alternative, Alternative 8 would result in a minimal change in selenium concentrations throughout the Delta. Alternative 8 would not be expected to substantially increase the frequency with which applicable benchmarks would be exceeded in the Delta or substantially degrade the quality of water in the Delta, with regard to selenium.

SWP/CVP Export Service Areas

Alternative 8 would result in small to moderate changes in average selenium concentrations relative to Existing Conditions and the No Action Alternative (Appendix 8M, Table M-10A). These changes in selenium concentrations in water are reflected in small (10% or less) to moderate (between 11% and 50%) changes in available assimilative capacity for selenium for all years. Relative to Existing Conditions and the No Action Alternative, Alternative 8 would result in increases in assimilative capacity at Jones PP (14% and 15%, respectively) and at Banks PP (7%) (Figures 8-59 and 8-60) and would have a positive effect at the Export Service Area locations. The ranges of modeled selenium concentrations in water (Appendix 8M, Table M-10Ae) for Alternative 8 (range 0.32–0.37 μg/L), Existing Conditions (range 0.37–0.58 μg/L), and the No Action Alternative (range 0.37–0.59 μg/L) are similar, and all would be well below the ecological risk benchmark (2 μg/L).

Relative to Existing Conditions and the No Action Alternative, Alternative 8 would result in small changes in estimated selenium concentrations in biota (Appendix 8M, Table M-19). Relative to Existing Conditions and the No Action Alternative, the largest increase of selenium concentrations in biota would be at Banks PP for drought years (except for bird eggs [assuming a fish diet] at Banks PP for all years), and the largest decrease would be at Jones PP for drought years. Concentrations in biota would not exceed any benchmarks for Alternative 8 (Figures 8-61 through 8-64).

Thus, relative to Existing Conditions and the No Action Alternative, Alternative 8 would result in small to moderate changes in selenium concentrations in water and minimal changes in selenium concentrations in biota at the Export Service Area locations. Selenium concentrations in water and biota generally would decrease under Alternative 8 and would not exceed ecological benchmarks at either location, whereas the lower benchmark for bird eggs (fish diet) would be exceeded under Existing Conditions and the No Action 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%, which may represent a measurable increase in the environment. Because both low and high toxicity benchmarks are already exceeded under the No Action Alternative, these potentially measurable increases represent an adverse impact.

***CEQA Conclusion*:** Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for selenium. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

There are no substantial point sources of selenium in watersheds upstream of the Delta, and no substantial nonpoint sources of selenium in the watersheds of the Sacramento River and the eastern tributaries. Nonpoint sources in the San Joaquin Valley that contribute selenium to the Delta will be controlled through a TMDL developed by the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the Grassland Bypass Project, and Basin Plan objectives (Central Valley Water Board 2010c) and State Water Board (2010d, 2010e) that are expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta. Consequently, any modified reservoir operations and subsequent changes in river flows under 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.

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 the frequency with which applicable benchmarks would be exceeded 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, significant impacts on some beneficial uses of waters in the Delta could occur because both low and high toxicity benchmarks are already exceeded under Existing Conditions, and uptake of selenium from water to biota may measurably increase. In comparison to Existing Conditions, water quality conditions under this alternative would increase levels of selenium (a bioaccumulative pollutant) by frequency, magnitude, and geographic extent such that the affected environment may have measurably higher body burdens of selenium in aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish); however, impacts to humans consuming those organisms are not expected to occur. Water quality conditions under this alternative with respect to selenium would cause long-term degradation of water quality in the western Delta. Except in the vicinity of the western Delta for sturgeon, water quality conditions under this alternative would not increase levels of selenium by frequency, magnitude, and geographic extent such that the affected environment would be expected to have measurably higher body burdens of selenium in aquatic organisms. The greater level of selenium bioaccumulation in the western Delta would further degrade water quality by measurable levels, on a long-term basis, for selenium and, thus, cause the 303(d)-listed impairment of beneficial use to be made discernibly worse. This impact is considered significant.

The need for, and the feasibility and effectiveness of, post-operation mitigation for the predicted level of selenium bioaccumulation is uncertain. The first step shall be to determine the reliability of the model in predicting biota selenium concentrations in the affected environment where effects are predicted but selenium data are lacking. For that reason, the model shall be validated with site-specific sampling before extensive mitigation measures relative to CM1 operations are developed and evaluated for feasibility, as the measures and their evaluation for feasibility are likely to be complex. Specifically, it remains to be determined whether the available existing data for transfer of selenium from water to particulates and through different trophic levels of the food chain are representative of conditions that may occur from implementation of Alternative 8. Therefore, the proposed mitigation measure requires that sampling be conducted to characterize each step of data inputs needed for the model, and then the refined model be validated for local conditions. This impact is considered significant and unavoidable.

Impact WQ-26: Effects on Selenium Concentrations Resulting from Implementation of CM2–CM22

NEPA Effects: In general, with the possible exception of changes in Delta hydrodynamics resulting from habitat restoration, CM2–CM11 would not substantially increase selenium concentrations in the water bodies of the affected environment. Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, and thus such effects of these restoration measures were included in the assessment of CM1 facilities operations and maintenance (see Impact WQ-25).

However, implementation of these conservation measures may increase water residence time within the restoration areas. Increased restoration area water residence times could potentially increase the bioaccumulation of selenium in biota, thereby potentially increasing fish tissue and bird egg concentrations of selenium, but models are not available to quantitatively estimate the level of changes in residence time and the associated selenium bioavailability. If increases in fish tissue or bird egg selenium were to occur, the increases would likely be of concern only where fish tissues or bird eggs are already elevated in selenium to near or above thresholds of concern. That is, where biota concentrations are currently low and not approaching thresholds of concern, changes in residence time alone would not be expected to cause them to then approach or exceed thresholds of concern. In consideration of this factor, although the Delta as a whole is a 303(d)-listed water body for selenium, and although monitoring data of fish tissue or bird eggs in the Delta are sparse, the most likely areas in which biota tissues would be at levels high enough that additional bioaccumulation due to increased residence time from restoration areas would be a concern are the western Delta and Suisun Bay, and the South Delta in areas that receive San Joaquin River water.

The western Delta and Suisun Bay receive elevated selenium loads from North San Francisco Bay (including San Pablo Bay, Carquinez Strait, and Suisun Bay) and from the San Joaquin River. Point sources of selenium in North San Francisco Bay (i.e., refineries) that contribute selenium to Suisun Bay are expected to be reduced through a TMDL under development by the San Francisco Bay Water Board (San Francisco Bay Water Board 2012) that is expected to result in decreasing discharges of selenium. Nonpoint sources of selenium in the San Joaquin Valley that contribute selenium to the San Joaquin River, and thus the Delta and Suisun Bay, will be controlled through a TMDL developed by the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the Grassland Bypass Project, and Basin Plan objectives (Central Valley Water Board 2010c, d) that are expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta. If selenium levels are not sufficiently reduced via these efforts, it is expected that the State Water Board and the San Francisco Bay and Central Valley Water Boards would initiate additional actions to further control sources of selenium.

The South Delta receives elevated selenium loads from the San Joaquin River. In contrast to Suisun Bay and possibly the western Delta in the future, the South Delta lacks the overbite clam (*Corbula* [*Potamocorbula*] *amurensis*), which is considered a key driver of selenium bioaccumulation in Suisun Bay, due to its high bioaccumulation of selenium and its role in the benthic food web that includes long-lived sturgeon. The South Delta does have *Corbicula fluminea*, another bivalve that bioaccumulates selenium, but it is not as invasive as the overbite clam and thus likely makes up a smaller fraction of sturgeon diet. Also, as mentioned above, nonpoint sources of selenium in the San Joaquin Valley that contribute selenium to the Delta will be controlled through a TMDL developed by the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the Grassland Bypass Project, and Basin Plan objectives (Central Valley Water Board 2010c, d) that are expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta. Further, if selenium levels in the San Joaquin River are not sufficiently reduced via these efforts, it is expected that the State Water Board and Central Valley Water Board would initiate additional TMDLs to further control nonpoint sources of selenium.

Wetland restoration areas will not be designed such that water flows in and does not flow out. Exchange of water between the restoration areas and existing Delta channels is an important design factor, since one goal of the restoration areas is to export food produced in these areas to the rest of the Delta (see BDCP Chapter 3, *Conservation Strategy*, Section 3.3, Biological Goals and Objectives). Thus, these areas can be thought of as "flow-through" systems. Consequently, although water residence times associated with BDCP restoration could increase, they are not expected to increase without bound. and selenium concentrations in the water column would not continue to build up and be recycled in sediments and organisms as may be the case within a closed system.

However, because increases in bioavailable selenium in the habitat restoration areas are uncertain, proposed avoidance and minimization measures would require evaluating risks of selenium exposure at a project level for each restoration area, minimizing to the extent practicable potential risk of additional bioaccumulation, and monitoring selenium levels in fish and/or wildlife to establish whether, or to what extent, additional bioaccumulation is occurring. See Appendix 3B, *Environmental Commitments* for a description of the environmental commitment BDCP proponents are making with respect to Selenium Management; and Appendix 3.C. of the BDCP for additional detail on this avoidance and minimization measure (AMM27). Data generated as part of the avoidance and minimization measures will assist the State and Regional Water Boards in determining whether beneficial uses are being impacted by selenium, and thus will provide the data necessary to support regulatory actions (including additional TMDL development), should such actions be warranted.

Given the factors discussed in the assessment above, any increases in bioaccumulation rates from water-borne selenium that could occur in some areas as a result of increased water residence time would not be of sufficient magnitude and geographic extent that any portion of the Delta would be expected to have measurably higher body burdens of selenium in aquatic organisms and, therefore, would not substantially increase risk for adverse effects to beneficial uses. Furthermore, although the Delta is a 303(d)-listed water body for selenium, given the discussion in the assessment above, it is unlikely that restoration areas would result in measurable increases in selenium in fish tissues or bird eggs such that the beneficial use impairment would be made discernibly worse.

Because it is unlikely that substantial increases in selenium in fish tissues or bird eggs would occur such that effects on aquatic life beneficial uses would be anticipated, and because of the avoidance and minimization measures that are designed to further minimize and evaluate the risk of such increases, the effects of WQ-26 are considered not adverse.

CEQA Conclusion**:** There would be no substantial, long-term increase in selenium concentrations in water in the rivers and reservoirs upstream of the Delta, water in the Delta, or the waters exported to the CVP and SWP service areas due to implementation of CM2–CM22 relative to Existing Conditions. Waterborne selenium concentrations under this alternative would not exceed applicable water quality objectives/criteria.

Given the factors discussed in the assessment above, any increases in bioaccumulation rates from water-borne selenium that could occur in some areas as a result of increased water residence times would not be of sufficient magnitude and geographic extent that any portion of the Delta would be expected to have measurably higher body burdens of selenium in aquatic organisms, and therefore would not substantially increase risk for adverse effects to beneficial uses. CM2-22 would not cause long-term degradation of water quality resulting in sufficient use of available assimilative capacity such that occasionally exceeding water quality objectives/criteria would be likely. Also, CM2-22 would not result in substantially increased risk for adverse effects to any beneficial uses. Furthermore, although the Delta is a 303(d)-listed water body for selenium, given the discussion in the assessment above, it is unlikely that restoration areas would result in measurable increases in selenium in fish tissues or bird eggs such that the beneficial use impairment would be made discernibly worse.

Since it is unlikely that substantial increases in selenium in fish tissues or bird eggs would occur such that effects on aquatic life beneficial uses would be anticipated, and because of the avoidance and minimization measures that are designed to further minimize and evaluate the risk of such increases (see Appendix 3.C. of the BDCP for more detail on AMM27) as well as the Selenium Management environmental commitment (see Appendix 3B, *Environmental Commitments*), this impact is considered less than significant. No mitigation is required.

Impact WQ-27: Effects on Trace Metal Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative, Alternative 8 would result in negligible, and likely immeasurable, increases in trace metal concentrations in the rivers and reservoirs upstream of the Delta, relative to Existing Conditions and the No Action Alternative. Effects due to the operation and maintenance of the conveyance facilities are expected to be immeasurable, on an annual and long-term average basis. As such, Alternative 8 would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or CTR criteria would be exceeded in water bodies of the affected environment located upstream of the Delta or substantially degrade the quality of these water bodies, with regard to trace metals.

Delta

For the same reasons stated for the No Action Alternative, Alternative 8 would not result in substantial increases in trace metal concentrations in the Delta relative to Existing Conditions and the No Action Alternative. However, substantial changes in source water fraction would occur in the south Delta (Appendix 8D, Source Water Fingerprinting). Throughout much of the south Delta, San Joaquin River water would replace Sacramento River water, with the future trace metals profile largely reflecting that of the San Joaquin River. As discussed for the No Action Alternative, trace metal concentration profiles between the San Joaquin and Sacramento Rivers are very similar and currently meet Basin Plan objectives and CTR criteria. While the change in trace metal concentrations in the south Delta would likely be measurable, Alternative 8 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 Delta waters with regard to trace metals.

SWP/CVP Export Service Areas

For the same reasons stated for the No Action Alternative, Alternative 8 would not result in substantial increases in trace metal concentrations in the water exported from the Delta or diverted from the Sacramento River through the proposed conveyance facilities. As such, there is not expected to be substantial changes in trace metal concentrations in the SWP/CVP export service area waters under Alternative 8, relative to Existing Conditions and the No Action Alternative. As such, Alternative 8 would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or CTR criteria would be exceeded in the water bodies of the affected environment in the SWP and CVP Service Area or substantially degrade the quality of these water bodies, with regard to trace metals.

NEPA Effects: In summary, Alternative 8, relative to the No Action Alternative, would not cause a substantial increase in long-term average trace metals concentrations within the affected environment, nor would it cause an increased frequency of water quality objective/criteria exceedances within the affected environment. The effect on trace metals is determined not to be adverse.

CEQA Conclusion: Effects of CM1 on trace metals under Alternative 8 would be similar to those discussed for Alternative 1A, and are summarized here, then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion under Alternative 1A.

While greater water demands under the Alternative 8 would alter the magnitude and timing of reservoir releases north, south and east of the Delta, these activities would have no substantial effect on the various watershed sources of trace metals. Moreover, long-term average flow and trace metals at Sacramento River at Hood and San Joaquin River at Vernalis are poorly correlated; therefore, changes in river flows would not be expected to cause a substantial long-term change in trace metal concentrations upstream of the Delta.

Average and 95th percentile trace metal concentrations are very similar across the primary source waters to the Delta. Given this similarity, very large changes in source water fraction would be necessary to effect a relatively small change in trace metal concentration at a particular Delta location. Moreover, average and 95th percentile trace metal concentrations for these primary source waters are all below their respective water quality criteria, including those that are hardness-based without a WER adjustment. No mixing of these three source waters could result in a metal concentration greater than the highest source water concentration, and given that trace metals do not already exceed water quality criteria, more frequent exceedances of criteria in the Delta would not be expected to occur under the Alternative 8.

The assessment of the Alternative 8 effects on trace metals in the SWP/CVP Export Service Areas is based on assessment of changes in trace metal concentrations at Banks and Jones pumping plants. As just discussed regarding similarities in Delta source water trace metal concentrations, the Alternative 8 is not expected to result in substantial changes in trace metal concentrations in Delta waters, including Banks and Jones pumping plants, therefore effects on trace metal concentrations in the SWP/CVP Export Service Area are expected to be negligible.

There would be no substantial long-term increase in trace metal concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the SWP/CVP export service area waters under Alternative 8 relative to Existing Conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because trace metal concentrations are not expected to increase substantially, no long-term water quality degradation for trace metals is expected to occur and, thus, no adverse effects to beneficial uses would occur. Furthermore, any negligible changes in long-term trace metal concentrations that may occur in water bodies of the affected environment would not be expected to make any existing beneficial use impairments measurably worse. The trace metals discussed in this assessment are not considered bioaccumulative, and thus would not directly cause bioaccumulative problems in aquatic life or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-28: Effects on Trace Metal Concentrations Resulting from Implementation of CM2–CM22

NEPA Effects: Conservation Measures 2–22 under Alternative 8 would be similar to those under Alternative 1A. Effects on trace metals resulting from the implementation of CM2–CM22 would be similar to that previously discussed for Alternative 1A. As they pertain to trace metals, implementation of CM2–CM22 would not be expected to adversely affect beneficial uses of the affected environment or substantially degrade water quality with respect to trace metals.

In summary, implementation of CM2–CM22 under Alternative 8, relative to the No Action Alternative, would have negligible, if any, effect on trace metals concentrations. The effect on trace metals from implementing CM2–CM22 is determined not to be adverse.

CEQA Conclusion: Implementation of CM2–CM22 under Alternative 8 would not cause substantial long-term increase in trace metal concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the SWP/CVP export service area. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because trace metal concentrations are not expected to increase substantially, no long-term water quality degradation for trace metals is expected to occur and, thus, no adverse effects to beneficial uses would occur. Furthermore, any negligible changes in long-term trace metal concentrations that may occur throughout the affected environment would not be expected to make any existing beneficial use impairments measurably worse. The trace metals discussed in this assessment are not considered bioaccumulative, and thus would not directly cause bioaccumulative problems in aquatic life or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-29: Effects on TSS and Turbidity Resulting from Facilities Operations and Maintenance (CM1)

NEPA Effects: Effects of CM1 on TSS and turbidity under Alternative 8 are the same as those discussed for Alternative 1A and are considered to not be adverse.

CEQA Conclusion: Effects of CM1 on TSS and turbidity under Alternative 8 would be similar to those discussed for Alternative 1A, and are summarized here, then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion under Alternative 1A.

Changes river flow rate and reservoir storage that would occur under Alternative 8, relative to Existing Conditions, would not be expected to result in a substantial adverse change in TSS concentrations and turbidity levels in the reservoirs and rivers upstream of the Delta, given that suspended sediment concentrations are more affected by season than flow. Site-specific and temporal exceptions may occur due to localized temporary construction activities, dredging activities, development, or other land use changes would be site-specific and temporal, which would be regulated to limit both their short-term and long-term effects on TSS and turbidity levels to less than substantial levels.

Within the Delta, geomorphic changes associated with sediment transport and deposition are usually gradual, occurring over years, and high storm event inflows would not be substantially affected. Thus, it is expected that the TSS concentrations and turbidity levels in the affected channels would not be substantially different from the levels under Existing Conditions. Consequently, this alternative is expected to have minimal effect on TSS concentrations and turbidity levels in the Delta region, relative to Existing Conditions.

There is not expected to be substantial, if even measurable, changes in TSS concentrations and turbidity levels in the SWP/CVP Export Service Areas waters under Alternative 8, relative to Existing Conditions, because as stated above, this alternative is not expected to result in substantial changes in TSS concentrations and turbidity levels at the south Delta export pumps, relative to Existing Conditions.

Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives where such objectives are not exceeded under Existing Conditions. Because TSS concentrations and turbidity levels are not expected to be substantially different, long-term water quality degradation is not expected, and, thus, beneficial uses are not expected to be adversely affected. Finally, TSS and turbidity are neither bioaccumulative nor Clean Water Act section 303(d) listed constituents. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-30: Effects on TSS and Turbidity Resulting from Implementation of CM2–CM22

***NEPA Effects*:** Effects of CM2–CM22 on TSS and turbidity under Alternative 8 are the same as those discussed for Alternative 1A and are considered to not be adverse.

***CEQA Conclusion*:** Conservation Measures 2–22 proposed under Alternative 8 would be similar to those proposed under Alternative 1A. As such, effects on TSS and turbidity resulting from the implementation of CM2–CM22 would be similar to that previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-31: Water Quality Effects Resulting from Construction-Related Activities (CM1–CM22)

The conveyance features for CM1 under Alternative 8 would be very similar to those discussed for Alternative 1A. The primary difference between Alternative 8 and Alternative 1A is that under Alternative 8, there would be two fewer intakes and two fewer pumping plant locations, which would result in a reduced level of construction activity. Additional construction activity also would occur to restore channel margin and seasonally inundated floodplain habitats. However, construction techniques and locations of major features of the conveyance system within the Delta would be similar. The remainder of the facilities constructed under Alternative 8, including CM2–CM22, would be very similar to, or the same as, those to be constructed for Alternative 1A. However, under Alternative 8, there would be up to 20,000 acres of inundated floodplain habitat restored (as opposed to 10,000 acres under the majority of the other alternatives), thus resulting in increased construction-related disturbances.

***NEPA Effects*:** The types and magnitude of potential construction-related water quality effects associated with implementation of CM1–CM22 under Alternative 8 would be very similar to the effects discussed for Alternative 1A, and the effects anticipated with implementation of CM2–CM22 would be essentially identical. Nevertheless, the construction of CM1, and any individual components necessitated by CM2, and CM4–CM10, with the implementation of the BMPs specified in Appendix 3B*, Environmental Commitments,* and other agency permitted construction requirements would result in the potential water quality effects being largely avoided and minimized. The specific environmental commitments that would be implemented under Alternative 8 would be similar to those described for Alternative 1A. Consequently, relative to Existing Conditions, Alternative 8 would not be expected to cause exceedance of applicable water quality objectives/criteria or substantial water quality degradation with respect to constituents of concern, and thus would not adversely affect any beneficial uses upstream of the Delta, in the Delta, or in the SWP and CVP service area.

In summary, with implementation of environmental commitments in Appendix 3B, the potential construction-related water quality effects are considered to be not adverse.

CEQA Conclusion**:** Because environmental commitments would be implemented under Alternative 8 for construction-related activities along with agency-issued permits that also contain construction requirements to protect water quality, the construction-related effects, relative to Existing Conditions, would not be expected to cause or contribute to substantial alteration of existing drainage patterns which would result in substantial erosion or siltation on- or off-site, substantial increased frequency of exceedances of water quality objectives/criteria, or substantially degrade water quality with respect to the constituents of concern on a long-term average basis, and thus would not adversely affect any beneficial uses in water bodies upstream of the Delta, within the Delta, or in the SWP and CVP service area. Moreover, because the construction-related activities would be temporary and intermittent in nature, the construction would involve negligible discharges, if any, of bioaccumulative or 303(d) listed constituents to water bodies of the affected environment. As such, construction activities would not contribute measurably to bioaccumulation of contaminants in organisms or humans or cause 303(d) impairments to be discernibly worse. Based on these findings, this impact is determined to be less than significant. No mitigation is required.

8.4.3.16 Alternative 9—Through Delta/Separate Corridors (15,000 cfs; Operational Scenario G)

Under Alternative 9, two fish-screened intakes would be constructed–one at the Delta Cross Channel and the other at Georgiana Slough. Water would be conveyed through a flow-collection channel and radial gates, eventually reaching the existing channel. Once in the channel, water would flow south through the Mokelumne River and San Joaquin River to Middle River and Victoria Canal, which would be dredged to accommodate increased flows. Along the way, diverted water would be guided by operable barriers. Water flowing through Victoria Canal would lead into two new canal segments and pass under two existing watercourses through culvert siphons, eventually reaching Clifton Court Forebay. From there, water would flow through existing SWP facilities, and a new canal would be constructed to connect the forebay to CVP facilities. Water supply and conveyance operational criteria under Alternative 9 would be guided by criteria identified in Scenario G. Conservation Measures 2–22 (CM2–22) would be implemented under this alternative, and would be the same as those under Alternative 1A. See Chapter 3, *Description of Alternatives,* Section 3.5.16, for additional details on Alternative 9.

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 9, over the long term, average annual delta exports are anticipated to decrease by 766 TAF relative to Existing Conditions, and by 63 TAF relative to the No Action Alternative. Although all of the diversions are from the existing south Delta intakes, the operable barriers included under this alternative would result in the exported water containing a higher proportion of Sacramento River water as opposed to San Joaquin River water (see Chapter 5, *Water Supply*, for more information). The result of this is greatly 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 9–Old River at Rock Slough for ALL years (1976–1991), which shows increased San Joaquin River (SJR) percentage and decreased Sacramento River (SAC) percentage under the alternative, relative to Existing Conditions and the No Action Alternative.

Under Alternative 9, long-term average annual Delta outflow is anticipated to increase 807 TAF relative to Existing Conditions, due to both changes in operations (including use of operable barriers and numerous other operational components of Scenario G) and climate change/sea level rise (see Chapter 5, *Water Supply*, for more information). The result of this is decreased sea water intrusion in the west Delta. The decrease of sea water intrusion in the west Delta under Alternative 9 is greater relative to the Existing Conditions because it does not include operations to meet Fall X2, whereas the No Action alternative and Alternative 9 do. Long-term average annual Delta outflow is anticipated to increase under Alternative 9 by 57 TAF relative to the No Action Alternative, due only to changes in operations. The decreases in sea water intrusion (represented by an decrease in San Francisco Bay (BAY) percentage) can be seen, for example, in Appendix 8D, ALT 9–Sacramento River at Mallard Island for ALL years (1976–1991).

Impact WQ-1: Effects on Ammonia Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative, Alternative 9 would have negligible, if any, effect on ammonia concentrations in the rivers and reservoirs upstream of the Delta relative to

Existing Conditions and the No Action Alternative. Any negligible increases in ammonia-N concentrations that could occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regard to ammonia.

Delta

Assessment of effects of ammonia under Alternative 9 is the same as discussed under Alternative 1A, except that because flows in the Sacramento River at Freeport are different between the two alternatives, estimated monthly average and long term annual average predicted ammonia-N concentrations in the Sacramento River downstream of Freeport are different.

As Table 8-72 shows, estimated ammonia-N concentrations in the Sacramento River downstream of Freeport (upon full mixing of the SRWTP discharge with river water) under Alternative 9 and the No Action Alternative are expected to be similar. Minor increases in ammonia-N concentrations would occur during January through March, July, October, and December, and remaining months would be unchanged or have a minor decrease. A minor increase in the annual average concentration would occur under Alternative 9, compared to the No Action Alternative. Moreover, the estimated concentrations downstream of Freeport under Alternative 9 would be similar to existing source water concentrations for the San Francisco Bay and San Joaquin River. Consequently, changes in source water fraction anticipated under Alternative 9, relative to the No Action Alternative, are not expected to substantially increase ammonia concentrations at any Delta locations.

Table 8-72. Estimated Ammonia-N (mg-L as N) Concentrations in the Sacramento River Downstream of the Sacramento Regional Wastewater Treatment Plant for the No Action Alternative and Alternative 9

	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
Alternative 9	0.076	0.084	0.070	0.061	0.058	0.061	0.058	0.063	0.067	0.061	0.067	0.064	0.066

Any negligible increases in ammonia-N concentrations that could occur at certain locations in the Delta would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to ammonia.

