Final

Analysis of Consistency with Clean Water Act Section 404 Requirements Appendix

Shasta Lake Water Resources Investigation

Prepared by:

United States Department of the Interior
Bureau of Reclamation
Mid-Pacific Region

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Executive Summary

The U.S. Department of the Interior, Bureau of Reclamation (Reclamation), Mid-Pacific Region is completing a feasibility study evaluating alternative plans to modify the existing Shasta Division of the Central Valley Project (CVP) by enlarging Shasta Dam and Reservoir in Shasta Lake, California. If Congress authorizes the National Economic Development (NED) Plan (Comprehensive Plan (CP4A)) or any other plan, as described in *the Shasta Lake Water Resources Investigation* (SLWRI) Final Feasibility Report, corresponding Final Environmental Impact Statement (Final EIS), and supporting documents, project construction will require authorization from the U.S. Army Corps of Engineers (USACE) pursuant to Section 404 of the Federal Clean Water Act (CWA) of 1977 (33 United States Code [USC] Section 1344).

The purpose this document is to comply with Reclamation's Feasibility Study requirements that the plan recommended for implementation is consistent with a major requirement of the U.S. Environmental Protection Agency (EPA) Guidelines (40 Code of Federal Regulations [CFR] Part 230) – that the plan proposed for implementation is the least environmentally damaging practicable alternative (LEDPA). However, until a plan is authorized by Congress, permitting efforts (including the USACE CWA Section 404 permit) will not commence. Therefore, this document will be subject to additional detailed analyses and documentation before any related permit applications and regulatory decision making by the USACE and/or other concerned agencies occurs.

This document describes the NED Plan and assesses its potential effects and impacts to waters of the United States, including wetlands and "other" waters. It addresses the No-Action Alternative and action alternatives to determine if they meet SLWRI planning objectives and if construction is practicable (including cost) as well as compares their potential impacts and benefits to waters of the United States and adverse environmental consequences to those of the NED Plan. These alternatives are:

- No-Action Alternative
- Alternative / Comprehensive Plan 1 (CP1)
- Alternative / Comprehensive Plan 2 (CP2)
- Alternative / Comprehensive Plan 3 (CP3)
- Alternative / Comprehensive Plan 4 (CP4)

- Alternative / Comprehensive Plan 5 (CP5)

These alternatives were screened using a four-step screening process (see Figure ES-1), and consistent with criteria of completeness, effectiveness, efficiency, and acceptability as required in the *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studi*es (P&G), and other pertinent Federal laws and policies.

- **Step 1** – Alternatives were screened to assess their ability to meet the overall project purpose, feasibility study authorization and specified planning objectives.

- **Step 2** – The practicability of the retained alternatives were assessed with respect to cost, logistics, and technology.

- **Step 3** – Practicable alternatives were evaluated with respect to other significant and unavoidable impacts.

- **Step 4** – Practicable alternatives were evaluated for benefits associated with an increase in waters of the United States if implemented.

Using this step-wise approach, it was found that CP1 and CP3 met the project objectives, but were impracticable due to costs as compared to the benefits. See Chapter 3 "National Economic Development Plan - CP4A" on how the cost/benefit ratio and net NED benefits are derived.

Alternative CP2, would meet the project objectives, would be practicable, and would have slightly reduced impacted to waters of the United States and slightly less significant and unavoidable impacts to other resource areas than the NED Plan. However, CP2 would have relatively low benefits when compared to NED Plan, including a lesser amount of a net increase in other waters of the United States. In addition, CP2 would not include ecosystem restoration features as with the NED Plan. The NED Plan would have the following ecosystem restoration features: (1) augmenting spawning gravel in the upper Sacramento River at targeted locations to provide either immediate spawning habitat or long-term recruitment, and (2) restoring riparian, floodplain, and side channel habitat in the upper Sacramento River to provide rearing habitat for juvenile salmonids. While these ecosystem restoration features may have an increase in impacts to Waters of the United States, there would be significant environmental benefits with these ecosystem restoration features.

In summary, greater project benefits could be recognized with a higher dam raise (as with the NED Plan) for relatively low increases in costs. Therefore, CP2 was eliminated for consideration as the LEDPA.

Alternative CP4 and CP5 would meet the project objectives and are practicable. The potential impacts to waters of the United States, and other environmental

consequences would be nearly identical to the NED Plan; therefore, they were not considered less damaging. However, CP4 would not meet the objectives as well as the NED Plan – water supply reliability would be compromised for increased anadromous fish survival. Alternative CP5 would have relatively low increased anadromous fish survival benefits in comparison with the NED Plan. Therefore, CP4 and CP5 were eliminated for consideration as the LEDPA.

This analysis identified Reclamation's rational for the NED Plan as the LEDPA, consistent with the CWA, while recognizing that USACE will ultimately be responsible for determining the LEDPA in connection with any related future permit action. The NED Plan would best balance and meet both of the primary and secondary objectives, maximize benefits relative to costs, incorporate measures to minimize impacts to waters of the United States, and allow for a net increase in other waters of the United States. For these reasons, CP4A is identified and recommended by Reclamation as the LEDPA for the purposes of the SLWRI Final Feasibility Report, subject to confirmation and/or modification by the USACE.

A summary of key data used in the screening analysis is presented in Table ES-1.

