Draft

Water Quality Technical Report

Shasta Lake Water Resources Investigation, California

Prepared by:

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Abbreviations and Acronyms

°F	degrees Fahrenheit
µg/L	micrograms per liter
2008 OCAP BA	2008 *Biological Assessment on the Continued Long-Term Operations of the CVP and SWP*
Basin Plan	Water Quality Control Plan for the Sacramento River and San Joaquin River Basins
Bay Area	San Francisco Bay Area
Bay-Delta	San Francisco Bay/Sacramento–San Joaquin River Delta
BLM	U.S. Bureau of Land Management
BMP	best management practice
BO	biological opinion
CALFED	CALFED Bay-Delta Program
CCWD	Contra Costa Water District
CDEC	California Data Exchange Center
COSMA	City of Stockton Metropolitan Area
CTR	California Toxics Rule
CVP	Central Valley Project
CVRWQCB	Central Valley Regional Water Quality Control Board
CWA	Clean Water Act
D-1275	Water Right Decision 1275
D-1379	Water Right Decision 1379
D-1485	Water Right Decision 1485
D-1641	Water Right Decision 1641
DBP	disinfectant byproducts
DDT	dichlorodiphenyl-trichloroethane
DEIS	Draft Environmental Impact Statement
Delta	Sacramento–San Joaquin River Delta
District Court	Eastern District of California
DOC	dissolved organic carbon
DPH	California Department of Public Health
DWR	California Department of Water Resources
E/I	export-to-inflow
EC	electrical conductivity
EIS	environmental impact statement
EPA	U.S. Environmental Protection Agency
General Industrial Permit	Industrial Storm Water General Permit

JPOD	joint point of diversion
M&I	municipal and industrial
MCL	maximum contaminant levels
mg/L	milligrams per liter
MWQI	Municipal Water Quality Investigation
NEPA	National Environmental Policy Act
ng/L	nanograms per liter
NMFS	National Marine Fisheries Service
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
OCAP	Operations and Criteria Plan
PCB	polychlorinated biphenyl
Porter-Cologne Act	Porter-Cologne Water Quality Control Act
RBPP	Red Bluff Pumping Plant
Reclamation	U.S. Department of the Interior, Bureau of Reclamation
RMP	Resource Management Plan
ROD	Record of Decision
RPA	reasonable and prudent alternative
RWD	reports of waste discharge
RWQCB	regional water quality control boards
SCWA	Solano County Water Agency
SDWA	Safe Drinking Water Act
SFBRWQCB	San Francisco Bay Regional Water Quality Control Board
STNF	Shasta-Trinity National Forest
STNR LRMP	Shasta-Trinity National Forest Land and Resource Management Plan
SWANCC	Solid Waste Agency of Northwestern Cook County
SWP	State Water Project
SWPPP	storm water pollution prevention plan
SWRCB	State Water Resources Control Board
TCD	temperature control device
TDS	total dissolved solids
Thermal Plan	Water Quality Control Plan for the Control of Temperature in the Coastal and Interstate Waters and Enclosed Bays and Estuaries of California
THM	trihalomethanes
TMDL	total maximum daily load
TOC	total organic carbon
USACE	U.S. Army Corps of Engineers

USGS	U.S. Geological Survey
WDR	waste discharge requirements
WQCP	Water Quality Control Plan
WR	Water Rights
X2	estuarine habitat

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Chapter 1
Affected Environment

This chapter describes the affected environment related to water quality for the dam and reservoir modifications proposed under the Shasta Lake Water Resources Investigation.

Environmental Setting

Surface water quality in the study areas is affected by multiple factors: natural runoff, agricultural return flows, abandoned mines, construction, logging, grazing, and operations of flow-regulating facilities, urbanization, and recreation. This chapter discusses key water quality constituents of concern in the study areas (i.e., temperature, sediments, and metals), the factors influencing concentrations of these constituents, and the regulatory objectives associated with maintaining beneficial uses.

For the purposes of this analysis, the study areas have been divided into a primary study area and an extended study area. The primary study area is located in both Shasta and Tehama counties and includes Shasta Dam and Shasta Lake. All major and minor tributaries to the reservoir and a corridor along the Sacramento River downstream to Red Bluff Pumping Plant (RBPP) are also within the primary study area (Figure 1-1). The extended study area extends from RBPP south (downstream along the Sacramento River) to the Sacramento–San Joaquin River Delta (Delta). Besides the Sacramento River, it also includes the San Francisco Bay/Sacramento–San Joaquin River Delta (Bay-Delta) area, and the facilities and the water service areas of the Central Valley Project (CVP) and State Water Project (SWP). This extended study area includes CVP and SWP reservoirs and the portions of tributaries that are downstream from these reservoirs and that affect Sacramento River and Delta flows. These reservoirs and tributaries include Lake Oroville, Folsom Lake, San Luis Reservoir, New Melones Reservoir, and Trinity Lake, and portions of the Trinity, Feather, American, and Stanislaus rivers. The CVP and SWP water service areas include much of the Sacramento and San Joaquin valleys, and substantial portions of the San Francisco Bay Area (Bay Area) and Southern California.

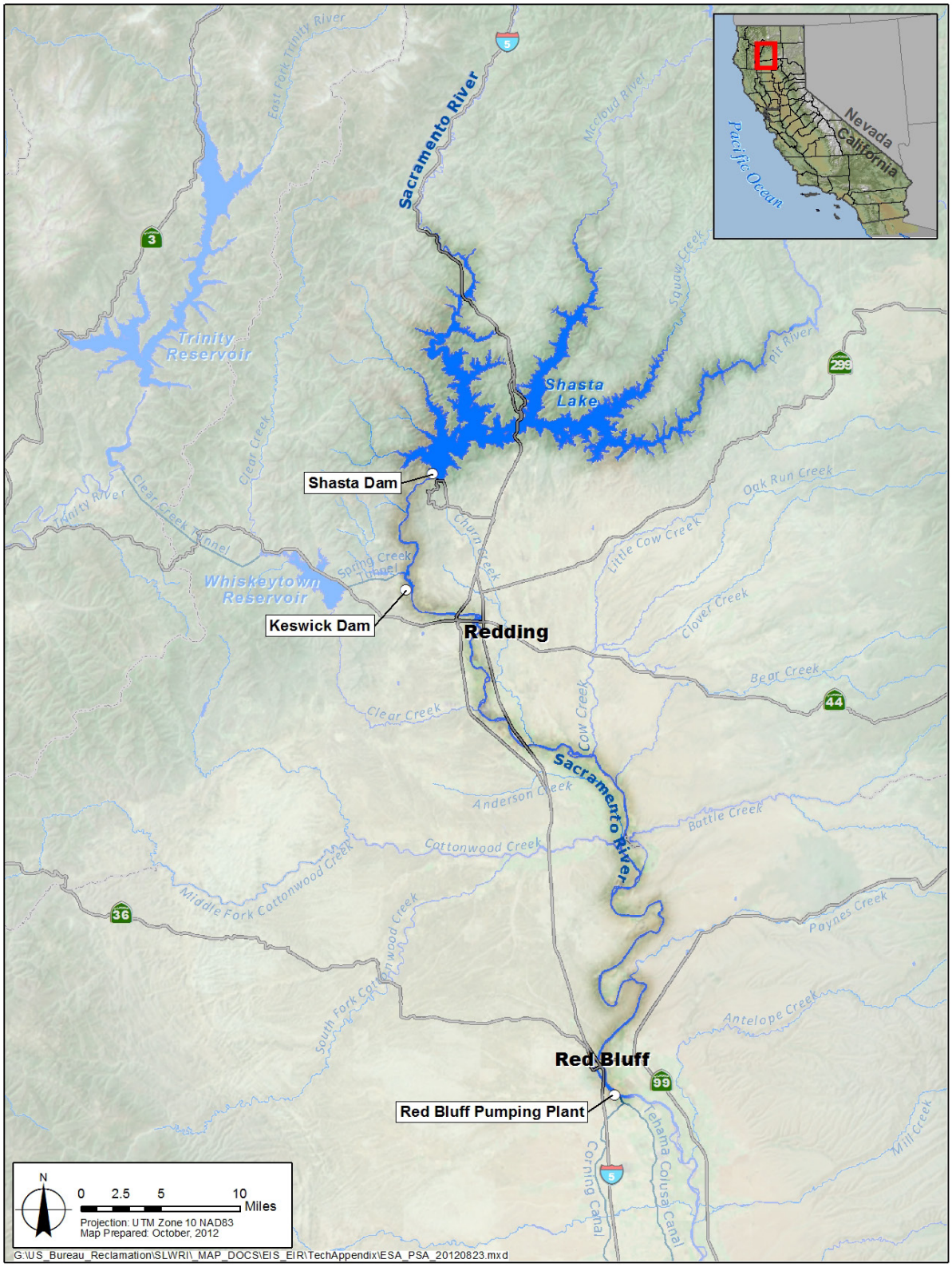


Figure 1-1. Shasta Lake Water Resources Investigation Primary Study Area, Shasta Lake Area and Shasta Dam to Red Bluff Pumping Plant

Overview of Water Quality Conditions

Surface water quality in the primary and extended study areas is affected by natural runoff, agricultural return flows, abandoned mines, construction, logging, grazing, and operations of flow-regulating facilities, urbanization, and recreation. This section discusses key water quality constituents of concern (i.e., temperature, sediments, and metals), the factors influencing their concentrations, and the regulatory objectives associated with maintaining beneficial uses.

The following discussion provides an overview of water quality and its relationship to beneficial uses throughout the primary and extended study areas. This section is followed by discussions of key water quality parameters that influence beneficial uses to varying degrees within the study areas; temperature, sediment and metals.

Shasta Lake and Vicinity

This section addresses water quality in the Shasta Lake and vicinity portion of the primary study area. It focuses on the six arms of Shasta Lake and tributaries that enter into Shasta Lake from the surrounding watersheds.

Water quality in this portion of the primary study area generally meets the standards for beneficial uses identified in the Water Quality Control Plan for the Sacramento River and San Joaquin River Basins (Basin Plan) (CVRWQCB 2009). The quality of surface waters in Shasta County is generally considered good, although some water bodies are affected by nonpoint pollution sources that influence surface water quality: high turbidity from controllable sediment discharge sources (e.g., land development and roads); high concentrations of nitrates and dissolved solids from range and agricultural runoff or septic tank failures; contaminated street and lawn runoff from urban areas, roads, and railroads; acid mine drainage and heavy metal discharges from historic mining and processing operations; and warm-water discharges into cold-water streams.

The quality of water in underground basins and water-bearing soils is also considered generally good throughout most of Shasta County. Potential hazards to groundwater quality involve nitrates and dissolved solids from agricultural and range practices and septic tank failures. The ability of soils in Shasta County to support septic tanks and on-site wastewater treatment systems is generally severely limited, particularly on older valley terrace soils and certain loosely confined volcanic soils in the eastern portions of the county (CVRWQCB 2009).