SWP/CVP Export Service Areas

The assessment of effects on ammonia in the SWP/CVP Export Service Area is based on assessment of ammonia-N concentrations at Banks and Jones pumping plants. Similar to the discussion for Alternative 1A, under Alternative 9 for areas of the Delta that are influenced by Sacramento River water, including Banks and Jones pumping plants, ammonia-N concentrations are expected to decrease, relative to Existing Conditions (in association with less diversion of water influenced by the SRWTP). This decrease in ammonia-N concentrations for water exported via the south Delta pumps is not expected to result in adverse effects on beneficial uses or substantially degrade water quality of exported water, with regards to ammonia.

Furthermore, as discussed above for the Plan Area, for all areas of the Delta, including Banks and Jones pumping plants, ammonia-N concentrations are not expected to be substantially different under Alternative 9, relative to No Action Alternative. Any negligible increases in ammonia-N concentrations that could occur at Banks and Jones pumping plants would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to ammonia.

NEPA Effects: In summary, based on the discussion above, effects on ammonia from implementation of CM1 are considered to be not adverse.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Ammonia-N concentrations are generally low in the reservoirs and rivers of the watersheds, owing to the lack of substantial point and nonpoint sources of ammonia-N upstream of the SRWTP in the Sacramento River watershed, in the watersheds of the eastern tributaries (Cosumnes, Mokelumne, and Calaveras Rivers), or upstream of the Delta in the San Joaquin River watershed. Consequently, any modified reservoir operations and subsequent changes in river flows under Alternative 9, relative to Existing Conditions, are expected to have negligible, if any, effects on reservoir and river ammonia-N concentrations upstream of Freeport in the Sacramento River watershed and upstream of the Delta in the San Joaquin River watershed.

Ammonia-N concentrations in the Sacramento River downstream of the SRWTP would be substantially lower under Alternative 9, relative to Existing Conditions, due to upgrades to the SRWTP that are assumed to be in place, and thus, ammonia concentrations for all areas of the Delta that are influenced by Sacramento River water are expected to decrease. At locations which are not influenced notably by Sacramento River water, concentrations are expected to remain relatively unchanged, due to the similarity in SJR and BAY concentrations and the lack of expected changes in either of these concentrations.

The assessment of effects on ammonia in the SWP/CVP Export Service Areas is based on assessment of ammonia-N concentrations at Banks and Jones pumping plants. As discussed above for the Plan Area, for areas of the Delta that are influenced by Sacramento River water, including Banks and Jones pumping plants, ammonia-N concentrations are expected to decrease under Alternative 9, relative to Existing Conditions.

Based on the above, there would be no substantial, long-term increase in ammonia-N concentrations in the rivers and reservoirs upstream of the Delta, in the Plan Area, or the waters exported to the CVP and SWP service areas under Alternative 9 relative to Existing Conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because ammonia concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects on beneficial uses would occur. Ammonia is not 303(d) listed within the affected environment and thus any minor increases that could occur in some areas would not make any existing ammonia-related impairment measurably worse because no such impairments currently exist. Because ammonia-N is not bioaccumulative, minor increases that could occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-2: Effects on Ammonia Concentrations Resulting from Implementation of CM2–CM22

NEPA Effects: Effects of CM2–CM22 on ammonia under Alternative 9 are the same as those discussed for Alternative 1A and are considered to be not adverse.

CEQA Conclusion: Conservation Measures 2–22 proposed under Alternative 9 would be similar to those proposed under Alternative 1A. As such, effects on ammonia resulting from the implementation of CM2–CM22 would be similar to that previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-3: Effects on Boron Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Effects of CM1 on boron under Alternative 9 in areas upstream of the Delta would be very similar to the effects discussed for Alternative 1A. There would be no expected change to the sources of boron in the Sacramento and east-side tributary watersheds, and resultant changes in flows from altered system-wide operations would have negligible, if any, effects on the concentration of boron in the rivers and reservoirs of these watersheds. The modeled long-term annual average lower San Joaquin River flow at Vernalis would decrease slightly compared to Existing Conditions (in association with changed operations, climate change, and increased water demands) and the No Action Alternative considering only changes due to Alternative 9 operations. The reduced flow would result in possible increases in long-term average boron concentrations of up to about 3% relative to the Existing Conditions (Appendix 8F, Table 24). The increased boron concentrations would not increase the frequency of exceedances of any applicable objectives or criteria and would not be expected to cause further degradation at measurable levels in the lower San Joaquin River, and thus would not cause the existing impairment there to be discernibly worse. Consequently, Alternative 9 would not be expected to cause exceedance of boron objectives/criteria or substantially degrade water quality with respect to boron, and thus would not adversely affect any beneficial uses of the Sacramento River, the east-side tributaries, associated reservoirs upstream of the Delta, or the San Joaquin River.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2-22 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for CM2-22. See section 8.3.1.3 for more information.

Relative to the Existing Conditions and No Action Alternative, Alternative 9 would result in similar or reduced long-term average boron concentrations for the 16-year period modeled at northern and eastern Delta locations, with a substantial reduction in boron concentrations in the San Joaquin River at Buckley Cove. Long-term average boron concentrations would increase at interior and western Delta locations (by as much as 66% at Franks Tract, 80% at Old River at Rock Slough, and 9% at the Sacramento River at Emmaton) (Appendix 8F, Table Bo-22). The comparison to Existing Conditions reflects changes due to both Alternative 9 operations (including use of operable barriers and numerous other operational components of Scenario G) and climate change/sea level rise. The comparison to the No Action Alternative reflects changes due only to operations.

Implementation of tidal habitat restoration under CM4 also may contribute to increased boron concentrations at western Delta assessment locations (more discussion of this phenomenon is included in Section 8.3.1.3), and thus would not be anticipated to substantially affect agricultural diversions which occur primarily at interior Delta locations. The long-term annual average and monthly average boron concentrations, for either the 16-year period or drought period modeled, would never exceed the 2,000 μg/L human health advisory objective (i.e., for children) or 500 μg/L agricultural objective at any of the eleven Delta assessment locations, which represents no change from the Existing Conditions and No Action Alternative (Appendix 8F, Table Bo-3A). The increased concentrations at interior Delta locations would result in moderate reductions in the long-term average assimilative capacity of up to 33% at Franks Tract and up to 46% at Old River at Rock Slough locations (Appendix 8F, Table Bo-23). However, because the absolute boron concentrations would still be well below the lowest 500 μg/L objective for the protection of the agricultural beneficial use under Alternative 9, the levels of boron degradation would not be of sufficient magnitude to substantially increase the risk of exceeding objectives or cause adverse effects to municipal and agricultural water supply beneficial uses, or any other beneficial uses, in the Delta (Appendix 8F, Figure Bo-5).

SWP/CVP Export Service Areas

Effects of CM1 on boron under Alternative 9 in the Delta would be similar to the effects discussed for Alternative 1A. Under Alternative 9, long-term average boron concentrations would decrease by as much as 18% at the Banks Pumping Plant and by as much as 31% at Jones Pumping Plant relative to Existing Conditions and No Action Alternative (Appendix 8F, Table Bo-22) as a result of export of a greater proportion of low-boron Sacramento River water. Commensurate with the decrease in exported boron concentrations, boron concentrations in the lower San Joaquin River may be reduced and would likely alleviate or lessen any expected increase in boron concentrations at Vernalis associated with flow reductions (see discussion of Upstream of the Delta), as well as locations in the Delta receiving a large fraction of San Joaquin River water. Reduced export boron concentrations also may contribute to reducing the existing 303(d) impairment in the lower San Joaquin River and associated TMDL actions for reducing boron loading.

Maintenance of SWP and CVP facilities under Alternative 9 would not be expected to create new sources of boron or contribute towards a substantial change in existing sources of boron in the affected environment. Maintenance activities would not be expected to cause any substantial increases in boron concentrations or degradation with respect to boron such that objectives would be exceeded more frequently, or any beneficial uses would be adversely affected anywhere in the affected environment.

NEPA Effects: In summary, relative to the No Action Alternative conditions, Alternative 9 would result in moderate increases in long-term average boron concentrations in the Delta and not appreciably change boron levels in the lower San Joaquin River. However, the predicted changes in the Delta would not be expected to result in exceedances of applicable objectives or further water quality degradation such that objectives would likely be exceeded or there would be substantially increased risk of adverse effect on water quality.

CEQA Conclusion**:** Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Boron is not a constituent of concern in the Sacramento River watershed upstream of the Delta, thus river flow rate and reservoir storage reductions that would occur under the Alternative 9, relative to Existing Conditions, would not be expected to result in a substantial adverse change in boron levels. Additionally, relative to Existing Conditions, Alternative 9 would not result in reductions in river flow rates (i.e., less dilution) or increased boron loading such that there would be any substantial increases in boron concentration upstream of the Delta in the San Joaquin River watershed.

Moderate increased boron levels (i.e., up to 82% increased concentration) and degradation predicted for interior and western Delta locations in response to a shift in the Delta source water percentages and tidal habitat restoration under this alternative would not be expected to cause exceedances of objectives. Alternative 9 maintenance also would not result in any substantial increases in boron concentrations in the affected environment. Boron concentrations would be reduced in water exported from the Delta to the CVP/SWP Export Service Areas, thus reflecting a potential improvement to boron loading in the lower San Joaquin River.

Boron is not a bioaccumulative constituent, thus any increased concentrations under Alternative 9 would not result in adverse boron bioaccumulation effects to aquatic life or humans. Relative to Existing Conditions, Alternative 9 would not result in substantially increased boron concentrations such that frequency of exceedances of municipal and agricultural water supply objectives would increase. The levels of boron degradation that may occur under Alternative 9, while widespread in particular at interior Delta locations, would not be of sufficient magnitude to cause substantially increased risk for adverse effects to municipal or agricultural beneficial uses within the affected environment. Long-term average boron concentrations would decrease in Delta water exports to the SWP and CVP service area, which may contribute to reducing the existing 303(d) impairment of agricultural beneficial uses in the lower San Joaquin River. Consequently, Alternative 9 would not be expected to cause any substantial increases in boron concentrations or degradation with respect to boron such that objectives would be exceeded more frequently, or any beneficial uses would be adversely affected anywhere in the affected environment. Based on these findings, this impact is determined to be less than significant. No mitigation is required.

Impact WQ-4: Effects on Boron Concentrations Resulting from Implementation of CM2–CM22

NEPA Effects**:** Effects of CM2–CM22 on boron under Alternative 9 are the same as those discussed for Alternative 1A and are determined to be not adverse.

CEQA Conclusion**:** Conservation Measures 2–22 proposed under Alternative 9 would be similar to those proposed under Alternative 1A. As such, effects on boron resulting from the implementation of CM2–CM22 would be similar to that previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-5: Effects on Bromide Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Under Alternative 9 there would be no expected change to the sources of bromide in the Sacramento and eastside tributary watersheds. Bromide loading in these watersheds would remain unchanged and resultant changes in flows from altered system-wide operations under Alternative 9 would have negligible, if any, effects on the concentration of bromide in the rivers and reservoirs of these watersheds. Consequently, Alternative 9 would not be expected to adversely affect the MUN beneficial use, or any other beneficial uses, of the Sacramento River, the eastside tributaries, or their associated reservoirs upstream of the Delta.

Under Alternative 9, modeling indicates that long-term annual average flows on the San Joaquin River would decrease by 6%, relative to Existing Conditions and would remain virtually the same relative to the No Action Alternative (Appendix 5A). These decreases in flow would result in possible increases in long-term average bromide concentrations of about 3% relative to Existing Conditions and less than <1% relative to the No Action Alternative (Appendix 8E, Bromide Table 22). The small increases in lower San Joaquin River bromide levels that could occur under Alternative 9, relative to existing and No Action Alternative conditions would not be expected to adversely affect the MUN beneficial use, or any other beneficial uses, of the lower San Joaquin River.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2-22 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for CM2-22. See section 8.3.1.3 for more information.

Using the mass-balance modeling approach for bromide (see Section 8.3.1.3), relative to Existing Conditions, Alternative 9 would result in increases in long-term average bromide concentrations at Buckley Cove (for the modeled drought period only), Emmaton, and Barker Slough, while long-term average concentrations would decrease at the other assessment locations (Appendix 8E, *Bromide*, Table 20). With regard to bromide, Emmaton is a suitable source of raw drinking water on a seasonal basis. While the relative change in long-term average bromide concentration at Emmaton is considerable (≤32%), the increase in the average would be due to more frequent seasonal peak concentrations in excess of 1,000 µg/L relative to Existing Conditions (Appendix 8E, *Bromide*, Figure 2). At Emmaton the predicted 50 µg/L exceedance frequency would increase only slightly from 82% under Existing Conditions to 86% under Alternative 9 (98% to 100% for the modeled drought period), and the predicted 100 µg/L exceedance frequency would increase from 72% under Existing Conditions to 81% under Alternative 9 (93% to 97% for the modeled drought period), indicative of very small changes during seasonally suitable periods of potential use. At Barker Slough, predicted long-term average bromide concentrations would increase from 51 µg/L to 61 µg/L (19% relative increase) for the modeled 16-year hydrologic period and 54 µg/L to 100 µg/L (88% relative increase) for the modeled drought period. At Barker Slough, the predicted 50 µg/L exceedance frequency would decrease from 49% under Existing Conditions to 41% under Alternative 9, but would increase from 55% to 80% during the drought period. At Barker Slough, the predicted 100 µg/L exceedance frequency would increase from 0% under Existing Conditions to 16% under

Alternative 9, and would increase from 0% to 42% during the drought period. At Buckley Cove, predicted long-term average bromide concentrations would remain the same (i.e., 259 μg/L), but would increase from 272 μg/L to 330 μg/L (21% relative increase) for the modeled drought period. At Buckley Cove, the predicted 50 μg/L exceedance frequency would not change (i.e., 100% exceedance), but the modeled 100 μg/L exceedance frequency would decrease from 100% under Existing Conditions to 90% under Alternative 9 (100% to 87% for the modeled drought period). This comparison to Existing Conditions reflects changes in bromide due to both Alternative 9 operations (including use of operable barriers and numerous other operational components of Scenario G) and climate change/sea level rise.

Due to the relatively small differences between modeled Existing Conditions and No Action baselines, changes in long-term average bromide concentrations and changes in exceedance frequencies relative to the No Action Alternative are generally of similar magnitude to those previously described for the existing condition comparison (Appendix 8E, *Bromide*, Table 20). Modeled long-term average bromide concentration at Emmaton would increase by as much as 36%, but change in 50 and 100 μg/L exceedance thresholds would be smaller than that described for the existing condition comparison, indicative of very small changes during seasonally suitable periods of potential use. Modeled long-term average bromide concentration at Barker Slough is predicted to increase by 23% (87% for the modeled drought period) relative to the No Action Alternative. Modeled long-term average bromide concentration increases at Buckley Cove are predicted to increase by 7% (36% for the modeled drought period) relative to the No Action Alternative. Unlike the comparison to Existing Conditions, this comparison to the No Action Alternative reflects changes in bromide due only to Alternative 9 operations.

At Barker Slough, modeled long-term average bromide concentrations for the various baseline conditions are very similar (≤4%) (Appendix 8E, *Bromide*, Table 20). Such similarity demonstrates that the modeled Alternative 9 change in bromide is almost entirely due to Alternative 9 operations, and not climate change/sea level rise. Therefore, operations are the primary driver of effects on bromide at Barker Slough, regardless whether Alternative 9 is compared to Existing Conditions, or compared to the No Action Alternative.

Results of the modeling approach which used relationships between EC and chloride and between chloride and bromide (see Section 8.3.1.3) differed somewhat from what is presented above for the mass-balance approach (see Appendix 8E, Table 21). For most locations, the frequency of exceedance of the 50 μg/L and 100 μg/L were similar. The greatest difference between the methods was predicted for Barker Slough. The increases in frequency of exceedance of the 100 μg/L threshold, relative to Existing Conditions and the No Action Alternative, were not as great using this alternative EC to chloride and chloride to bromide relationship modeling approach as compared to that presented above from the mass-balance modeling approach. However, there were still substantial increases, resulting in 9% exceedance over the modeled period under Alternative 9, as compared to 1% under Existing Conditions and 2% under the No Action Alternative. For the drought period, exceedance frequency increased from 0% under Existing Conditions and the No Action Alternative, to 23% under Alternative 9. Furthermore, concentrations predicted at Buckley Cove also differed. The EC to chloride and chloride to bromide relationship modeling approach predicted that concentrations at Buckley cove would decrease under Alternative 9 on both a long term basis and under the modeled drought period, relative to Existing Conditions and the No Action Alternative. This is in contrast to the mass-balance approach presented above, which predicted an increase in concentrations under the drought period. Because the mass-balance approach predicts a greater level of impact at Barker Slough, determination of impacts was based on the mass-balance results.

While the increase in long-term average bromide concentrations at Buckley Cove are relatively small when modeled over a representative 16-year hydrologic period, increases during the modeled drought period, principally the long-term average bromide concentration greater than 300 µg/L, would represent a substantial change in source water quality to the City of Stockton during a season of drought. Additionally, the increase in long-term average bromide concentrations predicted at Barker Slough, principally the relative increase in 100 µg/L exceedance frequency, would result in a substantial change in source water quality for existing drinking water treatment plants drawing water from the North Bay Aqueduct. While the implications of such modeled changes in bromide concentrations at Buckley Cove and Barker Slough is difficult to predict, the substantial modeled increases could lead to adverse changes in the formation of disinfection byproducts such that considerable treatment plant upgrades may be necessary in order to achieve equivalent levels of health protection. Because many of the other modeled locations already frequently exceed the 100 µg/L threshold under Existing Conditions and the No Action Alternative, these locations likely already require treatment plant technologies to achieve equivalent levels of health protection, and thus no additional treatment technologies would be triggered by the small increases in the frequency of exceeding the 100 µg/L threshold. Hence, no further impact on the drinking water beneficial use would be expected at these locations.

The seasonal intakes at Mallard Slough and City of Antioch are infrequently used due to water quality constraints related to sea water intrusion. On a long-term average basis, bromide at these locations is in excess of 3,000 µg/L, but during seasonal periods of high Delta outflow can be <300 µg/L. Based on modeling using the mass-balance approach, use of the seasonal intakes at Mallard Slough and City of Antioch under Alternative 9 would experience a period average increase in bromide during the months when these intakes would most likely be utilized. For those wet and above normal water year types where mass balance modeling would predict water quality typically suitable for diversion, predicted long-term average bromide would increase from 103 µg/L to 140 µg/L (37% increase) at City of Antioch and would decrease from 150 µg/L to 146 µg/L (3% decrease) at Mallard Slough relative to Existing Conditions (Appendix 8E, *Bromide*, Table 23). Changes would be similar for the No Action Alternative comparison. Modeling results using the EC to chloride and chloride to bromide relationships show increases during these months, but the relative magnitude of the increases is much lower (Appendix 8E, Bromide Table 24). Regardless of the differences in the data between the two modeling approaches, the decisions surrounding the use of these seasonal intakes is largely driven by acceptable water quality, and thus have historically been opportunistic. Opportunity to use these intakes would remain, and the predicted increases in bromide concentrations at the City of Antioch and Mallard Slough intake would not be expected to adversely affect MUN beneficial uses, or any other beneficial use, at these locations.

Based on modeling using the mass-balance approach, relative to existing and No Action Alternative conditions, Alternative 9 would lead to predicted improvements in long-term average bromide concentrations at Staten Island, Franks Tract, Rock Slough, and Contra Costa PP No. 1, in addition to Banks and Jones (discussed below). At Staten Island and Franks Tract, long-term average bromide concentrations would be predicted to decrease by 4–21% depending on baseline comparison, while at Rock Slough and Contra Costa PP No. 1, long-term average bromide concentrations would be predicted to decrease by 40–45%, depending on baseline comparison. Modeling results using the EC to chloride and chloride to bromide relationships generally do not show similar decreases for Rock

Slough and Contra Costa PP No. 1, but rather, predict small increases. Based on the small magnitude of increases predicted, these increases would not adversely affect beneficial uses at those locations.

SWP/CVP Export Service Areas

Under Alternative 9, improvement in long-term average bromide concentrations would occur at the Banks and Jones pumping plants, with exception to the modeled drought period when compared the No Action Alternative. Long-term average bromide concentrations for the modeled 16-year hydrologic period at these locations would decrease by as much as 21% relative to Existing Conditions and 9% relative to the No Action Alternative (Appendix 8E, *Bromide*, Table 20). However, during the modeled drought period, long-term average bromide concentrations would increase by as much as 12% relative to the No Action Alternative. Exceedances of the 50 μg/L assessment threshold would remain virtually the same for both Banks and Jones, but exceedance of the 100 μg/L assessment threshold would decrease, from 100% to 81% at Banks and from 100% to 80% at Jones (100% to 77% for the modeled drought period at both Banks and Jones). Lower long-term average bromide concentrations at Banks and Jones would result in overall improvement in Export Service Areas water quality 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, *Bromide*, Table 21).

Similar to the discussion pertaining to the No Action Alternative, maintenance of SWP and CVP facilities under Alternative 9 would not be expected to create new sources of bromide or contribute towards a substantial change in existing sources of bromide in the affected environment. Maintenance activities would not be expected to cause any substantial change in bromide such that MUN beneficial uses, or any other beneficial use, would be adversely affected anywhere in the affected environment.

NEPA Effects: In summary, Alternative 9 operations and maintenance, relative to the No Action Alternative, would result in small increases (i.e., <1%) in long-term average bromide concentrations at Vernalis related to relatively small declines in long-term average flow on the San Joaquin River. However, Alternative 9 operation and maintenance activities would cause substantial degradation to water quality with respect to bromide at Barker Slough, source of the North Bay Aqueduct. Resultant substantial change in long-term average bromide at Barker Slough could necessitate changes in water treatment plant operations or require treatment plant upgrades in order to maintain DBP compliance, and thus would constitute an adverse effect on water quality. Mitigation Measure WQ-5 is available to reduce these effects (implementation of this measure along with a separate, non-environmental commitment as set forth in EIR/EIS Appendix 3B, *Environmental*

Commitments, relating to the potential increased treatment costs associated with bromide-related changes would reduce these effects).

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Under Alternative 9 there would be no expected change to the sources of bromide in the Sacramento and eastside tributary watersheds. Bromide loading in these watersheds would remain unchanged and resultant changes in flows from altered system-wide operations under Alternative 9 would have negligible, if any, effects on the concentration of bromide in the rivers and reservoirs of these watersheds. However, south of the Delta, the San Joaquin River is a substantial source of bromide, primarily due to the use of irrigation water imported from the southern Delta. Concentrations of bromide at Vernalis are inversely correlated to net river flow. Under Alternative 9, long-term average flows at Vernalis would decrease only slightly, resulting in less than substantial predicted increases in long-term average bromide of about 3% relative to Existing Conditions.

Relative to Existing Conditions, Alternative 9 would result in modeled increases in long-term average bromide concentration at Buckley Cove (for the drought period only), Barker Slough, and Emmaton. While the relative change in long-term average bromide concentration at Emmaton is considerable (≤32%), the increase in the average would be due to more frequent seasonal peak concentrations in excess of 1,000 µg/L relative to Existing Conditions, rather than substantial increases during seasonally suitable periods of potential use. However, substantial increases in long-term average bromide at Barker Slough and Buckley Cove (i.e., vicinity of the City of Stockton's drinking water intake) during a season of drought could lead to adverse changes in the formation of disinfection byproducts at drinking water treatment plants such that considerable water treatment plant upgrades would be necessary in order to achieve equivalent levels of drinking water health protection.

The assessment of effects on bromide in the SWP/CVP Export Service Areas is based on assessment of changes in bromide concentrations at Banks and Jones pumping plants. Under Alternative 9, substantial improvement would occur at the Banks and Jones pumping plants, where predicted long-term average bromide concentrations are predicted to decrease by as much as 21% relative to Existing Conditions. An overall improvement in bromide-related water quality would be predicted in the SWP/CVP Export Service Areas.

Based on the above, Alternative 9 operation and maintenance would not result in any substantial change in long-term average bromide concentration upstream of the Delta. Furthermore, under Alternative 9, water exported from the Delta to the SWP/CVP service area would be substantially improved relative to bromide. Bromide is not bioaccumulative, therefore change in long-term average bromide concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Additionally, bromide is not a constituent related to any 303(d) listings. Alternative 9 operation and maintenance activities would not cause substantial long-term degradation to water quality respective to bromide with the exception of water quality at Buckley Cove (drought period only) and Barker Slough. At Buckley Cove, modeled long-term annual average concentrations of bromide would increase from 272 µg/L to 330 µg/L (21% relative increase) during the modeled drought period. At Barker Slough, modeled long-term annual average concentrations of bromide would increase from 54 µg/L to 100 µg/L (88% relative increase) for the modeled drought period. Furthermore, for Barker Slough the frequency of predicted bromide concentrations exceeding 100 µg/L would increase from 0% under Existing Conditions to 16% under Alternative 9 (0% to 42% for the modeled drought period). Substantial changes in long-term average bromide at these locations could necessitate changes in treatment plant operation or require treatment plant upgrades in order to maintain DBP compliance. The model predicted change at Buckley Cove during the drought period and at Barker Slough is substantial and, therefore, would represent a substantially increased risk for adverse effects on existing MUN beneficial uses should treatment upgrades not be undertaken. The impact is considered significant. However, there is no feasible mitigation available for identified impacts at Buckley Cove, which would remain significant and unavoidable during drought periods.

Implementation of Mitigation Measure WQ-5 along with a separate, non-environmental commitment relating to the potential increased treatment costs associated with bromide-related changes would reduce these effects. While mitigation measures to reduce these water quality effects in affected water bodies to less than significant levels are not available, implementation of Mitigation Measure WQ-5 is recommended to attempt to reduce the effect that increased bromide concentrations may have on Delta beneficial uses. However, because the effectiveness of this mitigation measure to result in feasible measures for reducing water quality effects is uncertain, this impact is considered to remain significant and unavoidable. Please see Mitigation Measure WQ-5 under Impact WQ-5 in the discussion of Alternative 1A.

In addition to and to supplement Mitigation Measure WQ-5, the BDCP proponents have incorporated into the BDCP, as set forth in EIR/EIS Appendix 3B, *Environmental Commitments*, a separate, non-environmental commitment to address the potential increased water treatment costs that could result from bromide-related concentration effects on municipal water purveyor operations. Potential options for making use of this financial commitment include funding or providing other assistance towards implementation of the North Bay Aqueduct AIP, acquiring alternative water supplies, or other actions to indirectly reduce the effects of elevated bromide and DOC in existing water supply diversion facilities. Please refer to Appendix 3B, *Environmental Commitments*, for the full list of potential actions that could be taken pursuant to this commitment in order to reduce the water quality treatment costs associated with water quality effects relating to chloride, electrical conductivity, and bromide.

Mitigation Measure WQ-5: Avoid, Minimize, or Offset, as Feasible, Adverse Water Quality Conditions

Please see Mitigation Measure WQ-5 under Impact WQ-5 in the discussion of Alternative 1A.