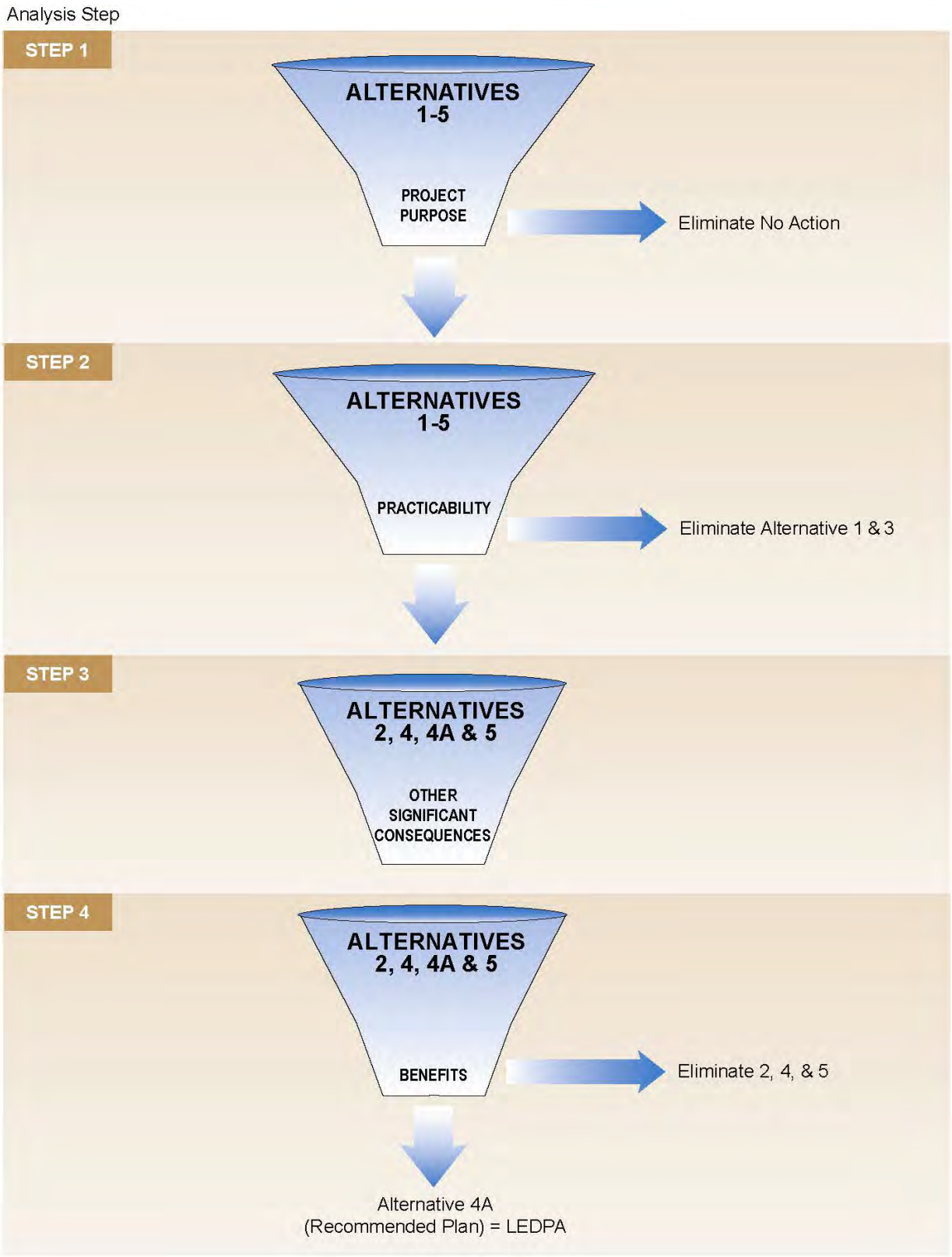

Figure ES-1. Four-Step Approach to Screening Alternatives

Table ES-1. Key Data Used in the Screening Analysis

Alternative	Meets Overall Purpose and Objectives as Compared to the NED Plan							Waters of the US			Practicability[1]			Benefits	
	Primary		Secondary					Waters of the US Impacted	Wetlands Impacted	Waters of the US increased (net)	Cost: Net NED Benefits ($ millions)[2]	Logistics[3] & Technology[4]	Overall Practicable?	Dry & Critical Year Water Supply (TAF/year)	Annual Fish Survival (Production Increase)[5]
	Increase Anadromous Fish Survival	Increase Water Supply Reliability	Reduce Flood Damage	Hydropower Generation	Ecosystem Resources	Water Quality	Recreation								
No Action	Less	Less	Less	Less	Less	Less	Less	----	-----	-----	0	Yes	No	---	----
CP1	Less	Less	Less	Less	Less	Less	Less	21 acres	16 acres	+31 acres	- 15.4	Yes	No	47.3	61,300
CP2	Less	Same	Same	Less	Less	Less	Less	28 acres	21 acres	+43 acres	10.5	Yes	Yes	77.8	379,200
CP3	Less	Less	More	Less	Less	Same	Less	51 acres	31 acres	+76 acres	- 11.2	Yes	No	63.1	207,400
CP4	More	Less	Less	More	Same (physical)/More Water Temp	Same	More	51 acres	31 acres	+76 acres	28.9	Yes	Yes	47.3	812,600
CP4A	Meets	Meets	Meets	Meets	Meets	Meets	Meets	51 acres	31 acres	+76 acres	29.9	Yes	Yes	77.8	710,000
CP5	Less	More	More	Less	More (physical)/Less Water Temp	Same	Less	51 acres	31 acres	+76 acres	13.2	Yes	Yes	113.5	377,800

Notes:
[1] Practicable means available and capable of being done after taking into account cost, existing technology, and logistics in light of overall project purpose. As shown by the estimated net annual benefits, the No-Action Alternative, CP1 and CP3 would not be cost effective, and thus would not be practicable
[2] Estimated annual net benefits were derived from estimated average annual costs minus average estimated benefits.
[3] Technical feasibility means that current design and construction methods and mitigation techniques are available to implement a plan.
[4] Logistical feasibility means that a plan is implementable in terms of its completeness, effectiveness, efficiency, and acceptability.
[5] Numbers were derived from SALMOD and represent an index of production increase, based on the estimated average annual increase in juvenile Chinook salmon surviving to migrate downstream from Red Bluff Pumping Plant.

Key:
LEDPA = Least Environmentally Damaging Practicable Alternative
NED = National Economic Development
SLWRI = Shasta Lake Water Resources Investigation
TAF = thousand acre feet
US = United States

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Abbreviations and Acronyms

Bay-Delta	San Francisco Bay/Sacramento-San Joaquin Delta
BLM	U.S. Department of the Interior, Bureau of Land Management
BMP	best management practices
Cal Fire	California Department of Forestry and Fire Protection
CALFED	CALFED Bay-Delta Program
Caltrans	California Department of Transportation
CCR	California Code of Regulations
CDFW	California Department of Fish and Wildlife
CESA	California Endangered Species Act
CFR	Code of Federal Regulations
cfs	cubic feet per second
CNDDB	California Natural Diversity Database
CP	Comprehensive Plan

CRPR	California Rare Plant Rank
CVP	Central Valley Project
CVPIA	Central Valley Project Improvement Act
CWA	Federal Clean Water Act
Delta	Sacramento-San Joaquin Delta
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
ESA	Federal Endangered Species Act
HMBP	Hazardous Materials Business Plan
LEDPA	least environmentally damaging practicable alternative
M&I	municipal and industrial
MAF	million-acre-foot
MOA	*Memorandum of Agreement between the EPA and the Corps Concerning the Determination of Mitigation Under the Clean Water Act Section 404(b)(1) Guidelines* (1990)
MOU	Memorandum of Understanding
MSCS	Multi-Species Conservation Strategy
NED	national economic development
NGVD29	National Geodetic Vertical Datum 1929
NMFS	National Marine Fisheries Service
NRA	National Recreation Area
NWFP	*Northwest Forest Plan*
OHWM	ordinary high-water mark
P&G	*Federal Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies*
PG&E	Pacific Gas and Electric Company
PEIS/R	Programmatic Environmental Impact Statement/Environmental Impact Report
PLSS	Public Land Survey System
RBPP	Red Bluff Pumping Plant
Reclamation	U.S. Department of Interior, Bureau of Reclamation
RM	River Mile
ROD	Record of Decision
S&M	survey and manage
SLWRI	Shasta Lake Water Resources Investigation
SRTTG	Sacramento River Temperature Task Group
State	State of California
SWP	State Water Project

SWPPP	Stormwater Pollution Prevention Plan
TCD	temperature control device
Uniform Act	Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, as amended
UPRR	United Pacific Railroad
USACE	U.S. Army Corps of Engineers
USC	United States Code
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
WTP	willingness to pay

Chapter 1
Introduction

The U.S. Department of the Interior, Bureau of Reclamation (Reclamation), Mid-Pacific Region is completing a feasibility study evaluating alternative plans to modify the existing Shasta Division of the Central Valley Project (CVP) by enlarging Shasta Dam and Reservoir in Shasta Lake, California. If Congress authorizes the National Economic Development (NED) Plan (Comprehensive Plan (CP4A)) or any other plan, as described in the Shasta Lake Water Resources Investigation (SLWRI) Final Feasibility Report, corresponding Final Environmental Impact Statement (Final EIS), and supporting documents, project construction will require authorization from the U.S. Army Corps of Engineers (USACE) pursuant to Section 404 of the Federal Clean Water Act (CWA) of 1977 (33 United States Code [USC] Section 1344).

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This document provides a background on the SLWRI; summarizes relevant CWA Guideline requirements; describes the SLWRI project purpose; describes the NED Plan and alternatives; provides information on existing waters of the United States and other biological resources in the study area; discusses potential effects and impacts to waters of the United States from the NED Plan and alternatives; describes the SLWRI development process, including those alternatives eliminated from further consideration; and provides an analysis of the retained alternatives.

This Analysis of Consistency with Clean Water Act Section 404 Requirements Appendix is based primarily on the findings of the SLWRI Final EIS and the SLWRI Final Feasibility Report.

This analysis is not intended to be a standalone document. References are given throughout this analysis where additional information may be obtained.

Project Background

Reclamation completed constructing Shasta Dam and Reservoir in 1945. Reclamation operates Shasta Dam and Reservoir, in conjunction with other facilities, to provide flood damage reduction and irrigation and municipal and industrial (M&I) water supply, maintain navigation flows, protect fish in the Sacramento River and the Sacramento-San Joaquin Delta (Delta), and generate hydropower. The Central Valley Project Improvement Act (CVPIA), enacted in 1992, added "fish and wildlife mitigation, protection, and restoration" as a priority equal to water supply, and added "fish and wildlife enhancement" as a priority equal to hydropower generation. Major modifications to Shasta Dam include construction of a temperature control device (TCD) in 1997 for improved management of water temperatures in the upper Sacramento River.

Shasta Dam and Reservoir were constructed as an integral element of the Central Valley Project (CVP), with Shasta Reservoir representing about 41 percent of the total reservoir storage capacity of the CVP. The 602-foot-tall Shasta Dam (533 feet above the streambed) and 4.55 million-acre-foot (MAF) Shasta Reservoir are located on the upper Sacramento River in Northern California, north of the City of Redding within the Whiskeytown-Shasta-Trinity National Recreation Area (NRA). Shasta Lake supports extensive water-oriented recreation. Recreation within these lands is managed by the U.S. Forest Service (USFS).

In 2000, as a result of the CALFED Bay-Delta Program (CALFED) Programmatic Record of Decision (ROD), increasing demands for water supplies, and growing concerns over declines in ecosystem resources in the Central Valley of California, Reclamation reinitiated a feasibility investigation to evaluate the potential for enlarging Shasta Dam and Reservoir.

Study Area

Shasta Dam and Shasta Lake are located on the upper Sacramento River in Northern California, approximately 9 miles northwest of Redding in Shasta County. Because of the potential influence of the proposed modification of Shasta Dam and subsequent system operations and water deliveries on resources over a large geographic area, the SLWRI includes both a primary study area and an extended study area.

Primary Study Area

The primary study area includes Shasta Dam and Lake, the lower portions of all contributing major and minor tributaries flowing into Shasta Lake, Trinity and Lewiston reservoirs, and the Sacramento River between Shasta Dam and the Red Bluff Pumping Plant (RBPP), including tributaries at their confluence. See Figure 1-1.