The surface water quality of streams and lakes draining Shasta-Trinity National Forest (STNF) and adjacent private lands generally meets standards for beneficial uses defined by the Basin Plan (CVRWQCB 2009). There are, however, some areas where the water quality does not meet the standards during periods of storm runoff because of past management activities, or as a result of drainage from historic mining and processing operations. These water courses

include West Squaw Creek below the Balakala Mine, lower Little Backbone Creek, lower Horse Creek, and Town Creek, which are all listed by the U.S. Environmental Protection Agency (EPA) as impaired water bodies under Section 303(d) of the Clean Water Act (CWA) (CVRWQCB 2011). The cumulative impacts of successive activities, such as road construction and timber harvesting on private and National Forest lands, also contribute to the degradation of water quality in STNF (USFS 1995). Within this portion of the primary study area, most of the road construction and timber harvest activities occur on private lands.

Shasta Dam and Shasta Lake constitute the "keystone of the Central Valley Project." Approximately 6.2 million acre-feet of water flows annually into Shasta Lake from the Sacramento River, McCloud River, and Pit River drainages. A favorable inflow-outflow relationship of 1.4 to 1 results in good water quality, both in the lake and downstream (USFS 1996), although 20 acres where West Squaw Creek enters Shasta Lake is listed as an impaired water body on the EPA's Section 303(d) list as impaired due to heavy metal accumulations (e.g., cadmium, copper and zinc) at locations throughout the reservoir (CVRWQCB 2011). Shasta Lake is listed on the EPA's 2008 – 2010 Section 303(d) list as impaired by mercury throughout the lake.

Nutrient inputs and bacteria are not of concern in the Sacramento and McCloud Arms (USFS 1998); however, they could be an issue in the Pit Arm as a result of runoff from agricultural and range lands in the upper Pit River watershed. Within Little Backbone Creek and West Squaw Creek, the waters are locally limited by low pH and elevated concentrations of heavy metals caused by drainage from abandoned mines and hence are listed as impaired on the EPA's Section 303(d) list (CVRWQCB 2003a). In addition, data suggest that sediment and turbidity locally affect beneficial uses, mainly contact recreation. A recent 2-year study conducted by the State Water Resources Control Board (SWRCB) sampled mercury accumulations in fish at a number of locations throughout Shasta Lake. This study documented elevated levels of mercury in some specimens (Davis et al. 2010).

Upper Sacramento River (Shasta Dam to Red Bluff)

Tributaries to the Upper Sacramento River and place names referred to in the text are shown in Figure 1-1. The main sources of water in the Sacramento River below Keswick Dam are rain and snowmelt that collect in upstream reservoirs and are released in response to water needs or flood control. The quality of surface water downstream from Keswick Dam also is influenced by other human activities along the Sacramento River downstream from the dam, including agricultural, historical mining, and municipal and industrial (M&I) inputs.

The quality of water in the Sacramento River is relatively good. Only during conditions of stormwater-driven runoff are water quality objectives typically not met (Domagalski et al. 2000). Water quality issues within the primary study

area of the Sacramento River include the presence of mercury, pesticides such as organochlorine pesticides, trace metals, turbidity, and toxicity from unknown origin (CALFED 2000a).

Water quality in the Sacramento River and its major tributaries above RBPP is generally good (Table 1-1). Nutrients such as nitrate were found to be low throughout the Sacramento River basin (Domagalski and Dileanis 2000, as cited in Domagalski et al. 2000). Water temperature is a principal water quality issue in the upper Sacramento River between Keswick Dam and RBPP.

Table 1-1. Summary of Conventional Water Quality Constituents Collected in the Sacramento River at Red Bluff from 1996 to 1998

Constituent (unit)	Water Quality Objective	Average Measurement
Conventional Physical and Chemical Constituents		
Temperature	< 2.5ºF [a]	52.7ºF
Conductivity (µS/cm)	–	116
Dissolved Oxygen (mg/L)	7.0 [b]	10.7
Dissolved Oxygen Saturation (percent)	85 [b]	99
pH (standard unit)	6.5 to 8.5 [c]	7.8
Alkalinity (mg/L $CaCO_3$)	–	48.3
Total Hardness (mg/L $CaCO_3$)	–	46.6
Suspended Sediment (mg/L)	–	38.8
Calcium (mg/L)	narrative [d]	10.3
Magnesium (mg/L)	–	5.0
Sodium (mg/L)	–	5.8
Potassium (mg/L)	–	1.1
Chloride (mg/L)	500 [e]	2.4
Sulfate (mg/L)	500 [e]	4.5
Silica (mg/L)	–	20.5
$NO_2 + NO_3$ (mg/L N)	NO3 < 10 [f]	0.12
Total Phosphorus (mg/L P)	–	0.0477
Trace Metals		
Arsenic (µg/L)	50 [g]	1.0
Chromium (µg/L)	180 [g]	1.0
Copper (µg/L)	5.1 [g]	1.6
Mercury (µg/L)	0.050 [g]	0.0045

Table 1-1. Summary of Conventional Water Quality Constituents Collected in the Sacramento River at Red Bluff from 1996 to 1998 (contd.)

Constituent (unit)	Water Quality Objective	Average Measurement
Nickel (µg/L)	52 [g]	1.2
Zinc (µg/L)	120 [g]	2.3
Organic Pesticides		
Molinate (ng/L)	13,000 [h]	< 60
Simazine (ng/L)	3,400 [i]	< 22
Carbofuran (mg/L)	40,000 [e], 500 [l]	< 31
Diazinon (mg/L)	51 [j]	< 28
Carbaryl (ng/L)	700 [k]	< 41
Thiobencarb (ng/L)	1,000 [a]	< 38
Chlorpyrifos (ng/L)	14 [j]	< 25
Methidathion (ng/L)	–	< 38

Source: CBDA 2005

Notes:
[a] The Water Quality Control Plan for the Sacramento River and San Joaquin River Basins (Basin Plan) water quality objective for allowable change from controllable factors.
[b] Basin Plan water quality objective.
[c] Basin Plan water quality objective; < 0.5 allowable change from controllable factors.
[d] Basin Plan narrative objective: Water shall not contain constituent in concentrations that would cause nuisance or adversely affect beneficial uses.
[e] Secondary drinking water maximum contaminant level (MCL).
[f] Primary drinking water MCL.
[g] California Toxics Rule (CTR) aquatic life criteria for 4-day average dissolved concentration.
[h] CTR human health maximum criteria total recoverable concentration.
[i] California Department of Fish and Wildlife (CDFW) hazard assessment value.
[j] CDFW aquatic life guidance value for 4-day average concentration.
[k] U.S. Environmental Protection Agency Integrated Risk Information System reference dose for drinking water quality.

Key:
– = not applicable
µg/L = micrograms per liter
µS/cm = microSiemens per centimeter
$CaCO_3$ = calcium carbonate
mg/L = milligrams per liter
N = nitrogen
ng/L = nanograms per liter
NO_2 = nitrate
NO_3 = nitrite
ºF = degrees Fahrenheit
P = phosphorus

Although all trace metals shown in Table 1-1 were well below their established water quality objectives, one of the principal water quality issues in the upper Sacramento River portion of the primary study area is acid mine drainage and associated heavy-metal contamination from the Spring Creek drainage and other

abandoned mining sites. It should be noted that the U.S. Geological Survey (USGS) study detected mercury, but it did not exceed the criterion of ambient level specified in the California Toxics Rule (CTR); however, CTR levels for mercury are not protective to prevent the high concentration of mercury found in fish tissue. In addition to heavy metal contamination, the Central Valley Regional Water Quality Control Board (CVRWQCB) determined that the 25-mile reach of the Sacramento River from Keswick Dam downstream to Cottonwood Creek is impaired because the water periodically contains levels of dissolved cadmium, copper, and zinc that exceed levels identified to protect aquatic organisms (CVRWQCB 2002). The 26-mile reach from Keswick Dam to Red Bluff is listed for unknown sources of toxicity (CVRWQCB 2007a).

Lower Sacramento River and Delta

Water quality in the lower Sacramento River is affected by agricultural runoff, acid mine drainage, stormwater discharges, water releases from dams, diversions, and urban runoff. However, the flow volumes generally provide sufficient dilution to prevent excessive concentrations of contaminants in the river.

Several total maximum daily loads (TMDL) are currently proposed for the lower Sacramento River. In addition, the Sacramento River downstream from RBPP to Knights Landing is listed as an impaired water body under the EPA's Section 303(d) list for mercury and unknown toxicity. Elevated metals and pesticide levels have been found at some sites in the Sacramento River Valley downstream from Knights Landing. The parameters of concern in the Sacramento River from Knights Landing to the Delta include diazinon, mercury, and unknown sources of toxicity (CVRWQCB 2007a, 2007b).

Water quality in the Delta is highly variable temporally and spatially. It is a function of complex circulation patterns that are affected by inflows, pumping for Delta agricultural operations and exports, operation of flow control structures, and tidal action. The existing water quality problems of the Delta system may be categorized as presence of toxic materials, eutrophication and associated fluctuations in dissolved oxygen, presence of suspended sediments and turbidity, salinity, and presence of bacteria (SWRCB 1999).

The Delta waterways within the area under the CVRWQCB's jurisdiction are listed as impaired on the EPA's 303(d) list for dissolved oxygen, electrical conductivity (EC), dichlorodiphenyl-trichloroethane (DDT), mercury, Group A pesticides, diazinon and chlorpyrifos, and unknown toxicity (CVRWQCB 2003b). The area of the Delta that is under the jurisdiction of the San Francisco Bay Regional Water Quality Control Board (SFBRWQCB) is listed as impaired for mercury, chlordane, selenium, DDT, dioxin compounds, polychlorinated biphenyl (PCB) compounds, dieldrin, nickel, exotic species, and furan compounds (SFBRWQCB 2007).

Organic carbon in the Delta originates from runoff from agricultural and urban land, drainage water pumped from Delta islands that have soils with high organic matter, runoff and drainage from wetlands, wastewater discharges, and primary production in Delta waters. Delta agricultural drainage can also contain high levels of nutrients, suspended solids, organic carbon, minerals (salinity), and trace chemicals such as organophosphate, carbamate, and organochlorine pesticides.

Salinity is also an important water quality constituent in the Delta. Salinity in the Delta is the result of tidal exchange with San Francisco Bay, variations in freshwater inflow from the San Joaquin and Sacramento rivers, agricultural and urban exports/diversions, and agricultural return flows. During dry conditions, seawater intrusion is the primary factor influencing Delta salinity and can adversely affect agricultural and municipal uses. The highest concentrations typically occur in late summer or early fall.

CVP/SWP Service Areas

The CVP and SWP service areas are affected by water quality from the Delta. Water quality concerns of particular concern are those related to salinity and drinking-water quality. Salinity is an issue because excessive salinity may adversely affect crop yields and require more water for salt leaching, may require additional M&I treatment, may increase salinity levels in agricultural soils and groundwater, and is the primary water quality constraint to recycling wastewater (CALFED 2000b).

Constituents that affect drinking-water quality include bromide, natural organic matter, microbial pathogens, nutrients, total dissolved solids (TDS), hardness, alkalinity, pH, organic carbon, disinfection byproducts, and turbidity.

Sediment

Shasta Lake and Vicinity

Sediment-caused turbidity is one of the limiting water quality issues for Shasta Lake and its tributaries. It is a noticeable recurring water quality problem that affects beneficial uses, including recreation and fisheries. Within the reservoir, turbid water results from clay- and silt-sized soil particles suspended in the water column. Under certain conditions, inflow to the Pit Arm appears to be influenced by water quality conditions upstream from Shasta Lake, but monitoring data are not available to adequately document this phenomenon.