Impact WQ-6: Effects on Bromide Concentrations Resulting from Implementation of CM2–CM22

***NEPA Effects*:** Conservation Measures 2–22 under Alternative 9 would be similar to those under Alternative 1A, but with changes in the south Delta to accommodate the modified corridors. As discussed for Alternative 1A, implementation of CM2–CM22 would not present new or substantially changed sources of bromide to the study area. Some conservation measures may replace or substitute for existing irrigated agriculture in the Delta. This replacement or substitution is not expected to substantially increase or present new sources of bromide. CM2–CM22 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.

In summary, implementation of CM2–CM22 under Alternative 9, relative to the No Action Alternative, would have negligible, if any, effects on bromide concentrations. The effects on bromide from implementing CM2–CM22 are determined to not be adverse.

***CEQA Conclusion*:** Conservation Measures 2–22 proposed under Alternative 9 would be similar to those proposed under Alternative 1A. As discussed for Alternative 1A, implementation of CM2–CM22 would not present new or substantially changed sources of bromide to the study area. As such, effects on bromide resulting from the implementation of CM2–CM22 would be similar to that previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-7: Effects on Chloride Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Under Alternative 9 there would be no expected change to the sources of chloride in the Sacramento and eastside tributary watersheds. Chloride loading in these watersheds would remain unchanged and resultant changes in flows from altered system-wide operations would have negligible, if any, effects on the concentration of chloride in the rivers and reservoirs of these watersheds. The modeled long-term annual average flows on the lower San Joaquin River at Vernalis would decrease slightly compared to Existing Conditions and be similar compared to the No Action Alternative (as a result of climate change). The reduced flow would result in possible increases in long-term average chloride concentrations of about 2%, relative to the Existing Conditions and no change relative to No Action Alternative (Appendix 8G, Table Cl-62). Consequently, Alternative 9 would not be expected to cause exceedance of chloride objectives/criteria or substantially degrade water quality with respect to chloride, and thus would not adversely affect any beneficial uses of the Sacramento River, the eastside tributaries, associated reservoirs upstream of the Delta, or the San Joaquin River.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2-22 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for CM2-22. See section 8.3.1.3 for more information.

Relative to the Existing Conditions and No Action Alternative, Alternative 9 would result in similar or reduced long-term average chloride concentrations for the 16-year period modeled at some of the assessment locations, and, depending on the modeling approach (see Section 8.3.1.3), increased concentrations at the North Bay Aqueduct at Barker Slough (i.e., up to 20% compared to No Action Alternative), Contra Costa Canal at Pumping Plant #1 (i.e., up to 23% compared to No Action Alternative), Rock Slough (i.e., up to 20% compared to No Action Alternative), Franks Tract (i.e., up to 29% compared to No Action Alternative), Sacramento River at Emmaton (i.e., up to 25% compared to No Action Alternative), Sacramento River at Mallard Island (i.e., up to 6% compared to No Action Alternative), and North Bay Aqueduct at Barker Slough (i.e., up to 18% compared to No

Action Alternative) (Appendix 8G, *Chloride*, Table Cl-55 and Table Cl-56). Moreover, the direction and magnitude of predicted changes for Alternative 9 are similar between the alternatives, thus, the effects relative to Existing Conditions and the No Action Alternative are discussed together. Additionally, implementation of tidal habitat restoration under CM4 would increase the tidal exchange volume in the Delta, and thus may contribute to increased chloride concentrations in the Bay source water as a result of increased salinity intrusion. More discussion of this phenomenon is included in Section 8.3.1.3. Consequently, while uncertain, the magnitude of chloride increases may be greater than indicated herein and would affect the western Delta assessment locations the most which are influenced to the greatest extent by the Bay source water. The comparison to Existing Conditions reflects changes in chloride due to both Alternative 9 operations (including use of operable barriers and numerous other operational components of Scenario G) and climate change/sea level rise. The comparison to the No Action Alternative reflects changes in chloride due only to operations. The following outlines the modeled chloride changes relative to the applicable objectives and beneficial uses of Delta waters.

Municipal Beneficial Uses

Estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3) were used to evaluate the 150 mg/L Bay-Delta WQCP objective for municipal and industrial beneficial uses on a basis of the percent of years the chloride objective is exceeded for the modeled 16-year period. The objective is exceeded if chloride concentrations exceed 150 mg/L for a specified number of days in a given water year at both the Antioch and Contra Costa Pumping Plant #1 locations. For Alternative 9, the modeled frequency of objective exceedance would increase from 6% of years under Existing Conditions and 6% under the No Action Alternative to 19% of years under Alternative 9 (Appendix 8G, Table Cl-64).

Similarly, estimates of chloride concentrations generated using EC-chloride relationships and DSM2 EC output (see Section 8.3.1.3) were also used to evaluate the 250 mg/L Bay-Delta WQCP objective for chloride at Contra Costa Pumping Plant #1 where daily average objectives apply. The basis for the evaluation was the predicted number of days the objective was exceeded for the modeled 16-year period. For Alternative 9, the modeled frequency of objective exceedance would decrease, from 6% of modeled days under Existing Conditions and 5% under the No Action Alternative to 1% of modeled days under Alternative 9 (Appendix 8G, Table Cl-63).

Given the limitations inherent to estimating future chloride concentrations (see Section 8.3.1.3), estimation of chloride concentrations through both a mass balance approach and an EC-chloride relationship approach was used to evaluate the 250 mg/L Bay-Delta WQCP objectives in terms of both frequency of exceedance and use of assimilative capacity. When utilizing the mass balance approach to model monthly average chloride concentrations for the 16-year period, the predicted frequency of exceeding the 250 mg/L objective would be eliminated at the Contra Costa Canal at Pumping Plant #1 (24% for Existing Conditions to 0% under Alternative 9), thus indicating complete compliance with this objective would be achieved (Appendix 8G, Table Cl-57 and Figure Cl-13). Compared to Existing Conditions, the frequency of exceedances would not change substantially at the San Joaquin River at Antioch (i.e., increase of 2% from 66% to 68%) or at Mallard Island (i.e., increase 6% from 77% to 83%) and would be similar, or decrease, compared to the No Action Alternative (Appendix 8G, Table Cl-57), and there would be no substantial long-term degradation (Appendix 8G, Table Cl-59).

In comparison, when utilizing the chloride-EC relationship to model monthly average chloride concentrations for the 16-year period, trends in frequency of exceedance generally agreed, but use of assimilative capacity were predicted to be larger at some locations (Appendix 8G, Table Cl-58 and Table Cl-60). Specifically, while the model predicted exceedance frequency would decrease at the Contra Costa Canal at Pumping Plant #1, Rock Slough and Franks Tract locations, use of assimilative capacity would increase substantially for the months of February through July at Rock at the Contra Costa Canal at Pumping Plant #1 (i.e., maximum of 79% in March and April for the modeled drought period) and at the San Joaquin River in March and April (i.e., 13% and 14%, respectively). Due to such seasonal long-term average water quality degradation at these locations, the potential exists for substantial adverse effects on the municipal and industrial beneficial uses through reduced opportunity for diversion of water with acceptable chloride levels. Moreover, due to the increased frequency of exceeding the 150 mg/L Bay-Delta WQCP objective, the potential exists for adverse effects on the municipal and industrial beneficial uses at Contra Costa Pumping Plant #1 and Antioch.

303(d) Listed Water Bodies

With respect to the 303(d) listing for chloride in Tom Paine Slough, the monthly average chloride concentrations for the 16-year period modeled at Old River at Tracy Road would generally be similar compared to Existing Conditions, and thus, would not be further degraded on a long-term basis (Appendix 8G, Figure Cl-14). With respect to Suisun Marsh, the monthly average chloride concentrations for the 16-year period modeled would generally increase compared to Existing Conditions 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), 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.

SWP/CVP Export Service Areas

Under Alternative 9, long-term average chloride concentrations based on the mass balance analysis of modeling results for the 16-year period modeled at the Banks and Jones pumping plants would decrease by as much as 21% relative to Existing Conditions and 10% compared to No Action Alternative (Appendix 8G, *Chloride*, Table Cl-55). The modeled frequency of exceedances of applicable water quality objectives/criteria would decrease relative to Existing Conditions and No Action Alternative, for both the 16-year period and the drought period modeled (Appendix 8G, *Chloride*, Table Cl-57). Consequently, water exported into the SWP/CVP service area would generally be of similar or better quality with regards to chloride relative to Existing Conditions and the No Action Alternative conditions.

Results of the modeling approach which used relationships between EC and chloride (see Section 8.3.1.3) were consistent with the discussion above, and assessment of chloride using these data results in the same conclusions as are presented above for the mass-balance approach (Appendix 8G, Table Cl-56 and Table Cl-58).

Commensurate with the reduced chloride concentrations in water exported to the service area, reduced chloride loading in the lower San Joaquin River would be anticipated which would likely alleviate or lessen any expected increase in chloride at Vernalis related to decreased annual average San Joaquin River flows (see discussion of Upstream of the Delta).

Maintenance of SWP and CVP facilities would not be expected to create new sources of chloride or contribute towards a substantial change in existing sources of chloride in the affected environment. Maintenance activities would not be expected to cause any substantial change in chloride such that any long-term water quality degradation would occur, thus, beneficial uses would not be adversely affected anywhere in the affected environment.

NEPA Effects: In summary, relative to the No Action Alternative conditions, Alternative 9 would result in 150 mg/L Bay-Delta WCCP objective at Contra Costa Pumping Plant #1 and Antioch, substantial seasonal use of assimilative capacity at Contra Costa Pumping Plant #1, Rock Slough and Franks Tract, measureable water quality degradation relative to the 303(d) impairment in Suisun Marsh. The predicted chloride increases constitute an adverse effect on water quality (see Mitigation Measure WQ-7 below; implementation of this measure along with a separate, non-environmental commitment relating to the potential increased chloride treatment costs would reduce these effects). Additionally, the predicted changes relative to the No Action Alternative conditions indicate that in addition to the effects of climate change/sea level rise, implementation of CM1 and CM4 under Alternative 9 would contribute substantially to the adverse water quality effects.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Chloride is not a constituent of concern in the Sacramento River watershed upstream of the Delta, thus river flow rate and reservoir storage reductions that would occur under the Alternative 9, relative to Existing Conditions, would not be expected to result in a substantial adverse change in chloride levels. Additionally, relative to Existing Conditions, the Alternative 9 would not result in reductions in river flow rates (i.e., less dilution) or increased chloride loading such that there would be any substantial increase in chloride concentrations upstream of the Delta in the San Joaquin River watershed.

Relative to Existing Conditions, Alternative 9 operations would result in substantially reduced chloride concentrations in the Delta such that exceedances of the 250 mg/L Bay-Delta WQCP objective at the San Joaquin River at Antioch and Mallard Slough would be reduced. Nevertheless, due to the predicted increased frequency of exceeding the 150 mg/L Bay-Delta WQCP objective at Contra Costa Pumping Plant #1 and Antioch as well as substantial seasonal use of assimilative capacity at Contra Costa Pumping Plant #1 and Antioch, the potential exists for adverse effects on the municipal and industrial beneficial uses (see Mitigation Measure WQ-7 below; implementation of this measure along with a separate, non-environmental commitment relating to the potential increased chloride treatment costs would reduce these effects). Moreover, the modeled increased chloride concentrations and degradation in the western Delta could further contribute, at measurable levels (i.e., over a doubling of concentration), to the existing 303(d) listed impairment due to chloride in Suisun Marsh for the protection of fish and wildlife.

Chloride concentrations would be reduced in water exported from the Delta to the CVP/SWP Export Service Areas, thus reflecting a potential improvement to chloride loading in the lower San Joaquin River.

Chloride is not a bioaccumulative constituent, thus any increased concentrations under Alternative 9 would not result in substantial chloride bioaccumulation impacts on aquatic life or humans. Alternative 9 maintenance would not result in any substantial changes in chloride concentration upstream of the Delta or in the SWP/CVP Export Service Areas. However, based on these findings, this impact is determined to be significant due to increased chloride concentrations and frequency of objective exceedance in the western Delta, as well as potential adverse effects on fish and wildlife beneficial uses in Suisun Marsh.

While mitigation measures to reduce these water quality effects in affected water bodies to less than significant levels are not available, implementation of Mitigation Measure WQ-7 is recommended to attempt to reduce the effect that increased chloride concentrations may have on Delta beneficial uses. However, because the effectiveness of this mitigation measure to result in feasible measures for reducing water quality effects is uncertain, this impact is considered to remain significant and unavoidable. Please see Mitigation Measure WQ-7 under Impact WQ-7 in the discussion of Alternative 1A.

In addition to and to supplement Mitigation Measure WQ-7, the BDCP proponents have incorporated into the BDCP, as set forth in EIR/EIS Appendix 3B, *Environmental Commitments*, a separate, non-environmental commitment to address the potential increased water treatment costs that could result from chloride concentration effects on municipal, industrial and agricultural water purveyor operations. Potential options for making use of this financial commitment include funding or providing other assistance towards acquiring alternative water supplies or towards modifying existing operations when chloride concentrations at a particular location reduce opportunities to operate existing water supply diversion facilities. Please refer to Appendix 3B, *Environmental Commitments*, for the full list of potential actions that could be taken pursuant to this commitment in order to reduce the water quality treatment costs associated with water quality effects relating to chloride, electrical conductivity, and bromide.

Mitigation Measure WQ-7: Conduct Additional Evaluation and Modeling of Increased Chloride Levels and Develop and Implement Phased Mitigation Actions

Please see Mitigation Measure WQ-7 under Impact WQ-7 in the discussion of Alternative 1A.

Impact WQ-8: Effects on Chloride Concentrations Resulting from Implementation of CM2–CM22

***NEPA Effects*:** Under Alternative 9, the types and geographic extent of effects on chloride concentrations in the Delta as a result of implementation of the other conservation measures (i.e., CM2–22) would be similar to, and undistinguishable from, those effects previously described for Alternative 1A. The conservation measures would present no new direct sources of chloride to the affected environment. Moreover, some habitat restoration conservation measures (CM4–10) would occur on lands within the Delta currently used for irrigated agriculture, thus replacing agricultural land uses with restored tidal wetlands, floodplain, and related channel margin and off-channel habitats. The potential reduction in irrigated lands within the Delta may result in reduced discharges of agricultural field drainage with elevated chloride concentrations, which would be considered an improvement compared to Existing Conditions and No Action Alternative conditions.

In summary, based on the discussion above, the effects on chloride from implementing CM2-CM22 are considered to be not adverse.

CEQA Conclusion: Implementation of the CM2–CM22 for Alternative 9 would not present new or substantially changed sources of chloride to the affected environment upstream of the Delta, within Delta, or in the SWP/CVP service area. Replacement of irrigated agricultural land uses in the Delta with habitat restoration conservation measures may result in some reduction in discharge of agricultural field drainage with elevated chloride concentrations, thus resulting in improved water quality conditions. Based on these findings, this impact is considered to be less than significant. No mitigation is required.

Impact WQ-9: Effects on Dissolved Oxygen Resulting from Facilities Operations and Maintenance (CM1)

NEPA Effects: Effects of CM1 on dissolved oxygen under Alternative 9 are the same as those discussed for Alternative 1A and are determined to be not adverse.

CEQA Conclusion: Effects of CM1 on DO under Alternative 9 would be similar to those discussed for Alternative 1A, and are summarized here, then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion under Alternative 1A.

River flow rate and reservoir storage reductions that would occur under Alternative 9, relative to Existing Conditions, would not be expected to result in a substantial adverse change in DO levels in the reservoirs and rivers upstream of the Delta, given that mean monthly flows would remain within the ranges historically seen under Existing Conditions and the affected river are large and turbulent. Any reduced DO saturation level that may be caused by increased water temperature would not be expected to cause DO levels to be outside of the range seen historically. Finally, amounts of oxygen demanding substances and salinity would not be expected to change sufficiently to affect DO levels.

It is expected there would be no substantial change in Delta DO levels in response to a shift in the Delta source water percentages under this alternative or substantial degradation of these water bodies, with regard to DO. DO levels would be affected by nutrient loading, which the state has begun to aggressively regulate the discharges of, and this loading would not be expected to lower DO levels relative to Existing Conditions based on historical DO levels. Further, the anticipated changes in salinity would have relatively minor effects on DO levels, and tidal exchange, which contribute to the reaeration of Delta waters would not be expected to change substantially.

There is not expected to be substantial, if even measurable, changes in DO levels in the SWP/CVP Export Service Areas waters under Alternative 9, relative to Existing Conditions, because the biochemical oxygen demand of the exported water would not be expected to substantially differ from that under Existing Conditions (due to ever increasing water quality regulations), canal turbulence and exposure of the water to the atmosphere and the algal communities that exist within the canals would establish an equilibrium for DO levels within the canals. The same would occur in downstream reservoirs.

Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would result in significant impacts on any beneficial uses within affected water bodies. Because no substantial changes in DO levels are expected, long-term water quality degradation would not be expected to occur, and, thus, beneficial uses would not be adversely affected. Various Delta waterways are 303(d)-listed for low DO, but because no substantial decreases in DO levels would be expected, greater degradation and DO-related impairment of these areas would not be expected. This impact would be less than significant. No mitigation is required.

Impact WQ-10: Effects on Dissolved Oxygen Resulting from Implementation of CM2–CM22

***NEPA Effects*:** Effects of CM2–CM22 on DO under Alternative 9 are the same as those discussed for Alternative 1A and are determined to be not adverse.

***CEQA Conclusion*:** Conservation Measures 2–22 proposed under Alternative 9 would be similar to those proposed under Alternative 1A. As such, effects on DO resulting from the implementation of CM2–CM22 would be similar to that previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-11: Effects on Electrical Conductivity Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative, EC levels (highs, lows, typical conditions) in the Sacramento River and its tributaries, the eastside tributaries, their associated reservoirs, and the San Joaquin River upstream of the Delta under Alternative 9 are not expected to be outside the ranges occurring under Existing Conditions or would occur under the No Action Alternative. Any minor changes in EC levels that could occur under Alternative 9 in water bodies upstream of the Delta would not be of sufficient magnitude, frequency and geographic extent that would cause adverse effects on beneficial uses or substantially degrade water quality with regard to EC.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2-22 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for CM2-22. See section 8.3.1.3 for more information.

Relative to Existing Conditions, Alternative 9 would result in an increase in the number of days the Bay-Delta WQCP EC objectives would be exceeded in the Sacramento River at Emmaton and the San Joaquin River at San Andreas Landing (Appendix 8H, Table EC-9). The percent of days the Emmaton EC objective would be exceeded for the entire period modeled (1976–1991) would increase from 6% under Existing Conditions to 17% under Alternative 9, and the percent of days out of compliance would increase from 11% under Existing Conditions to 28% under Alternative 9. The percent of days the San Andreas Landing EC objective would be exceeded would be 1% under Existing Conditions and Alternative 9, and the percent of days out of compliance with the EC objective would increase from 1% under Existing Conditions to 2% under Alternative 9. Average EC levels at the western and southern Delta compliance locations, except at Emmaton in the western Delta, and S. Fork Mokelumne River at Terminous (an interior Delta location) would decrease from 1–33% for the entire period modeled and 2–33% during the drought period modeled (1987–1991) (Appendix 8H, Table EC-20). In the Sacramento River at Emmaton, average EC would increase 22% for the entire period modeled and 36% during the drought period modeled. In the San Joaquin River at San Andreas Landing, average EC would increase 16% for the entire period modeled and 33% during the drought period modeled. Average EC in the Sacramento River at Emmaton and San Joaquin River at San Andreas Landing would increase during all months (Appendix 8H, Table EC-20). In the San Joaquin River at Prisoners Point, average EC would increase 2% for the entire period modeled and 16% during the drought period modeled. Average EC at Prisoners Point would increase in September through December (Appendix 8H, Table EC-20). The western portion of the Delta–which is Clean Water Act section 303(d) listed as impaired due to elevated EC–would have an increased frequency of exceedance of the Bay-Delta WQCP objectives (Appendix 8H, Table EC-9) and long-term average EC levels at compliance locations in this region would increase relative to Existing Conditions (Appendix 8H, Table EC-20). Thus, Alternative 9 could contribute to additional impairment and potentially adversely affect beneficial uses for section 303(d) listed Delta waterways, relative to Existing Conditions. The comparison to Existing Conditions reflects changes in EC due to both Alternative 9 operations (including use of operable barriers and numerous other operational components of Scenario G) and climate change/sea level rise.

Relative to the No Action Alternative, the change in percent compliance with Bay-Delta WQCP EC objectives under Alternative 9 would be similar to that described above relative to Existing Conditions. For the entire period modeled, average EC levels would increase in the Sacramento River at Emmaton, and San Joaquin River at San Andreas Landing and Prisoners Point. The greatest average EC increase would occur in the San Joaquin River at San Andreas Landing (22%); the increase at Emmaton would be 21% and at Prisoners Point would be 12% (Appendix 8H, Table EC-20). Similarly, during the drought period modeled, average EC would increase at these locations. The greatest average EC increase during the drought period modeled also would occur in the San Joaquin River at San Andreas Landing (33%); the average EC increase at Emmaton would be 24% and at Prisoners Point would be 25% (Appendix 8H, Table EC-20). The western portion of the Delta–which is Clean Water Act section 303(d) listed as impaired due to elevated EC–would have an increased frequency of exceedance of the Bay-Delta WQCP objectives (Appendix 8H, Table EC-9) and long-term average EC levels at this compliance location would increase relative to the No Action Alternative (Appendix 8H, Table EC-20). Thus, Alternative 9 could contribute to additional impairment and potentially adversely affect beneficial uses for section 303(d) listed Delta waterways, relative to the No Action Alternative. The comparison to the No Action Alternative reflects changes in EC due only to Alternative 9 operations (including use of operable barriers and numerous other operational components of Scenario G).

For Suisun Marsh, October–May is the period when Bay-Delta WQCP EC objectives for protection of fish and wildlife apply. Long-term average EC would increase under Alternative 9, relative to Existing Conditions, during the months of December through May by 0.2–0.4 mS/cm in the Sacramento River at Collinsville (Appendix 8H, Table EC-21). In Montezuma Slough at National Steel during January and February, long-term average EC would increase 0.1–0.2 mS/cm (Appendix 8H, Table EC-22). The most substantial increase would occur near Beldon Landing, with long-term average EC levels increasing by 1.5–6.3 mS/cm, depending on the month, nearly doubling and tripling during some months the long-term average EC relative to Existing Conditions (Appendix 8H, Table EC-23). Sunrise Duck Club and Volanti Slough also would have long-term average EC increases during February–May of 1.5–3.9 mS/cm (Appendix 8H, Tables EC-24 and EC-25). The degree to which the long-term average EC increases would cause exceedance of Bay-Delta WQCP objectives is unknown, because objectives are expressed as a monthly average of daily high tide EC, which does not have to be met if it can be demonstrated "equivalent or better protection will be provided at the location" (State Water Resources Control Board 2006:14). 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 be substantial and it is uncertain the degree to which current management plans for the Suisun Marsh would be able to address these substantially higher EC levels and protect beneficial uses. Thus, these increased EC levels in Suisun Marsh are considered to have a potentially adverse effect on marsh beneficial uses. Long-term average EC increases in Suisun Marsh under Alternative 9 relative to the No Action Alternative would be similar to the increases relative to Existing Conditions. Suisun Marsh is section 303(d) listed as impaired due to elevated EC, and the potential increases in long-term average EC concentrations could contribute to additional impairment, because the increases would be double or triple that relative to Existing Conditions and the No Action Alternative.

SWP/CVP Export Service Areas

At the Banks and Jones pumping plants, Alternative 9 would result in no exceedances of the Bay-Delta WQCP's 1,000 µmhos/cm EC objective for the entire period modeled (Appendix 8H, Table EC-10). Thus, there would be no adverse effect on the beneficial uses in the SWP/CVP Export Service Areas using water pumped at this location under the Alternative 9.

At the Banks pumping plant, relative to Existing Conditions, average EC levels under Alternative 9 would decrease substantially on average: 56% for the entire period modeled and 62% during the drought period modeled. Relative to the No Action Alternative, average EC levels would decrease by 53% for the entire period modeled and 60% during the drought period modeled (Appendix 8H, Table EC-20).

At the Jones pumping plant, relative to Existing Conditions, average EC levels under Alternative 9 would also decrease on average, but to a lesser degree: 22% for the entire period modeled and 18% during the drought period modeled. Relative to the No Action Alternative, average EC levels would decrease by 18% for the entire period modeled and 14% during the drought period modeled (Appendix 8H, Table EC-20).

Based on the decreases in long-term average EC levels that would occur at the Banks and Jones pumping plants, Alternative 9 would not cause degradation of water quality with respect to EC in the SWP/CVP Export Service Areas; rather, Alternative 9 would improve long-term average EC conditions in the SWP/CVP Export Service Areas.

Commensurate with the EC decrease in exported waters, an improvement in lower San Joaquin River average EC levels would be expected since EC in the lower San Joaquin River is, in part, related to irrigation water deliveries from the Delta. While the magnitude of this expected lower San Joaquin River improvement in EC is difficult to predict, the relative decrease in overall loading of EC-elevating constituents to the Export Service Areas would likely alleviate or lessen any expected increase in EC at Vernalis related to decreased annual average San Joaquin River flows (see EC impact discussion under the No Action Alternative).

The export area of the Delta is listed on the state's CWA Section 303(d) list as impaired due to elevated EC. Alternative 9 would result in lower long-term average EC levels relative to Existing Conditions and the No Action Alternative and, thus, would not contribute to additional beneficial use impairment related to elevated EC in the SWP/CVP Export Service Areas waters.

NEPA Effects: In summary, the increased frequency of exceedance of EC objectives and increased long-term and drought period average EC levels that would occur in the San Joaquin River at San

Andreas Landing (interior Delta), and the increased frequency of exceedance of EC objectives in the Sacramento River at Emmaton under Alternative 9, relative to the No Action Alternative, would contribute to adverse effects on the agricultural beneficial uses. Given that the western Delta is Clean Water Act section 303(d) listed as impaired due to elevated EC, the increased frequency of exceedance of the Bay-Delta WQCP objectives and long-term average EC levels at this compliance location could contribute to additional impairment and potentially adversely affect beneficial uses for section 303(d) listed Delta waterways, relative to the No Action Alternative. The increases in long-term average EC levels that would occur in Suisun Marsh would further degrade existing EC levels and could contribute additional to adverse effects on the fish and wildlife beneficial uses. Suisun Marsh is section 303(d) listed as impaired due to elevated EC, and the potential increases in long-term average EC levels could contribute to additional beneficial use impairment. These increases in EC constitute an adverse effect on water quality. Mitigation Measure WQ-11 would be available to reduce these effects (implementation of this measure along with a separate, non-environmental commitment as set forth in EIR/EIS Appendix 3B, *Environmental Commitments*, relating to the potential EC-related changes would reduce these effects).