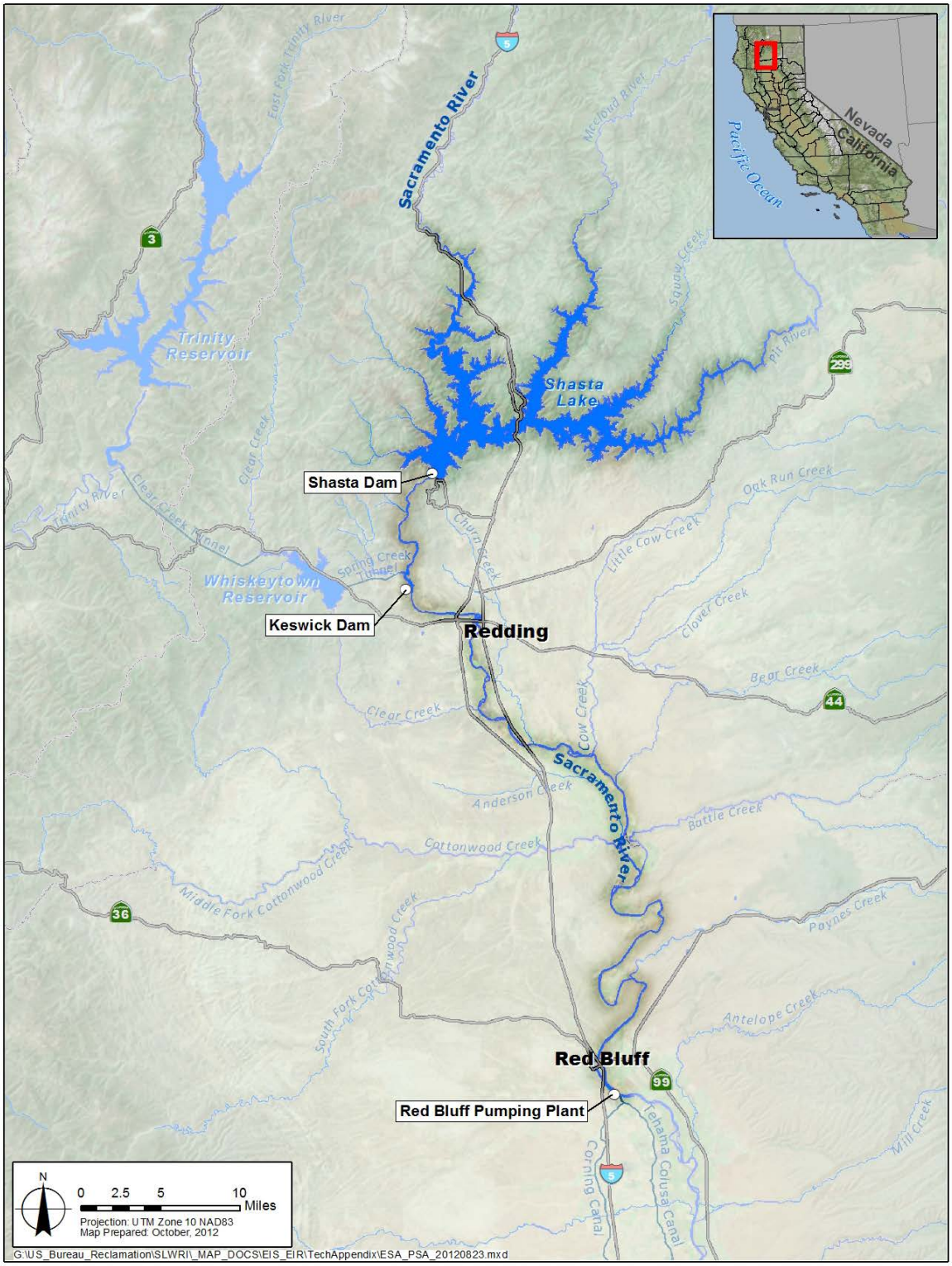

Figure 1-1. Primary Study Area—Shasta Lake Area and Sacramento River from Shasta Dam to Red Bluff Pumping Plant

Botanical Resources, Wetlands and Other Waters of the United States Setting in the Primary Study Area The botanical resources, wetlands and other waters of the United States setting for the Shasta Lake and vicinity portion of the primary study area consists of the impoundment area (five arms and the Main Body of Shasta Lake, as described below) and the relocation areas (Figure 1-2).

Reclamation established project boundaries for focused surveys in the areas that would be subject to inundation under the various enlargement scenarios. The lower boundary corresponds to the current full pool elevation defined by Reclamation (1,070-foot mean sea level contour line). The upper boundary was established using the 1,090-foot mean sea level contour line around the entire lake. This area is referred to as the "impoundment area" (Figure 1-2).

Areas subject to physical disturbance as an indirect result of the NED Plan (i.e., areas proposed as relocation sites for roadways, bridges, utilities, and campgrounds that would be inundated after the enlargement of Shasta Dam as well as proposed dike locations) were incorporated into the Shasta Lake and vicinity portion of the primary study area. These locations are hereafter referred to as "relocation areas" (Figure 1-2).

To examine the biological resources along riverine reaches that would be subject to inundation if Shasta Dam were enlarged, reaches of 11 streams and rivers that are tributary to Shasta Lake were also incorporated into the Shasta Lake and vicinity portion of the primary study area. These streams were selected by Reclamation in conjunction with the USFS as an initial sampling of streams representative of riverine and riparian habitats. Subsequently, botany studies have been expanded into select areas of the impoundment area and within all of the relocation areas.

As a component of the NED Plan, Reclamation proposes to restore and/or enhance riparian and riverine habitats at six locations along the lower Sacramento River below Shasta Dam. These six locations occur generally between the city of Redding and Redding Island, Shasta County, California. The purpose of the restoration effort is to improve spawning and rearing habitat for anadromous fish occurring in the Sacramento River. These six locations are referred to as the potential Sacramento River downstream habitat restoration areas (Figure 1-3).