Before the construction of Shasta Dam, the widespread loss of vegetation caused by historic copper mining and smelting operations resulted in large-scale erosion, particularly in the watersheds that are tributary to the Main Body of Shasta Lake and the Squaw Creek Arm. In addition to sediment sources from upland areas, including roads and historic mining features, the construction and operation of Shasta Dam continue to influence erosional processes that

introduce sediment into Shasta Lake, causing turbid conditions that are visible to the casual observer.

Nonpoint sources of fine sediment that increase turbidity in Shasta Lake include sediment discharge from tributaries, wave-related erosion below and adjacent to the fluctuating water surface, and surficial erosion of exposed surfaces as the lake levels fluctuate (USFS 1996). Erosion of the fine-textured soil and rock types that constitute much of the shoreline is a predominant factor in causing turbidity. The turbid water is noticeable along the shoreline throughout the year, but typically increases during wind and runoff events. Plumes of turbid water entering from tributaries are also visible periodically throughout the year. The fluctuation of lake levels, combined with various wave-generating processes, also influences the degree and location of erosion-related turbidity. Turbidity and, to a lesser degree, sediment suspended in the water column influence recreational uses of the lake, including fishing, swimming, and boating, by decreasing the clarity of the water along the shoreline.

Although some amount of fine sediment is transported downstream from Shasta Dam, the size and location of the reservoir provide an efficient sediment trap for material typically mobilized as bedload. Additional discussion of erosional processes is provided in Chapter 4, "Geology, Geomorphology, Minerals, and Soils," of the Draft Environmental Impact Statement (DEIS).

Upper Sacramento River (Shasta Dam to Red Bluff)

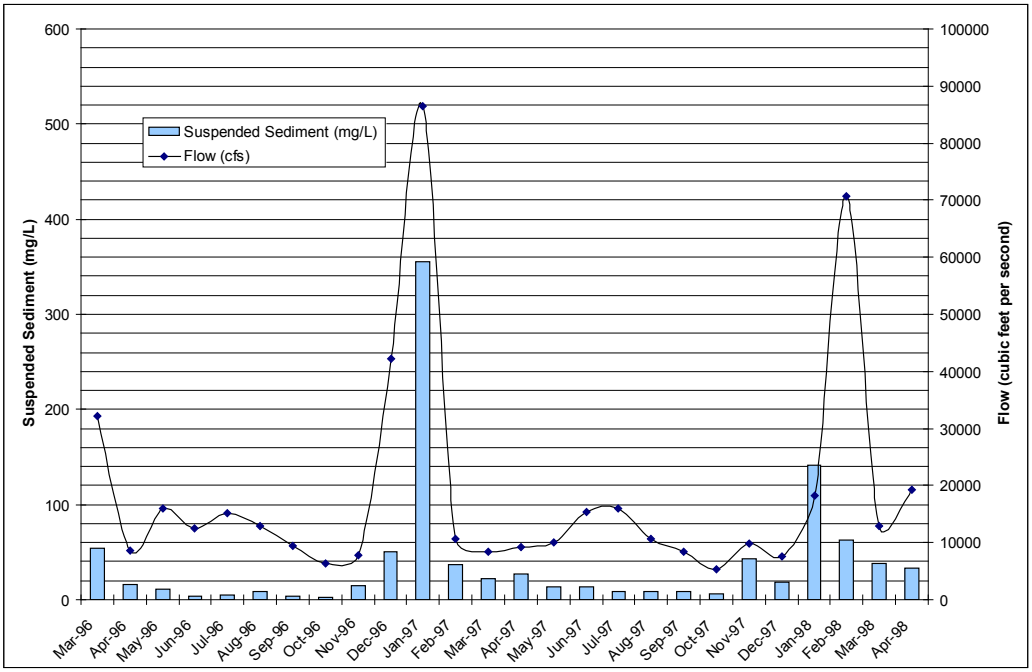
Rates of loading and discharge of suspended sediment within the upper Sacramento River watershed have been altered by activities such as mining, smelting, agriculture, urbanization, and dam construction. The storage and diversion of water within reservoirs for either hydroelectric or other purposes can affect sediment yield, downstream sediment levels, and transport characteristics. In particular, dams such as Shasta can trap sediment and result in the depletion of coarse sediments needed by fisheries. This has resulted in the creation of gravel replenishment programs on the upper Sacramento River as part of the Central Valley Project Improvement Act restoration program.

Historic hydraulic gold mining has probably had the greatest effect on sediment yield in the Sacramento River watershed (Wright and Schoellhamer 2004). During the late 1800s, such mining introduced mass quantities of silt, sand, and gravel into the Sacramento River system. Suspended sediment was washed downstream into the Delta. Current sediment transport patterns in the Sacramento River watershed are greatly affected by the trapping of sediment in reservoirs such as Shasta Lake (Wright and Schoellhamer 2004).

Characteristics of peak-flow events are fundamental regulators of sediment mobilization, bed scour, riparian recruitment, and bank erosion. However, upstream sediment supply rates and sediment load distribution also affect suspended sediment loading (CALFED 2003). The upper Sacramento River contributes little coarse sediment from erosion because it is bounded by erosion-

resistant bedrock and terrace deposits (Stillwater Sciences 2006). Therefore, today a decreasing trend in suspended sediment exists in the Sacramento River (Wright and Schoellhamer 2004).

USGS assessed concentrations of suspended sediment in the Sacramento River at Big Bend above Red Bluff from February 1996 to April 1998 (USGS 2000a). Concentrations of suspended sediment ranged from 3 milligrams per liter (mg/L) to 355 mg/L, with an average of 38.8 mg/L (Figure 1-2).



Source: USGS 2000a

Figure 1-2. Concentrations of Suspended Sediment and Associated Flows in the Sacramento River above Big Bend near Red Bluff

Lower Sacramento River and Delta

Delivery of suspended sediment from the Sacramento River to the Delta and finally to San Francisco Bay decreased by about one-half during the period 1957–2001 (Wright and Schoellhamer 2004). Factors contributing to this trend in sediment yield included the depletion of erodible sediment from hydraulic mining in the late 1800s, trapping of sediment in reservoirs, riverbank protection, altered land uses, and levee construction.

Sediment supply to the Sacramento and San Joaquin river watersheds has declined over recent years because dams on rivers and other water management actions have resulted in less sediment transport (CALFED 2000c), although agricultural drainage in the Delta often contains high levels of suspended sediments (Reclamation and DWR 2005). Sediments that include fine sands, silts, and clays are transported by rivers and the Yolo Bypass into the Delta. Coarser materials are deposited at points higher up in the river basins. The sands

typically are transported in the bed load, while the clays and silts move the suspended load. The suspended load is composed of generally finer materials moving downstream in the water column. Sediment loads from the Sacramento River are higher than those from the San Joaquin River (Reclamation and DWR 2005).

Hydraulic gold mining, particularly through the major westerly flowing tributaries such as the American, Feather, Yuba, and Bear rivers, may also affect sediment transport in the extended study area. USGS found that the Sacramento River is the primary supplier of suspended sediment to the Delta.

CVP/SWP Service Areas

Some suspended sediments are transported within the CVP and SWP service areas, but turbidity and sedimentation are not issues within the service areas (CALFED 2000c).

Temperature

Shasta Lake and Vicinity

Water temperature is an important water quality parameter affecting the beneficial uses of Shasta Lake and its tributaries, including contact and noncontact recreation and aquatic organisms. Within the reservoir, water temperature commonly controls the growth of algae and the rate of biochemical processes. Shasta Lake periodically stratifies and a thermocline develops on an annual basis, although turnover is incomplete and the lake has not been known to freeze over (Bartholow et al. 2001). Strong stratification of the reservoir occurs during summer at a depth of 10 to 15 meters. This stratification isolates the epilimnion from nutrients available in the deeper hypolimnion, segregating spring and fall algal blooms when water temperatures might otherwise support algal production in the euphotic zone, the zone close to the surface that provides opportunities for photosynthesis. The period of stratification generally overlaps with the peak recreation season (May to September), when surface water temperatures are comfortable for contact recreation activities. During fall, the stratification dissipates and the surface water temperature is reduced.

Shasta Dam operations greatly influence the annual and seasonal water temperature of the reservoir. The wetness of a given water year or series of years generally controls the mean annual water temperature. The current temperature regime of Shasta Lake is related to CVP operational requirements, including those necessary to optimize the water temperatures in the Sacramento River downstream from Keswick Dam. Overall, the tributaries that enter Shasta Lake meet the Basin Plan water quality objective for temperature.

Upper Sacramento River (Shasta Dam to Red Bluff)

Water temperature in the Sacramento River from Shasta Dam to Keswick Dam is determined primarily by Shasta Dam releases. Shasta Dam release flows are

then mixed with flows from Whiskeytown Reservoir at Keswick Reservoir and released into the upper Sacramento River.

Water temperature for rivers within the Sacramento River basin is reportedly maintained consistent with regulatory requirements (e.g., National Marine Fisheries Service (NMFS) biological opinion (BO) and Basin Plan) most of the time, but temperature management can be difficult during low-flow periods (USGS 2000a). Historically, low-flow events and a lack of flexibility in dam operations can cause water temperatures to periodically approach critical levels for sustaining juvenile salmon populations. In addition to low flows, high water temperatures released from reservoirs, coupled with natural instream warming, can cause elevated river water temperatures (Vermeyen 1997).

According to the 2004 BO for CVP and SWP operations for the Sacramento River winter-run Chinook salmon, the Sacramento River water temperatures will be below 56°F at compliance locations between Balls Ferry and Bend Bridge from April 15 through September 30, and not in excess of 60°F at the same compliance locations between Balls Ferry and Bend Bridge from October 1 through October 31. On June 4, 2009, NMFS issued the NMFS Operations and Criteria Plan (OCAP) BO for listed anadromous fishes and marine mammal species and their critical habitats governing the long-term operations of the CVP and SWP. The 2009 NMFS BO established Sacramento River water temperature requirements not to exceed 56°F between Balls Ferry and Bend Bridge compliance points from May 15 through September 30 for protection of winter-run Chinook salmon, from October 1 through October 31 for the protection of mainstem spring-run Chinook salmon, whenever possible.

Several lawsuits were filed challenging the validity of the 2009 NMFS BO and, the U.S. Department of the Interior, Bureau of Reclamation's (Reclamation) acceptance of the reasonable and prudent alternative included in the BO (see *Consolidated Salmonid Cases*, 1:09-CV-1053 OWW DLB (E.D. Cal.)). On September 20, 2011, the Eastern District of California (District Court) remanded the 2009 NMFS BO to the fishery agency. The District Court ordered NMFS and Reclamation to prepare a final BO and associated final National Environmental Policy Act (NEPA) document by February 1, 2016. Despite the uncertainty resulting from the ongoing reconsultation process, the 2009 NMFS BO contains the most recent estimate of potential changes in water operations that could occur in the near future and it is currently anticipated that the final BO issued by NMFS will contain similar RPAs.

The Basin Plan specifies that water temperature shall not be elevated above 56 degrees Fahrenheit (°F) from Keswick Dam to Hamilton City (CVRWQCB 2009). In addition, the Basin Plan specifies that at no time or place shall the temperature of cold or warm intrastate waters be increased more than 5°F above natural receiving-water temperature (CVRWQCB 2009). Keswick Dam releases are managed to meet temperature control requirements.