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

River flow rate and reservoir storage reductions that would occur under Alternative 9, relative to Existing Conditions, would not be expected to result in a substantial adverse change in EC levels in the reservoirs and rivers upstream of the Delta, given that: changes in the quality of watershed runoff and reservoir inflows would not be expected to occur in the future; the state's aggressive regulation of point-source discharge effects on Delta salinity-elevating parameters and the expected further regulation as salt management plans are developed; the salt-related TMDLs adopted and being developed for the San Joaquin River; and the expected improvement in lower San Joaquin River average EC levels commensurate with the lower EC of the irrigation water deliveries from the Delta.

Relative to Existing Conditions, Alternative 9 would not result in any substantial increases in long-term average EC levels in the SWP/CVP Export Service Areas. There would be no exceedance of the EC objective at the Jones and Banks pumping plants. Average EC levels for the entire period modeled would decrease at both plants and, thus, this alternative would not contribute to additional beneficial use impairment related to elevated EC in the SWP/CVP Export Service Areas waters. Rather, this alternative would improve long-term EC levels in the SWP/CVP Export Service Areas, relative to Existing Conditions.

In the Plan Area, Alternative 9 would result in an 11% increase in the frequency with which the Bay-Delta WQCP EC objectives are exceeded at Emmaton (western Delta) and a <1% increase in the frequency with which EC objectives are exceeded in the San Joaquin River at San Andreas Landing (interior Delta) for the entire period modeled (1976–1991). Further, average EC levels at Emmaton would increase by 22% for the entire period modeled and 36% during the drought period modeled, and EC levels at San Andreas Landing would increase by 16% for the entire period modeled and 33% during the drought period modeled. Because EC is not bioaccumulative, the increases in long-term average EC levels would not directly cause bioaccumulative problems in aquatic life or humans. The interior Delta is not Clean Water Act section 303(d) listed for elevated EC, however, the western Delta is. The increases in long-term and drought period average EC levels and increased frequency of exceedance of EC objectives that would occur in the Sacramento River at Emmaton and San Joaquin River at San Andreas would potentially contribute to adverse effects on the agricultural beneficial uses in the interior Delta. This impact is considered to be significant.

Further, relative to Existing Conditions, Alternative 9 would 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.

Mitigation Measure WQ-11: Avoid, Minimize, or Offset, as Feasible, Reduced Water Quality Conditions

Please see Mitigation Measure WQ-11 under Impact WQ-11 in the discussion of Alternative 1A.

Impact WQ-12: Effects on Electrical Conductivity Resulting from Implementation of CM2–CM22

***NEPA Effects*:** Effects of CM2–CM22 on EC under Alternative 9 are the same as those discussed for Alternative 1A and are considered not to be adverse.

***CEQA Conclusion*:** Conservation Measures 2–22 proposed under Alternative 9 would be similar to those proposed under Alternative 1A. As such, effects on EC resulting from the implementation of

CM2–CM22 would be similar to that previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-13: Effects on Mercury Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Under Alternative 9, the magnitude and timing of reservoir releases and river flows upstream of the Delta in the Sacramento River watershed and east-side tributaries would be altered, relative to Existing Conditions and the No Action Alternative.

The Sacramento River at Freeport and San Joaquin River at Vernalis (as summarized for water quality average concentrations in Tables 8-48 and 8-49) were examined for flow/concentration relationships for mercury and methylmercury. No significant, predictive regression relationships were discovered for mercury or methylmercury, except for total mercury with flow at Freeport (monthly or annual)(Figures 8I-10 through 8I-13, Appendix 8I). Such a positive relationship between total mercury and flow is to be expected based on the association of mercury with suspended sediment and the mobilization of sediments during storm flows. However, the changes in flow in the Sacramento River under Alternative 9 relative to Existing Conditions and the No Action Alternative are not of the magnitude of storm flows, in which substantial sediment-associated mercury is mobilized. Therefore mercury loading should not be substantially different due to changes in flow. In addition, even though it may be flow-affected, total mercury concentrations remain well below criteria at upstream locations. Any negligible changes in mercury concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies as related to mercury. Both waterborne methylmercury concentrations and largemouth bass fillet mercury concentrations are expected to remain above guidance levels at upstream of Delta locations, but will not change substantially relative to Existing Conditions or the No Action Alternative due to changes in flows under Alternative 9.

The upstream of Delta areas in the north will benefit from the implementation of the Cache Creek, Sulfur Creek, Harley Gulch, and Clear Lake Mercury TMDLs and the American River methylmercury TMDL. These projects will target specific sources of mercury and methylation upstream of the Delta and could result in net improvement to Delta mercury loading in the future. The implementation of these projects could help to ensure that upstream of Delta environments will not be substantially degraded for water quality with respect to mercury or methylmercury.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2-22 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for CM2-22. See section 8.3.1.3 for more information.

The water quality impacts of waterborne concentrations of mercury and methylmercury and fish tissue mercury concentrations were evaluated for 9 Delta locations. The analysis of percentage change in assimilative capacity of waterborne total mercury of Alternative 9 relative to the 25 ng/L ecological risk benchmark as compared to Existing Conditions showed the greatest decrease of 10.2% at Old River at Rock Slough, and a 10.1% reduction relative to the No Action Alternative at that location (Figures 8-53 and 8-54). Similarly, increases in long term annual average methylmercury concentration are expected to be greatest (approximately 30%) at the Contra Costa Pumping Plant as compared to Existing Conditions and the No Action Alternative (Appendix 8I, Figure 8I-9, Table I-6). The concentration of methylmercury is estimated to be 0.163 ng/L at that location, which is greater than Existing Conditions (0.121 ng/L) and the No Action Alternative (0.122 ng/L). All modeled input concentrations exceeded the methylmercury TMDL guidance objective of 0.06 ng/L, therefore percentage change in assimilative capacity was not evaluated for methylmercury.

Fish tissue estimates show some substantial percentage increases in concentration and exceedance quotients for mercury at some Delta locations. The greatest change in exceedance quotients are expected for Old River at Rock Slough with changes of 66% over Existing Conditions, and 59% over the No Action Alternative (Figure 8-55, Appendix 8I, Table I-16b). The Contra Costa Pumping Plant values shows a 62% increase in fish tissue concentrations over Existing Conditions, and 59% over the No Action Alternative (Appendix 8I, Table I-16b).

SWP/CVP Export Service Areas

The analysis of mercury and methylmercury in the SWP/CVP Export Service Areas was based on concentrations estimated at the Banks and Jones pumping plants. Both waterborne total and methylmercury concentrations for Alternative 9 are projected to be lower than Existing Conditions and the No Action Alternative at the Jones and Banks pumping plants (Appendix 8I, Figures 8I-7 and 8I-9). Therefore, mercury shows an increased assimilative capacity at these locations (Figures 8-53 and 8-54). Bass tissue mercury concentrations are also improved under Alternative 9, relative to Existing Conditions and the No Action Alternative (Figure 8-55; Appendix 8I, Table I-16a,b).

***NEPA Effects*:** Based on the above discussion, the effects of mercury and methylmercury in comparison of Alternative 9 to the No Action Alternative (as waterborne and bioaccumulated forms) are considered to be adverse for the case of fish tissue bioaccumulation at some locations.

***CEQA Conclusion*:** Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Under Alternative 9, greater water demands and climate change would alter the magnitude and timing of reservoir releases and river flows upstream of the Delta in the Sacramento River watershed and east-side tributaries, relative to Existing Conditions. Concentrations of mercury and methylmercury upstream of the Delta will not be substantially different relative to Existing Conditions due to the lack of important relationships between mercury/methylmercury concentrations and flow for the major rivers.

Methylmercury concentrations exceed criteria at all locations in the Delta and no assimilative capacity exists. However, monthly average waterborne concentrations of total and methylmercury, over the period of record, are very similar to Existing Conditions. Similarly, estimates of fish tissue mercury concentrations show almost no differences would occur among sites for Alternative 9 as compared to Existing Conditions for Delta sites.

Assessment of effects of mercury in the SWP and CVP Export Service Areas were based on effects on mercury concentrations and fish tissue mercury concentrations at the Banks and Jones pumping plants. The Banks and Jones pumping plants are expected to show increased assimilative capacity for waterborne mercury and decreased fish tissue concentrations of mercury for Alternative 9 as compared to Existing Conditions.

As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. However, increases in fish tissue mercury concentrations are substantial, and changes in fish tissue mercury concentrations would make existing mercury-related impairment in the Delta measurably worse. In comparison to Existing Conditions, Alternative 9 would increase levels of mercury by frequency, magnitude, and geographic extent such that the affected environment would be expected to have measurably higher body burdens of mercury in aquatic organisms, thereby substantially increasing the health risks to wildlife (including fish) or humans consuming those organisms. This impact is considered to be significant. Feasible or effective actions to reduce the effects on mercury resulting from CM1 are unknown. General mercury management measures through CM12, or actions taken by other entities or programs such as TMDL implementation, may minimize or reduce sources and inputs of mercury to the Delta and methylmercury formation. However, it is uncertain whether this impact would be reduced to a level that would be less than significant as a result of CM12 or other future actions. Therefore, the impact would be significant and unavoidable.

Impact WQ-14: Effects on Mercury Concentrations Resulting from Implementation of CM2–CM22

***NEPA Effects*:** Some habitat restoration activities under Alternative 9 would occur on lands in the Delta formerly used for irrigated agriculture. Tidal and other restoration proposed under Alternative 9 have the potential to increase water residence times and increase accumulation of organic sediments that are known to enhance methylmercury bioaccumulation in biota in the restored habitat. Therefore, increases in mercury methylation in the habitat restoration areas is possible but uncertain depending on the specific restoration design implemented at a particular Delta location. Models to estimate the potential for methylmercury formation in restored areas are not currently available. However, DSM2 modeling for Alternative 9 operations does incorporate assumptions for certain habitat restoration activities proposed under CM2 and CM4 (see Section 8.3.1.3) that result in changes to Delta hydrodynamics compared to the No Action Alternative. These modeled restoration assumptions provide some insight into potential hydrodynamic changes that could be expected related to implementing CM2 and CM4 and are considered in the evaluation of the potential for increased mercury and methylmercury concentrations under Alternative 9.

BDCP Conservation Measure 12 (CM12) addresses the potential for methylmercury bioaccumulation associated with restoration activities and acknowledges the uncertainties associated with mitigating or minimizing this potential effect. CM12 proposes project-specific mercury management plans for restoration actions that will incorporate relevant approaches recommended in Phase 1 Methylmercury TMDL control studies. Specific approaches recommended under CM12 that are intended to minimize or mitigate for potential increases in methylmercury bioaccumulation at future restoration sites include:

- Characterizing mercury, methylmercury, organic carbon, iron, and sulfate concentrations to better inform restoration design,
- Sequestering methylmercury at restoration sites using low intensity chemical dosing techniques,
- Minimizing microbial methylation associated with anoxic conditions by reducing the amount of organic material at a restoration site,
- Designing restoration sites to enhance photo degeneration that converts methylmercury into a biologically unavailable, inorganic form of mercury,
- Remediating restoration site soils with iron to reduce methylation in sulfide rich soils, and
- Considering capping mercury laden sediments, where possible to reduce methylation potential at a site.

Because of the uncertainties associated with site-specific estimates of methylmercury concentrations and the uncertainties in source modeling and tissue modeling, the effectiveness of methylmercury management proposed under CM12 to reduce methylmercury concentrations would need to be evaluated separately for each restoration effort, as part of design and implementation. Because of this uncertainty and the known potential for methylmercury creation in the Delta this potential effect of implementing CM2-CM22 is considered adverse.

CEQA Conclusion: There would be no substantial, long-term increase in mercury or methylmercury concentrations or loads in the rivers and reservoirs upstream of the Delta or the waters exported to the CVP and SWP service areas due to implementation of CM2–CM22 relative to Existing Conditions. However, uptake of mercury from water and/or methylation of inorganic mercury may increase to an unquantified degree as part of the creation of new, marshy, shallow, or organic-rich restoration areas. Methylmercury is 303(d)-listed within the affected environment, and therefore any potential measurable increase in methylmercury concentrations would make existing mercury-related impairment measurably worse. Because mercury is bioaccumulative, increases in water-borne mercury or methylmercury that could occur in some areas could bioaccumulate to somewhat greater levels in aquatic organisms and would, in turn, pose health risks to fish, wildlife, or humans. Design of restoration sites under Alternative 9 would be guided by CM12 which requires development of site specific mercury management plans as restoration actions are implemented. The effectiveness of minimization and mitigation actions implemented according to the mercury management plans is not known at this time although the potential to reduce methylmercury concentrations exists based on current research. Although the BDCP will implement CM12 with the goal to reduce this potential effect the uncertainties related to site specific restoration conditions and the potential for increases in methylmercury concentrations in the Delta result in this potential impact being considered significant. No mitigation measures would be available until specific restoration actions are proposed. Therefore this programmatic impact is considered significant and unavoidable.

Impact WQ-15: Effects on Nitrate Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative, Alternative 9 would have negligible, if any, impact on nitrate concentrations in the rivers and reservoirs upstream of the Delta in the Sacramento River watershed relative to Existing Conditions and the No Action Alternative.

Under Alternative 9, modeling indicates that long-term annual average flows on the San Joaquin River would decrease by an estimated 6% relative to Existing Conditions, and would remain virtually the same relative to the No Action Alternative (Appendix 5A). Given these relatively small decreases in flows and the weak correlation between nitrate and flows in the San Joaquin River (see Nitrate Appendix 8J, Figure 2), it is expected that nitrate concentrations in the San Joaquin River would be minimally affected, if at all, by changes in flow rates under Alternative 9.

Any negligible changes in nitrate-N concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regards to nitrate.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2-22 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for CM2-22. See section 8.3.1.3 for more information.

Results of the mixing calculations indicate that under Alternative 9, relative to Existing Conditions, and the No Action Alternative, nitrate concentrations throughout the Delta are anticipated to remain low (<1.4 mg/L-N) relative to adopted objectives (Nitrate Appendix 8J, Table 31 and 32). Long-term average nitrate concentrations are anticipated to increase at most locations in the Delta. The increase would be greatest at Franks Tract, Old River at Rock Slough, and Contra Costa Pumping Plant #1 (all >100% increase). Long-term average concentrations were estimated to increase to 0.96, 1.32, and 1.38 mg/L-N for Franks Tract, Old River at Rock Slough, and Contra Costa Pumping Plant #1, respectively, due primarily to increased San Joaquin River water percentage at these locations (see Fingerprinting Appendix 8D). Although changes at specific Delta locations and for specific months may be substantial on a relative basis, the absolute concentration of nitrate in Delta waters would remain low (<1.4 mg/L-N) in relation to the drinking water MCL of 10 mg/L-N, as well as all other thresholds identified in Table 8-50. No additional exceedances of the MCL are anticipated at any location (Nitrate Appendix 8J, Table 31). On a monthly average basis and on a long term annual average basis, for all modeled years and for the drought period (1987–1991) only, use of assimilative capacity available under Existing Conditions and the No Action Alternative, relative to the drinking water MCL of 10 mg/L-N, was up to approximately 13% at Old River at Rock Slough and Contra Costa Pumping Plant #1, and averaged approximately 9% on a long-term average basis (Nitrate Appendix 8J, Table 33). Similarly, the use of available assimilative capacity at Franks Tract was up to approximately 10%, and averaged approximately 6% over the long term. The concentrations estimated for these locations would not increase the likelihood of exceeding the 10 mg/L-N MCL, nor would they increase the risk for adverse effects to beneficial uses. At all other locations, use of assimilative capacity was negligible (<5%) (Nitrate Appendix 8J, Table 33).

Nitrate concentrations will likely be higher than the modeling results indicate in certain locations. This includes in the Sacramento River between Freeport and Mallard Island and other areas in the Delta downstream of Freeport that are influenced by Sacramento River water. These increases are associated with ammonia and nitrate that are discharged from the SRWTP, which are not included in the modeling.

- Under Existing Conditions, most of the ammonia discharged from the SRWTP is converted to nitrate downstream of the facility's discharge at Freeport, and thus, nitrate concentrations under Existing Conditions in these areas are expected to be higher than the modeling predicts, the increase becoming greater with increasing distance downstream. However, the increase in nitrate concentrations downstream of the SRWTP is expected to be small—the existing increase appears to be from approximately 0.1 mg/L-N to approximately 0.4–0.5 mg/L-N over this reach, due to approximately a 1:1 conversion of ammonia-N to nitrate-N (Central Valley Water Board 2010a:32).
- Under Alternative 9, the planned upgrades to the SRWTP, which include nitrification/partial denitrification, would substantially decrease ammonia concentrations in the discharge, but would increase nitrate concentrations in the discharge up to 10 mg/L-N, which is substantially higher than under Existing Conditions.
- Overall, under Alternative 9, the nitrogen load from the SRWTP discharge is expected to decrease (by up to 50%), relative to Existing Conditions, due to nitrification/partial dentrification ugrades at the SRWTP facility. Thus, while concentrations of nitrate downstream of the facility are expected to be higher than modeling results indicate for both Existing Conditions and Alternative 9, the increase is expected to be greater under Existing Conditions than for Alternative 9 due to the upgrades that are assumed under Alternative 9.

The other areas in which nitrate concentrations will be higher than the modeling results indicate are immediately downstream of other wastewater treatment plants that practice nitrification, but not denitrification (e.g., City of Rio Vista Beach WWTF, Town of Discovery Bay WWTF, City of Stockton RWCF). For all such facilities in the Delta, the Regional Water Boards have issued NPDES permits that allow discharge of wastewater containing nitrate into the Delta, and under these permits, the State has determined that no beneficial uses are adversely affected by the discharge, and that the discharger's use of available assimilative capacity of the water body is acceptable. When dilution is necessary in order for the discharge to be in compliance with the Basin Plans (which incorporate the 10 mg/L-N MCL by reference), not all of the assimilative capacity of the receiving water is granted to the discharger. Thus, limited decreases in flows are not anticipated to result in systemic exceedances of the MCLs by these POTWs. Furthermore, NPDES permits are renewed on a 5-year basis, and thus, if under changes in flows, dilution was no longer sufficient to maintain nitrate below the MCL in the receiving water, the NPDES permit renewal process would address such cases.

Therefore, any increases in nitrate-N concentrations that may occur at certain locations within the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the water quality at these locations, with regards to nitrate.

SWP/CVP Export Service Areas

Assessment of effects of nitrate in the SWP and CVP Export Service Areas is based on effects on nitrate-N at the Banks and Jones pumping plants.

Results of the mixing calculations indicate that under Alternative 9, relative to Existing Conditions and the No Action Alternative, nitrate concentrations at Banks and Jones pumping plants are anticipated to decrease on a long-term average annual basis (Nitrate Appendix 8J, Table 31 and 32). No additional exceedances of the MCL are anticipated (Nitrate Appendix 8J, Table 31). On a monthly average basis and on a long term annual average basis, for all modeled years and for the drought period (1987–1991) only, use of assimilative capacity available under Existing Conditions and the No Action Alternative, relative to the 10 mg/L-N MCL, was negligible for both Banks and Jones pumping plants (Nitrate Appendix 8J, Table 33).

Therefore, implementation of this alternative is not expected to result in adverse effects to beneficial uses or substantially degrade the quality of exported water, with regards to nitrate.

NEPA Effects: In summary, based on the discussion above, the effects on nitrate from implementing CM1 are considered to be not adverse.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Nitrate-N concentrations are generally low in the reservoirs and rivers of the watersheds, owing to substantial dilution available for point sources and the lack of substantial nonpoint sources of nitrate-N upstream of the SRWTP in the Sacramento River watershed, and in the watersheds of the eastern tributaries (Cosumnes, Mokelumne, and Calaveras Rivers). Although higher in the San Joaquin River watershed, nitrate-N concentrations are not well-correlated with flow rates. Consequently, any modified reservoir operations and subsequent changes in river flows under Alternative 9, relative to Existing Conditions, are expected to have negligible, if any, effects on reservoir and river nitrate-N concentrations upstream of Freeport in the Sacramento River watershed and upstream of the Delta in the San Joaquin River watershed.

In the Delta, results of the mixing calculations indicate that under Alternative 9, relative to Existing Conditions, long-term average nitrate concentrations are anticipated to increase at most locations. The increase would be greatest at Franks Tract, Old River at Rock Slough, and Contra Costa Pumping Plant #1 (all >100% increase), due primarily to increased San Joaquin River water percentage at these locations. However, nitrate concentrations throughout the Delta are anticipated to remain low (<1.4 mg/L-N) relative to adopted objectives, and no additional exceedances of the MCL are anticipated at any location. Use of assimilative capacity at locations throughout the Delta (up to 13%) did not result in concentrations that would increase the likelihood of exceeding the 10 mg/L-N MCL, nor would they increase the risk for adverse effects to beneficial uses.

Assessment of effects of nitrate in the SWP and CVP Export Service Areas is based on effects on nitrate-N concentrations at the Banks and Jones pumping plants. Results of the mixing calculations indicate that under Alternative 9, relative to Existing Conditions, long-term average nitrate concentrations at Banks and Jones pumping plants are anticipated to decrease. No additional exceedances of the MCL are anticipated, and use of assimilative capacity available under Existing

Conditions, relative to the MCL, for both Banks and Jones pumping plants was negligible for all months.

Based on the above, this alternative is not expected to cause additional exceedance of applicable water quality objectives/criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. No long-term water quality degradation is expected to occur such that exceedance of criteria is more likely or such that there is an increased risk of adverse impacts to beneficial uses. Nitrate is not 303(d) listed within the affected environment and thus any increases that may occur in some areas and months would not make any existing nitrate-related impairment measurably worse because no such impairments currently exist. Because nitrate is not bioaccumulative, increases that may occur in some areas and months would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-16: Effects on Nitrate Concentrations Resulting from Implementation of CM2–CM22

***NEPA Effects*:** Effects of CM2–CM22 on nitrate under Alternative 9 are the same as those discussed for Alternative 1A and are considered not to be adverse.

***CEQA Conclusion*:** Conservation Measures 2–22 proposed under Alternative 9 would be similar to those proposed under Alternative 1A. As such, effects on nitrate resulting from the implementation of CM2–CM22 would be similar to that previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-17: Effects on Dissolved Organic Carbon Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

Under Alternative 9, there would be no substantial change to the sources of DOC within the watersheds upstream of the Delta. Moreover, long-term average flow and DOC levels in the Sacramento River at Hood and San Joaquin River at Vernalis are poorly correlated. Thus changes in system operations and resulting reservoir storage levels and river flows would not be expected to cause a substantial long-term change in DOC concentrations in the water bodies upstream of the Delta. Any negligible changes in DOC levels in water bodies upstream of the Delta under Alternative 9, relative to Existing Conditions and the No Action Alternative, would not be of sufficient frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regards to DOC.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2-22 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for CM2-22. See section 8.3.1.3 for more information.

Under Alternative 9, the geographic extent of effects pertaining to long-term average DOC concentrations in the Delta would be similar to that previously described for Alternative 1A, although the magnitude of predicted long-term increase and relative frequency of concentration threshold exceedances would be substantially greater. Modeled effects would be greatest at Franks Tract, Rock Slough, and Contra Costa PP No. 1., where for the 16-year hydrologic period and the modeled drought period, long-term average concentration increases ranging from 0.6–1.0 mg/L would be predicted (≤28% net increase), resulting in long-term average DOC concentrations greater than 4 mg/L at Rock Slough and Contra Costa PP No. 1 (Appendix 8K, DOC Table 10). Increases in long-term average concentrations would correspond to more frequent concentration threshold exceedances, with the greatest change occurring at Rock Slough and Contra Costa PP No. 1 locations. For Rock Slough, long-term average DOC concentrations exceeding 3 mg/L would increase from 52% under Existing Conditions to 99% under the Alternative 9 (an increase from 47% to 100% for the drought period), and concentrations exceeding 4 mg/L would increase from 30% to 44% (32% to 67% for the drought period). For Contra Costa PP No. 1, long-term average DOC concentrations exceeding 3 mg/L would increase from 52% under Existing Conditions to 100% under Alternative 9 (45% to 100% for the drought period), and concentrations exceeding 4 mg/L would increase from 32% to 45% (35% to 65% for the drought period). Relative change in frequency of threshold exceedance for other assessment locations would be similar or less. This comparison to Existing Conditions reflects changes in DOC due to both Alternative 9 operations (including use of operable barriers and numerous other operational components of Scenario G) and climate change/sea level rise.

In comparison, Alternative 9 relative to the No Action Alternative would generally result in a similar magnitude of change to that discussed for the comparison to Existing Conditions. Maximum increases of 0.6–0.9 mg/L DOC (i.e., ≤24%) would be predicted at Franks Tract, Rock Slough, and Contra Costa PP No. 1 relative to No Action Alternative (Appendix 8K, DOC Table 10). Threshold concentration exceedance frequency trends would also be similar to that discussed for the existing condition comparison, with exception to the predicted 4 mg/L exceedance frequency at Buckley Cove. In comparison to the No Action Alternative, the frequency which long-term average DOC concentrations exceeded 4 mg/L at Buckley Cove would increase from 27% to 39% (42% to 50% for the modeled drought period). Unlike the comparison to Existing Conditions, this comparison to the No Action Alternative reflects changes in DOC due only to Alternative 9 operations.

The increases in long-term average DOC concentrations estimated to occur at Franks Tract, Rock Slough, and Contra Costa PP No. 1 are considered substantial and could potentially trigger significant changes in drinking water treatment plant design or operations. In particular, assessment locations at Rock Slough and Contra Costa PP No. 1 represent municipal intakes servicing existing drinking water treatment plants. Under Alternative 9, drinking water treatment plants obtaining water from these interior Delta locations would likely need to upgrade existing treatment systems in order to achieve EPA Stage 1 Disinfectants and Disinfection Byproduct Rule action thresholds. While treatment technologies sufficient to achieve the necessary DOC removals exist, implementation of such technologies would likely require substantial investment in new or modified infrastructure.

Relative to existing and No Action Alternative conditions, Alternative 9 would lead to predicted improvements in long-term average DOC concentrations at Barker Slough and Staten Island, as well Banks and Jones pumping plants (discussed below). Predicted long-term average DOC concentrations at Barker Slough and Staten Island would decrease <0.1–0.2 mg/L, depending on baseline conditions comparison and modeling period.