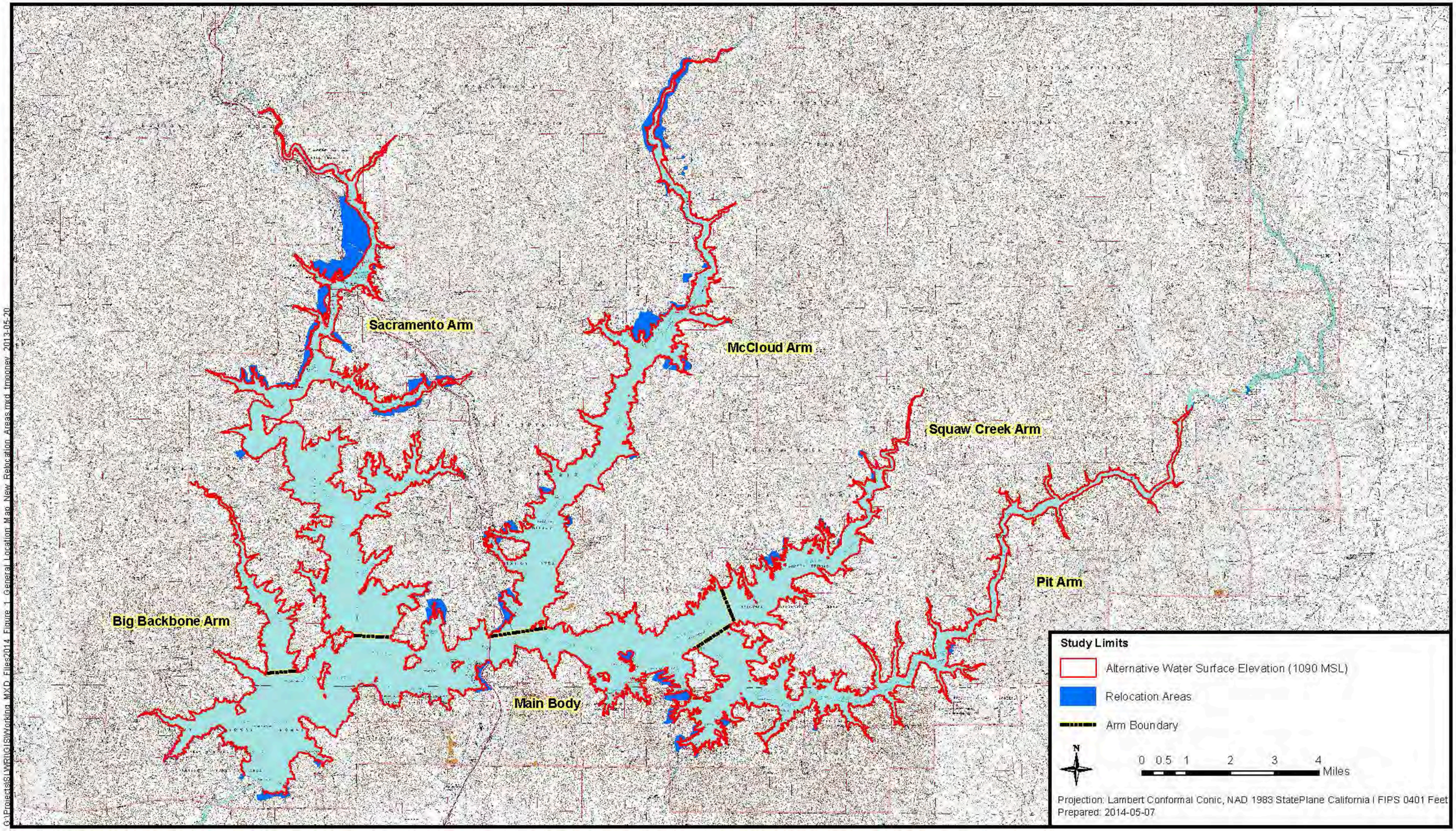

Figure 1-2. Study Limits

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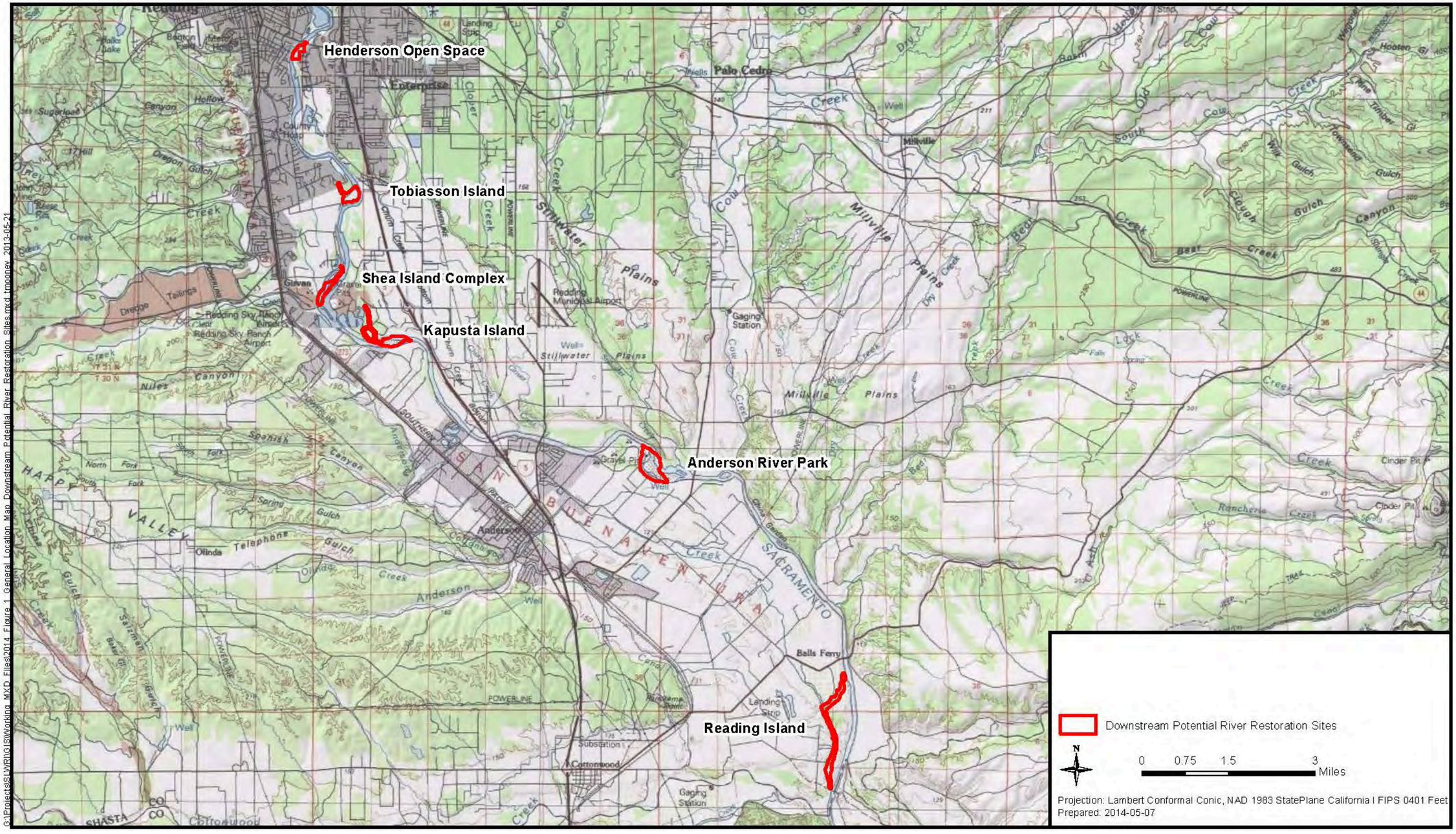

Figure 1-3. General Location Map Downstream Potential River Restoration Areas

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Extended Study Area

The extended study area includes the Sacramento River downstream from the RBPP, including portions of the American and Feather river basins downstream from CVP/State Water Project (SWP) facilities; the San Francisco Bay/Sacramento-San Joaquin Delta (Bay-Delta); lower portions of the San Joaquin River basin downstream from CVP facilities (Friant and New Melones reservoirs); and CVP and SWP facilities and water service areas.

Vegetation communities and special-status plant species in the extended study area are discussed in less detail.

Study Authorization

The SLWRI is being conducted under the authority of Public Law 96-375, which was reaffirmed under Public Law 108-361, also known as the CALFED Bay-Delta Authorization Act. Public Law 96-375 (October 3, 1980) provides feasibility study authority for the SLWRI and allows the Secretary of the Interior to:

> *(a)…engage in feasibility studies relating to enlarging Shasta Dam and Reservoir, Central Valley Project, California or to the construction of a larger dam on the Sacramento River, California, to replace the present structure.*
>
> *(b) The Secretary of the Interior is further authorized to engage in feasibility studies for the purpose of determining the potential costs, benefits, environmental impacts, and feasibility of using the Sacramento River for conveying water from the enlarged Shasta Dam and Reservoir or the larger dam to points of use downstream from the dam.*

Section 103(c), "Authorizations for Federal Activities Under Applicable Law," of the CALFED Bay-Delta Authorization Act (Public Law 108-361, October 25, 2004), authorizes the Secretary of the Interior to carry out the activities described in paragraphs (1) through (10) of Subsection (d), which include:

> *…(1)(A)(i) planning and feasibility studies for projects to be pursued with project-specific study for enlargement of (1) the Shasta Dam in Shasta County.*

Also, Section 103(a)(1) of Public Law 108-361 (October 25, 2004) states the following:

> *The Record of Decision is approved as a general framework for addressing the CALFED Bay-Delta Program, including its components relating to water storage, ecosystem restoration, water supply reliability (including new firm yield), conveyance, water use efficiency, water quality, water transfers, watersheds,*

> *the Environmental Water Account, levee stability, governance, and science.*

The CALFED Programmatic ROD called for the Secretary of the Interior to conduct feasibility studies of expanding CVP storage in Shasta Lake to:

> *…increase the pool of cold water available to maintain lower Sacramento River temperatures needed by certain fish and provide other water management benefits, such as water supply reliability.*

Regulatory Background

This section describes the regulatory background as it pertains to the CWA requirements and USACE sequencing approach.

Clean Water Act Requirements

Section 404 of the CWA authorizes USACE to issue permits for the discharge of dredged or fill material into waters of the United States, including wetlands (33 USC 1344).

Any activity requiring an individual permit pursuant to Section 404 of the CWA must undergo an analysis of alternatives to identify the LEDPA pursuant to the requirement of the *Section 404(b)(1) Guidelines* (Guidelines) established by EPA.

At the core of the Guidelines are four major restrictions on discharge – alternatives to the proposed discharge; water quality standards, toxic effluent standards, and the Endangered Species Act; significant degradation; and adverse impact minimization. In addition to the LEDPA, USACE may authorize a project only if it meets the requirements of each of these restrictions, which are discussed below.

Alternatives to the Proposed Discharge [40 CFR 230.10(a)] "…no discharge of dredged or fill material shall be permitted if there is a practicable alternative to the proposed discharge which would have less adverse impact on the aquatic ecosystem, so long as the alternative does not have other significant adverse environmental consequences."

Practicable alternatives include "activities which do not involve a discharge of dredged or fill material into the waters of the United States..," and "discharges of dredged or fill material at other locations in waters of the United States…" An alternative is practicable if it is "available and capable of being done after taking into consideration cost, existing technology, and logistics in light of overall project purposes." Practicable alternatives may include placing a project in "an area not presently owned by the applicant, which could be reasonably

obtained, used, expanded or mange to fulfill the basic purpose of the proposed activity may be considered."

If the proposed activity involves a discharge into a special aquatic site, such as a wetland, the Guidelines distinguishes between those projects that are water dependent and those that are not. A water dependent project is one that requires access or proximity to or siting within a special aquatic site to fulfill its basic purpose. A non-water dependent project is one that does not require access or proximity to or siting within a special aquatic site to achieve its basic purpose.

The Guidelines establishes a double rebuttable presumption for non-water dependent projects that propose a discharge of fill into a special aquatic site, such as wetlands. First, it is presumed that there are practicable alternatives to non-water dependent projects, "unless clearly demonstrated otherwise." [40 CFR Section 230.10(a)(3).] Second, "where a discharge is proposed for a special aquatic site, all practicable alternatives to the proposed discharge which do not involve a discharge into a special aquatic site are presumed to have less adverse impact on the aquatic ecosystem, unless clearly demonstrated otherwise." [Id.] The thrust of the Guidelines is that applicants should design recommended plans to meet the overall project purpose while avoiding and minimizing impacts to aquatic environments.

Water quality standards/toxic effluent standards/Endangered Species Act [40 CFR 230.10(b)] "No discharge of dredged or fill material shall be permitted if it causes or contributes, after consideration of disposal site dilution and dispersion, to violations of any applicable State water quality standard; violates any applicable toxic effluent standard or prohibition under section 307 of the Act; or Jeopardizes the continued existence of species listed as endangered or threatened under the Endangered Species Act…"

Significant Degradation [40 CFR 230.10(c)] "No discharge of dredged or fill material shall be permitted which will cause or contribute to significant degradation of the waters of the United States." Degradation includes adverse effects on "…human health or welfare, including but not limited to effects on municipal water supplies, plankton, fish, shellfish, wildlife, and special aquatic sites;" "…life stages of aquatic life and other wildlife dependent on aquatic ecosystems;" "…aquatic ecosystem diversity, productivity, and stability;" and "…recreational, aesthetic, and economic values."