Sacramento River water temperatures below Shasta Dam were analyzed from January 1991 through December 2005. The data set indicates that average temperatures vary seasonally, ranging from 47.9°F in February to 55.7°F in November. Water temperatures below Keswick Dam were analyzed for January 1990 through December 2006. Like the temperatures below Shasta Dam, average temperatures below Keswick Dam vary seasonally, ranging from 47.8°F in February to 54.9°F in November. Summer and fall temperatures typically increase by about 7°F. Water temperatures just downstream from Keswick Dam are influenced by releases from Shasta Lake and Whiskeytown Reservoir and Keswick Dam operations.

To achieve water temperature objectives in the Sacramento River without interrupting power generation, Reclamation constructed a temperature control device (TCD) on Shasta Dam that became operational in 1997. Before 1997, to help meet the needs of federally listed winter-run Chinook salmon, cold water was released from low outlets at Shasta Dam. These cold-water releases bypassed hydropower facilities, causing the loss of power revenues. The TCD allows selective withdrawal of water from different reservoir depths without bypassing power generation, provides flexibility to Shasta Dam operations, and allows downstream temperature goals to be consistently achieved (Reclamation 2004a).

Lower Sacramento River and Delta

Water temperature in the Sacramento River at Colusa varies seasonally, ranging from 47.5°F to 67.5°F. Water temperatures gradually increase through the spring and summer and reach an average of about 65°F. Water temperature in the Sacramento River at Freeport varies seasonally, ranging from 48.7°F to 72.1°F (USGS 2000a).

Water temperature in the Delta is influenced only slightly by water management activities (i.e., dam releases) (Reclamation and DWR 2005). The BOs for Sacramento River winter-run Chinook salmon are among the most influential factors governing Shasta releases, in terms of both quantity and timing (NMFS 1993, 2004, 2009). The BOs set temperature requirements below Keswick Dam for April through October. In years when CVP facilities cannot be operated to meet required temperature and storage objectives, Reclamation reinitiates consultation with NMFS (Reclamation 2004b).

CVP/SWP Service Areas

Water quality in the CVP and SWP service areas, including water temperature, is affected by fluctuations of water quality in the Delta, which in turn are influenced by water quality in the San Joaquin River, CVP and SWP export pumping rates, local agricultural diversions and drainage water, and the Sacramento River (CALFED 2000c).

Metals

Shasta Lake and Vicinity

Certain areas of Shasta Lake have been identified as impaired by toxic metal pollutants. For this reason, Shasta Lake is listed on the EPA's Section 303(d) list of impaired water bodies. For water bodies on the Section 303(d) list, the CWA requires the development of TMDL allocations for the pollutants of concern. A TMDL allocation must estimate the total maximum daily load, with seasonal variations and a margin of safety, for all suitable pollutants and thermal loads, at a level that would ensure protection and propagation of a balanced population of indigenous fish, shellfish, and wildlife. Table 1-2 shows the potential sources of pollution within specific areas of Shasta Lake, along with the TMDL priority and the estimated affected area of the pollutants.

Table 1-2. EPA Section 303(d) List of Water Quality Limited Segments, Shasta Lake, 2010

Pollutant	Potential Sources	TMDL Priority	Estimated Area Affected
Horse Creek, Town Creek, and Little Backbone Creek			
Cadmium	Resource extraction	Low	1.5 miles
Copper	Resource extraction	Low	1.5 miles
Lead	Resource extraction	Low	1.5 miles
Zinc	Resource extraction	Low	1.5 miles
All of Shasta Lake			
Mercury	Resource extraction	Low	430 miles
Area where West Squaw Creek enters Squaw Creek Arm of Shasta Lake			
Cadmium	Resource extraction	Low	20 acres
Copper	Resource extraction	Low	20 acres
Zinc	Resource extraction	Low	20 acres

Source: SWRCB 2006

Key:
TMDL = total maximum daily load

Waters discharged by stream channels draining the areas disturbed by the mining of sulfide ore deposits are generally acidic and contain high concentrations of dissolved metals, including iron, copper, and zinc. The streams with the highest metal concentrations are Flat, Little Backbone, Spring, Squaw, Horse, and Zinc creeks (USGS 1978). Dissolved metals concentrations discharged by these streams violate water quality objectives (CVRWQCB 2003a). The sources of the metals are surface and groundwater discharge from underground mines and waters flowing through open pits, tunnels, mine tailings, waste rock, and tertiary deposits that include modern alluvium along

the shoreline. Interaction with sulfide minerals and erosion of metal-rich material commonly result in low pH readings and high metal concentrations.

The sources of the metals in the two areas identified in Table 7-2 in Chapter 7, "Water Quality" of the DEIS, are associated with the Bully Hill/Rising Star mining complex adjacent to the Squaw Creek Arm. Although the mines are no longer operational and remedial action continues, these areas are a documented source of metals and continue to be subject to an abatement order issued by the CVRWQCB. A containment structure constructed sometime during the early 1900s has filled with sediment downstream from the Bully Hill Mine. No information is available on the character of the material stored behind this earth fill dam. In 2006, North State Resources, Inc., conducted a Phase 1 Site Assessment of an area adjacent to, but over a small divide from, the Bully Hill Mine. This assessment documented elevated levels of sulfide minerals in sediment samples and extremely low pH values in surface waters draining the mine (NSR 2007).

Tributaries to the Main Body of Shasta Lake are also a source of metals, along with acid mine drainage from a number of mines in the West Straw Creek and Little Backbone Creek watersheds. In addition to runoff from the historic workings (i.e., adits and portals), a number of large mine tailing deposits are currently leaching various metals into tributaries to Shasta Lake (CVRWQCB 2003a).

Between 2002 and 2003, the CVRWQCB conducted an investigation intended to increase the understanding of the relationship between elevated metal concentrations (dissolved copper and zinc) in discharges from Shasta Dam and the temporal and spatial distribution of these metals within and upslope of Shasta Lake (CVRWQCB 2003a). Specifically, this investigation attempted to answer two questions:

- Why do these elevated metal concentrations appear seasonally?
- Are the concentrations somehow related to the operation of the temperature control device that is attached to the upstream face of Shasta Dam?

In 2003, the CVRWQCB issued an interim report that provided data and limited analysis at 17 sites upstream from Shasta Dam. The data set included 412 discrete samples and included 1,043 specific chemical analyses for various chemical constituents (CVRWQCB 2003a). The interim report offers the following conclusion: "This study shows a direct correlation between dissolved copper concentrations in the upper water column near the dam and dissolved copper concentrations immediately downstream from the dam in the winter months." The report goes on to suggest that this correlation may somehow be related to the operation of the temperature control device as it relates to the seasonal thermocline that develops in Shasta Lake (CVRWQCB 2003a).

Upper Sacramento River (Shasta Dam to Red Bluff)

A major source of metals to the Sacramento River is drainage from inactive mines in the Iron Mountain area of the West Shasta mining district. During mining and smelting activities from the 1880s to the 1960s, Iron Mountain's acid mine drainage discharged directly to Spring Creek, a Sacramento River tributary upstream from Redding (USGS 2000b).

USGS conducted a water quality assessment of trace metal concentrations in the Sacramento River at Big Bend above Red Bluff from February 1996 to May 1998 (USGS 2000b). Although metals concentrations are a serious water quality concern in the project area, metals did not exceed water quality objectives during the study period.

The CVRWQCB has determined that the 25-mile segment of the upper Sacramento River between Keswick Dam and Cottonwood Creek near Balls Ferry in Shasta County is impaired because of levels of dissolved cadmium, copper, and zinc that exceed water quality standards (CVRWQCB 2002). The impairment results primarily from inactive mines in the upper Sacramento River watershed, predominantly the Iron Mountain site upstream from Keswick Dam and other mines upstream from Shasta Dam.

Water quality enhancement actions at the mines and improved coordination of the Spring Creek and Keswick Reservoirs have resulted in a notable decrease in the number of water quality targets exceeded in the past 10 years. However, metal loading remains high enough to cause periodic exceedances (CVRWQCB 2002). The sediments found in the Spring Creek Arm of Keswick Reservoir contain high levels of copper and zinc, which settled out of the contaminated stormwater runoff from the Iron Mountain Mine Superfund site. In 2009 and 2010, EPA dredged and removed contaminated sediments at this location with the goal of protecting the downstream Sacramento River ecosystem during storm events, when contaminated sediments can become mobilized and carried downstream. EPA expects that dredging the contaminated sediments will eliminate the last major threat that contamination from the Iron Mountain Mine poses to human health and the environment (EPA 2009).

High mercury concentrations in the Sacramento River correlate with concentrations of suspended sediment and high flows, because much of the mercury is transported adsorbed to suspended sediments (Domagalski et al. 2000). In May 2000, EPA adopted a water quality objective for total mercury for the Sacramento River watershed of 50 nanograms per liter (ng/L) (30-day average). In a USGS study of mercury levels along the Sacramento River at Big Bend above Red Bluff, conducted from February 1996 to May 1998, mercury levels were consistently below the EPA criterion of 50 ng/L (USGS 2000b).

Lower Sacramento River and Delta

The downstream tributaries Cache Creek and Putah Creek are known to be substantial sources of mercury to the Sacramento River. The Sacramento River

from Knights Landing to the Delta is listed as impaired on EPA's 303(d) list for mercury (CVRWQCB 2002).

The Delta waterways within the area under the CVRWQCB's jurisdiction are listed on EPA's 303(d) list as impaired for mercury from agriculture and historic mining, while the western Delta, under the jurisdiction of the SFBRWQCB, is listed as impaired for mercury, nickel, and selenium. The primary sources of mercury are abandoned mine sites in the upper watershed that drain into the lower Sacramento River and Delta. The City of Sacramento is also the largest urban source of nitrogen, mercury, and assorted other urban waste products. Selenium concentrations are attributed to agriculture and oil refiners, while the primary source of nickel is unknown (SWRCB 2006).

CVP/SWP Service Areas

Water quality in the CVP and SWP service areas is affected by fluctuations of water quality in the south Delta, which in turn are influenced by water quality in the San Joaquin River, CVP and SWP export pumping rates, local agricultural diversions and drainage water, and the Sacramento River (CALFED 2000c).

Salinity and Dissolved Solids

The following discussion of the affected environment in the study areas with regard to salinity and dissolved solids is limited to a discussion of conditions in the lower Sacramento River and Delta portion of the extended study area because of the potential effects of salinity in this geographic area on beneficial uses. Salinity is particularly important in the Delta, which is influenced by tidal exchange with San Francisco Bay; during low-flow periods, seawater intrusion results in increased salinity.

Extended Study Area

Lower Sacramento River and Delta Water quality in the Delta is continually changing in response to natural hydrologic conditions, operation of upstream reservoirs, agricultural and water supply diversions, and discharges into the Delta system. Seasonal trends reflect the effects of higher spring/summer runoff and fall/winter low-flow periods.

Recognized water quality issues in the Delta include the following (Reclamation and DWR 2005):

- High salinity from Suisun Bay intrudes into the Delta during periods of low Delta outflow. Salinity can adversely affect agricultural, M&I, and recreational uses.

- Delta exports contain elevated concentrations of disinfection byproduct precursors (e.g., dissolved organic carbon (DOC)), and the presence of bromide increases the potential for formation of brominated compounds in treated drinking water.