SWP/CVP Export Service Areas

Under Alternative 9, modeled long-term average DOC concentrations would decrease at Banks and Jones pumping plants for both the modeled 16-year hydrologic period and the modeled drought period. Modeled decreases would generally be similar between Existing Conditions and the No Action Alternative. Relative to Existing Conditions, long-term average DOC concentrations at Banks would be predicted to decrease by 1.5 mg/L (1.8 mg/L during drought period) (Appendix 8K, DOC Table 10 Table). At Jones, long-term average DOC concentrations would be predicted to decrease by 1.5 mg/L (1.7 mg/L during drought period). Such substantial improvement in long-term average DOC concentrations would include fewer exceedances of concentration thresholds. At both Banks and Jones, average DOC concentrations exceeding the 2 mg/L concentration threshold would decrease from 100% under Existing Conditions and the No Action Alternative to 39% under Alternative 9 (100% to 32% during the drought period), while concentrations exceeding 4 mg/L would nearly be eliminated (i.e., ≤10% exceedance frequency). Such modeled improvement would correspond to substantial improvement in Export Service Areas water quality, respective to DOC.

Similar to the discussion pertaining to the No Action Alternative, maintenance of SWP and CVP facilities under Alternative 9 would not be expected to create new sources of DOC or contribute towards a substantial change in existing sources of DOC in the affected area. Maintenance activities would not be expected to cause any substantial change in long-term average DOC concentrations such that MUN beneficial uses, or any other beneficial use, would be adversely affected.

NEPA Effects: In summary, Alternative 9, relative to the No Action Alternative, would not cause a substantial long-term change in DOC concentrations in the water bodies upstream of the Delta. Long-term average DOC concentrations at Banks and Jones pumping plants are predicted to decrease by as much as 1.9 mg/L, while long-term average DOC concentrations for some Delta interior locations, including Franks Tract, Rock Slough and Contra Costa PP #1, are predicted to increase by as much as 0.9 mg/L. Resultant substantial changes in long-term average DOC at these Delta interior locations could necessitate changes in water treatment plant operations or require treatment plant upgrades in order to maintain DBP compliance, and thus would constitute an adverse effect on water quality and MUN beneficial uses. Mitigation Measure WQ-17 is available to reduce these effects.

CEQA Conclusion: Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

While greater water demands under the Alternative 9 would alter the magnitude and timing of reservoir releases north, south and east of the Delta, these activities would have no substantial effect on the various watershed sources of DOC. Moreover, long-term average flow and DOC at Sacramento River at Hood and San Joaquin River at Vernalis are poorly correlated; therefore, changes in river flows would not be expected to cause a substantial long-term change in DOC concentrations upstream of the Delta.

Relative to Existing Conditions, Alternative 9 would result in substantial increases (i.e., 0.6–1.0 mg/L) in long-term average DOC concentrations at some Delta interior locations, and would be greatest at Franks Tract, Rock Slough, and Contra Costa PP No. 1. At these locations the predicted changes in DOC would substantially increase the frequency with which long-term average concentrations exceeds 2, 3, or 4 mg/L. Drinking water treatment plants obtaining water from these interior Delta locations would likely need to upgrade existing treatment systems in order to achieve EPA Stage 1 Disinfectants and Disinfection Byproduct Rule action thresholds. Such predicted magnitude change in long-term average DOC concentrations would represent a substantially increased risk for adverse effects on existing MUN beneficial.

The assessment of Alternative 9 effects on DOC in the SWP/CVP Export Service Areas is based on assessment of changes in DOC concentrations at Banks and Jones pumping plants. Relative to the existing condition, long-term average DOC concentrations would decrease by as much as 1.8 mg/L at Banks and Jones pumping plants. The frequency with which long-term average DOC concentrations would exceed 2, 3, or 4 mg/L would be substantially reduced, where predicted exceedances of >4 mg/L would be nearly eliminated (i.e., ≤10% exceedance frequency). As a result, substantial improvement in DOC-related water quality would be predicted in the SWP/CVP Export Service Areas.

Based on the above, Alternative 9 operation and maintenance would not result in any substantial change in long-term average DOC concentration upstream of the Delta. Furthermore, under Alternative 9, water exported from the Delta to the SWP/CVP service area would be substantially improved relative to DOC. DOC is not bioaccumulative, therefore change in long-term average DOC concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Additionally, DOC is not a constituent related to any 303(d) listings. Nevertheless, new and modified conveyance facilities proposed under Alternative 9 would result in a substantial increase in long-term average DOC concentrations (i.e., 0.6–1.0 mg/L, equivalent to ≤28% relative increase) at Franks Tract, Rock Slough, and Contra Costa PP No. 1. In particular, under Alternative 9, model predicted long-term average DOC concentrations would be greater than 4 mg/L at Rock Slough and Contra Costa PP No. 1 with commensurate substantial increases in the frequency with which average DOC concentrations exceed 2, 3, and 4 mg/L levels. Drinking water treatment plants obtaining water from these interior Delta locations would likely need to upgrade existing treatment systems in order to achieve EPA Stage 1 Disinfectants and Disinfection Byproduct Rule action thresholds. Therefore, such a magnitude change in long-term average DOC concentrations would represent a substantially increased risk for adverse effects on existing MUN beneficial uses at Rock Slough and Contra Costa PP No. 1 should such treatment upgrades not be undertaken. The impact is considered significant and mitigation is required. While Mitigation Measure WQ-17 is available to partially reduce this impact of DOC, the feasibility and effectiveness of this mitigation measure is uncertain and implementation would not necessarily reduce the identified impact to a level that would be less than significant, and therefore it is significant and unavoidable.

Mitigation Measure WQ-17: Consult with Delta Water Purveyors to Identify Means to Avoid, Minimize, or Offset Increases in Long-Term Average DOC Concentrations

Please see Mitigation Measure WQ-17 under Impact WQ-17 in the Alternative 6A discussion.

Impact WQ-18: Effects on Dissolved Organic Carbon Concentrations Resulting from Implementation of CM2–CM22

***NEPA Effects*:** Conservation Measures 2–22 under Alternative 9 would be similar to those under Alternative 1A, but with changes in the south Delta to accommodate the modified corridors. Therefore, effects on DOC resulting from the implementation of CM2–CM22 would be similar to that previously discussed for Alternative 1A. In summary, CM4–CM7 and CM10 could contribute substantial amounts of DOC to raw drinking water supplies, largely depending on final design and operational criteria for the related wetland and riparian habitat restoration activities. Substantially increased long-term average DOC in raw water supplies could lead to a need for treatment plant upgrades in order to appropriately manage DBP formation in treated drinking water. This potential for future DOC increases would lead to substantially greater associated risk of long-term adverse effects on the MUN beneficial use.

In summary, the habitat restoration elements of CM4–CM7 and CM10 under Alternative 9 would present new localized sources of DOC to the study area, and in some circumstances would substitute for existing sources related to replaced agriculture. Depending on localized hydrodynamics and proximity to municipal drinking water intakes, such restoration activities could contribute substantial amounts of DOC to municipal raw water. Substantial increases in municipal raw water DOC could necessitate changes in water treatment plant operations or require treatment plant upgrades in order to maintain DBP compliance, and thus would constitute an adverse effect on water quality. Mitigation Measure WQ-18 is available to reduce these effects.

***CEQA Conclusion*:** Effects of CM4–CM7 and CM10 on DOC under Alternative 9 are similar to those discussed for Alternative 1A. Similar to the discussion for Alternative 1A, this impact is considered to be significant. Mitigation is required. It is uncertain whether implementation of Mitigation Measure WQ-18 would reduce identified impacts to a less-than-significant level. Hence, this impact remains significant and unavoidable.

In addition to and to supplement Mitigation Measure WQ-18, the BDCP proponents have incorporated into the BDCP, as set forth in EIR/EIS Appendix 3B, *Environmental Commitments*, a separate, non-environmental commitment to address the potential increased water treatment costs that could result from DOC concentration effects on municipal and industrial water purveyor operations. Potential options for making use of this financial commitment include funding or providing other assistance towards implementing treatment for DOC and/or DBPs or DOC source control strategies. Please refer to Appendix 3B, *Environmental Commitments*, for the full list of potential actions that could be taken pursuant to this commitment in order to reduce the water quality treatment costs associated with water quality effects relating to DOC.

Mitigation Measure WQ-18: Design Wetland and Riparian Habitat Features to Minimize Effects on Municipal Intakes

Please see Mitigation Measure WQ-18 under Impact WQ-18 in the discussion of Alternative 1A.

Impact WQ-19: Effects on Pathogens Resulting from Facilities Operations and Maintenance (CM1)

***NEPA Effects*:** Effects of CM1 on pathogens under Alternative 9 are the same as those discussed for Alternative 1A and are considered to not be adverse.

***CEQA Conclusion*:** Effects of CM1 on pathogens under Alternative 9 are the same as those discussed for Alternative 1A, and are summarized here, then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion under Alternative 1A.

River flow rate and reservoir storage reductions that would occur due to implementation of CM1 (water facilities and operations) under Alternative 9, relative to Existing Conditions, would not be expected to result in a substantial adverse change in pathogen concentrations in the reservoirs and rivers upstream of the Delta, given the small magnitude of urban runoff contributions relative to the magnitude of river flows, that pathogen concentrations in the rivers have a minimal relationship to river flow rate, and the expected reduced pollutant loadings in response to NPDES stormwater-related regulations.

It is expected there would be no substantial change in Delta pathogen concentrations in response to a shift in the Delta source water percentages under this alternative or substantial degradation of these water bodies, with regard to pathogens. This conclusion is based on the Pathogens Conceptual Model, which found that pathogen sources in close proximity to a Delta site appear to have the greatest influence on pathogen levels at the site, rather than the primary source(s) of water to the site. In-Delta potential pathogen sources, including water-based recreation, tidal habitat, wildlife, and livestock-related uses, would continue under this alternative.

In the SWP/CVP Export Service Areas waters, relative to Existing Conditions, an increased proportion of water coming from the Sacramento River would not adversely affect beneficial uses in the SWP/CVP Export Service Areas. The pathogen levels in the Sacramento River are similar to or lower than the water diverted at the Delta export pumps. Further, it is localized sources of pathogens that appear to have the greatest influence on concentrations. Thus, an increased proportion of Sacramento River water diverted to the SWP/CVP Export Service Areas would result in minimal changes in pathogen levels in the SWP/CVP Export Service Areas waters.

Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because pathogen concentrations are not expected to increase substantially, no long-term water quality degradation for pathogens is expected to occur and, thus, no adverse effects on beneficial uses would occur. The San Joaquin River in the Stockton Deep Water Ship Channel is Clean Water Act section 303(d) listed for pathogens. Because no measurable increase in Deep Water Ship Channel pathogen concentrations are expected to occur on a long-term basis, further degradation and impairment of this area is not expected to occur. Finally, pathogens are not bioaccumulative constituents. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-20: Effects on Pathogens Resulting from Implementation of CM2–CM22

***NEPA Effects*:** Effects of CM2–CM22 on pathogens under Alternative 9 are the same as those discussed for Alternative 1A and are considered to not be adverse.

***CEQA Conclusion*:** Conservation Measures 2–22 proposed under Alternative 9 would be similar to those proposed under Alternative 1A. As such, effects on pathogens resulting from the implementation of CM2–CM22 would be similar to that previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-21: Effects on Pesticide Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative, under Alternative 9 no specific operations or maintenance activity of the SWP or CVP would substantially drive a change in pesticide use, and thus pesticide sources would remain unaffected upstream of the Delta. Nevertheless, changes in the timing and magnitude of reservoir releases could have an effect on available dilution capacity along river segments such as the Sacramento, Feather, American, and San Joaquin Rivers.

Under Alternative 9, winter (November–March) and summer (April–October) season average flow rates on the Sacramento River at Freeport, American River at Nimbus, Feather River at Thermalito and the San Joaquin River at Vernalis would change. Relative to existing condition and the No Action Alternative, seasonal average flow rates on the Sacramento would decrease no more than 3% during the summer and winter (Appendix 8L, Seasonal average flows Tables 1-4). On the Feather River, average flow rates would increase by as much as 10% during the summer, but would decrease by as much as 5% in the winter. American River average flow rates would decrease by as much as 17% in the summer but would increase by as much as 7% in the winter. Seasonal average flow rates on the San Joaquin River would decrease by as much as 12% in the summer, but increase by as much as 1% in the winter. For the same reasons stated for the No Action Alternative, decreased seasonal average flow of ≤17% is not considered to be of sufficient magnitude to substantially increase pesticide concentrations or alter the long-term risk of pesticide-related toxicity to aquatic life, nor adversely affect other beneficial uses of water bodies upstream of the Delta.

Delta

Sources of diuron, OP and pyrethroid insecticides to the Plan Area include direct input of surface runoff from in-Delta agriculture and Delta urbanized areas as well as inputs from rivers upstream of the Delta. Similar to Upstream of the Delta, CVP/SWP operations would not affect these sources.

Under Alternative 9, the distribution and mixing of Delta source waters would change. Percent change in monthly average source water fraction were evaluated for the modeled 16-year (1976–1991) hydrologic period and a representative drought period (1987–1991), with special attention given to changes in San Joaquin River, Sacramento River and Delta Agriculture sources water fractions. Relative to Existing Conditions, under Alternative 9 modeled San Joaquin River fractions would increase greater than 10% at Franks Tract, Rock Slough, Contra Costa PP No. 1, and the San Joaquin River at Antioch (Appendix 8D, Source Water Fingerprinting). At Antioch, San Joaquin River source water fractions would increase by 12–15% from October through May (11–14% from November through April for the modeled drought period). While this change at Antioch is not considered substantial, changes in San Joaquin River source water fraction in the Delta interior would be considerable. At Franks Tract, San Joaquin River source water fractions would increase between 25–57% for the entire calendar year of January through December (11–52% for October through July of the modeled drought period). Changes at Rock Slough and Contra Costa PP No. 1 would be very similar, where modeled San Joaquin River source water fractions would increase from 35–80% (25–78% for the modeled drought period) for the entire calendar year of January through December. In addition, Sacramento River fractions would increase greater than 10% at Staten Island and Buckley Cove (not including Banks and Jones). At Staten Island, Sacramento River fractions would increase by 16% in April and 20% in May (13–15% from February through April of the modeled drought period). These changes at Staten Island are not considered substantial. At Buckley Cove, however, Sacramento source water fraction would increase between 36–72% (46–73% for the drought period) for the entire calendar year of January through December. Although a considerable change, this change in source water fraction at Buckley Cove would balance through a nearly equivalent decrease in San Joaquin River water. Delta agricultural fractions would not increase greater than 8% at any assessment location.

Relative to Existing Conditions, increases in San Joaquin River source water fraction at Franks Tract, Rock Slough, and Contra Costa PP NO. 1 would primarily balance through decreases in Sacramento River water, and as a result the San Joaquin River would account for greater than 50% of the total source water volume at Franks Tract between October and June (>50% for November and December during the modeled drought period), and would be greater than 50%, and as much as 86% for the entire calendar year at Rock Slough and Contra Costa PP No. 1 (greater than 50% and as high as 80% for October through June of the modeled drought period). While the source water and potential pesticide related toxicity co-occurrence predictions do not mean adverse effects would occur, such considerable modeled increases in winter and early summer source water fraction at Franks Tract and winter and summer source water fractions at Rock Slough and Contra Costa PP No. 1 could substantially alter the long-term risk of pesticide-related toxicity to aquatic life, given the apparent greater incidence of pesticides in the San Joaquin River.

When compared to the No Action Alternative, changes in source water fractions would be similar in season, geographic extent, and magnitude to those discussed for Existing Conditions (Appendix 8D, Source Water Fingerprinting). Relative to the No Action Alternative the similar magnitude increase in San Joaquin River source water fraction at Franks Tract, Rock Slough, and Contra Costa PP No. 1 would be considered substantial and could substantially increase the long-term risk of pesticide-related toxicity to aquatic life.

These predicted adverse effects on pesticides relative to Existing Conditions and the No Action Alternative fundamentally assume that the present pattern of pesticide incidence in surface water will occur at similar levels into the future. In reality, however, the makeup and character of the pesticide use market in the late long-term (i.e., the year 2060) will not be exactly as it is today. Current use of chlorpyrifos and diazinon is on the decline with their replacement by pyrethroids on the rise, yet in this assessment it is the apparent greater incidence of diazinon and chlorpyrifos on the San Joaquin River that serves as the basis for concluding that substantially increased San Joaquin River source water fraction would correspond to an increased risk of pesticide-related toxicity to aquatic life. By 2060, however, alternative pesticides, such as neonicitinoids and biologicals, will likely be a more substantial contributing part of the existing mix of pesticides, and perhaps more prominent. The trend in the development of future-use pesticides is towards reduced risk pesticides, including more biopesticides, with greater targeted specificity, fewer residues, and lower overall non-target toxicity. By 2060 existing chlorpyrifos and diazinon TMDLs for the Sacramento and San Joaquin Rivers will have been in effect for more than 50 years. Moreover, it is reasonable to expect that CWA section 303(d) listings and future additional listings will have developed TMDLs by 2060. To the extent these existing and future TMDL's address current and future-use pesticides, a greater degree of pesticide related source control can be anticipated. Nevertheless, forecasting whether these various efforts will ultimately be successful at resolving current pesticide related impairments requires considerable speculation. While the fundamental assumptions that have guided this assessment of pesticides may be somewhat altered by 2060, these assumptions are informed by actual studies and monitoring data collected from the recent past and, therefore, judging project alternative effects in the future remain most accurate through use of these informed assumptions rather than based on assumptions founded upon future speculative conditions.

SWP/CVP Export Service Areas

Assessment of effects in SWP/CVP Export Service Areas is based on effects seen in the Plan Area at the Banks and Jones pumping plants. Under Alternative 9, Sacramento River source water fractions would increase at both Banks and Jones pumping plants relative to Existing Conditions and the No

Action Alternative (Appendix 8D, Source Water Fingerprinting). At Banks pumping plant, Sacramento source water fractions would generally increase from 12–38% for February through June (12–37% for February through June of the modeled drought period) and at Jones pumping plant Sacramento source water fractions would generally increase from 7–54% for the entire calendar year (14–69% for September through June of the modeled drought period). These increases in Sacramento source water fraction would primarily balance through equivalent decreases in San Joaquin River water. Based on the general observation that San Joaquin River, in comparison to the Sacramento River, is a greater contributor of OP insecticides in terms of greater frequency of incidence and presence at concentrations exceeding water quality benchmarks, modeled increases in Sacramento River fraction at Banks and Jones would generally represent an improvement in export water quality respective to pesticides.

NEPA Effects: In summary, the changes in long-term average flows on the Sacramento, Feather, American, and San Joaquin Rivers, under Alternative 9 relative to the No Action Alternative, are of insufficient magnitude to substantially increase the long-term risk of pesticide-related water quality degradation and related toxicity to aquatic life in these water bodies upstream of the Delta. However, modeled increases in San Joaquin River fraction at Franks Tract, Rock Slough, and Contra Costa PP No. 1 are of sufficient magnitude to substantially alter the long-term risk of pesticide-related water quality degradation and related toxicity to aquatic life in the Delta. The effects on pesticides from operations and maintenance (CM1) are determined to be adverse and unavoidable.

CEQA Conclusion: Key findings discussed in the effects assessment relative to Existing Conditions is provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Sources of pesticides upstream of the Delta include direct input of pesticide containing surface runoff from agriculture and urbanized areas. Flows in rivers receiving these discharges dilute these pesticide inputs. Relative to Existing Conditions, however, modeled changes in long-term average flows on the Sacramento, Feather, American, and San Joaquin Rivers are of insufficient magnitude to substantially increase the long-term risk of pesticide-related water quality degradation and related toxicity to aquatic life in these water bodies upstream of the Delta.

In the Delta, sources of pesticides include direct input of surface runoff from Delta agriculture and Delta urbanized areas as well as inputs from rivers upstream of the Delta. While facilities operations and maintenance activities would not affect these sources, changes in Delta source water fraction could change the relative risk associated with pesticide related toxicity to aquatic life. Under Alternative 9, modeled long-term average San Joaquin River source water fractions at Franks Tract, Rock Slough and Contra Costa PP No. 1 locations would increase considerably for some months such that the long-term risk of pesticide-related toxicity to aquatic life could substantially increase.

The assessment of Alternative 9 effects on pesticides in the SWP/CVP Export Service Areas is based on assessment of changes predicted at Banks and Jones pumping plants. Sacramento River source water fractions would increase substantially at both Banks and Jones pumping plants and would generally represent an improvement in export water quality respective to pesticides.

Based on the above, Alternative 9 would not result in any substantial change in long-term average pesticide concentration or result in substantial increase in the anticipated frequency with which long-term average pesticide concentrations would exceed aquatic life toxicity thresholds or other beneficial use effect thresholds upstream of the Delta or the SWP/CVP service area. Numerous pesticides are currently used throughout the affected environment, and while some of these pesticides may be bioaccumulative, those present-use pesticides for which there is sufficient evidence for their presence in waters affected by SWP and CVP operations (i.e., diazinon, chlorpyrifos, diuron, and pyrethroids) are not considered bioaccumulative, and thus changes in their concentrations would not directly cause bioaccumulative problems in aquatic life or humans. Furthermore, while there are numerous 303(d) listings throughout the affected environment that name pesticides as the cause for beneficial use impairment, the modeled changes in upstream river flows and Delta source water fractions would not be expected to make any of these beneficial use impairments measurably worse, with principal exception to locations in the Delta that would receive a substantially greater fraction San Joaquin River water under Alternative 9. Long-term average San Joaquin River source water fractions at Franks Tract, Rock Slough and Contra Costa PP No. 1 locations would change considerably for the calendar year such that the long-term risk of pesticide-related toxicity to aquatic life could substantially increase. Additionally, the potential for increased incidence of pesticide related toxicity could include pesticides such as chlorpyrifos and diazinon for which existing 303(d) listings exist for the Delta, and thus existing beneficial use impairment could be made discernibly worse. The impact is considered to be significant and unavoidable. There is no feasible mitigation available to reduce the effect of this significant impact.

Impact WQ-22: Effects on Pesticide Concentrations Resulting from Implementation of CM2–CM22

NEPA Effects**:** Conservation Measures 2–22 under Alternative 9 would be similar to those under Alternative 1A, but with changes in the south Delta to accommodate the modified corridors. Effects on pesticides resulting from the implementation of CM2–CM22 would be similar to that previously discussed for Alternative 1A. In summary, CM13 proposes the use of herbicides to control invasive aquatic vegetation around habitat restoration sites. Herbicides directly applied to water could include adverse effects on non-target aquatic life, such as aquatic invertebrates and beneficial aquatic plants. As such, aquatic life toxicity objectives could be exceeded with sufficient frequency and magnitude such that beneficial uses would be impacted, thus constituting an adverse effect on water quality.

In summary, based on the discussion above, the effects on pesticides from implementing CM2-CM22 are considered to be adverse. Mitigation Measure WQ-22 would be available to reduce this adverse effect.

CEQA Conclusion**:** Effects of CM2–CM22 on pesticides under Alternative 9 are similar to those discussed for Alternative 1A. Potential environmental effects related only to CM13 are considered to be significant. Mitigation is required. While Mitigation Measure WQ-22 is available to partially reduce this impact of pesticides, no feasible mitigation is available that would reduce it to a level that would be less than significant.

Mitigation Measure WQ-22: Implement Least Toxic Integrated Pest Management Strategies

Please see Mitigation Measure WQ-22 under Impact WQ-22 in the discussion of Alternative 1A.

Impact WQ-23: Effects on Phosphorus Concentrations Resulting from Facilities Operations and Maintenance (CM1)

***NEPA Effects*:** Effects of water facilities and operations (CM1) on phosphorus levels in water bodies of the affected environment under Alternative 9 would be very similar (i.e., nearly the same) to those discussed for Alternative 1A. Consequently, the environmental consequences to phosphorus levels discussed in detail for Alternative 1A also adequately represent the effects under Alternative 9, which are considered to be not adverse.

CEQA Conclusion: Key findings discussed in the effects assessment relative to Existing Conditions is provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

Because phosphorus loading to waters upstream of the Delta is not anticipated to change, and because changes in flows do not necessarily result in changes in concentrations or loading of phosphorus to these water bodies, substantial changes in phosphorus concentration upstream of the Delta are not anticipated for Alternative 9, relative to Existing Conditions.

Because phosphorus concentrations in the major source waters to the Delta are similar for much of the year, phosphorus concentrations in the Delta are not anticipated to change substantially on a long term-average basis under Alternative 9, relative to Existing Conditions. Algal growth rates are limited by availability of light in the Delta, and therefore any minor increases in phosphorus levels that may occur at some locations and times within the Delta would be expected to have little effect on primary productivity in the Delta.

The assessment of effects of phosphorus under Alternative 9 in the SWP and CVP Export Service Areas is based on effects on phosphorus at the Banks and Jones pumping plants. As noted above, phosphorus concentrations in the Delta (including Banks and Jones pumping plants) are not anticipated to change substantially on a long term-average basis.

Based on the above, there would be no substantial, long-term increase in phosphorus concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the waters exported to the CVP and SWP service areas under Alternative 9 relative to Existing Conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives/ criteria by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because phosphorus concentrations are not expected to increase substantially, no long-term water quality degradation is expected to occur and, thus, no adverse effects to beneficial uses would occur. Phosphorus is not 303(d) listed within the affected environment and thus any minor increases that may occur in some areas would not make any existing phosphorus-related impairment measurably worse because no such impairments currently exist. Because phosphorus is not bioaccumulative, minor increases that may occur in some areas would not bioaccumulate to greater levels in aquatic organisms that would, in turn, pose substantial health risks to fish, wildlife, or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-24: Effects on Phosphorus Concentrations Resulting from Implementation of CM2–CM22

***NEPA Effects*:** Effects of CM2–CM22 on phosphorus levels in water bodies of the affected environment under Alternative 9 would be very similar (i.e., nearly the same) to those discussed for Alternative 1A. Consequently, the environmental consequences to phosphorus levels from implementing CM2–CM22 discussed in detail for Alternative 1A also adequately represent the effects of these same actions under Alternative 9, which are considered to be not adverse.

***CEQA Conclusion*:** Conservation Measures 2–22 proposed under Alternative 9 would be similar to those proposed under Alternative 1A. As such, effects on phosphorus resulting from the implementation of CM2–CM22 would be similar to that previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-25: Effects on Selenium Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative, Alternative 9 would have negligible, if any, effect on selenium concentrations in the rivers and reservoirs upstream of the Delta relative to Existing Conditions and the No Action Alternative. Any negligible increases in selenium concentrations that could occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies, with regard to selenium.

Delta

Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, To the extent that restoration actions alter hydrodynamics within the Delta region, which affects mixing of source waters, these effects are included in this assessment of operations-related water quality changes (i.e., CM1). Other effects of CM2-22 not attributable to hydrodynamics, for example, additional loading of a constituent to the Delta, are discussed within the impact header for CM2-22. See section 8.3.1.3 for more information.