Adverse Impact Minimization [40 CFR 230.10(d)] "No discharge of dredged or fill material shall be permitted unless appropriate and practicable steps have been taken which will minimize potential adverse impacts of the discharge on the aquatic ecosystem."

U.S. Army Corps of Engineers Sequencing Approach

A sequencing approach to impacts is emphasized in a *Memorandum of Agreement between the EPA and the Corps Concerning the Determination of*

Mitigation Under the Clean Water Act Section 404(b)(1) Guidelines (1990) (MOA) as modified by the Corps and EPA Final Mitigation Rule (33 CFR Parts 325 and 332 and40 CFR Part 230). The MOA articulates the Guidelines "sequencing" protocol as first, avoiding impacts; second, minimizing impacts; and third, providing practicable compensatory mitigation for unavoidable impacts and no overall net loss of functions and services.

Organization of Document

This document is organized as follows:

Chapter 1, Introduction: This chapter describes the project background, study area, Clean Water Act Section 404 requirements, and organization of the document.

Chapter 2, Basic and Overall Project Purpose: This chapter describes the basic and overall project purpose.

Chapter 3, National Economic Development Plan - CP4A: This chapter describes the NED Plan, including the major components of the project; construction, operation, maintenance activities, and avoidance and minimization measures and environmental commitments; proposed construction schedule; how the NED Plan meets the project objectives, and NED analysis.

Chapter 4, Waters of the United States and other Biological Resources in the Project Area: This chapter describes the existing waters of the United States and other biological resources in the study area.

Chapter 5, Potential Impacts to Waters of the United States from the National Economic Development Plan: This chapter describes the potential impacts to waters of the United States from the NED Plan and mitigation for unavoidable impacts to waters of the United States.

Chapter 6, Alternative Development Process: This chapter provides a discussion of the SLWRI alternatives development process and alternatives considered and eliminated from further analysis.

Chapter 7, Analysis of Retained Alternatives: This chapter provides an analysis of project alternatives retained for further analysis.

Chapter 8, Identification of the Least Environmentally Damaging Practicable Alternative: This chapter summarizes identification of the LEDPA.

Chapter 9, References: This chapter identifies the documents consulted during preparation of this document and the documents used as sources for the analysis.

Chapter 2
Project Purpose

The project purpose frames the scope of the alternatives analysis. For CWA Section 404(b)(1) evaluations, the project purpose is expressed in terms of "basic project purpose" and "overall project purpose." While these terms are not strictly defined in the Guidelines, in practical application, they are generally defined as presented in the following sections.

Basic Project Purpose – Water Dependency

The basic project purpose comprises the fundamental, essential, or irreducible purpose of the plan recommended for implementation, and is used by USACE to determine whether the applicant's project is water-dependent.

The Guidelines state that if an activity associated with the discharge proposed for a water body does not require access or proximity to, or siting within, water to fulfill its basic purpose, the activity is not water-dependent.

The SLWRI basic project purpose is "*to improve operational flexibility of the Sacramento-San Joaquin Delta (Delta) watershed system to meet specified primary and secondary project objectives.*" Improving operational flexibility is not water-dependent as, theoretically, improving operational flexibility doesn't have to include discharge into a water body.

However, as described in Chapter 6 "Alternative Development Process," the CALFED alternative and the SLWRI Plan Formulation Screening Processes evaluated a broad range of water management options (with and without storage) to be implemented to achieve the basic project purpose. After these screening processes, the only alternatives retained for further consideration in the SLWRI EIS was the raising of Shasta Dam. The raising of Shasta Dam would necessitate the discharge of fill materials into wetlands through construction or inundation. These wetlands are classified as a special aquatic site; therefore, according to the Guidelines, the NED Plan is considered to be water dependent. Other options to raising Shasta Dam were not considered to be practicable. Accordingly, there is no need in this alternatives analysis to rebut the presumption that there are practicable alternatives to the NED Plan that do not involve a discharge of dredged or fill material to a special aquatic site [see 40 CFR 230.10(a)(3)].

Overall Project Purpose

The overall project purpose serves as the basis for the USACE's section 404(b)(1) alternatives analysis and is determined by further defining the basic project purpose in a manner that more specifically describes the applicant's goals and accounts for logistical considerations for the project, thereby allowing a reasonable range of alternatives to be analyzed.

The purpose of the proposed action, as stated above, is to improve operational flexibility of the Delta watershed system to meet specified primary and secondary project objectives.

Two primary project objectives and five secondary project objectives were developed for the SLWRI.

Primary Project Objectives

Anadromous Fish Survival

The Sacramento River system supports four separate runs of Chinook salmon: fall-, late fall-, winter-, and spring-run. The adult populations of the four runs of salmon and other important fish species that spawn in the upper Sacramento River have considerably declined over the last 40 years. Several fish species in the upper Sacramento River have been listed under the Federal Endangered Species Act: Sacramento River winter-run Chinook salmon (endangered), Central Valley spring-run Chinook salmon (threatened), Central Valley steelhead (threatened), and the Southern Distinct Population Segment of North American green sturgeon (threatened). Two of these species are also listed under the California Endangered Species Act: Sacramento River winter-run Chinook salmon (endangered) and Central Valley spring-run Chinook salmon (threatened).

Unsuitable water temperature in the upper Sacramento River, especially in dry and critical years, is a critical factor affecting the abundance of Chinook salmon and steelhead in the river. Water temperatures that are too high or, less commonly, too low, can be detrimental to the various life stages of Chinook salmon. Elevated water temperatures can negatively impact holding and spawning adults, egg viability and incubation, preemergent fry, and rearing juveniles and smolts, significantly diminishing the next generation of returning spawners. Stress caused by high water temperatures also may reduce the resistance of fish to parasites, disease, and pollutants. Releases of cold water from Shasta Reservoir can improve seasonal water temperatures in the Sacramento River downstream from Shasta Dam for anadromous fish during critical periods.

Various Federal, State of California (State), and local projects are addressing factors contributing to declines in anadromous fish populations. Recovery actions range from changing the timing and magnitude of reservoir releases to

structural changes at Shasta Dam. Despite these steps, additional actions are needed to address anadromous fish survival in the upper Sacramento River.

Water Supply Reliability

Demands for water in California exceed available supplies. Reclamation's 2008 *Water Supply and Yield Study* (2008b) describes dramatic increases in statewide population, land use changes, regulatory requirements, and limitations on storage and conveyance facilities that have resulted in unmet water demands and subsequent increases in competition for water supplies among urban, agricultural, and environmental uses. The California Department of Water Resources (DWR) *California Water Plan Update* 2013 (DWR 2014) concludes that California is facing one of the most significant water crises in its history; drought impacts are growing and climate change is affecting statewide hydrology. Challenges are greatest during dry years, when water supplies are less available. Despite significant physical improvements in water resource systems and in system management over the past few decades, California still faces unreliable water supplies, continued depletion and degradation of groundwater resources, habitat and species declines, and unacceptable risks from flooding.

As the population of California grows, and the demand for adequate water supplies becomes more acute, the ability to maintain a healthy and viable industrial and agricultural economy while protecting aquatic species will be increasingly difficult. Compounding these issues, potential effects of climate change, such as changed precipitation patterns, less snowfall, and earlier snowmelt, may considerably increase the demands on available water supplies in the future. As owner and operator of the CVP, one of the largest water storage and conveyance systems in the world, Reclamation has identified the need to increase the reliability of CVP water deliveries to its water contractors, particularly during dry and critical water years. Similar needs and challenges are faced by the SWP and other water projects throughout the State. As one of many efforts to improve the reliability of California's water supply, the SLWRI was established to evaluate the potential to improve water supply reliability, primarily by modifying Shasta Dam and enlarging Shasta Lake.

Secondary Project Objectives

Ecosystem Resources

The quantity, quality, diversity, and connectivity of riparian, wetland, floodplain, and shaded riverine habitat in along the Sacramento River have been severely limited through confinement of the river system by levees, reclamation of adjacent lands for farming, bank protection, construction of dams and reservoirs, channel stabilization, and land development, contributing to a decline in habitat and native species populations. Ecosystem restoration along the Sacramento River has been the focus of several ongoing programs, including the Senate Bill 1086 Program, CVPIA, CALFED, Central Valley Habitat Joint Venture, and numerous local programs within the Central Valley.

Despite these efforts, a significant need remains to conserve and restore ecosystem resources along the Sacramento River.

Flood Management

Communities and agricultural lands in the Central Valley are subject to flooding along the Sacramento River that poses risks to human life, health, safety, and property. Physical impacts from flooding include damage to buildings, contents, automobiles, agricultural crops, equipment, etc. Threats from flooding are caused by many factors, including overtopping or sudden failures of levees, which can result in deep and rapid flooding with little warning. In addition, urban development in flood-prone areas has exposed the public to the risk of flooding.

Hydropower

Although California is the most energy-efficient state per capita in the nation, demands for electricity are growing at a rapid pace. According to the California Energy Commission's *2012 Integrated Energy Policy Report Update*, over the next 10 years, California's peak demand for electricity is expected to increase at a rate of approximately 1.5 percent per year through 2022, from about 60,000 megawatts (MW) in 2011 to about 70,000 MW by 2022. Executive Orders S-14-08 and S-21-09, issued in 2008 and 2009, respectively, established a goal of using renewable energy sources, including hydropower, for 33 percent of the State's energy consumption by 2020. To implement recent California renewable resources mandates, significant increases in non-dispatchable intermittent renewable resources, such as wind and solar generation, will need to be added to California's power system. This means that other significant flexible generation resources, such as hydropower, will be needed to support and integrate renewable generation. Adding to the need for additional energy sources, existing nuclear power plants are nearing the end of their design lives and some may be offline within the next 10 to 20 years.