- Agricultural drainage in the Delta contains high levels of nutrients, suspended solids, DOC and minerals (salinity), as well as agricultural chemicals (pesticides).

- Synthetic and natural contaminants have bioaccumulated in Delta fish and other aquatic organisms. Synthetic organic chemicals and heavy metals are found in Delta fish in quantities occasionally exceeding acceptable standards for food consumption.

- The San Joaquin River delivers water of relatively poor quality to the Delta, with agricultural drainage to the river being a major source of salts and pollutants. Because the south Delta receives a substantial portion of water from the San Joaquin River, the influence of this relatively poor San Joaquin River water quality is greatest in the south Delta channels and in the CVP and SWP exports.

Trends in water quality in the Delta reflect the effects of river inflows, tidal exchanges with San Francisco Bay, diversions, and pollutant releases in the Delta. The north Delta tends to have better water quality primarily because of inflow from the Sacramento River. The quality of water in the west Delta is strongly influenced by tidal exchange with San Francisco Bay; during low-flow periods, seawater intrusion results in increased salinity. In the south Delta, water quality tends to be poorer because of the combination of inflows of poorer water quality from the San Joaquin River, discharges (agricultural return flows) from Delta islands, export pumping, seasonal agricultural barriers, and effects of diversions that can sometimes increase seawater intrusion from San Francisco Bay.

The California Department of Water Resources (DWR), Reclamation, USGS, California Data Exchange Center (CDEC), various water and reclamation districts, and various cities monitor water quality in the Delta. City of Stockton Department of Municipal Utilities et al. (2003) discusses water quality data collected historically near the proposed intake site by these agencies. In general, water quality improves from upstream to downstream in the Delta (northwesterly direction). This improvement is due primarily to dilution from higher flows and the quality of the Sacramento River inflow that is drawn southwards to the CVP and SWP pumping plants.

Table 1-3 identifies current mean water quality concentrations of selected constituents at various locations in the Delta. As shown, water quality of the north Delta is generally higher than in the south Delta.

Table 1-3. Water Quality for Selected Stations in the Delta

Location	Mean TDS (mg/L)	Mean EC (µmhos/ cm)	Mean Chloride (mg/L)	Mean Bromide (mg/L)	Mean DOC (mg/L)
Sacramento River at Greene's Landing	100	160	6.8	0.018	2.5
North Bay Aqueduct at Barker Slough	192	332	26	0.015	5.3
Clifton Court Forebay	286	476	77	0.269	4.0
CVP Jones Pumping Plant	258	482	81	0.269	3.7
CCWD Intake at Rock Slough	305	553	109	0.455	3.4
San Joaquin River at Vernalis	459	749	102	0.313	3.9

Sources: CALFED 2000c; data provided by Environmental Science Associates ESA in 2004

Note:
Sampling period varies, depending on location and constituent, but generally is between 1990 and 1998.

Key:
µmhos/cm = micromhos per centimeter
CCWD = Contra Costa Water District
CVP = Central Valley Project
Delta = Sacramento-San Joaquin Delta
DOC = dissolved organic carbon
EC = electrical conductivity
mg/L = milligrams per liter
TDS = total dissolved solids

Salinity Excess salinity in Delta waters may affect M&I and agricultural water supply beneficial uses, as well as habitat quality for aquatic biota in the Delta. Sources of salinity include seawater intrusion, agricultural drainage, municipal wastewater, urban runoff, connate groundwater, and evapotranspiration of plants. Seawater intrusion is the major source of salinity in the Delta (CALFED 2000c).

TDS and EC are measures of dissolved salts in water. Because the EC of water generally changes proportionately to changes in dissolved salt concentrations, EC is often measured rather than salinity. In fresher waters, TDS is measured instead of salinity. Based on DWR's Municipal Water Quality Investigations (MWQI) data for Delta channels, TDS is approximately equal to EC times 0.58 (CALFED 2000c).

Salinity control in the Delta is necessary since the Delta is influenced by the ocean, and Delta water channels are at or below sea level. Unless repelled by continuous seaward flow of freshwater, seawater will advance up the estuary and into the Delta and degrade water quality. Salinity varies geographically and seasonally within the Delta, and also varies depending on water year type (SWRCB 1997).

CVP and SWP exports and pumping patterns have the potential to influence the direction of flow at various locations throughout the Delta, and thereby have the

potential to affect the salinity at export locations. Operation of the Banks and Jones pumping plants draws high quality Sacramento River water across the Delta and restricts the low quality area to the southeast corner (SWRCB 1997). Each portion of the Delta is dominated by different hydraulic variables and, therefore, salinity varies within different sections of the Delta.

The Sacramento and San Joaquin rivers contribute approximately 61 percent and 33 percent, respectively, to tributary inflow TDS concentrations within the Delta. TDS concentrations are relatively low in the Sacramento River, but because of its large volumetric contribution, the river provides the majority of the TDS load supplied by tributary inflow to the Delta (DWR 2001). Although actual flow from the San Joaquin River is lower than from the Sacramento River, TDS concentrations in San Joaquin River water average approximately seven times that in the Sacramento River.

In addition to varying geographically within the Delta, salinity varies seasonally, depending on the quantity and quality of freshwater inflows. During winter and early spring, flows through the Delta are usually above the minimum required to control salinity. However, for a few months in summer and fall of most years, salinity must be carefully monitored and controlled (SWRCB 1997). During the summer, salinity in the Delta may increase due to decreased inflows or increased salt loading resulting from agricultural runoff. Additionally, decreased inflow during late summer increases the possibility that reverse flow could cause increased salt water intrusion within the Delta. Salinity control and monitoring is provided by the CVP and SWP, and regulated by the SWRCB under its water rights authority. Salinity is carefully monitored because water exported from the Delta for delivery to CVP and SWP contractors is used for a variety of M&I and agricultural uses (SWRCB 1997).

Table 1-3 shows that mean TDS concentrations are highest in the western Delta and the south Delta channels that are affected by the San Joaquin River (CALFED 2000c). Salinity problems in the western Delta result primarily from the intrusion of saline water from the San Francisco Bay system. The extent of seawater intrusion into the Delta is a function of daily tidal fluctuations, freshwater inflow from the Sacramento and San Joaquin rivers, the rate of export at the CVP/SWP intake pumps, and the operation of various control structures (e.g., Delta Cross Channel Gates and Suisun Marsh Salinity Control System) (DWR 2001). In the south Delta, salinity is largely associated with the high salt concentrations carried by the San Joaquin River into the Delta (SWRCB 1997). The high mean TDS concentration in the San Joaquin River at Vernalis reflects the accumulation of salts in agricultural soils and the effects of recirculation of these salts via the Delta-Mendota Canal (CALFED 2000c). Locations in the north Delta at Barker Slough, which is not substantially affected by seawater intrusion, and in the Sacramento River at Greene's Landing, have lower mean concentrations of TDS. A similar pattern is also seen using mean EC levels as a surrogate for TDS concentrations (Reclamation and DWR 2003).

Seasonal changes in chloride concentrations occur in the Delta. The lowest mean concentrations of chloride typically occur in early spring and early summer (March through July) (CALFED 2000c). Salinity patterns in the Delta also vary with water year type (DWR 2001). Salinity is higher in dry years than in wet years.

Bromide The primary source of bromide in the Delta is saltwater intrusion. Other sources include drainage returns in the San Joaquin River and the Delta, connate water (saline water trapped in sediment when the sediment was deposited) beneath some Delta islands, and possibly agricultural applications of methyl bromide. River and agricultural irrigation sources are primarily a recycling of bromide that originated from seawater intrusion. As shown in Table 1-3, TDS, EC, bromide, and chloride data indicate that seawater intrusion is highest in the western and southern portions of the Delta, where the direct effects of recirculated bromide from the San Joaquin River exist (DWR 2001).

Overall, bromide patterns in the Delta are similar to salinity patterns in the Delta (DWR 2001). Like salinity, bromide concentrations are highest in the west and south Delta channels affected by the San Joaquin River (DWR 2001). Like salinity, bromide concentrations are higher in dry years than in wet years and bromide concentrations are higher during low Delta outflows as compared to medium or high flows (DWR 2001).

Bromide is important from a drinking water perspective because during chlorination for disinfection of drinking water, bromide reacts with natural organic compounds in the water to form disinfectant byproducts (DBP) such as trihalomethanes (THM). Four types of THMs are regulated in drinking water, including chloroform, bromodichloromethane, dibromochloromethane, and bromoform.

Organic Carbon Naturally occurring organic carbon compounds are present in surface waters as a result of degradation of plant and animal tissues. Two forms of organic carbon occur in surface waters: (1) DOC, which is a measure of the organic carbon dissolved in the water, and (2) total organic carbon (TOC), which is a measure of all organic carbon in the water, including organic carbon from particulate matter such as plant residues and DOC. Organic carbon is important because of its role in the formation of DBPs, specifically THMs.

The Sacramento and San Joaquin rivers, and in-Delta island drainage return flows, are important sources of DOC and TOC to the Delta (CALFED 2000c). Of the DOC loading contributed by tributary inflow, the Sacramento River is the major contributor to the Delta carbon load, contributing an estimated 71 percent of the total carbon load attributed to tributary inflow in the Delta (DWR 2001). The Sacramento River is a major contributor because although its carbon concentrations are relatively low, approximately three-quarters of the inflow to the Delta come from the Sacramento River (DWR 2001). The San Joaquin

River contributes approximately 20 percent of the total carbon load attributed to tributary inflow in the Delta (DWR 2001).

Drainage from Delta islands, particularly islands with highly organic peat soils, contributes significantly to the DOC load in the Delta (DWR 2001). Studies conducted by DWR (2001) suggest that during winter, 38–52 percent of the DBP-forming carbon in the Delta is contributed by Delta island drainage; while during summer irrigation, island drainage contributes 40–45 percent of the DBP-forming carbon. In general, monitoring data suggest that most of the TOC in the Delta is in the form of DOC (CALFED 2000c).

Similar to salinity and bromide, organic carbon concentrations in the Delta vary both geographically and seasonally. Like salinity and bromide, organic carbon concentrations are higher in west and south Delta locations (the San Joaquin River near Vernalis and Banks Pumping Plant) than in the Sacramento River at Greene's Landing (Table 1-3). However, unlike salinity and bromide, organic carbon concentrations are typically lowest in summer and higher during rainy winter months.

Regulatory Framework

Several regulatory authorities at the Federal, State, and local levels control the flow, quality, and supply of water in California either directly or indirectly. This section of this chapter focuses on those laws related directly to the water quality aspect of the project.

Management of the Delta is partly determined by Federal and State regulations developed to protect both human and environmental beneficial uses. Primary institutional and regulatory influences on the use and management of the Delta include the Federal CVP, the SWP, direct Delta diverters, including Contra Costa Water District (CCWD), Solano County Water Agency (SCWA), and the City of Stockton Metropolitan Area (COSMA), San Francisco Bay water quality needs, and multiple regulations covering protection of endangered species.

At the State level, the SWRCB and the regional water quality control boards (RWQCB) regulate and monitor Delta water quality. Nine regional boards oversee water quality in California. Two of these, the CVRWQCB and SFBRWQCB, oversee Delta water quality. EPA also plays an important role under the auspices of the CWA and Safe Drinking Water Act (SDWA). The California Department of Public Health (DPH) has an interest in the Delta because the Delta is the source of drinking water for over 23 million Californians. DWR extensively monitors Delta water quality as part of its MWQI program and DWR, in cooperation with Reclamation, monitors Delta water quality under the SWRCB's compliance monitoring requirements.