Alternative 9 would result in small to moderate changes in average selenium concentrations in water at modeled Delta assessment locations relative to Existing Conditions and the No Action Alternative (Appendix 8M, Table M-10A). The various changes in selenium concentrations in water are reflected in small (10% or less) to moderate (between 11% and 50%) changes in available assimilative capacity for selenium (based on 2 µg/L ecological risk benchmark) for all years. Relative to Existing Conditions, Alternative 9 would result in the largest modeled increase in assimilative capacity at Buckley Cove (32%) and the three largest decreases would be at Franks Tract (13%), Rock Slough (19%), and Contra Costa PP (18%) (Figure 8-59). Relative to the No Action Alternative, the largest modeled increase in assimilative capacity would be at Buckley Cove (26%) and the three largest decreases would be at Franks Tract (13%), Rock Slough (19%), and Contra Costa PP (18%) (Figure 8-60). Although there would be moderate (greater than 10%) negative changes in assimilative capacity at three locations (Franks Tract, Rock Slough, and Contra Costa PP), the changes would be minimal (10% or less decrease) at the other locations and the available assimilative capacity at all locations would remain substantial; overall, the effect of Alternative 9 would be generally moderate for portions of the Delta represented by Franks Tract, Rock Slough, and Contra Costa PP. However, the ranges of modeled selenium concentrations in water (Appendix 8M, Table M-10A) for Alternative 9 (range 0.23–0.70 µg/L), Existing Conditions (range 0.21–0.76 µg/L), and the No Action Alternative (range 0.21–0.69 µg/L) are similar, and all would be below the ecological risk benchmark (2 µg/L).

Relative to Existing Conditions and the No Action Alternative, Alternative 9 would generally result in minimal to moderate changes in estimated selenium concentrations in biota (whole-body fish, bird eggs [invertebrate diet], bird eggs [fish diet], and fish fillets) (Appendix 8M, Table M20 and Addendum M.A to Appendix 8M, Table M.A-2). Relative to Existing Conditions and the No Action Alternative, the largest increase of selenium concentrations in biota would be at Rock Slough and Contra Costa PP for drought years and in sturgeon at the two western Delta locations in all as well as drought years, and the largest decrease would be at Buckley Cove for drought years. Except for sturgeon in the western Delta, concentrations of selenium in whole-body fish and in bird eggs (invertebrate and fish diets) would exceed the lower benchmarks (4 and 6 mg/kg dry weight, respectively, indicating a low potential for effects), under drought conditions, at Buckley Cove for Existing Conditions and the No Action Alternative, and at Rock Slough and Contra Costa PP for Alternative 9 (Figures 8-61 through 8-63). Exceedance Quotients for these comparisons to the lower benchmarks are between 1.0 and 1.5, indicating a low risk to biota in the Delta, but modeled selenium concentrations in whole-body fish and in bird eggs (invertebrate and fish diets) exceed those benchmarks at two locations where they do not exceed under Existing Conditions and the No Action Alternative. Selenium concentrations in fish fillets would not exceed the screening value for protection of human health (Figure 8-64). For sturgeon in the western Delta, whole-body selenium concentrations would increase from 12.3 mg/kg under Existing Conditions and the No Action Alternative to 15.1 mg/kg under Alternative 9, a 23% increase (Table M.A-2). All of these values exceed both the low and high toxicity benchmarks. The predicted increases are high enough that they may represent a measurable increase in body burdens of sturgeon, which would constitute an adverse impact (see also the discussion of results provided in Addendum M.A to Appendix 8M).

Under Alternative 9, the most notable effect on selenium concentrations in water would be the increase at Rock Slough, Franks Tract, and Contra Costa PP, decreasing the available assimilative capacity and increasing the selenium concentrations in biota at those locations. Alternative 9 is the only action alternative that would exceed benchmarks for biota that are not exceeded under Existing Conditions and the No Action Alternative (and only at Rock Slough and Contra Costa PP); this level of bioaccumulation is predicted despite the conclusion that selenium concentrations in water would not exceed ecological benchmarks at any location and the assimilative capacity would remain substantial. The foremost difference between Alternative 9 and the other alternatives is the exceedances of risk-based benchmarks for biota at Rock Slough and Contra Costa PP (and a large increase in tissue concentrations predicted at Franks Tract, although the tissue benchmarks would not be exceeded) compared to the exceedances at Buckley Cove for Existing Conditions and the No Action Alternative and the other alternatives. In essence, the location where selenium bioaccumulation is highest would be displaced from Buckley Cove to Rock Slough, Franks Tract, and Contra Costa PP. Therefore, selenium concentrations in water and biota within the Delta would also differ spatially for Alternative 9 compared to Existing Conditions and the No Action Alternative and the other action alternatives, and under Alternative 9 could increase the frequency with which applicable benchmarks would be exceeded in some regions of the Delta or substantially degrade the quality of water with respect to beneficial uses in the Delta.

SWP/CVP Export Service Areas

Alternative 9 would result in small to moderate changes in average selenium concentrations in water relative to Existing Conditions and the No Action Alternative (Appendix 8M, Table M-10A). These changes are reflected in the small (10% or less) to moderate (between 11% and 50%) changes in available assimilative capacity for selenium for all years. Relative to Existing Conditions and the No Action Alternative, Alternative 9 would result in increases in assimilative capacity at Jones PP (12% and 13%, respectively) and at Banks PP (5%) (Figures 8-59 and 8-60), so it would have a positive effect at the Export Service Area locations. The ranges of modeled selenium concentrations in water (Appendix 8M, Table M-10A) for Alternative 9 (range 0.32–0.40 µg/L), Existing Conditions (range 0.37–0.58 µg/L), and the No Action Alternative (range 0.37–0.59 µg/L) are similar, and all would be well below the ecological risk benchmark (2 µg/L).

Relative to Existing Conditions and the No Action Alternative, Alternative 9 would result in minimal changes in estimated selenium concentrations in biota (Appendix 8M, Table M-20). Relative to Existing Conditions and the No Action Alternative, the largest increase of selenium concentrations in biota would be at Banks PP for all years. Relative to all Existing Conditions and the No Action Alternative, the largest decrease of selenium concentrations in biota would be at Jones PP for drought years. Selenium concentrations in biota would not exceed any benchmarks for Alternative 9 (Figures 8-61 through 8-64).

Thus, relative to Existing Conditions and the No Action Alternative, Alternative 9 would result in small to moderate changes in selenium concentrations in water and minimal changes in selenium concentrations in biota at the Export Service Area locations. Selenium concentrations in water and biota generally would decrease under Alternative 9 and would not exceed ecological benchmarks at either location, whereas the lower benchmark for bird eggs (fish diet) would be exceeded under Existing Conditions and the No Action Alternative at Jones PP under drought conditions. This small positive change in selenium concentrations under Alternative 9 would be expected to slightly decrease the frequency with which applicable benchmarks would be exceeded or slightly improve the quality of water at the Export Service Area locations, with regard to selenium.

NEPA Effects**:** Based on the discussion above, the effects on selenium from Alternative 9 are considered to be adverse. This determination is reached because 1) modeled selenium concentrations in water would increase at Rock Slough, Franks Tract, and Contra Costa PP, decreasing the available assimilative capacity by more than 10 percent at each of those locations; 2) selenium concentrations in whole-body fish and in bird eggs (invertebrate and fish diets) at those locations would increase so that Level of Concern benchmarks for biota that are not exceeded under the No Action Alternative would be exceeded at Rock Slough and Contra Costa PP (and approach exceedance at Franks Tract); and selenium concentrations in whole-body sturgeon modeled at two western Delta locations would increase by an estimated 23%, which may represent a measurable increase in the environment. Because both low and high toxicity benchmarks are already exceeded under the No Action Alternative, these potentially measurable increases represent an adverse impact.

CEQA Conclusion**:** Key findings discussed in the effects assessment provided above are summarized here, and are then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for selenium. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion that immediately precedes this conclusion.

There are no substantial point sources of selenium in watersheds upstream of the Delta, and no substantial nonpoint sources of selenium in the watersheds of the Sacramento River and the eastern tributaries. Nonpoint sources in the San Joaquin Valley that contribute selenium to the Delta will be controlled through a TMDL developed by the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the Grassland Bypass Project, and Basin Plan objectives (Central Valley Water Board 2010c) and State Water Board (2010d, 2010e) that are expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta. Consequently, any modified reservoir operations and subsequent changes in river flows under Alternative 9, relative to Existing Conditions, are expected to cause negligible changes in selenium concentrations in water. Any negligible changes in selenium concentrations that may occur in the water bodies of the affected environment located upstream of the Delta would not be of frequency, magnitude, and geographic extent that would adversely affect any beneficial uses or substantially degrade the quality of these water bodies as related to selenium.

Relative to Existing Conditions, modeling estimates indicate that selenium concentrations in water and biota within the Delta would differ spatially for Alternative 9 compared to Existing Conditions, and the differences would be substantial. Under Alternative 9, modeled selenium concentrations in water would increase at Rock Slough, Franks Tract, and Contra Costa PP, decreasing the available assimilative capacity by more than 10 percent at each of those locations; consequently, selenium concentrations in whole-body fish and in bird eggs (invertebrate and fish diets) at those locations would increase so that Level of Concern benchmarks for biota that are not exceeded under Existing Conditions would be exceeded at Rock Slough and Contra Costa PP (and approach exceedance at Franks Tract). Additionally, relative to Existing Conditions, modeling estimates indicate that Alternative 9 would increase selenium concentrations in whole-body sturgeon modeled at two western Delta locations by an estimated 23%, which may represent a measurable increase in the environment. Because both low and high toxicity benchmarks are already exceeded under Existing Conditions, these potentially measurable increases represent a potential impact to aquatic life beneficial uses.

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 the frequency with which applicable benchmarks would be exceeded 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, 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 303(d)-listed impairment of beneficial use to be made discernibly worse. This impact is considered significant.

The need for, and the feasibility and effectiveness of, post-operation mitigation for the predicted level of selenium bioaccumulation is uncertain. The first step shall be to determine the reliability of the model in predicting biota selenium concentrations in the affected environment where effects are predicted but selenium data are lacking. For that reason, the model shall be validated with site-specific sampling before extensive mitigation measures relative to CM1 operations are developed and evaluated for feasibility, as the measures and their evaluation for feasibility are likely to be complex. Specifically, it remains to be determined whether the available existing data for transfer of selenium from water to particulates and through different trophic levels of the food chain are representative of conditions that may occur from implementation of Alternative 9. Therefore, the proposed mitigation measure requires that sampling be conducted to characterize each step of data inputs needed for the model, and then the refined model be validated for local conditions. This impact is considered significant and unavoidable.

Impact WQ-26: Effects on Selenium Concentrations Resulting from Implementation of CM2–CM22

NEPA Effects: In general, with the possible exception of changes in Delta hydrodynamics resulting from habitat restoration, CM2–CM11 would not substantially increase selenium concentrations in the water bodies of the affected environment. Modeling scenarios included assumptions regarding how certain habitat restoration activities (CM2 and CM4) would affect Delta hydrodynamics, and thus such effects of these restoration measures were included in the assessment of CM1 facilities operations and maintenance (see Impact WQ-25).

However, implementation of these conservation measures may increase water residence time within the restoration areas. Increased restoration area water residence times could potentially increase the bioaccumulation of selenium in biota, thereby potentially increasing fish tissue and bird egg concentrations of selenium, but models are not available to quantitatively estimate the level of changes in residence time and the associated selenium bioavailability. If increases in fish tissue or bird egg selenium were to occur, the increases would likely be of concern only where fish tissues or bird eggs are already elevated in selenium to near or above thresholds of concern. That is, where biota concentrations are currently low and not approaching thresholds of concern, changes in residence time alone would not be expected to cause them to then approach or exceed thresholds of concern. In consideration of this factor, although the Delta as a whole is a 303(d)-listed water body for selenium, and although monitoring data of fish tissue or bird eggs in the Delta are sparse, the most likely areas in which biota tissues would be at levels high enough that additional bioaccumulation due to increased residence time from restoration areas would be a concern are the western Delta and Suisun Bay, and the South Delta in areas that receive San Joaquin River water.

The western Delta and Suisun Bay receive elevated selenium loads from North San Francisco Bay (including San Pablo Bay, Carquinez Strait, and Suisun Bay) and from the San Joaquin River. Point sources of selenium in North San Francisco Bay (i.e., refineries) that contribute selenium to Suisun Bay are expected to be reduced through a TMDL under development by the San Francisco Bay Water Board (San Francisco Bay Water Board 2012) that is expected to result in decreasing discharges of selenium. Nonpoint sources of selenium in the San Joaquin Valley that contribute selenium to the San Joaquin River, and thus the Delta and Suisun Bay, will be controlled through a TMDL developed by the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the Grassland Bypass Project, and Basin Plan objectives (Central Valley Water Board 2010c, d) that are expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta. If selenium levels are not sufficiently reduced via these efforts, it is expected that the State Water Board and the San Francisco Bay and Central Valley Water Boards would initiate additional actions to further control sources of selenium.

The South Delta receives elevated selenium loads from the San Joaquin River. In contrast to Suisun Bay and possibly the western Delta in the future, the South Delta lacks the overbite clam (*Corbula* [*Potamocorbula*] *amurensis*), which is considered a key driver of selenium bioaccumulation in Suisun Bay, due to its high bioaccumulation of selenium and its role in the benthic food web that includes long-lived sturgeon. The South Delta does have *Corbicula fluminea*, another bivalve that bioaccumulates selenium, but it is not as invasive as the overbite clam and thus likely makes up a smaller fraction of sturgeon diet. Also, as mentioned above, nonpoint sources of selenium in the San Joaquin Valley that contribute selenium to the Delta will be controlled through a TMDL developed by the Central Valley Water Board (2001) for the lower San Joaquin River, established limits for the Grassland Bypass Project, and Basin Plan objectives (Central Valley Water Board 2010c, d) that are expected to result in decreasing discharges of selenium from the San Joaquin River to the Delta. Further, if selenium levels in the San Joaquin River are not sufficiently reduced via these efforts, it is expected that the State Water Board and Central Valley Water Board would initiate additional TMDLs to further control nonpoint sources of selenium.

Wetland restoration areas will not be designed such that water flows in and does not flow out. Exchange of water between the restoration areas and existing Delta channels is an important design factor, since one goal of the restoration areas is to export food produced in these areas to the rest of the Delta (see BDCP Chapter 3, *Conservation Strategy*, Section 3.3, Biological Goals and Objectives). Thus, these areas can be thought of as “flow-through” systems. Consequently, although water residence times associated with BDCP restoration could increase, they are not expected to increase without bound. and selenium concentrations in the water column would not continue to build up and be recycled in sediments and organisms as may be the case within a closed system.

However, because increases in bioavailable selenium in the habitat restoration areas are uncertain, proposed avoidance and minimization measures would require evaluating risks of selenium exposure at a project level for each restoration area, minimizing to the extent practicable potential risk of additional bioaccumulation, and monitoring selenium levels in fish and/or wildlife to establish whether, or to what extent, additional bioaccumulation is occurring. See Appendix 3B, *Environmental Commitments* for a description of the environmental commitment BDCP proponents are making with respect to Selenium Management; and Appendix 3.C. of the BDCP for additional detail on this avoidance and minimization measure (AMM27). Data generated as part of the avoidance and minimization measures will assist the State and Regional Water Boards in determining whether beneficial uses are being impacted by selenium, and thus will provide the data necessary to support regulatory actions (including additional TMDL development), should such actions be warranted.

Given the factors discussed in the assessment above, any increases in bioaccumulation rates from water-borne selenium that could occur in some areas as a result of increased water residence time would not be of sufficient magnitude and geographic extent that any portion of the Delta would be expected to have measurably higher body burdens of selenium in aquatic organisms and, therefore, would not substantially increase risk for adverse effects to beneficial uses. Furthermore, although the Delta is a 303(d)-listed water body for selenium, given the discussion in the assessment above, it is unlikely that restoration areas would result in measurable increases in selenium in fish tissues or bird eggs such that the beneficial use impairment would be made discernibly worse.

Because it is unlikely that substantial increases in selenium in fish tissues or bird eggs would occur such that effects on aquatic life beneficial uses would be anticipated, and because of the avoidance and minimization measures that are designed to further minimize and evaluate the risk of such increases, the effects of WQ-26 are considered not adverse.

***CEQA Conclusion*:** There would be no substantial, long-term increase in selenium concentrations in water in the rivers and reservoirs upstream of the Delta, water in the Delta, or the waters exported to the CVP and SWP service areas due to implementation of CM2–CM22 relative to Existing Conditions. Waterborne selenium concentrations under this alternative would not exceed applicable water quality objectives/criteria.

Given the factors discussed in the assessment above, any increases in bioaccumulation rates from water-borne selenium that could occur in some areas as a result of increased water residence times would not be of sufficient magnitude and geographic extent that any portion of the Delta would be expected to have measurably higher body burdens of selenium in aquatic organisms, and therefore would not substantially increase risk for adverse effects to beneficial uses. CM2-22 would not cause long-term degradation of water quality resulting in sufficient use of available assimilative capacity such that occasionally exceeding water quality objectives/criteria would be likely. Also, CM2-22 would not result in substantially increased risk for adverse effects to any beneficial uses. Furthermore, although the Delta is a 303(d)-listed water body for selenium, given the discussion in the assessment above, it is unlikely that restoration areas would result in measurable increases in selenium in fish tissues or bird eggs such that the beneficial use impairment would be made discernibly worse.

Since it is unlikely that substantial increases in selenium in fish tissues or bird eggs would occur such that effects on aquatic life beneficial uses would be anticipated, and because of the avoidance and minimization measures that are designed to further minimize and evaluate the risk of such increases (see Appendix 3.C. of the BDCP for more detail on AMM27) as well as the Selenium Management environmental commitment (see Appendix 3B, *Environmental Commitments*), this impact is considered less than significant. No mitigation is required.

Impact WQ-27: Effects on Trace Metal Concentrations Resulting from Facilities Operations and Maintenance (CM1)

Upstream of the Delta

For the same reasons stated for the No Action Alternative, Alternative 9 would result in negligible, and likely immeasurable, increases in trace metal concentrations in the rivers and reservoirs upstream of the Delta, relative to Existing Conditions and the No Action Alternative. Effects due to the operation and maintenance of the conveyance facilities are expected to be immeasurable, on an annual and long-term average basis. As such, Alternative 9 would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or CTR criteria would be exceeded in water bodies of the affected environment located upstream of the Delta or substantially degrade the quality of these water bodies, with regard to trace metals.

Delta

For the same reasons stated for the No Action Alternative, Alternative 9 would not result in substantial increases in trace metal concentrations in the Delta relative to Existing Conditions and the No Action Alternative. However, substantial changes in source water fraction would occur in the south Delta (Appendix 8D, Source Water Fingerprinting). Throughout much of the south Delta, San Joaquin River water would replace Sacramento River water, with the future trace metals profile largely reflecting that of the San Joaquin River. As discussed for the No Action Alternative, trace metal concentration profiles between the San Joaquin and Sacramento Rivers are very similar and currently meet Basin Plan objectives and CTR criteria. While the change in trace metal concentrations in the south Delta would likely be measurable, Alternative 9 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 Delta waters with regard to trace metals.

SWP/CVP Export Service Areas

For the same reasons stated for the No Action Alternative, Alternative 9 would not result in substantial increases in trace metal concentrations in the water exported from the Delta or diverted from the Sacramento River through the proposed conveyance facilities. As such, there is not expected to be substantial changes in trace metal concentrations in the SWP/CVP export service area waters under Alternative 9, relative to Existing Conditions and the No Action Alternative. As such, Alternative 9 would not be expected to substantially increase the frequency with which applicable Basin Plan objectives or CTR criteria would be exceeded in the water bodies of the affected environment in the SWP and CVP Service Area or substantially degrade the quality of these water bodies, with regard to trace metals.

NEPA Effects: In summary, Alternative 9, relative to the No Action Alternative, would not cause a substantial increase in long-term average trace metals concentrations within the affected environment, nor would it cause an increased frequency of water quality objective/criteria exceedances within the affected environment. The effect on trace metals is determined not to be adverse.

CEQA Conclusion: Effects of CM1 on trace metals under Alternative 9 would be similar to those discussed for Alternative 1A, and are summarized here, then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion under Alternative 1A.

While greater water demands under the Alternative 9 would alter the magnitude and timing of reservoir releases north, south and east of the Delta, these activities would have no substantial effect on the various watershed sources of trace metals. Moreover, long-term average flow and trace metals at Sacramento River at Hood and San Joaquin River at Vernalis are poorly correlated; therefore, changes in river flows would not be expected to cause a substantial long-term change in trace metal concentrations upstream of the Delta.

Average and 95th percentile trace metal concentrations are very similar across the primary source waters to the Delta. Given this similarity, very large changes in source water fraction would be necessary to effect a relatively small change in trace metal concentration at a particular Delta location. Moreover, average and 95th percentile trace metal concentrations for these primary source waters are all below their respective water quality criteria, including those that are hardness-based without a WER adjustment. No mixing of these three source waters could result in a metal concentration greater than the highest source water concentration, and given that trace metals do not already exceed water quality criteria, more frequent exceedances of criteria in the Delta would not be expected to occur under the Alternative 9.

The assessment of the Alternative 9 effects on trace metals in the SWP/CVP Export Service Areas is based on assessment of changes in trace metal concentrations at Banks and Jones pumping plants. As just discussed regarding similarities in Delta source water trace metal concentrations, the Alternative 9 is not expected to result in substantial changes in trace metal concentrations in Delta waters, including Banks and Jones pumping plants, therefore effects on trace metal concentrations in the SWP/CVP Export Service Area are expected to be negligible.

Based on the above, there would be no substantial long-term increase in trace metal concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the SWP/CVP export service area waters under Alternative 9 relative to Existing Conditions. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because trace metal concentrations are not expected to increase substantially, no long-term water quality degradation for trace metals is expected to occur and, thus, no adverse effects to beneficial uses would occur. Furthermore, any negligible changes in long-term trace metal concentrations that may occur in water bodies of the affected environment would not be expected to make any existing beneficial use impairments measurably worse. The trace metals discussed in this assessment are not considered bioaccumulative, and thus would not directly cause bioaccumulative problems in aquatic life or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-28: Effects on Trace Metal Concentrations Resulting from Implementation of CM2–CM22

NEPA Effects: Conservation Measures 2–22 under Alternative 9 would be similar to those under Alternative 1A, but with changes in the south Delta to accommodate the modified corridors. Effects on trace metals resulting from the implementation of Conservation Measures 2–22 would be similar to that previously discussed for Alternative 1A. As they pertain to trace metals, implementation of CM2–CM22 would not be expected to adversely affect beneficial uses of the affected environment or substantially degrade water quality with respect to trace metals.

In summary, implementation of CM2–CM22 under Alternative 9, relative to the No Action Alternative, would have negligible, if any, effect on trace metals concentrations. The effect on trace metals from implementing CM2–CM22 is determined not to be adverse.

CEQA Conclusion: Implementation of CM2–CM22 under Alternative 9 would not cause substantial long-term increase in trace metal concentrations in the rivers and reservoirs upstream of the Delta, in the Delta Region, or the SWP/CVP export service area. As such, this alternative is not expected to cause additional exceedance of applicable water quality objectives by frequency, magnitude, and geographic extent that would cause adverse effects on any beneficial uses of waters in the affected environment. Because trace metal concentrations are not expected to increase substantially, no long-term water quality degradation for trace metals is expected to occur and, thus, no adverse effects to beneficial uses would occur. Furthermore, any negligible changes in long-term trace metal concentrations that may occur throughout the affected environment would not be expected to make any existing beneficial use impairments measurably worse. The trace metals discussed in this assessment are not considered bioaccumulative, and thus would not directly cause bioaccumulative problems in aquatic life or humans. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-29: Effects on TSS and Turbidity Resulting from Facilities Operations and Maintenance (CM1)

***NEPA Effects*:** Effects of CM1 on TSS and turbidity under Alternative 9 are the same as those discussed for Alternative 1A. The effects on TSS and turbidity from implementing CM1 is determined to not be adverse.

***CEQA Conclusion*:** Effects of CM1 on TSS and turbidity under Alternative 9 would be similar to those discussed for Alternative 1A, and are summarized here, then compared to the CEQA thresholds of significance (defined in Section 8.3.2) for the purpose of making the CEQA impact determination for this constituent. For additional details on the effects assessment findings that support this CEQA impact determination, see the effects assessment discussion under Alternative 1A.

Changes river flow rate and reservoir storage that would occur under Alternative 9, relative to Existing Conditions, would not be expected to result in a substantial adverse change in TSS concentrations and turbidity levels in the reservoirs and rivers upstream of the Delta, given that suspended sediment concentrations are more affected by season than flow. Site-specific and temporal exceptions may occur due to localized temporary construction activities, dredging activities, development, or other land use changes would be site-specific and temporal, which would be regulated to limit both their short-term and long-term effects on TSS and turbidity levels to less than substantial levels.

Within the Delta, geomorphic changes associated with sediment transport and deposition are usually gradual, occurring over years, and high storm event inflows would not be substantially affected. Thus, it is expected that the TSS concentrations and turbidity levels in the affected channels would not be substantially different from the levels under Existing Conditions. Consequently, this alternative is expected to have minimal effect on TSS concentrations and turbidity levels in the Delta region, relative to Existing Conditions.

There is not expected to be substantial, if even measurable, changes in TSS concentrations and turbidity levels in the SWP/CVP Export Service Areas waters under Alternative 9, relative to Existing Conditions, because as stated above, this alternative is not expected to result in substantial changes in TSS concentrations and turbidity levels at the south Delta export pumps, relative to Existing Conditions.

Therefore, this alternative is not expected to cause additional exceedance of applicable water quality objectives where such objectives are not exceeded under Existing Conditions. Because TSS concentrations and turbidity levels are not expected to be substantially different, long-term water quality degradation is not expected, and, thus, beneficial uses are not expected to be adversely affected. Finally, TSS and turbidity are neither bioaccumulative nor Clean Water Act section 303(d) listed constituents. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-30: Effects on TSS and Turbidity Resulting from Implementation of CM2–CM22

NEPA Effects**:** Effects of CM2–CM22 on TSS and turbidity under Alternative 9 are the same as those discussed for Alternative 1A. The effects on TSS and turbidity from implementing CM2–CM22 is determined to not be adverse.

CEQA Conclusion**:** Conservation Measures 2–22 proposed under Alternative 9 would be similar to those proposed under Alternative 1A. As such, effects on TSS and turbidity resulting from the implementation of CM2–CM22 would be similar to that previously discussed for Alternative 1A. This impact is considered to be less than significant. No mitigation is required.