Recreation

As California's population continues to grow, demands will increase substantially for recreation opportunities at and near the lakes, reservoirs, streams, and rivers of the Central Valley. Further increases in demand, accompanied by relatively static recreation resources, will cause issues at existing recreation areas. These challenges will be especially pronounced at Shasta Lake, which is one of the most visited recreation destinations in the State and in the region. Even under current levels of demand, USFS, which manages recreation at Shasta Lake, has expressed concern about seasonal access and capacity problems at existing marinas and USFS facilities. A substantial and increasing need exists to improve recreation-related facilities and conditions at Shasta Lake.

Water Quality

The Sacramento River and the Delta support fish and wildlife while providing water supplies for urban, agricultural, and environmental uses across the State.

Saltwater intrusion, municipal discharges, agricultural drainage, and water project flows and diversions have led to water quality issues within the Delta, particularly related to salinity. In the Sacramento River, urban and agricultural runoff, and runoff and seepage from abandoned mining operations, have resulted in elevated levels of pesticides, phosphorous, mercury, and other metals. Additional operational flexibility could provide opportunities to improve Sacramento River and Delta water quality conditions.

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Chapter 3
National Economic Development Plan - CP4A

The plan being considered is modifying Shasta Dam and Reservoir to provide an additional 634,000 acre-feet of increased storage capacity by raising the dam 18.5 feet. The NED Plan focuses on increasing anadromous fish survival, while also increasing water supply reliability.

This chapter describes the NED Plan including the major components, operation and maintenance, avoidance and minimization measures, and environmental commitments. The chapter also describes the benefits, how the NED Plan meets the stated overall project purpose and planning objectives associated with the project, construction activities, and the NED analysis.

Major Project Components

The major components of the NED Plan include:

- Raise Shasta Dam and Appurtenant Facilities by 18.5 feet
- Enlarge Shasta Lake Cold-Water Pool
- Modify Temperature Control Device
- Increase Conservation Storage
- Reduce Demand through a Water Conservation Program
- Modify Flood Operations and Flood Damage Reduction
- Modify Hydropower Facilities and Develop Additional Hydropower Generation
- Maintain and Increase Recreation Opportunities
- Maintain or Improve Delta Water Quality
- Augment Spawning Gravel in the Upper Sacramento River
- Restore Riparian, Floodplain and Side Channel Habitat in the Upper Sacramento River

Raise Shasta Dam and Appurtenant Facilities by 18.5 Feet

By raising Shasta Dam 18.5 feet, from a crest elevation of 1,077.5 feet to 1,096.0 feet (based on National Geodetic Vertical Datum 1929 (NGVD29)), the NED Plan would increase the height of the reservoir full pool by 20.5 feet. This increase in full pool height would add approximately 634,000 acre-feet of storage to the reservoir's capacity. Accordingly, storage in the overall full pool would be increased from 4.55 MAF to 5.19 MAF.

Enlarge Shasta Lake Cold-Water Pool

Cold water released from Shasta Dam significantly influences water temperature conditions in the Sacramento River between Keswick Dam and the RBPP. The NED Plan includes reserving 191,000 acre-feet (30 percent) of storage for maintaining cold-water volumes (cold-water pool) to benefit anadromous fish in the upper Sacramento River. An increase in the cold-water pool would allow Reclamation to operate Shasta Reservoir to provide not only a more reliable source of water during dry and critical water years, but also to provide more cool water for release into the Sacramento River to improve conditions for anadromous fish.

Adaptive Management of Cold-Water Pool

The adaptive management plan may include operational changes to the timing and magnitude of releases from Shasta Dam to benefit anadromous fish, as long as there were no conflicts with current operational guidelines or adverse impacts on water supply reliability. Adaptive management of the cold-water pool for anadromous fish is discussed further below under "Operations" and "Maintenance" for the NED Plan.

Modify Temperature Control Device

The TCD would be modified to account for an increased dam height and to reduce leakage of warm water into the structure. Minimum modifications to the TCD include raising the existing structure and modifying the shutter control. This measure would increase the ability of operators at Shasta Dam to meet downstream temperature requirements, and provide more operational flexibility to achieve desirable water temperatures during critical periods for anadromous fish. The TCD would also be extended to achieve efficient use of the expanded cold-water pool for the NED Plan.

Increase Conservation Storage

The NED Plan includes increasing the amount of space available for water conservation storage in Shasta Reservoir by raising Shasta Dam. Conservation storage is the portion of the reservoir capacity available to store water for subsequent release to increase water supply reliability for agricultural, M&I, and environmental purposes.

Reduce Demand through a Water Conservation Program

The proposed water conservation program would consist of a 10-year initial program to which Reclamation would allocate approximately $2.6 million to

fund water conservation efforts. Funding would be proportional to additional water supplies delivered and would focus on assisting project beneficiaries (agencies receiving increased water supplies because of the project), with developing new or expanded urban water conservation, agricultural water conservation, and water recycling programs. Program actions would be a combination of technical assistance, grants, and loans to support a variety of water conservation projects, such as recycled wastewater projects, irrigation system retrofits, and urban utilities retrofit and replacement programs. Reclamation, in collaboration with project beneficiaries, would identify and develop water conservation projects for funding under the program. Reclamation would then implement an investment strategy, in coordination with project beneficiaries, to identify and prioritize projects which, in conjunction with other water conservation activities, would cost-effectively reduce water demand and increase water conservation. This process would result in developing, evaluating, and prioritizing projects for funding. The program could be established as an extension of existing Reclamation programs, or as a new program through teaming with cost-sharing partners. Combinations and types of water use efficiency actions funded would be tailored to meet the needs of identified cost-sharing partners, including consideration of cost-effectiveness at a regional scale for agencies receiving funding.

Modify Flood Operations and Flood Damage Reduction

Enlargement of Shasta Reservoir would require alterations to existing flood operation guidelines or rule curves, to reflect physical modifications, such as an increase in dam/spillway elevation. The rule curves would be revised with the goal of reducing flood damage and enhancing other objectives to the extent possible.

Modify Hydropower Facilities and Develop Additional Hydropower Generation

Enlargement of Shasta Dam would require various minimum modifications, commensurate with the magnitude of the enlargement, to the existing hydropower facilities at the dam to enable their continued efficient use. These modifications, in conjunction with increased lake surface elevations, may provide incidental benefits to hydropower generation. Although modifications could also be included to further increase the power production capabilities of the reservoir (e.g., additional penstocks and generators), they are believed to be a detail beyond the scope of this investigation and are not considered further at this level of planning.

Maintain and Increase Recreation Opportunities

Outdoor recreation, and especially recreation at Shasta Lake, represents a major source of enjoyment to millions of people annually and is a major source of income to the northern Sacramento Valley. Shasta Dam and Reservoir are within the Shasta Unit of the Whiskeytown-Shasta-Trinity NRA. Recreation within these lands is managed by USFS. As part of this administration, USFS either directly operates and maintains, or manages through special use permits, numerous public campgrounds, marinas, boat launching facilities, and related

water-oriented recreation facilities. Enlarging Shasta Dam and Reservoir would affect and benefit some of these facilities. Consistent with the position of USFS, and planning conditions described in this chapter, the NED Plan would include features to, at a minimum, maintain the overall recreation capacity of the existing facilities. In addition, the NED Plan would also provide for modernization of relocated recreation facilities, including, at a minimum, modifications to comply with current standards of health and safety.

Maintain or Improve Delta Water Quality

Additional storage in Shasta Reservoir would provide improved operational flexibility. Shasta Dam has the ability to provide increased releases and high-flow releases to improve Delta water quality. Improved Delta water quality conditions could provide benefits for both water supply reliability and ecosystem restoration by potentially increasing Delta outflow during drought years and reducing salinity during critical periods.

Augment Spawning Gravel in the Upper Sacramento River

Gravel suitable for spawning has been identified as a significant influencing factor in the recovery of anadromous fish populations in the Sacramento River (USFWS 2001, NMFS 2009). Under the NED Plan, spawning-sized gravel would be placed at multiple locations along the Sacramento River between Keswick Dam and the RBPP.

Gravel augmentation would occur at one to three locations every year, for a period of 10 years, unless unusual conditions or agency requests precluded placement during a single year. This program, in combination with the ongoing CVPIA gravel augmentation program, would help address the gravel deficit in the upper Sacramento River. However, this reach may continue to be gravel-limited in the future. Therefore, the proposed gravel augmentation program would be reevaluated after the 10-year period to assess the need for continued spawning gravel augmentation, and to identify opportunities for future gravel augmentation actions or programs.

On average, 5,000 to 10,000 tons of gravel would be placed each year, although the specific quantity of gravel placed in a given year may vary from that range. Gravel would be obtained as uncrushed, rounded river rock, free of debris and organic material, from local, commercial sources. To maximize the benefit to anadromous fish, gravel would be washed and sorted to meet specific size criteria. To minimize impacts on salmonid spawning activity, gravel placement within the active river channels would occur between August and September each year, consistent with the time frame for the ongoing CVPIA gravel augmentation program.