At the local level, water agencies that divert from the Delta have both strong interest in and influence on Delta water quality management. These agencies include CCWD, SCWA, and COSMA.

Two agencies with key planning roles in the Delta are the California Bay-Delta Authority and the Delta Protection Commission. The California Bay-Delta Authority became a State agency in January 2003, and is responsible for implementing the CALFED Bay-Delta Program (CALFED). State legislation created the Delta Protection Commission in 1992 with the goal of developing regional policies for the Delta to protect and enhance existing land uses. In 2000, the Commission was made a permanent State agency. The Delta Protection Commission comments on applications for CALFED ecosystem restoration grants that affect the Delta and participates in meetings with other CALFED agencies to provide input to CALFED management decisions.

Federal

Safe Drinking Water Act

The SDWA was established to protect the quality of drinking water in the United States. The SDWA authorized EPA to set National health-based standards for drinking water and requires many actions to protect drinking water and its sources, including rivers, lakes, reservoirs, springs, and groundwater wells. Furthermore, the SDWA requires all owners or operators of public water systems to comply with primary (health-related) standards. EPA has delegated to the DPH, Division of Drinking Water and Environmental Management, the responsibility for administering California's drinking-water program. DPH is accountable to EPA for program implementation and for adopting standards and regulations that are at least as stringent as those developed by EPA. Contaminants of concern relevant to domestic water supply are defined as those that pose a public health threat or that alter the aesthetic acceptability of the water. These types of contaminants are regulated by EPA primary and secondary maximum contaminant levels (MCL) that are applicable to treated water supplies delivered to the distribution system. MCLs and the process for setting these standards are reviewed triennially.

Clean Water Act

The CWA is the major Federal legislation governing the water quality aspects of the project. The objective of the act is "to restore and maintain the chemical, physical, and biological integrity of the nation's waters." The CWA establishes the basic structure for regulating discharge of pollutants into the waters of the United States and gives EPA the authority to implement pollution control programs such as setting wastewater standards for industries (EPA 2008). In certain states such as California, EPA has delegated authority to state agencies.

Section 303 This section of the CWA requires states to adopt water quality standards for all surface waters of the United States. The three major components of water quality standards are as follows:

- **Designated uses** – Uses that society, through the Federal and State governments, determines should be attained in the water body, such as supporting communities of aquatic life, supplying water for drinking, irrigating crops and landscaping, and industrial purposes, and recreational uses (e.g., fishing, swimming, boating).

- **Water quality criteria** – Levels of individual pollutants or water quality characteristics, or descriptions of conditions of a water body that, if met, will generally protect the designated use of the water. Water quality criteria must be scientifically consistent with attainment of designated uses, which means that only scientific considerations can be taken into account when determining what water quality conditions are consistent with meeting a given designated use. Economic and social impacts are not considered when developing water quality criteria.

- **Antidegradation policy** – Designed to prevent deterioration of existing levels of good water quality (see the "Antidegradation Policy" section below for more information).

Where multiple uses exist, water quality standards must protect the most sensitive use. In California, EPA has given the SWRCB and its nine RWQCBs the authority to identify beneficial uses and adopt applicable water quality objectives.

Section 303(d) of the CWA requires states and authorized Native American tribes to develop a list of water quality–impaired segments of waterways. The list includes waters that do not meet water quality standards necessary to support the beneficial uses of that waterway, even after point sources of pollution have installed the minimum required levels of pollution control technology. Only waters impaired by "pollutants," not those impaired by other types of "pollution" (e.g., altered flow and/or channel modification), are to be included on the list.

Section 303(d) of the CWA also requires states to maintain a listing of impaired water bodies so that a TMDL can be established A TMDL is a plan to restore the beneficial uses of a stream or to otherwise correct an impairment. It establishes the allowable pollutant loadings or other quantifiable parameters (e.g., pH or temperature) for a water body and thereby provides the basis for the establishment of water quality–based controls. The calculation for establishment of TMDLs for each water body must include a margin of safety to ensure that the water body can be used for the purposes the State has designated. Additionally, the calculation also must account for seasonal variation in water quality (EPA 2011). The CVRWQCB develops TMDLs for the Sacramento River (see discussion on the Porter-Cologne Water Quality Control Act below). Sedimentation/siltation impacts are the primary water quality parameters of concern with construction projects.

Reductions in pollutant loading are achieved by implementing strategies authorized by the CWA, such as the following, which are discussed in more detail below.

- **Section 401** – This section of the CWA requires Federal agencies to obtain certification from the State or Native American tribes before issuing permits that would result in increased pollutant loads to a water body. The certification is issued only if such increased loads would not cause or contribute to exceedances of water quality standards.

- **Section 402** – This section creates the National Pollutant Discharge Elimination System (NPDES) permit program. This program covers point sources of pollution discharging into a surface water body.

- **Section 404** – This section regulates the placement of dredged or fill materials into wetlands and other waters of the United States.

Section 401 – Water Quality Certification This section of the CWA requires an applicant for any Federal license or permit (e.g., a Section 404 permit) that may result in a discharge into waters of the United States to obtain a certification from the State that the discharge would comply with provisions of the CWA. The SWRCB and RWQCBs administer this program. The SWRCB issues 401 certifications for projects that would take place in two or more regions. Any condition of a 401 certification (or water quality certification) would be incorporated into the U.S. Army Corps of Engineers (USACE) permit.

The CVRWQCB has jurisdiction over the primary study area, while the extended study area encompasses the San Francisco Bay, Central Coast, Los Angeles, Lahontan, Colorado River basin, and the Santa Ana and San Diego RWQCBs. A 401 certification would not be required from the RWQCBs within the extended study area because no construction would occur in the extended study area.

Section 402 – National Pollutant Discharge Elimination System All point sources that discharge into waters of the United States must obtain a NPDES permit under provisions of Section 402 of the CWA. As with Section 401, the SWRCB and RWQCBs are responsible for the implementation of the NPDES permitting process at the State and regional levels, respectively.

The NPDES permit process also provides a regulatory mechanism for the control of nonpoint source pollution created by runoff from construction and industrial activities, and general and urban land use, including runoff from streets. Projects involving construction activities (e.g., clearing, grading, or excavation) involving land disturbance greater than one acre must file a Notice of Intent (NOI) with the appropriate RWQCB(s) to indicate their intent to comply with the General Permit for Discharges of Storm Water Associated with Construction Activity (Construction General Permit 99-08-DWQ). This general

permit establishes conditions to minimize sediment and pollutant loadings and requires preparation and implementation of a storm water pollution prevention plan (SWPPP) before construction. The SWPPP is intended to help identify the sources of sediment and other pollutants, and to establish best management practices (BMP) for stormwater and nonstormwater source control and pollutant control. A sediment monitoring plan must be included in the SWPPP if the discharges occur directly to a water body listed on the 303(d) TMDL list for sediment.

The CVRWQCB has jurisdiction over the primary study area. An NPDES would not be required from the RWQCBs within the extended study area because no construction would occur.

Section 404 – Discharge of Dredged or Fill Material into Waters of the United States Section 404 deals with one broad type of pollution—the placement of dredged or fill material into "waters of the United States." Jurisdictional limits of these features are typically noted by the ordinary high-water mark. Isolated ponds or seasonal depressions had been previously regulated as waters of the United States. However, in *Solid Waste Agency of Northwestern Cook County (SWANCC) v. United States Army Corps of Engineers et al.* (January 8, 2001), the U.S. Supreme Court ruled that certain "isolated" wetlands (e.g., nonnavigable, isolated, and intrastate) do not fall under the jurisdiction of the CWA and are no longer under USACE jurisdiction. Some circuit courts (e.g., *U.S. v. Deaton*, 2003; *U.S. v. Rapanos*, 2003; *Northern California River Watch v. City of Healdsburg*, 2006), however, have ruled that SWANCC does not prevent CWA jurisdiction if a "significant nexus" such as a hydrologic connection exists. The hydrologic connection may be human-made (e.g., roadside ditch) or a natural tributary to navigable waters, or direct seepage from the wetland to the navigable water, a surface or underground hydraulic connection. An ecological connection (e.g., the same bird, mammal, and fish populations are supported by both the wetland and the navigable water) and changes to chemical concentrations in the navigable water caused by water from the wetland may also constitute a significant nexus.

The discharge of dredge or fill generally includes the following activities:

- Placement of fill that is necessary for the construction of any structure or infrastructure in a water of the United States
- The building of any structure, infrastructure, or impoundment requiring rock, sand, dirt, or other material for its construction
- Site-development fills for recreational, industrial, commercial, residential, or other uses
- Causeways or road fills

- Dams and dikes
- Artificial islands
- Property protection and/or reclamation devices such as riprap, groins, seawalls, breakwaters, and revetments
- Beach nourishment
- Levees
- Fill for structures such as sewage treatment facilities, intake and outfall pipes associated with powerplants, and subaqueous utility lines
- Placement of fill material for construction or maintenance of any liner, berm, or other infrastructure associated with solid waste landfills
- Placement of overburden, slurry, mine tailing deposits, or similar mining-related materials
- Artificial reefs

USACE regulations and policies mandate avoiding the filling of wetlands unless it can be demonstrated that no practicable alternatives (to filling wetlands) exist. Four basic processes exist for obtaining Section 404 authorization from USACE. Because of its scale and potential impact, this project would require an individual permit.

USACE's Sacramento District has jurisdiction over the primary study area, but the extended study area encompasses the USACE's San Francisco and Los Angeles Districts.

Antidegradation Policy

The Antidegradation Policy, established in 1968 and revised in 2005 (Title 40, Code of Federal Regulations, Section 131.12), is designed to protect existing uses and water quality and National water resources, as authorized by Section 303(c) of the CWA. At a minimum, the policy and implementation methods must be consistent with the following:

- Existing instream water uses and the level of water quality necessary to protect the existing uses shall be maintained and protected.
- Where the quality of the waters exceeds 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 that allowing lower water quality is necessary to accommodate important economic or social development in the area in which the

waters are located. In allowing such degradation or lower water quality, the State shall assure water quality adequate to protect existing uses fully. Further, the State shall assure that there shall be achieved the highest statutory and regulatory requirements for all new and existing point sources and all cost-effective and reasonable BMPs for nonpoint source control.

- 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.

Although the quality of water in the upper Sacramento River is relatively good, water quality problems do occur, including the presence of mercury, pesticides such as organochlorine pesticides, trace metals, turbidity, and toxicity from unknown origin (CALFED 2000a).

The CWA requires states to maintain a listing of impaired water bodies so that a TMDL can be established. A TMDL is a plan to restore the beneficial uses of a stream or to otherwise correct an impairment. The most prevalent contaminants in the Sacramento River basin are for organophosphate pesticides (agricultural runoff) and trace metals (acid mine drainage), for which TMDLs currently are being considered. Only during conditions of stormwater-driven runoff are water quality objectives typically not met (Domagalski et al. 2000).

Shasta-Trinity National Forest Land and Resource Management Plan

The Shasta-Trinity National Forest Land and Resource Management Plan (STNF LRMP) contains Forest goals, standards, and guidelines designed to guide the management of STNF. The following goals, standards, and guidelines related to water quality issues associated with the study areas were excerpted from the STNF LRMP (USFS 1995).