Impact WQ-31: Water Quality Effects Resulting from Construction-Related Activities (CM1–CM22)

The construction activities necessary to implement new conveyance features for CM1 under Alternative 9 would involve substantially different locations and types of construction activity to those discussed for Alternative 1A. In particular, the construction of permanent operable gates, locks, new levees, channel improvements and enlargement within Delta channels would involve considerable in-channel dredging and in-water facility construction activity. However, construction techniques for many features of the conveyance system within the Delta would be similar. Landside construction of water conveyance facilities under Alternative 9 would involve an array of intakes, pumping plants, pipelines, culvert siphons, canals, borrow areas, and other facilities. The remainder of the facilities constructed under Alternative 9, including CM2–CM22, would be very similar to, or the same as, those to be constructed for Alternative 1A.

NEPA Effects**:** The types of potential construction-related materials used, constituent discharges, and related water quality effects associated with implementation of CM1 under Alternative 9 would be similar to the effects discussed for Alternative 1A, and the effects anticipated with implementation of CM2–CM22 would be essentially identical. However, given the substantial differences in the conveyance features under CM1, there could be differences in the location, magnitude, duration, and frequency of construction activities and related water quality effects. In particular, relative to the Existing Conditions and No Action Alternative conditions, the extensive in-water dredging, and construction of channel enlargements, operable barriers, culvert siphons, and canal segments under Alternative 9 would result in potential direct turbidity discharges and sediment resuspension. Nevertheless, the construction of CM1, and any individual components necessitated by CM2, and CM4–CM10, with the implementation of the BMPs specified in Appendix 3B*, Environmental Commitments,* and other agency permitted construction requirements would result in the potential water quality effects being largely avoided and minimized. The specific environmental commitments that would be implemented under Alternative 9 would be similar to those described for Alternative 1A with the exception that Category "B" BMPs for RTM dewatering basin construction and operations, if necessary at all, would be much reduced. Moreover, the in-channel construction activities would result in Consequently, relative to Existing Conditions, Alternative 9 would not be expected to cause exceedance of applicable water quality objectives/criteria or substantial degradation with respect to constituents of concern, and thus would not adversely affect any beneficial uses upstream of the Delta, in the Delta, or in the SWP and CVP service area.

In summary, with implementation of environmental commitments in Appendix 3B, the potential construction-related water quality effects are considered to be not adverse.

CEQA Conclusion: Because environmental commitments would be implemented under Alternative 9 for construction-related activities along with agency-issued permits that also contain construction requirements to protect water quality, the construction-related effects, relative to Existing Conditions, would not be expected to cause or contribute to substantial alteration of existing drainage patterns which would result in substantial erosion or siltation on- or off-site, substantial increased frequency of exceedances of water quality objectives/criteria, or substantially degrade water quality with respect to the constituents of concern on a long-term average basis, and thus would not adversely affect any beneficial uses in water bodies upstream of the Delta, within the Delta, or in the SWP and CVP service area. Moreover, because the construction-related activities would be temporary and intermittent in nature, the construction would involve negligible discharges, if any, of bioaccumulative or 303(d) listed constituents to water bodies of the affected environment. As such, construction activities would not contribute measurably to bioaccumulation of contaminants in organisms or humans or cause 303(d) impairments to be discernibly worse. Based on these findings, this impact is determined to be less than significant. No mitigation is required.

Cumulative Analysis

The cumulative effects analysis for water quality considers past, present, and reasonably foreseeable projects or programs, as well as these in combination with the effects of BDCP implementation. This assessment discusses only water quality constituents which could result, in part, from construction and implementation of the BDCP. Constituents or constituent groups which could not be affected by the BDCP are identified and addressed in the water quality Screening Analysis presented in Appendix 8C. The majority of the constituents assessed in the Screening Analysis have not been detected in the major source waters to the Delta, and others that have been detected have generally not exceeded water quality objectives/criteria or would not be affected by construction and implementation of the BDCP. Consequently, they are not specifically addressed in this cumulative assessment. For a discussion of cumulative effects related to water temperature, see Chapter 11, *Fish and Aquatic Resources*.

No Action Alternative

The cumulative effect of the No Action Alternative is as follows. Water quality conditions upstream of the Delta, in the Delta Region, and in the SWP/CVP export service areas of the affected environment are expected to change as a result of past, present, and reasonably foreseeable future projects, population growth, climate change, and changes in water quality regulations (e.g., completion of TMDLs, adoption of new or more restrictive criteria/objectives). Many past, present, and reasonably foreseeable future projects are identified and described in Appendix 3D, and specific projects or regulatory programs that are either ongoing or proposed for future implementation, and thus, could affect future cumulative water quality conditions, are listed in Table 8-73. The combined water quality effects of projects considered in the cumulative condition will vary, including potential contribution to the degradation of various water quality parameters, whereas others will function to improve constituent-specific water quality in certain areas. Future population growth may produce increased constituent loadings to the water bodies of the affected environment through increased urban stormwater runoff, increased POTW discharges, and changes in land uses. Climate change is anticipated to cause salinity increases in the western and southern Delta due to sea level rise. This is evidenced by the increase in violations of the D-1641 salinity standard in the Sacramento River at Emmaton under the No Action Alternative, relative to Existing Conditions, as described in section 8.3.3.1 above. Conversely, changes in water quality regulations generally are in a direction that results in improvements in water quality (e.g., increased monitoring and restrictions on urban stormwater runoff, completion of TMDLs to lessen or eliminate existing beneficial use impairments through improved water quality, more restrictive regulations on POTW discharges, new and/or more restrictive water quality criteria/objectives in Basin Plans).

Some water quality constituents are at levels under Existing Conditions that cause some impact to beneficial uses. These include:

- Bromide
- Chloride
- Electrical Conductivity
- Mercury
- Organic Carbon
- Pesticides and Herbicides
- Selenium

Under the cumulative No Action Alternative, even with consideration of the factors that will affect water quality discussed above, these constituents are expected to remain at levels that cause some impact to beneficial uses. Thus, for the purposes of NEPA, water quality conditions for these constituents under the cumulative No Action Alternative constitute an adverse environmental condition. The cumulative effect of the No Action Alternative for all other water quality constituents is not adverse.

Although the constituents listed above are at levels under Existing Conditions that cause some impact to beneficial uses, the only constituent for which the cumulative effects of the No Action Alternative are expected to adversely affect beneficial uses, relative to Existing Conditions, is electrical conductivity, due to the effects of climate change and sea level rise. Thus, for the purposes of CEQA, water quality conditions for electrical conductivity under the cumulative No Action Alternative constitute a significant environmental condition. The cumulative effect of the No Action Alternative for all other water quality constituents is less than significant, relative to Existing Conditions.

Table 8-73. Effects on Water Quality from the Programs, Projects, and Policies Considered for Cumulative Analysis

Agency	Program/Project	Status	Description of Program/Project	Effects on Water Quality
Regulatory-, Discharge-, and Source Control-related Actions				
Sacramento Regional County Sanitation District	SRWTP Facility Upgrade Project	Proposed	Upgrade existing secondary treatment facilities to advanced unit processes including improved nitrification/denitrification and filtration.	Reduced discharge concentration and mass of many constituents in wastewater to Sacramento River.
Sacramento County, Sacramento, Citrus Heights, Elk Grove, Folsom, Galt, and Rancho Cordova	Sacramento Stormwater Quality Partnership	Ongoing and future actions	Development and implementation of federal stormwater compliance programs	Reduced discharge concentration and mass of many constituents in stormwater to Sacramento River.
San Joaquin County, Stockton, Tracy, and the State Water Resources Control Board	San Joaquin County, Stockton, and Tracy Stormwater Management Programs	Ongoing and future actions	Development and implementation of federal stormwater compliance programs	Reduced discharge concentration and mass of many constituents in stormwater to San Joaquin River.
Yolo County, Public Works Division	Yolo County Stormwater Management Program	Ongoing and future actions	Development and implementation of federal stormwater compliance programs	Reduced discharge concentration and mass of many constituents in stormwater to Yolo Bypass.
Central Valley Water Board	Irrigated Lands Regulatory Program	Ongoing and future actions	Prevent agricultural discharges from impairing the waters that receive runoff.	Reduced discharge concentration and mass of many constituents in agricultural drainage to the Delta and tributaries.
U.S. Bureau of Reclamation and San Luis & Delta Mendota Water Authority	Grassland Bypass Project, 2010-2019	Ongoing and future actions	Agricultural drainage management actions to reduce selenium discharges.	Goal is regulatory compliance for reduced selenium discharges to San Joaquin River.
U.S. Bureau of Reclamation and San Luis & Delta Mendota Water Authority	Agricultural Drainage Selenium Management Program Plan	Ongoing and future actions	Agricultural drainage management actions to reduce selenium discharges.	Goal is regulatory compliance for reduced selenium discharges to San Joaquin River.
California Department of Water Resources and U.S. Bureau of Reclamation	Franks Tract Project	Proposed	Proposed operable gates to control channel flows at key locations to reduce sea water intrusion.	Goal is reduced western Delta salinity.
Central Valley Water Board	Sacramento-San Joaquin Delta Estuary TMDL for Methylmercury	Ongoing and future actions	Regulatory and implementation actions to achieve compliance with water quality objectives.	Goal is reduced source loading of mercury and methylmercury formation.

Agency	Program/Project	Status	Description of Program/Project	Effects on Water Quality
Central Valley Water Board	Total Maximum Daily Load for Selenium in the Lower San Joaquin River	Ongoing and future actions	Regulatory and implementation actions to achieve compliance with water quality objectives.	Goal is reduced source loading of selenium.
Central Valley Water Board	San Joaquin River Selenium TMDL	Ongoing and future actions	Regulatory and implementation actions to achieve compliance with water quality objectives.	Goal is reduced source loading of selenium.
Central Valley Water Board	Central Valley Pesticide TMDL	Ongoing and future actions	Regulatory and implementation actions to achieve compliance with water quality objectives.	Goal is reduced source loading of pesticides.
Central Valley Water Board	Salt and Boron TMDL for the Lower San Joaquin River	Ongoing and future actions	Regulatory and implementation actions to achieve compliance with water quality objectives.	Goal is reduced source loading of salts and boron.
Central Valley Water Board	Cache Creek, Bear Creek, Sulphur Creek, and Harley Gulch TMDL for Mercury	Ongoing and future actions	Regulatory and implementation actions to achieve compliance with water quality objectives.	Goal is reduced source loading of mercury and methylmercury formation.
Central Valley Water Board	Clear Lake Mercury TMDL	Ongoing and future actions	Regulatory and implementation actions to achieve compliance with water quality objectives.	Goal is reduced source loading of mercury and methylmercury formation.
Central Valley Water Board	American River TMDL for Methylmercury	Ongoing and future actions	Regulatory and implementation actions to achieve compliance with water quality objectives.	Goal is reduced source loading of mercury and methylmercury formation.
Central Valley Water Board	Central Valley Organochlorine Pesticide TMDL	Ongoing and future actions	Regulatory and implementation actions to achieve compliance with water quality objectives.	Goal is reduced source loading of legacy organochlorine pesticides.
Central Valley Water Board	Central Valley Diuron TMDL	Ongoing and future actions	Regulatory and implementation actions to achieve compliance with water quality objectives.	Goal is reduced source loading of diruon pesticide.
Central Valley Water Board	Central Valley Pyrethroid Pesticides TMDL	Ongoing and future actions	Regulatory and implementation actions to achieve compliance with water quality objectives.	Goal is reduced source loading of pyrethroid pesticides.
Central Valley Water Board	Stockton Urban Waterbodies Pathogen TMDL	Ongoing and future actions	Regulatory and implementation actions to achieve compliance with water quality objectives.	Goal is reduced source loading of pathogens in urban stormwater runoff.

Agency	Program/Project	Status	Description of Program/Project	Effects on Water Quality
U.S. Bureau of Reclamation, U.S. Fish and Wildlife Service, and California Department of Water Resources	Biological Opinion on the Long-Term Operations of the Central Valley Project and State Water Project (Delta smelt)	Ongoing and future actions	Regulatory program and actions for CVP/SWP water supply operations for recovery of Delta smelt population. Actions include habitat, flow, and water quality management.	Actions may affect seasonal and long-term Delta water quality conditions.
U.S. Department of Commerce, National Marine Fisheries Service, U.S. Bureau of Reclamation, and California Department of Water Resources	Biological Opinion and Conference Opinion on the Long-Term Operations of the Central Valley Project and State Water Project	Ongoing and future actions	Regulatory program and actions for CVP/SWP water supply operations for recovery of special-status anadromous fish. Actions include habitat, flow, and water quality management.	Actions may affect seasonal and long-term Delta water quality conditions.
Restoration Actions				
California Department of Fish and Wildlife	Ecosystem Restoration Program Conservation Strategy		Actions to address the critical environmental conditions in the Delta and Suisun Marsh/Bay including Delta flows and habitat restoration.	Changes in tidal prism and salinity patterns; potential incremental increase methylmercury formation and contribution to Delta load.
California Department of Fish and Wildlife, U.S. Fish and Wildlife Service, U.S. Bureau of Reclamation, and Suisun Marsh Charter Group	Suisun Marsh Habitat Management, Preservation, and Restoration Plan	Ongoing	Seasonal wetland and tidal marsh restoration actions in Suisun Marsh.	Changes in tidal prism and salinity patterns; potential incremental increase methylmercury formation and contribution to Delta load.
California Department of Water Resources	Dutch Slough Tidal Marsh Restoration Project	Future	Seasonal wetland and tidal marsh restoration actions in western Delta.	Changes in tidal prism and salinity patterns; potential incremental increase methylmercury formation and contribution to Delta load.
California Department of Water Resources and Department of Fish and Wildlife	Cache Slough Area Restoration	Ongoing and future actions	Enhancement and restoration of existing and potential open water, marsh, floodplain and riparian habitat in northern Delta.	Changes in tidal prism and salinity patterns; potential incremental increase methylmercury formation and contribution to Delta load.
Reclamation District 2093	Liberty Island Conservation Bank	Future	Tidal marsh restoration project in northern Delta.	Changes in tidal prism and salinity patterns; potential incremental increase methylmercury formation and contribution to Delta load.

Alternatives 1A through 9

When the effects of the BDCP alternatives on water quality are considered in connection with the potential effects of projects listed in Appendix 3D, *Ongoing Programs, Projects, and Policies included in the Cumulative Impact Assessment for the BDCP EIR/EIS* and Attachment A of Appendix 3A, *Alternatives Development Report*, the potential effects range from beneficial to potentially adverse cumulative effects on water quality, depending upon water quality constituent/parameter and location. This cumulative analysis thus follows the list approach outlined in CEQA guidelines 15130(b)(1), the list including the defined past, present, and foreseeable actions in Appendix 3D, and in particular the future potential actions listed in Table 8-73. If the cumulative water quality condition (which includes implementation of the BDCP along with past, present, and reasonably foreseeable future projects, population growth, climate change, and changes in water quality regulations) for a constituent or group of constituents within a defined region of the affected environment is determined not to be adverse for the purposes of NEPA compliance (or significant under CEQA), then no further assessment is conducted. No further assessment is conducted because a cumulative condition that is non-adverse (NEPA terminology), or less than significant (CEQA terminology), demonstrates that the BDCP alternative would not have adverse effects that are individually minor but that would "cumulate" or "be additive" with those of other past, present, and reasonably foreseeable projects to result in an adverse cumulative effect.

Conversely, if the cumulative water quality condition for a particular constituent is determined to be adverse for NEPA purposes or significant for CEQA purposes, then further assessment is conducted.

For compliance with the CEQA Guidelines (Section 15130), further assessment is provided to determine if implementation of the BDCP alternatives would contribute considerably to that significantly impacted cumulative condition. If a BDCP alternative's implementation would not contribute considerably to the significantly impacted cumulative water quality condition identified, then no further mitigation is required. However, if a BDCP alternative's implementation would contribute considerably to the significantly impacted cumulative water quality condition identified, then mitigation for the BDCP alternative's cumulatively considerable contribution to the identified significantly impacted cumulative water quality condition is proposed (if any is at least potentially feasible).

For the purposes of NEPA compliance, the context and intensity of the potential BDCP-related contribution to any adverse cumulative condition is evaluated and mitigation measures are identified that would reduce or minimize the BDCP alternative's contribution to the cumulative impact.

The potential for cumulative impacts on water quality for Alternatives 1A through 9 is assessed for: 1) construction-related activities, 2) facilities operations and maintenance (CM1), and 3) implementation of CM2–CM22 for the same geographic scope (Affected Environment) as done for analyses contained within the Effects and Mitigation Approaches section. Each BDCP alternative is assessed under each of these three impact assessment categories. Effects are specifically discussed by region of the affected environment (i.e., Upstream of the Delta, Delta Region, and SWP/CVP Export Service Areas) and by constituent or constituent groups. Individual discussions for specific action alternatives are provided only if the anticipated effects under one or more action alternatives can be meaningfully distinguished from the effects anticipated under other alternatives. If the contributions of the various action alternatives to a cumulative condition cannot be readily distinguished from one another, then a single assessment that addresses all BDCP alternatives is provided.

Cumulative Impact WQ-1: Cumulative Impacts on Water Quality Resulting from Construction-Related Activities Upstream of the Delta

Construction activities upstream of the Delta would be tied to conservation measures. Conservation measures or components of these measures that would be constructed in areas upstream of the Delta would be: 1) the Yolo Bypass Fishery Enhancement (CM2) (i.e., the Fremont Weir component of the action), 2) Conservation Hatcheries (CM18) (i.e., the new hatchery facility), and 3) Urban Stormwater Treatment (CM19). Neither the construction to be undertaken nor the techniques and conservation measures to be employed upstream of the Delta would differ sufficiently among alternatives to warrant separate alternative-specific discussions here. Hence, Alternatives 1A–9 will be discussed collectively in this cumulative assessment. Construction of individual components necessitated by CM2, CM18, and CM19 could involve site preparation and earthwork adjacent to water bodies of the affected environment. If so, their construction also would include water quality protection actions in the form of Environmental Commitments (Appendix 3B) and related water quality protection actions issued in agency permits required for construction and operation of facilities. Such actions would include SWPPPs that would minimize erosion of soils into water bodies and would minimize/eliminate the direct spilling of earthmoving equipment fuels, oils, and other construction materials into water bodies, thus minimizing any effects on water quality in adjacent water bodies. Other water quality protection actions issued in agency permits would include those in the State Water Board's NPDES Stormwater General Permit for Stormwater Discharges Associated with Construction and Land Disturbance Activities (Order No. 2009-0009-DWQ/NPDES Permit No. CAS000002), project-specific WDRs or CWA Section 401 water quality certification from the appropriate Central Valley Water Board, CDFW Streambed Alteration Agreements, and USACE CWA Section 404 dredge and fill permits. Thus, construction activities associated with Alternatives 1A through 9 would not contribute considerably to any adverse cumulative water quality condition upstream of the Delta, nor would construction-related effects make an otherwise non-adverse cumulative water quality condition adverse in this region.

Delta

For Alternatives 1A through 9, the construction of new conveyance facilities (CM1) and construction associated with implementing CM2–CM22, particularly CM2–CM10, could result in substantial adverse water quality effects associated with turbidity/TSS due to the erosion of disturbed soils and associated sedimentation entering Delta waterways or other construction-related wastes (e.g., concrete, asphalt, cleaning agents, paint, and trash). In addition, the use of heavy earthmoving equipment adjacent to Delta waterways may result in spills and leakage of oils, gasoline, diesel fuel, and related petroleum contaminants used in the fueling and operation of such construction equipment. The extensive construction activities that will be necessary to implement CM 1, and 4-10 would involve a variety of land disturbances in the Delta including vegetation removal; grading and excavation of soils; establishment of roads-bridges, staging, and storage areas; in-water sediment dredging and dredge material storage; and hauling and placement or disposal of excavated soils and dredge materials. Although the number of intakes to be constructed, pipeline alignments and other construction aspects vary among the alternatives, all alternatives involve sufficient construction activities that, if conducted improperly, could adversely affect Delta water quality. Although alternatives having greater number of intakes and greater construction activities pose a greater overall potential to adversely affected water quality, adverse water quality effects for all alternatives will be avoided or reduced to less than substantial levels in the same manner, which is by implementing proper conservation measures and obtaining and abiding by agency-issued permits need for construction activities (e.g., State Water Board's NPDES Stormwater General Permit for

Stormwater Discharges Associated with Construction and Land Disturbance Activities (Order No. 2009-0009-DWQ/NPDES Permit No. CAS000002), possibly project-specific WDRs, CWA Section 401 water quality certification from the appropriate Central Valley Water Board, CDFW Streambed Alteration Agreements, and USACE CWA Section 404 dredge and fill permits.) Because of this commonality among alternatives regarding potential for construction-related water quality effects, and the common means of avoiding or reducing such effects, Alternatives 1A–9 are assessed collectively rather than individually.

As stated in Section 8.3 (*Water Quality Environmental Consequences*), the implementation of construction-related Environmental Commitments (Appendix 3B) and abiding by agency-issued permits need for construction activities would reduce potential construction-related water quality impacts in the Delta to less-than-significant levels. Moreover, the cumulative condition for turbidity/TSS and petroleum contaminants in Delta waters are not expected to be adverse. This is due, in large part, to the implementation (or planned implementation) of construction-related Environmental Commitments (Appendix 3B) and agency permitted construction "best management practices" for construction of not only the selected BDCP alternative (including its CMs), but also other past, present, and reasonably foreseeable future projects. Because construction-related effects on all water quality constituents/parameters would be minimized through BDCP Environmental Commitments (Appendix 3B) and permitted construction "best management practices" in the agency-issued permits discussed above, construction activities associated with Alternatives 1A through 9 would not contribute considerably to any adverse cumulative water quality condition in the Delta, nor would construction-related effects make an otherwise non-adverse cumulative water quality condition adverse.

SWP/CVP Export Service Areas

Because construction-related activities associated with Alternatives 1A through 9 are not expected to contribute considerably to any adverse cumulative Delta water quality condition, including conditions at the Banks and Jones pumping plants, which are the primary locations of water export to the SWP/CVP Export Service Areas, the construction of these alternatives would not contribute considerably to any adverse cumulative water quality condition in water bodies located in the SWP/CVP Export Service Areas.

***NEPA Effects*:** Alternatives 1A–9 involve minimal construction elements upstream of the Delta and would include implementation of construction-related Environmental Commitments (Appendix 3B) that would mitigate any temporary construction-related effects on water quality. Thus their construction would not adversely affect any cumulative water quality constituent/parameter condition upstream of the Delta. Construction of conveyance facilities and CMs for the selected BDCP alternative could potentially result in temporary water quality effects on Delta turbidity/TSS levels and petroleum contaminants. However, the cumulative condition for Delta turbidity/TSS and petroleum contaminants would not be adverse for several reasons. First, there is currently no adverse conditions for turbidity/TSS levels and petroleum contaminants in the Delta. Second, implementation of construction-related Environmental Commitments (Appendix 3B) for the BDCP alternative to be implemented and use of related construction BMPs for other projects would reduce effects on these and other Delta water quality constituents/parameters. Third, because construction-related effects on water quality are temporary in nature, they tend not to be cumulative over time (i.e., construction effects on water quality are not permanent).

CEQA Conclusion. The temporary construction-related effects on water quality resulting from constructing the selected BDCP alternative, including its CMs, would not contribute considerably to any significant adverse cumulative Delta water quality condition, nor would construction-related effects make an otherwise non-adverse cumulative Delta water quality condition for any constituent/parameter potentially significant. Because construction-related activities are not expected to contribute considerably to any adverse cumulative Delta water quality condition, they also would not contribute considerably to any adverse cumulative water quality condition in water bodies located in the SWP/CVP Export Service Areas. No mitigation is required.

Cumulative Impact WQ-2: Cumulative Impacts on Water Quality Upstream of the Delta Resulting from Facilities Operations and Maintenance (CM1) and Implementation of Conservation Measures 2–22

Constituent loading from upstream watersheds and resultant concentrations/levels in the water bodies upstream of the Delta would remain unchanged, or would be negligibly affected, by implementation of facilities operations and maintenance (CM1) under Alternatives 1A–9. Changes in seasonal reservoir storage levels and river flows from altered system-wide operations under Alternatives 1A–9 would have negligible, if any, effects on water quality in the rivers and reservoirs upstream of the Delta. Consequently, facilities operations and maintenance (CM1) under any of the Alternatives 1A–9 would not be expected to contribute considerably to any cumulative water quality condition within the affected environment, upstream of the Delta.

Regarding CM2–CM22, the measures or components of these measures that would be implemented in areas upstream of the Delta would be: 1) the Yolo Bypass Fishery Enhancement (CM2), 2) Conservation Hatcheries (CM18), and 3) Urban Stormwater Treatment (CM19). CM2 is a fish enhancement measure and, thus, is not expected to alter water quality upstream of the Delta. CM18 involves the operation of a new fish hatchery, discharges from which would be required to meet NPDES permit requirements to protect water quality and beneficial uses. CM19 may involve actions to improve stormwater quality coming from urban areas outside the Delta, but that drain to Delta waters, and would result in either no effect or beneficial effects on water quality upstream of the Delta. All other conservation measures would be implemented in the Delta region. Maintenance activities associated with the physical structures would not result in substantial, adverse effects on water quality. Consequently, the implementation of CM2–CM22 is not expected to contribute considerably to any cumulative water quality condition within the affected environment, upstream of the Delta.

NEPA Effects**:** Implementation of BDCP Alternatives 1A–9 facilities operations and maintenance (CM1), and their associated CM2–CM22, would have negligible, if any, water quality effects on water bodies of the affected environment located upstream of the Delta. Any negligible effects that may occur would not contribute considerably to any adverse cumulative water quality condition in water bodies upstream of the Delta, nor would Alternatives 1A–9 effects make an otherwise non-adverse cumulative water quality condition for any constituent/parameter adverse.

CEQA Conclusion. Because the potential effects of operations and maintenance of CM1–CM22 on water quality upstream of the Delta would be minimal, implementation of Alternatives 1A-9 would not contribute considerably to any significant adverse cumulative water quality condition upstream of the Delta, No mitigation is required.

Cumulative Impact WQ-3: Cumulative Impacts on Water Quality in the Delta and SWP/CVP Export Service Areas Resulting from Facilities Operations and Maintenance (CM1) and Implementation of Conservation Measures 2–22

When the effects of implementing any one of the BDCP Alternatives 1A–9 on water quality are considered (including the new conveyance facilities, fish screens, gates and other physical structures and their operations and maintenance activities) together with the potential effects of projects listed in Appendix 3D (and Table 8-73), *Defining Existing Conditions, No Action Alternative, No Project Alternative, and Cumulative Impact Conditions*, the cumulative water quality condition in the Delta Region and SWP/CVP Export Service Areas for the following constituents is considered to not be adverse. Additional discussion for these water quality constituents is provided below.