Fifteen preliminary locations for spawning gravel augmentation were identified in the Sacramento River between Keswick Dam and Shea Island. Each site would be eligible for gravel placement one or more times during the 10-year program. Selection of these locations was based on potential benefits to

anadromous fish and site accessibility. Gravel placement would provide either immediate spawning habitat or long-term recruitment.

Although preliminary sites have been identified, specific gravel augmentation site(s) and volume(s) would be selected each year in the spring or early summer through discussions among Reclamation, United States Fish and Wildlife Service (USFWS), California Department of Fish and Wildlife (CDFW), and National Marine Fisheries Service (NMFS). The discussions would include topics such as avoiding redundancy with planned CVPIA gravel augmentation activities in a given year; identifying hydrology or morphology issues that could affect the potential benefit of placing gravel at any particular site; identifying changes in spawning trends based on ongoing CVPIA monitoring efforts; evaluating potential new sites; and appropriately distributing selected gravel sites along the river reach(es).

Restore Riparian, Floodplain and Side Channel Habitat in the Upper Sacramento River

Under the NED Plan, riparian, floodplain, and side channel habitat restoration would occur at one or a combination of potential locations along the upper Sacramento River. Restoration measures for six potential sites, referred to collectively as “upper Sacramento River restoration sites,” are described below. The sites under consideration for habitat restoration are shown in Figure 3-1.

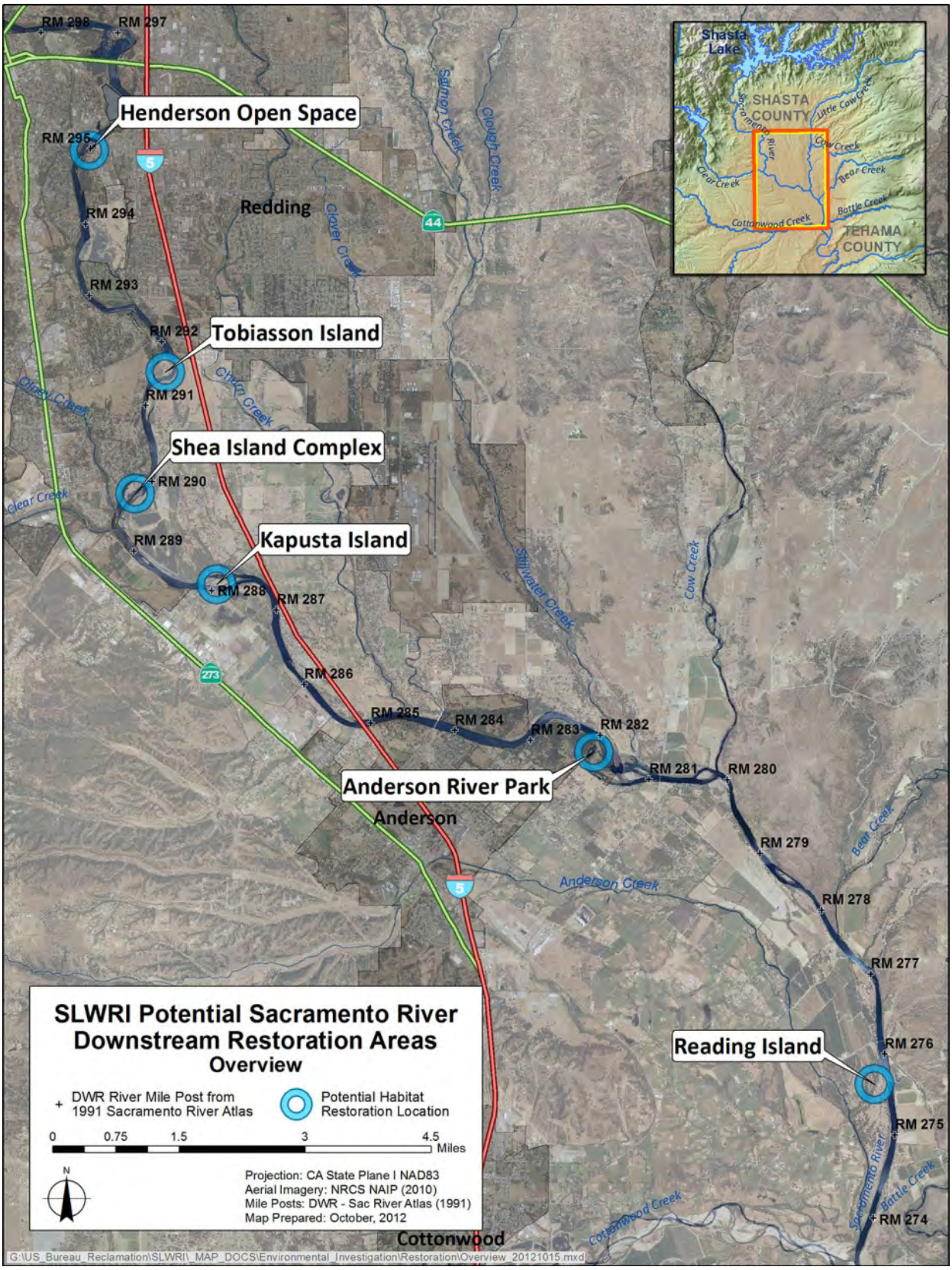


Figure 3-1. Potential Sacramento River Habitat Restoration Areas

Henderson Open Space

The City of Redding Henderson Open Space area is located south of Cypress Bridge on the east side of the Sacramento River at River Mile (RM) 295. Riparian and side channel restoration at the Henderson Open Space site could consist of enhancing an existing side channel to activate the frequency and duration of flows for Chinook salmon spawning habitat throughout the side channel. This potential modification would create up to 2,000 more linear feet of spawning habitat near areas of the Sacramento River that are actively used by anadromous fish for spawning.

Tobiasson Island

Tobiasson Island is located downstream from South Bonnyview Bridge in the center of the Sacramento River at RM 292. Riparian, floodplain, and side channel habitat enhancement at this site would involve creating a side channel through the island to be activated at Sacramento River flows for Chinook salmon spawning. Riparian vegetation would be established along the course of the new side channel, adding approximately 1,350 linear feet of spawning and floodplain habitat to this section of the Sacramento River.

Shea Island Complex

The Shea Island Complex is located on the west side of the Sacramento River upstream from the river's confluence with Clear Creek at RM 291. Restoration at the Shea Island Complex to improve side channel, riparian, and floodplain habitat would involve enhancing a major side channel through the site to keep the side channel hydraulically connected with the main stem of the Sacramento River at a broader range of flows. Adding channel complexity and enhancing riparian vegetation throughout the length of the side channel would improve Chinook salmon habitat along an additional 1,930 feet of the Sacramento River.

Kapusta Island

Kapusta Island is located adjacent to the Kapusta Open Space area upstream from the Interstate-5 crossing of the Sacramento River at RM 288. Restoration of riparian, side channel and floodplain habitat at Kapusta Island would involve enhancing an existing side channel by allowing it to carry water at a broader range of flows specifically to increase spawning habitat for winter-run and spring-run Chinook salmon. Allowing flow through the island, and increasing floodplain habitat would increase potential spawning habitat in this area of the river by about 1,590 linear feet.

Anderson River Park

Anderson River Park is an open space area on the south bank of the Sacramento River downstream from Churn Creek, and upstream from the Deschutes Road crossing at RM 283. Restoration at this site would involve hydraulically reconnecting a remnant Sacramento River side channel with the Sacramento River. Regularly flowing water throughout the length of this side channel would increase anadromous fish rearing habitat along 4,750 feet of side channel in this section of the river.

Reading Island

Reading Island lies along the Sacramento River just north of Cottonwood Creek at RM 274. The channel for Anderson Creek, a remnant Sacramento River side channel, defines the western edge of Reading Island. Construction of a levee on Anderson Creek has blocked the channel's connectivity with the Sacramento River and has created Anderson Slough, an area of still water. Riparian, floodplain, and side channel restoration on Reading Island would involve restoring flows in Anderson Creek and through Anderson Slough. These activities, alongside removal of invasive aquatic vegetation in the channel and reestablishment of riparian vegetation would aid in restoring rearing habitat for winter-run Chinook, and spawning habitat for steelhead along 4,225 feet of channel in this area of the river.

Operations

The 191,000 acre-feet of additional water would be the first increment of the reservoir filled after the reservoir was enlarged. This amount of water would be available as additional water for the cold-water pool each year regardless of water year type, unless Reclamation elected to use the additional water to augment flows protecting anadromous fish in the Sacramento River, as part of a proposed adaptive management plan, as explained below. An additional 443,000 acre-feet of the increased storage space would be used primarily to improve water supply reliability. Operations for water supply, hydropower, and environmental and other regulatory requirements for the 443,000 acre-feet of increased storage would be similar to existing operations, except during dry and critical years when a portion of the increased storage in Shasta Reservoir would be reserved to specifically focus on increasing M&I deliveries. In dry years, 120,000 acre-feet of the 443,000 acre-feet increased storage capacity in Shasta Reservoir would be reserved for increasing M&I deliveries. In critical years, 60,000 acre-feet of the increased storage capacity would be reserved for increasing M&I deliveries. Operations targeting increased M&I deliveries were based on existing and anticipated future demands, operational priorities, and facilities of the SWP.