Water Quality

Goals (LRMP, p.4-6)

- Maintain or improve water quality and quantity to meet fish habitat requirements and domestic use needs.

- Maintain water quality to meet or exceed applicable standards and regulations.

Standards and Guidelines (LRMP, p. 4-25)

- Implement BMPs for protection or improvement of water quality, as described in “Water Quality Management for National Forest System Lands in California,” for applicable management activities. Determine specific practices or techniques during project level planning using

information obtained from on-site soil, water, and geology investigations.

Best Management Practices

Standards and Guidelines (LRMP, Appendix E)

- STNF water quality BMPs were developed in compliance with Section 208 of the CWA, Public Law 92-500, as amended and are certified by the RWQCB and approved by EPA. The following BMPs are applicable to the proposed action:

Road Building and Site Construction

Standards and Guidelines (LRMP, Appendix E, pp. E-2 through E-3)

- General guidelines for the location and design of roads
- Erosion control plan
- Timing of construction activities
- Road slope stabilization (preventive practice)
- Road slope stabilization (administrative practice)
- Dispersion of subsurface drainage from cut and fill slopes
- Control of road drainage
- Construction of stable embankments
- Minimization of sidecast material
- Servicing and refueling equipment
- Control of construction in riparian management zones
- Controlling in-channel excavation
- Diversion of flows around construction sites
- Bridge and culvert installation
- Disposal of right-of-way and roadside debris
- Specifying riprap composition
- Maintenance of roads

- Road surface treatment to prevent loss of materials
- Traffic control during wet periods
- Surface erosion control at facility sites

Recreation

Standards and Guidelines (LRMP, Appendix E, p. E-3)

- Sampling and surveillance of designated swimming sites
- On-site interdisciplinary sanitary surveys will be conducted to augment the sampling of swimming waters
- Documentation of water quality data
- Control of sanitation facilities
- Control of refuse disposal
- Protection of water quality within developed and dispersed recreation areas

U.S. Bureau of Land Management

The U.S. Bureau of Land Management's (BLM) Resource Management Plan (RMP), which is its plan for managing Federal lands in Shasta County, was amended by the 1994 Record of Decision (ROD) for the Northwest Forest Plan (Final Supplemental Environmental Impact Statement (EIS) for Amendments to Forest Service and Bureau of Land Management Planning Documents within the Range of the Northern Spotted Owl). This amendment required preparation of Watershed Analysis before initiating BLM activities. As a party to the Northwest Forest Plan, BLM, like USFS, is also required to ensure that projects are consistent with the Aquatic Conservation Strategy.

Biological Opinions on the Long-term Central Valley Project and State Water Project Operations Criteria and Plan

Since 2004, NMFS and USFWS BOs regarding effects of the proposed OCAP have been revised twice. On October 22, 2004, NMFS issued a BO regarding effects of the proposed OCAP for the CVP in coordination with the SWP on winter-run Chinook salmon, spring-run Chinook salmon, Central Valley steelhead, Southern Oregon/Northern California Coast Coho salmon, and Central California Coast steelhead and their designated critical habitat. On February 16, 2005, USFWS issued a BO regarding effects of the proposed OCAP on delta smelt. The 2004 and 1995 BOs supersede the prior BOs issued by NMFS and USFWS, and contain reasonable and prudent measures and terms and conditions that specify fisheries monitoring actions, spawning gravel augmentation, forecasting of deliverable water, management of cold-water

supply within reservoirs, temperature monitoring, adaptive management processes to analyze annual cold-water management, minimization of flow fluctuations, passage at Red Bluff Diversion Dam, operation of gates in the Delta, fish screening at pumping facilities, and numerous other effects minimization measures. In response to litigation, the 2004 and 2005 BOs were remanded to USFWS and NMFS.

In August 2008, Reclamation reinitiated consultation with the fishery agencies based on the 2008 *Biological Assessment on the Continued Long-Term Operations of the CVP and SWP* (2008 OCAP BA). In December 2008, the USFWS issued a new BO, *Formal Endangered Species Act Consultation on the Proposed Coordinated Operations of the CVP and SWP,* finding that the long-term operations of the CVP and SWP would jeopardize the continued existence of the Delta smelt. In July 2009, NMFS issued a new BO finding that the same operations would jeopardize populations of listed salmonids, steelhead, green sturgeon and orcas. Because both agencies made jeopardy determinations, both agencies included a reasonable and prudent alternative (RPA) in their BOs.

In response to lawsuits challenging the 2008 and 2009 BOs, the District Court for the District Court remanded the BOs to USFWS and NMFS in 2010 and 2011, respectively. The District Court ordered USFWS and Reclamation to prepare a final BO and associated final NEPA document by December 1, 2013. Similarly, the District Court ordered NMFS and Reclamation to prepare a final BO and associated final NEPA document by February 1, 2016. These legal challenges may result in changes in CVP and SWP operational constraints, if the revised USFWS and NMFS BOs contain new or amended RPAs. Despite this uncertainty, the 2008 OCAP BA and the 2008 and 2009 BOs issued by the fishery agencies contain the most recent estimate of potential changes in water operations that could occur in the near future. Furthermore, it is anticipated that the final BOs issued by the resource agencies will contain similar RPAs.

State

Porter-Cologne Water Quality Control Act

The Porter-Cologne Water Quality Control Act (Porter-Cologne Act) is California's statutory authority for the protection of water quality. Under the act, the State must adopt water quality policies, plans, and objectives protecting the State's waters for the use and enjoyment of the people. Obligations of the SWRCB and RWQCBs to adopt and periodically update their basin plans are set forth in the act. A basin plan identifies the designated beneficial uses for specific surface water and groundwater resources, applicable water quality objectives necessary to support the beneficial uses, and implementation programs that are established to maintain and protect water quality from degradation for each of the RWQCBs. The act also requires waste dischargers to notify the RWQCBs of their activities through the filing of reports of waste discharge (RWD) and authorizes the SWRCB and RWQCBs to issue and enforce waste discharge requirements (WDR), NPDES permits, Section 401

water quality certifications, or other approvals. The RWQCBs also have authority to issue waivers to RWDs/WDRs for broad categories of "low threat" discharge activities that have minimal potential for adverse water quality effects when implemented according to prescribed terms and conditions.

The CVRWQCB Basin Plan (originally published in 1998, last revised in September 2009) (CFRWQCB 2009) regulates waters of the State located within the primary study area. The CVRWQCB Basin Plan covers an area including the Sacramento and San Joaquin River basins, involving an area bounded by the crests of the Sierra Nevada on the east and the Coast Range and Klamath Mountains on the west. The area covered in the CVRWQCB Basin Plan extends some 400 miles, from the California/Oregon border southward to the headwaters of the San Joaquin River, encompassing a substantial portion of the extended study area. The beneficial uses of the Sacramento River are as follows (CVRWQCB 2009):

- Municipal and domestic supply
- Irrigation and stock watering
- Service supply
- Power
- Contact recreation and canoeing and rafting
- Other noncontact recreation
- Freshwater habitat (warm and cold)
- Migration habitat (warm and cold)
- Spawning habitat (warm and cold)
- Wildlife habitat
- Navigation

The Basin Plan recognizes Shasta Reservoir (i.e., Shasta Lake) as a discrete water body and identifies a number of specific beneficial uses:

- Municipal and domestic supply
- Agricultural supply
- Hydropower generation
- Water contact recreation

- Noncontact recreation
- Freshwater habitat (warm and cold)
- Spawning, reproduction, and/or early development
- Wildlife habitat

The CVRWQCB has also promulgated water quality objectives for all surface waters in the Sacramento and San Joaquin River basins (CVRWQCB 2009) for the following:

- Bacteria levels
- Biostimulatory substances
- Chemical constituents
- Color
- Dissolved oxygen
- Floating material
- Methylmercury
- Oil and grease
- pH
- Pesticides
- Radioactivity
- Salinity
- Sediment
- Settleable material
- Suspended material
- Tastes and odors
- Temperature
- Toxicity
- Turbidity

Primary Study Area The CVRWQCB determined that the 25-mile reach of the Sacramento River from Keswick Dam downstream to Cottonwood Creek is impaired because the water periodically contains levels of dissolved cadmium, copper, and zinc that exceed levels identified to protect aquatic organisms. Consequently, the CVRWQCB developed a TMDL program for dissolved cadmium, copper, and zinc loading into the upper Sacramento River because of these exceedances of water quality standards (CVRWQCB). No other TMDLs have been finalized for this area (CVRWQCB 2007a).

Extended Study Area The Sacramento River downstream from RBPP was listed as an impaired water body under Section 303(d) of the CWA. The parameters of concern in this reach included diazinon, mercury and unknown sources of toxicity (CVRWQCB 2003b). A few TMDLs are under development for the Sacramento River, including diazinon, methylmercury, and chlorpyrifos (CVRWQCB 2007b). The extended study area encompasses the San Francisco, Central Coast, Los Angeles, Lahontan, Colorado River basin, and the Santa Ana and San Diego RWQCBs.

RWQCBs are responsible for preparing and adopting basin plans, as 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. Basin plans are regulatory references for meeting the State and Federal requirements for water quality. Each basin plan designates beneficial uses for the waters within the area covered by the plan, water quality objectives to protect those uses, and a program for achieving the objectives.

The Basin Plan for the Sacramento and San Joaquin River basins was prepared by the CVRWQCB. The Basin Plan was first adopted in 1975 and has since been updated. The most recent edition, the fourth edition, was adopted in 1998 and amended in 2004. The Basin Plan recognizes Shasta Reservoir (i.e., Shasta Lake) as a discrete water body and identifies a number of specific beneficial uses:

- **Municipal and domestic supply** – Uses of water for community, military, or individual water supply systems, including, but not limited to, drinking water supply.
- **Agricultural supply** – Uses of water for farming, horticulture, or ranching, including, but not limited to, irrigation (including leaching of salts), stock watering, or support of vegetation for range grazing.
- **Hydropower generation** – Uses of water for hydropower generation.
- **Water contact recreation** – Uses of water for recreational activities involving body contact with water where ingestion of water is

reasonably possible. These uses include, but are not limited to, swimming, wading, water-skiing, water boarding, fishing, or use of personal watercraft.

- **Noncontact recreation** – Uses of water for recreational activities involving proximity to water, but where there is generally no body contact with water nor any likelihood of ingestion of water. These uses include, but are not limited to, picnicking, sunbathing, hiking, camping, boating, hunting, sightseeing, or aesthetic enjoyment in conjunction with the above activities.

- **Freshwater habitat:**

  – **Warm freshwater habitat** – Uses of water that support warm water ecosystems, including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish (e.g., black bass, catfish), or wildlife, including invertebrates.

  – **Cold freshwater habitat** – Uses of water that support cold-water ecosystems, including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish (e.g., salmon, trout), or wildlife, including invertebrates.

- **Spawning, reproduction, and/or early development** – Uses of water that support high-quality aquatic habitats suitable for reproduction and early development of fish (i.e., warm water for bass; cold water for salmon and trout).

- **Wildlife habitat** – Uses of water that support terrestrial or wetland ecosystems, including, but not limited to, preservation and enhancement of terrestrial habitats or wetlands, vegetation, wildlife (e.g., mammals, birds, reptiles, amphibians, invertebrates), or wildlife water and food sources.