- Ammonia
- Boron
- Dissolved oxygen
- Nitrate + Nitrite
- Pathogens
- Phosphorus
- Trace metals
- Turbidity/TSS

Ammonia

Ammonia levels are not expected to be adverse under the cumulative condition as a result of the Sacramento Regional Wastewater Treatment Plant, and other publicly owned treatment works (POTWs) that discharge to the Delta, nitrifying their effluent that is discharged to Delta tributaries and waters.

Boron

The lower San Joaquin River is listed on the State's CWA section 303(d) list of impaired water bodies for salt and boron (State Water Resources Control Board 2011). Boron is paired with salt in this listing due to its regular association with saline waters. The Central Valley Water Board has prepared a TMDL with an implementation program where it is expected that actions taken to control salts also will control boron as well (Central Valley Water Board 2004). With regulatory actions being taken to improve boron concentrations (and salinity in general on the San Joaquin River), the cumulative condition for boron is considered to not be adverse.

Dissolved Oxygen

Dissolved oxygen throughout the Delta is generally suitable for beneficial use protection, with the notable exception of the Stockton Deep Water Ship Channel. The TMDL for dissolved oxygen as well as CM14 (Stockton Deep Water Ship Channel DO improvement) of the BDCP is expected to further improve DO levels in the future. Thus, dissolved oxygen levels under the cumulative condition are not expected to be adverse.

Nitrate/Nitrite

Similar to ammonia levels, nitrate/nitrite levels in the Delta may be reduced in the future as Sacramento Regional Wastewater Treatment Plant and other POTWs discharging to Delta waters implement de-nitrification processes. The Central Valley Water Board is currently permitting such requirements with regularity and thus notable reductions in POTW-related nitrate/nitrite discharges are expected in the future, and other new or greater sources are not anticipated that would offset such point-source reductions. Thus, nitrate/nitrite levels under the cumulative condition are not expected to be adverse.

Pathogens

Similarly, increasingly stringent state regulations on both POTWs and urban runoff through the NPDES program is anticipated to reduce pathogen loading to Delta waters from these sources. As discussed in the project-specific analyses of alternatives, pathogen levels in the Delta are most affected by local factors, primarily local land uses and associated runoff from such lands. Conversion of Delta agricultural lands to tidal wetlands under the action alternatives may alter levels of coliforms and *E. coli* (either up or down), but would be expected to reduce loading of *Cryptosporidium*. Moreover, increased municipal wastewater discharges resulting from future population growth would not be expected to measurably increase pathogen concentrations in receiving waters due to State and Federal water quality regulations requiring disinfection of effluent discharges and the State's implementation of Title 22 filtration requirements for many wastewater dischargers in the Sacramento River and San Joaquin River watersheds. Municipal stormwater regulations and permits have become increasingly stringent in recent years, and such further regulation of urban stormwater runoff is expected to continue in the future. Implementation of BDCP CM19 (Urban Stormwater Treatment) also may reduce pathogen loading to Delta waters. The ability of these BMPs to consistently reduce pathogen loadings and the extent of future implementation is uncertain, but would be expected to improve as new technologies are continually tested and implemented. Also, some of the urbanization may occur on lands used by other pathogens sources, such as grazing lands, resulting in a change in pathogen source, but not necessarily an increase (and possibly a decrease) in pathogen loading. In sum, Delta pathogen levels are not anticipated to be adverse under the cumulative condition.

Phosphorus

Primary sources of phosphorus to Delta waters include agriculture, municipal POTWs, individual septic treatment systems, urban runoff, stream bank erosion, and decaying plant material. Currently, Delta phosphorous levels are not of substantial concern to state water quality regulatory agencies, nor is there clear evidence that phosphorous levels are adversely affecting Delta beneficial uses. Due to increased regulations and regulatory monitoring anticipated in the future, which may include water quality objectives for phosphorus at some point in the future, loading from agriculture, municipal POTWs, individual septic treatment systems, and urban runoff are all expected to remain at similar levels to that under current conditions, or decline, under the future cumulative condition. Loadings from stream bank erosion and decaying plants are not expected to change notably in the future. Hence, phosphorus levels are not anticipated to be adverse under the cumulative condition.

Trace Metals

Primary sources of trace metals to Delta waters include acid mine drainage (e.g., zinc, cadmium, copper, lead) from abandoned and inactive mines (i.e., Iron Mountain and Spring Creek mines) in the

Shasta watershed area, which enter the Sacramento River system through Shasta Lake and Keswick Reservoir, agriculture (e.g., copper and zinc), POTW discharges (e.g., copper, zinc, and aluminum), and urban runoff (e.g., zinc, copper, lead, cadmium). Continued efforts to control acid mine drainage into the Sacramento River system and increasingly stringent regulations are expected in the future. Monitoring and regulatory controls on agricultural runoff, POTW discharges, and urban runoff are anticipated to prevent trace metal concentration under the cumulative condition from becoming adverse.

Turbidity/TSS

Future land use changes could have minor effects on TSS concentrations and turbidity levels throughout the affected environment. Site-specific and temporal exceptions may occur due to localized temporary construction activities, dredging activities, development, or other land use changes. These localized actions would generally require agency permits that would regulate and limit both their short-term and long-term effects on TSS concentrations and turbidity levels to less-than substantial levels. Construction activities are closely regulated under construction NPDES permits, which require the preparation of SWPPPs and the implementation of agency permitted construction BMPs that will minimize sedimentation into adjacent water bodies which would, in turn, increase turbidity/TSS. Moreover, construction projects are short-term in nature and thus their effects on turbidity/TSS tend not to be additive among multiple construction activities over time. Consequently, Delta turbidity/TSS levels under the cumulative condition are not expected to be adverse.

Because the cumulative water quality condition in the Delta for the constituents discussed above are considered to not be adverse in the Delta when considering all past, present, and reasonably foreseeable projects and regulatory actions, and because this cumulative condition includes the anticipated effects of implementing the facilities operations and maintenance (CM1) of any one of the BDCP Alternatives 1A–9, along with their associated CM2–CM22, none of these alternatives would contribute to an adverse cumulative condition for these constituents either in the Delta Region or the SWP/CVP Export Service Areas.

Cumulative water quality conditions for the constituents listed below are considered to be adverse, or have reasonable potential to be adverse, in portions of the Delta. Adverse cumulative water quality conditions for these constituents are expected when the effects of implementing any one of the BDCP Alternatives 1A–9 on water quality are considered (including the new conveyance facilities, fish screens, gates and other physical structures and their operations and maintenance activities) together with the effects of past, present, and reasonably foreseeable projects, including those listed in Appendix 3D, *Defining Existing Conditions, No Action Alternative, No Project Alternative, and Cumulative Impact Conditions*.

- Bromide
- Chloride
- Electrical Conductivity
- Mercury
- Organic Carbon
- Pesticides and Herbicides
- Selenium

Each of the constituents listed above, for which the cumulative Delta conditions are determined to be adverse, or potentially adverse, are discussed further below to determine whether implementation of the BDCP Alternatives 1A–9 would contribute considerably to these adverse cumulative water quality conditions.

Bromide

The cumulative condition for bromide is considered adverse in the Delta, because of marked increases in bromide concentrations anticipated to occur in the northwest Delta, including at the North Bay Aqueduct intake at Barker Slough. Alternatives 1A–6 and 9 would increase long-term average bromide concentrations at Barker Slough to levels substantially higher than those under Existing Conditions. Alternative 7 would not increase the long-term average bromide concentration at this location, and Alternative 8 would only increase it slightly. However, all alternatives would increase the drought period average bromide concentration at Barker Slough substantially, relative to concentrations during the drought period analyzed under Existing Conditions (Appendix 8E, Bromide). Increased levels would not occur in the SWP/CVP Export Service Areas south of the Delta due to greater source fraction of Sacramento River water on an annual average basis at the south Delta pumps under all alternatives. Based on their causing substantially increased average bromide concentrations at Barker Slough in the northwest Delta on a long-term average basis and/or during drought periods, implementation of facilities operations and maintenance (CM1) under Alternatives 1A–9 would contribute substantially to this adverse cumulative condition for bromide. Implementation of CM2–CM22 would not contribute substantially to this adverse cumulative condition.

Chloride

The cumulative condition for chloride is considered adverse in the Delta, because of marked increases in chloride concentrations anticipated to occur in the western Delta, including Suisun Marsh, and the interior Delta, but not in the SWP/CVP Export Service Areas south of the Delta due to greater source fraction of Sacramento River water on an annual average basis at the south Delta pumps under all alternatives. Alternatives 1A–5 and 9 would substantially increase chloride levels in Suisun Marsh relative to Existing Conditions, primarily during the October through May period, whereas alternatives 6A–8 would result in somewhat lesser (but still substantial) increases in Suisun Marsh. With regards to the frequency of exceeding the 150 mg/L Bay-Delta WQCP objective at Antioch and Contra Costa Canal Pumping Plant #1, Alternatives 1A–9 would result in a substantial increase in the frequency of objective exceedance. With regards to the frequency of exceeding the 250 mg/l chloride objective at Antioch, Alternatives 1A–5 would result in a substantial increase in the frequency of exceeding this objective, relative to Existing Conditions, whereas Alternative 9 would cause only a minor increase in frequency of exceedance and Alternatives 6A–8 would result in a reduction in frequency of exceeding the 250 mg/L chloride objective (Appendix 8G, *Chloride*). Hence, based on their respective effects on increased chloride levels in Suisun Marsh and increased frequency of exceeding Bay-Delta WQCP objectives at Antioch and Contra Costa Canal Pumping Plant #1, implementation of facilities operations and maintenance (CM1) under Alternatives 1A–9 would contribute substantially to this adverse cumulative condition for chloride. Additionally, implementation of tidal habitat restoration under CM4 would increase the tidal exchange volume in the Delta, and thus may contribute to increased chloride concentrations in the Bay source water as a result of increased salinity intrusion. As such, CM4 is expected to contribute to this adverse cumulative condition. Implementation of CM2, CM3, and CM5–CM22 would not contribute substantially to this adverse cumulative condition.

Electrical Conductivity

The cumulative condition for EC is considered to be adverse, at various Delta locations and Suisun Marsh, depending on BDCP alternative implemented. EC levels at the south Delta export pumps would improve under all alternatives and thus the cumulative EC condition at the export pumps would not be adverse. As such, cumulative EC levels in the SWP/CVP Export Service Areas would not be adverse. Alternatives 1A–5 and 9 would substantially increase EC levels in Suisun Marsh relative to Existing Conditions, primarily during the October through May period, whereas Alternatives 6A–8 would result in somewhat lesser (but still substantial) increases in Suisun Marsh. Moreover, in the central Delta at Prisoner's Point, Alternatives 2A–C, 4 (including all operational scenarios H1 through H4), and 6A–8 would result in substantially increased frequency of exceedance of the EC objective, whereas Alternative 5 would cause a lesser increase in frequency of exceedance, and Alternatives 1A–C, 3, and 9 would have little to no effect on frequency of exceedance of the EC objective at Prisoner's Point (Appendix 8H). Based on their adverse effects on EC levels in Suisun Marsh as well as adverse effects in the western, interior, and/or south Delta, Alternatives 1A–9 would all contribute substantially to the adverse cumulative conditions for EC in the Delta and in Suisun Marsh. Additionally, implementation of tidal habitat restoration under CM4 would increase the tidal exchange volume in the Delta, and thus may contribute to increased EC concentrations in the Bay source water as a result of increased salinity intrusion. As such, CM4 is expected to contribute to this adverse cumulative condition. Implementation of CM2, CM3, and CM5–CM22 would not contribute substantially to this adverse cumulative condition.

Mercury

Numerous regulatory efforts have been implemented or are under development to control and reduce mercury loading to the Delta, Upstream of the Delta and in the SWP/CVP Export Service Areas, which include a Delta mercury TMDL, methylmercury TMDL, and their implementation strategies (e.g., methylmercury control studies), increased restrictions on point-source discharges such as POTWs, greater restrictions on suction dredging in Delta tributary watersheds, and continued clean-up actions on mine drainage in the upper watersheds. A key challenge surrounds the pool of mercury deposited in the sediments of the Delta which cannot be readily or rapidly reduced, despite efforts to reduce future loads in Delta tributaries, and serves as a source for continued methylation and bioaccumulation of methylmercury by Delta biota. Consequently, mercury levels in Delta waters are considered to be an adverse cumulative condition. Facilities operations and maintenance (CM1) of Alternatives 1A–9 would not be expected to substantially alter the cumulative condition for mercury and the mercury impairment in the Delta or contribute substantially to the cumulative mercury condition in the SWP/CVP Export Service Areas with the exception of Alternative 8, at selected locations, where fish tissue mercury is expected to increase. Implementation of CM4 (tidal wetland habitat), CM5 (floodplain habitat), CM10 (freshwater marsh habitat), and possibly CM2 (Yolo Bypass fisheries enhancements) could create conditions resulting in increased methylation of mercury within the Delta per unit time, increased biotic exposure to and uptake of methylmercury, and resulting increased mercury bioaccumulation in fish tissues. The methylation of mercury in these restored wetland habitats would contribute substantially to the cumulative condition for mercury in the Delta.

Organic Carbon

Delta water quality conditions for DOC are anticipated to be adverse under the cumulative condition. However, facilities operations and maintenance (CM1) for Alternatives 1A–5 would not contribute considerably to the adverse cumulative condition for DOC within Delta waters. Conversely, Alternatives 6A–9 would result in increased DOC levels at Franks Tract, Rock Slough and Contra Costa PP No. 1. Under these alternatives, long-term average DOC concentration could increase by up to 46%, relative to Existing Conditions. Thus, the DOC contributions from alternatives 6A–9 at Franks Tract, Rock Slough and Contra Costa PP No. 1 (i.e., interior Delta locations) are determined to contribute considerably to the adverse cumulative condition for DOC in the Delta. However, overall, modeling results for the south Delta pumps and thus the SWP/CVP export service area predict a long-term improvement in export service area water quality, primarily through a reduction in exports of water exceeding 4 mg/L. This is particularly true for Alternatives 6A–9 where notable improvements to DOC levels at the south Delta pumps would occur. Hence, facilities operations and maintenance (CM1) for Alternatives 6A–9 would contribute substantially to adverse cumulative conditions in the interior Delta, but would improve cumulative DOC conditions at the south Delta pumps and thus in the SWP/CVP Export Service Areas.

In addition, implementation of CM4 (tidal wetland habitat), CM5 (floodplain habitat), and CM10 (freshwater marsh habitat) would create substantial new localized sources of DOC to Delta waters, and in some circumstances would substitute for existing sources related to replaced agriculture. In addition, CM2 would create greater localized source loading of DOC to Delta waters, to the degree that the Yolo Bypass is inundated more frequently and/or to a greater geographic extent under the alternatives, relative to the existing condition. Depending on localized hydrodynamics and proximity to municipal drinking water intakes, such restoration activities could contribute substantial amounts of DOC to municipal raw water supplies. The potential for substantial increases in long-term average DOC concentrations related to the habitat restoration elements of CM4, CM5, and CM10 could contribute to long-term water quality degradation with respect to DOC and, thus, adversely affect the MUN beneficial use at various interior Delta locations. Hence, Implementation of CM2–CM22 would contribute substantially to the adverse cumulative condition for DOC.

Pesticides and Herbicides

Pesticide and herbicide use within and upstream of the Delta are changing continuously. Historically, when society has substituted one class of pesticide for another without a corresponding change in patterns of use (i.e., substitution of organochlorines with organophosphates), incidence of non-target toxicity or environmental harm has changed and perhaps been lessened, but has remained nevertheless. While factors such as TMDLs and future development of more target specific and less toxic pesticides will ultimately influence the future cumulative condition for pesticides, forecasting whether these various efforts will ultimately be successful at resolving current pesticide related impairments requires considerable speculation. As such it is conservatively assumed that the cumulative condition will be adverse with respect to pesticides. Alternatives 1A–C–5 are not expected to contribute considerably to the adverse cumulative condition due to facilities operations and maintenance (CM1). However, implementation of CM1 under Alternatives 6A–9 would result in long-term average San Joaquin River source water fractions at Franks Tract, Rock Slough and Contra Costa PP No. 1 (interior Delta) increasing considerably for some months such that the long-term risk of pesticide-related toxicity to aquatic life could substantially increase at these locations. Additionally, the potential for increased incidence of pesticide related toxicity could include pesticides such as chlorpyrifos and diazinon for which existing Clean Water Act section 303(d) listings exist for the Delta, and thus existing beneficial use impairment could be made discernibly worse. In addition, implementation of CM13 (nonnative aquatic vegetation control) under Alternatives 1A–9 would be expected to contribute substantially to the adverse cumulative condition for pesticides and herbicides in the Delta. The greater source fraction of Sacramento River water on an annual average basis at the south Delta pumps under all alternatives would be expected to result in the cumulative condition for pesticides and herbicides in the SWP/CVP Export Service Areas to not be adverse.

Selenium

The lower San Joaquin River and the western Delta are listed as impaired in accordance with section 303(d) of the Clean Water Act for exceeding selenium water quality objectives or bioaccumulation in biota. The San Joaquin River impairment is listed as extending from the Mud Slough confluence to the Airport Way Bridge near Vernalis, a reach distance of about 43 river miles. Selenium occurs naturally throughout the lower San Joaquin River watershed, with elevated concentrations of selenium occurring in the shallow groundwater within the Grassland Watershed. Subsurface agricultural drainage discharges from this area are the major source of selenium to the San Joaquin River and Delta. Load allocations for agricultural subsurface drainage discharges from the Grassland Drainage Area have been developed through completion of the lower San Joaquin River selenium TMDL and the Grassland Bypass Project. The Grassland Bypass Project prevents discharge of subsurface agricultural drainage water into wildlife refuges and wetlands. The Grassland Area Farmers have been successful in meeting TMDL wasteload allocations and continue to utilize and expand the San Joaquin River Water Quality Improvement Project. Moreover, the Grassland Area Farmers continue to work closely with the Central Valley Water Board and U.S. Bureau of Reclamation to further develop and improve their drainage solutions for the Grassland Drainage Area. Despite these improvements in reducing selenium loading to the San Joaquin River and Delta, it is anticipated that the cumulative condition for selenium in the lower San Joaquin River and Delta will remain adverse.

Facilities operations and maintenance (CM1) of Alternatives 1A–5 would not be expected to substantially alter the cumulative condition for selenium and selenium impairment in the Delta. Modeled selenium concentrations in sturgeon in the western Delta increased under Alternatives 6A-9 by 20-23%, which may represent a measurable increase in the environment. Because both low and high toxicity benchmarks are already exceeded under the No Action Alternative, these increases would further degrade water quality by measurable levels, on a long-term basis, for selenium and, thus, cause the 303(d)-listed impairment of beneficial use to be made discernibly worse. These potentially measurable increases would contribute substantially to the adverse cumulative condition for selenium in the Delta. Under Alternative 9, modeled selenium concentrations in water would increase at Rock Slough, Franks Tract, and Contra Costa PP, decreasing the available assimilative capacity by more than 10 percent at each of those locations; consequently, selenium concentrations in whole-body fish and in bird eggs (invertebrate and fish diets) at those locations would increase so that Level of Concern benchmarks for biota would be exceeded at Rock Slough and Contra Costa PP (and approach exceedance at Franks Tract). The greater level of selenium bioaccumulation in the vicinities of Rock Slough and Contra Costa PP would further degrade water quality by measurable levels, on a long-term basis, for selenium and, thus, cause the 303(d)-listed impairment of beneficial use to be made discernibly worse. However, the greater Sacramento River flow fraction at the south Delta pumps under all alternatives would be expected to result in reduced selenium concentrations in the SWP/CVP Export Service Areas and thus would not contribute to the adverse cumulative condition. Implementation of CM4 (tidal wetland habitat), CM5 (floodplain habitat), and CM10 (freshwater marsh habitat) could create conditions resulting in increased flow residence time at the restored Delta locations, which could increase biotic exposure to and uptake of selenium, potentially resulting in increased selenium bioaccumulation in fish tissues. The potential for increased biotic exposure in and near these restored wetland habitats would contribute substantially to the adverse cumulative condition for selenium in the Delta. However, Environmental Commitment: Selenium Management (AMM27), which affords for site-specific measures to reduce effects, would be available to reduce BDCP-related effects associated with selenium.

NEPA Effects: The cumulative water quality conditions are considered to be adverse for bromide, chloride, electrical conductivity, mercury, organic carbon, pesticides and herbicides, and selenium in areas of the Delta, and thus may adversely affect beneficial uses of the Delta such as domestic, agricultural, municipal and industrial water supply and recreation, aesthetic, and fish and wildlife resources. The implementation of BDCP Alternatives 1A–9 would contribute substantially to these adverse cumulative water quality conditions. With respect to bromide, chloride, and electrical conductivity, implementation of Alternatives 1A-9 would improve water quality conditions for these constituents at the Banks and Jones pumping plants in the south Delta and thus in the SWP/CVP Export Service Areas. Mitigation measures (described below) and environmental commitments have been developed to mitigate the alternatives' contributions to the adverse cumulative water quality conditions elsewhere in the Delta for bromide (WQ-5), chloride (WQ-7), electrical conductivity (WQ-11), mercury (see mitigation measure below), organic carbon (WQ-17 and WQ-18), pesticides and herbicides (WQ-21 and WQ-22) and selenium (Environmental Commitment: Selenium Management (AMM27)).

***CEQA Conclusion*:** The cumulative Delta water quality conditions are anticipated to be significant for bromide, chloride, electrical conductivity, mercury, organic carbon, pesticides and herbicides, and selenium. The incremental effects of Alternatives 1A–9 would be cumulatively considerable with respect to significant cumulative bromide, chloride, and electrical conductivity conditions at various western and interior Delta locations. However, implementation of Alternatives 1A-9 would not contribute considerably, and would, in fact, improve conditions for these constituents at the Banks and Jones pumping plants in the south Delta and thus in the SWP/CVP Export Service Areas.

Regarding mercury and selenium, facilities operations and maintenance (CM1) would not be expected to contribute considerably to the significant cumulative mercury and selenium conditions in the Delta (with the exception of Alternative 8 for mercury and Alternative 9 for selenium), but implementation of CM4, CM5, and CM10 would be expected to contribute considerably to certain localized areas (i.e., near where the wetland restoration areas are planned) within the Delta through the potential for increased mercury methylation and selenium bioaccumulation in these restored wetland habitats. However, with implementation of Environmental Commitment: Selenium Management (AMM27), which affords for site-specific measures to reduce effects, the incremental effects of BDCP would not be expected to be cumulatively considerable. Likewise, CM2 would create greater localized source loading of methylmercury to Delta waters, to the degree that the Yolo Bypass is inundated more frequently and/or to a greater geographic extent under the alternatives, relative to the existing condition. Conversely, CM2 is not expected to contribute considerably to future Delta selenium levels and thus would not be expected to affect future bioaccumulation of selenium in Delta fish tissues.

For organic carbon, implementation of facilities operations and maintenance (CM1) for Alternatives 6A–9 would contribute considerably to the significant cumulative organic carbon condition in the Delta, but Alternatives 1A–C, 2A–C, and 3–5 would not contribute considerably to this cumulative condition. Conservation Measures 4, 5, and 10, through the ability of these new wetlands to load additional organic carbon to Delta waters, would contribute considerably to the significant adverse cumulative organic carbon condition in the Delta. In addition, CM2 would create greater localized source loading of DOC to Delta waters for all alternatives, to the degree that the Yolo Bypass is inundated more frequently and/or to a greater geographic extent under the alternatives, relative to the existing condition. These cumulative effects are not expected to extend to the south Delta pumps or the SWP/CVP Export Service Areas, but to the extent that they do, the mitigation measure proposed also would address such effects.

Implementation of facilities operations and maintenance (CM1) for Alternatives 2A–C and 4–9 would contribute considerably to the adverse cumulative pesticide and herbicide condition in the Delta, but Alternatives 1A–C and 3 would not contribute considerably to this significant cumulative condition. Also, implementation of CM13 (nonnative aquatic vegetation control) is the only conservation measure identified that would contribute considerably to the cumulative pesticide and herbicide condition in the Delta. The cumulative effects for pesticides and herbicides are not expected to extend to the SWP/CVP Export Service Areas due to the increases in Sacramento River source fraction at Banks and Jones pumping plants under all alternatives and its generally lower levels of pesticides relative to the San Joaquin River source water.

Mitigation Measures:

The following mitigation measures and environmental commitments have been developed to mitigate the alternatives' contributions to the adverse cumulative water quality conditions described above for bromide (WQ-5), chloride (WQ-7), electrical conductivity (WQ-11), mercury (see mitigation measure below), organic carbon (WQ-17 and WQ-18), pesticides and herbicides (WQ-21 and WQ-22) and selenium (Environmental Commitment: Selenium Management (AMM27)).

To mitigate the alternatives' contribution to adverse mercury effects, implementation of conservation measures (CM 2, CM4, CM5, and CM10) associated with wetland/floodplain habitat shall conform to the relevant requirements of the Delta Mercury Control Strategy of the Central Valley Water Board Basin Plan. Requirements of the Delta Mercury Control Strategy include the following.

- Required participation in efforts to evaluate and minimize health risk associated with eating mercury contaminated fish.
- Required participation in monitoring methylmercury loading from wetlands.
- Implementation of appropriate and site-specific methylmercury control measures.

It is anticipated that these same, or similar, measures can be utilized to address and mitigate wetland-related bioaccumulation issues for selenium, as well.

Appropriate mercury and methylmercury selenium control measures shall be developed at the time of formal restoration planning and design. All practicable measures (i.e., those that are both feasible and reasonable from a cost-benefit perspective) to reduce methylmercury formation shall be considered for implementation. Appropriate strategies and control measures may include the following.

- Conservation measure design features, such as use of seasonal inundation periods, hydraulic residence time, sediment basins and vegetation traps to control mercury inputs and exports, inundation depths and related vegetation type and density selection so as to control oxidation-reduction conditions.

- Appropriate consideration of conservation measure location, preferably not in the direct path of large mercury loading sources such as the Sacramento River, Yolo Bypass, Cosumnes River, or San Joaquin River.
- Prioritization of conservation measures that minimize trophic level transfer of mercury through active or passive operation and maintenance controls, such as targeted control and/or removal of hyperaccumulating plant or animal species.
- Pre- and post-restoration monitoring of water and biota (sentinel species) for mercury content in the context of a targeted adaptive management strategy whereby new or modified mercury/methylmercury controls would be implemented in order to, at the minimum, maintain methylmercury formation and fish tissue accumulation at baseline conditions.

These mitigation measures may not completely eliminate the contributions identified to the adverse cumulative water quality conditions, but would be expected to lessen the contributions to the degree feasible. Hence, some level of contribution to adverse cumulative conditions are anticipated to remain after mitigation.

8.5 References

8.5.1 Printed References

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8.5.2 Personal Communications

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