The Basin Plan provides the foundation for assessing the water quality of Shasta Lake and ensuring that any waste water discharges are in compliance with the Basin Plan. The following discussion provides an overview of the history and regulatory requirements for waste water discharges in Shasta Lake.

Clean Water Act Section 401 Water Quality Certification

The CVRWQCB, under the auspices of the SWRCB, requires that a project proponent obtain a Clean Water Act Section 401 water quality certification in conjunction with the Section 404 permits granted by the Corps. Since the project would have the potential to affect water quality in Shasta Lake, the CVRWQCB is likely to impose water quality limitations on the project through waste discharge requirements. Reclamation will prepare and submit to the RWQCB a request for water quality certification prior to development of the project. A likely condition of the water quality certification is preparation of an

erosion and sedimentation control plan and a spill prevention and containment plan.

Waste Discharge Permit

The CVRWQCB controls the discharge of wastes to surface waters from industrial processes or construction activities through the NPDES permit process. Waste discharge requirements are established in the permit to protect beneficial uses. The CVRWQCB will require an application for a waste discharge permit for the project.

Industrial Storm Water General Permit

The Industrial Storm Water General Permit (General Industrial Permit) is an NPDES permit that regulates discharges associated with 10 broad categories of industrial activities. This permit requires the implementation of management measures that will achieve the performance standard of best available technology economically achievable and best conventional pollutant control technology. This permit also requires the development of a SWPPP and a monitoring plan. Through the SWPPP, sources of pollutants are to be identified and the means to manage the sources to reduce stormwater pollution are described.

Storm Water Pollution Prevention Plan

The General Industrial Permit includes provisions for developing a SWPPP to maximize the potential benefits of pollution prevention and sediment- and erosion-control measures at construction sites. Developing and implementing a SWPPP would provide Reclamation with the framework for reducing soil erosion and minimizing pollutants in stormwater during project construction.

Water Quality Control Plan for the Control of Temperature in the Coastal and Interstate Waters and Enclosed Bays and Estuaries of California

The Water Quality Control Plan for the Control of Temperature in the Coastal and Interstate Waters and Enclosed Bays and Estuaries of California (Thermal Plan) sets limits for "thermal waste" and "elevated temperature waste" discharged into coastal and interstate waters and enclosed bays and estuaries of California (SWRCB no date). Estuarine waters are considered to extend from "…a bay or the open ocean to the upstream limit of tidal action" (SWRCB no date). This definition includes the Delta as defined by Section 12220 of the California Water Code, as well as portions of the Sacramento River that are subject to tidal action. Generally, the Basin Plan defines temperature objectives in two parts (CVRWQCB 2009):

> *At no time or place shall the temperature of COLD or WARM intrastate waters be increased more than 5°F above natural receiving water temperature…*
>
> *The temperature shall not be elevated above 56°F in the reach from Keswick Dam to Hamilton City nor above 68°F in the*

reach from Hamilton City to the I Street Bridge during periods when temperature increases will be detrimental to the fishery.

The first water quality standards for the Delta were adopted in May 1967, when the State Water Rights Board (predecessor to the SWRCB) released Water Right Decision 1275 (D-1275), approving water rights for the SWP while setting agricultural salinity standards as terms and conditions. Since then, these requirements were changed in 1971 under Water Right Decision 1379 (D-1379), and again in 1978 under Water Right Decision 1485 (D-1485) and the Water Quality Control Plan (WQCP) for the Delta and Suisun Marsh (1978 WQCP). In May 1995, the SWRCB adopted a new Bay-Delta WQCP, and it was implemented through SWRCB Revised Water Right Decision 1641 (D-1641) in March 2000.

1995 Water Quality Control Plan

The 1995 Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary (1995 WQCP) (SWRCB 1995) established water quality control measures that contribute to the protection of beneficial uses in the Delta. The 1995 WQCP identified (1) beneficial uses of the Delta to be protected, (2) water quality objectives for the reasonable protection of beneficial uses, and (3) a program of implementation for achieving the water quality objectives. The 1995 WQCP superseded the Water Quality Control Plan for Salinity (adopted in May 1991) and the Water Quality Control Plan for the Sacramento-San Joaquin Delta and Suisun Marsh that was adopted in August 1978.

The 1995 WQCP was developed as part of the December 15, 1994, Bay-Delta Accord, which committed the CVP and SWP to new Delta habitat objectives. Since these new beneficial objectives and water quality standards were more protective than those of the previous D-1485, the new objectives were adopted by amendment in 1995 through a Water Rights (WR) Order for operation of the CVP and SWP. One key feature of the 1995 WQCP was the estuarine habitat (X2) objectives for Suisun Bay and the western Delta. The X2 objective required specific daily or 14-day surface EC criteria, or 3-day averaged outflow requirements to be met for a certain number of days each month, February through June. These requirements were designed to provide improved shallow water habitat for fish species in spring. Because of the relationship between seawater intrusion and interior Delta water quality, the X2 criteria also improved water quality at Delta drinking water intakes. Other new elements of the 1995 WQCP included export-to-inflow (E/I) ratios intended to reduce entrainment of fish at the export pumps, Delta Cross Channel gate closures, and San Joaquin River EC and flow standards.

Water Right Decision 1641

D-1641 and WR Order 2001-05 contain the current water right requirements to implement the 1995 WQCP. D-1641 incorporates water right settlement agreements between Reclamation and DWR and certain water users in the Delta

and upstream watersheds regarding contributions of flows to meet water quality objectives. However, Reclamation and/or DWR are responsible for ensuring that objectives are met in the Delta. D-1641 also authorizes the CVP and SWP to use joint points of diversion (JPOD) in the south Delta, and recognizes the CALFED Operations Coordination Group process for operational flexibility in applying or relaxing certain protective standards. The additional exports allowed under the JPOD could result in additional degradation of water quality for water users in the south and central Delta, including CCWD. JPOD also could affect water levels in the south Delta and endangered fish species.

In February 2006, the SWRCB issued notice to Reclamation and DWR that each agency is responsible for meeting the objectives in the interior south Delta, as described in D-1641. The SWRCB order requires Reclamation and DWR to comply with a detailed plan and time schedule that will bring them into compliance with their respective permit and license requirements for meeting interior south Delta salinity objectives by July 1, 2009. The SWRCB order also revised the previously issued (July 1, 2005) Water Quality Response Plan approval governing Reclamation's and DWR's use of each other's respective point of diversion in the south Delta. Additionally, the order specifies that JPOD operations are authorized pursuant to the 1995 WQCP, and that Reclamation and DWR may conduct JPOD diversions, provided that both agencies are in compliance with all conditions of their respective water right permits and licenses at the time the JPOD diversions would occur (SWRCB 2006).

Municipal and Industrial Water Quality Objectives

In the 1978 WQCP, the SWRCB set two objectives that it believed would provide reasonable protection for M&I beneficial uses of Delta waters from the effects of salinity intrusion. The first objective established a year-round maximum mean daily chloride concentration measured at five Delta intake facilities, including CCWD's Pumping Plant Number 1, of 250 mg/L for the reasonable protection of municipal beneficial uses. This objective was consistent with the EPA secondary MCL for chloride of 250 mg/L, and is based only on aesthetic (taste) considerations. The second objective established a maximum mean daily chloride concentration of 150 mg/L (measured at either CCWD Pumping Plant No. 1 or the San Joaquin River at the Antioch water works intake) for the reasonable protection of industrial beneficial uses (specifically manufacture of cardboard boxes by Gaylord Container Corporation in Antioch). This requirement is in effect for a minimum of between 155 and 240 days each calendar year, depending on the water year type.

In the 1991 WQCP, the SWRCB reviewed the water quality objectives for M&I use contained in the 1978 WQCP, and reviewed potential new objectives for THM and other DBP, including bromides. The SWRCB concluded that technical information regarding THMs and other DBPs was not sufficient to set a scientifically sound objective. Accordingly, the SWRCB continued the existing objectives for chloride concentration, and until development of more information about these constituents, set a water quality "goal" for bromides of

0.15 mg/L (150 micrograms per liter (µg/L)). The SWRCB also noted that the 150 mg/L chloride objective was maintained in part because it provides ancillary protection for other M&I uses in the absence of objectives for THMs and other DBPs.

These objectives remained unchanged in the 1995 WQCP. The SWRCB and CVRWQCB basin plans specify water quality objectives to protect designated beneficial uses, including municipal drinking-water supply. The CVRWQCB also is developing a Central Valley drinking-water policy that may lead to regulations limiting the discharge of bromide, organic carbon, pathogens, and other drinking water constituents of concern. The CVRWQCB took the important step of adopting resolutions in July 2004 (Resolution No. R5-2004-0091) and July 2010 (Resolution No. R5-2010-0079) supporting development of the policy. Resolution No. R5-2010-0079 directed CVRWQCB staff to develop and bring a comprehensive drinking water policy to the board within 3 years (i.e., by 2013).

Coordinated Operations Agreement

The Coordinated Operations Agreement defines how Reclamation and DWR share their joint responsibility to meet Delta water quality standards and meet the water demands of senior water right holders. The Coordinated Operations Agreement defines the Delta as being in either “balanced water conditions” or “excess water conditions.” Balanced conditions are periods when Delta inflows are just sufficient to meet water user demands within the Delta, outflow requirements for water quality and flow standards, and export demands. Under excess conditions, Delta outflow exceeds the flow required to meet the water quality and flow standards. Typically, the Delta is in balanced water conditions from June to November, and in excess water conditions from December through May. However, depending on the volume and timing of winter runoff, excess or balanced conditions may extend throughout the year.

During excess water conditions, but during periods when Delta outflow is still relatively low, additional Delta diversions can degrade the water quality needed to meet drinking water standards, even when SWRCB M&I objectives are being met.

Local

The primary study area is located within both Shasta and Tehama counties, while the extended study area includes the following counties: Glenn, Butte, Colusa, Sutter, Yolo, Yuba, Sacramento, Napa, Solano, San Francisco, Contra Costa, San Joaquin, Alameda, Santa Clara, Stanislaus, Santa Cruz, San Benito, Merced, Madera, Fresno, Tulare, King, Kern, Santa Barbara, Ventura, Los Angeles, San Bernardino, Orange, Riverside, San Diego, and Imperial. Each of these counties has a general plan that includes general policies to protect water quality, water supply, water resources, and watersheds. No specific local requirements are pertinent to this analysis.

Water quality protection measures are included in the Shasta County General Plan. The county's goal is to protect all aspects of water quality in the county. The county defines erosion and downstream sedimentation as geologic hazards that must be prevented as part of grading and site development. The Shasta County Grading Ordinance sets requirements for grading and erosion control, including prevention of sedimentation or damage to off-site property. Grading permits require a vested map and the following information:

- A detailed grading plan
- Geological studies if located within an area prone to slippage, having highly erodible soils or of known geologic hazards
- Detailed drainage or flood control information as required by the department of public works
- A final development plan if the project is located in a zone or district that requires a final development plan
- A noise analysis if the project is located in the vicinity of a high noise generating use

Chapter 2
Model Output

Detailed Delta Simulation 2 outputs for the comprehensive plans are attached to the DEIS Modeling Appendix for Water Quality (Attachment 17) and Temperature (Attachment 2).

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Chapter 3
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