As stated above, of the total 634,000 acre-feet of additional storage, 191,000 acre-feet of water would be used to increase the cold-water pool for fisheries. Reclamation is currently working with NMFS, USFWS, and CDFW through the Sacramento River Temperature Task Group (SRTTG), a multiagency group established to adaptively manage flows and water temperatures in the Sacramento River, to improve and stabilize Chinook salmon populations in the upper Sacramento River. The additional 191,000 acre-feet of cold-water pool would be managed by Reclamation in coordination with the SRTTG.

Current analysis indicated that the most beneficial use of the additional 191,000 acre-feet of storage for fisheries protection would be as an expanded cold-water pool; however, Reclamation has agreed to adaptively manage the 191,000 acre-

feet of water, as appropriate, to increase benefits to anadromous fish as part of CP4A. Adaptive management is an approach allowing decision makers to take advantage of a variety of strategies and techniques that are adjusted, refined, and/or modified based on an improved understanding of system dynamics. Adaptive management, if applied appropriately, allows for flexible operations based on best available science and new information as it becomes available.

The adaptive management plan may include operational changes to the timing and magnitude of releases primarily to improve the quality and quantity of aquatic habitat. These changes may include increasing minimum flows, timing releases from Shasta Dam to mimic more natural seasonal flows, meeting flow targets for side channels, or retaining the additional 191,000 acre-feet of water in storage to meet temperature requirements. Reclamation would work cooperatively with the SRTTG to determine the best use of the cold-water pool each year under an adaptive management plan. Reclamation would manage the cold-water pool and operate Shasta Dam each year based on recommendations from the SRTTG. Because adaptive management would be predicated on using best available science and new information to make decisions, a monitoring program would be implemented as part of the adaptive management plan. SRTTG members would conduct monitoring, develop monitoring protocols, and set performance standards to determine the success of adaptive management actions.

Under the currently proposed operations, the 191,000 acre-feet of additional storage would be the first increment of water in the reservoir to fill after dam enlargement. This water would be available each year independent of water year type if used exclusively to enlarge the cold-water pool. If the 191,000 acre-feet of stored water was used to augment flows based on recommendations from the SRTTG, this water would not be guaranteed to be available for use the following year because of uncertainty in hydrologic conditions. Once water was released to augment flows as part of the adaptive management plan, the 191,000 acre-feet of additional storage space would be refilled after the 443,000 acre-feet of additional storage space was filled for the primary purpose of increasing water supply reliability. Each year that the 191,000 acre-feet of additional water was held in storage as part of an increase in the cold-water pool, the allocated amount would be available as long as the cold-water pool continued to provide benefits to fisheries.

SALMOD modeling and related analysis indicated that in most cases, providing an increased cold-water pool would benefit Chinook salmon populations in the Upper Sacramento River more than increasing flows.

Operation of pumping facilities downstream from Shasta Dam would vary slightly from current operations and would result in higher costs. In addition, Reclamation would provide in-kind power to offset reduced generation at Pit 7 Dam and related facilities.

Maintenance

Maintenance of facilities related to the proposed dam and reservoir enlargement would be similar to maintenance activities currently conducted at Shasta Dam and Reservoir.

Avoidance and Minimization Measures and Environmental Commitments

Avoidance and minimization efforts are weighed against a variety of issues including, but not limited to, the ability of the project to meet the purpose and need, safety considerations, fiscal constraints, ability to prove necessity for land acquisition and compliance with applicable laws.

The NED Plan has been designed to avoid and minimize impacts to waters of the United States to the greatest extent feasible. For example, Reclamation worked with design engineers relocate roads, bridges, facilities, etc. to avoid wetland and waters of the United States to the extent feasible. Reclamation has taken a sequential planning approach for the SLWRI, particularly with respect to avoidance.

Environmental Commitments

In addition, Reclamation and/or its contractors would incorporate certain environmental commitments and best management practices (BMP) into any action alternative, including the NED Plan, identified for implementation to avoid or minimize potential impacts. Reclamation would also coordinate planning, engineering, design and construction, operation, and maintenance phases of any authorized project modifications with applicable resource agencies.

The environmental commitment section of the Draft EIS included a commitment to develop and implement a mitigation plan to minimize potential impacts to physical, biological, and socioeconomic resources. In conjunction with an interagency, interdisciplinary team, Reclamation refined and enhanced the mitigation measures, including developing a framework to quantify impacts (where appropriate) and establish mitigation ratios that were applicable to a number of impacts related to biological resources. The refined and enhanced mitigation measures are incorporated into Chapters 4 through 25 of the Final EIS and are presented in the Preliminary Environmental Commitments and Mitigation Plan Appendix.

The following environmental commitments would be incorporated for any project-related construction activities. This section does not include mitigation measures that are also required as stated in the Final EIS.

Develop and Implement Construction Management Plan

Reclamation would develop and implement a construction management plan to avoid or minimize potential impacts on public health and safety during project construction, to the extent feasible. The construction management plan would inform contractors and subcontractors of work hours, modes and locations of transportation and parking for construction workers; location of overhead and underground utilities; worker health and safety requirements; truck routes; stockpiling and staging procedures; public access routes; terms and conditions of all project permits and approvals; and emergency response services contact information.

The construction management plan would also include construction notification procedures for the police, public works, and fire department in the cities and counties where construction would occur. Notices would also be distributed to neighboring property owners. The health and safety component of the construction management plan would be monitored for the implementation of the plan on a day-to-day basis by a Certified Industrial Hygienist.

The construction management plan would include effort to notify businesses, residents, and visitors associated with recreation activities on and surrounding Shasta Lake. In addition to information available at the Shasta Lake Visitors Center, informational signs and booths would be placed at key locations to be identified by Reclamation in conjunction with agencies and local business organizations. Reclamation will also develop and maintain a project-specific website that will be used for a wide range of informational purposes.

Comply with Permit Terms and Conditions

If any action alternative is approved and authorized for construction, Reclamation would require its contractors and suppliers, its general contractor, and all of the general contractor's subcontractors and suppliers to comply with all of the terms and conditions of all required project permits, approvals, and conditions attached thereto. If necessary, additional information (e.g., detailed designs and additional documentation) would be prepared and provided for review by decision makers and the public. Reclamation would ultimately be responsible for the actions of its contractors in complying with permit conditions.

Provide Relocation Assistance through Federal Relocation Assistance Program

All Federal, State, and local government agencies and others receiving Federal financial assistance for public programs and projects that require the acquisition of real property must comply with the policies and provisions set forth in the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, as amended (Uniform Act) (Title 49, CFR, Part 24). All relocation and property acquisition activities would be performed in compliance with the Uniform Act. Any individual, family, or business displaced by implementation of any of the action alternatives would be offered relocation assistance services

for the purpose of locating a suitable replacement property, to the extent consistent with the Uniform Act.

Under the Uniform Act, relocation services for residences would include providing a determination of the housing needs and desires, a list of comparable properties, transportation to inspect housing referrals, and reimbursement of moving costs and related expenses. For business relocation activities, relocation services would include providing a determination of the relocation needs and requirements; a determination of the need for outside specialists to plan, move, and reinstall personal property; advice as to possible sources of funding and assistance from other local, State, and Federal agencies; listings of commercial properties; and reimbursement for costs incurred in relocating and reestablishing the business. No relocation payment received would be considered as income for the purpose of the Internal Revenue Code.

Remain Consistent with USFS Built Environment Image Guide

Any facilities subject to USFS authorization that are constructed or reconstructed would be consistent with USFS Built Environment Image Guide. The architectural character of facilities on National Forest System lands would be constructed using materials and design that keep with the visual and cultural identity of the landscape in which they are constructed. Reclamation would seek to maintain the quality of visitor experiences by replacing affected facilities with facilities providing equivalent visual resource quality and amenities.

Protect Public Land Survey System Monuments and Property Corners

Reclamation would identify Public Land Survey System (PLSS) monuments or survey property corners affected by either inundation due to increased lake levels or construction activities. Reclamation or its contractors would protect all PLSS monuments and associated references and all property corners, either by positioning, or, where necessary, creating new references. The results would be filed with U.S. Department of the Interior, Bureau of Land Management (BLM) and Shasta County.

Evaluate and Protect Paleontological Resources Discovered During Construction

If paleontological resources are discovered during construction activities, all work in the immediate vicinity of the discovery would stop immediately and Reclamation would be notified (as applicable). A qualified paleontologist would be retained to evaluate the find and recommend appropriate conservation measures, such as data recovery or protection in place. The conservation measures would be implemented before reinitiation of activities in the immediate vicinity of the discovery.

Develop and Implement Stormwater Pollution Prevention Plan

Any project authorized for construction would be subject to the construction-related stormwater permit requirements of the CWA National Pollutant Discharge Elimination System program. Reclamation would obtain any required

permits through the Central Valley Regional Water Quality Control Board before any ground-disturbing construction activity. According to the requirements of Section 402 of the CWA, Reclamation and/or its contractors would prepare and implement a Stormwater Pollution Prevention Plan (SWPPP) before construction, identifying BMPs to prevent or minimize erosion and the discharge of sediments and other contaminants with the potential to affect beneficial uses of or lead to violations of water quality objectives for surface waters. The SWPPP would include site-specific structural and operational BMPs to prevent and control impacts on runoff quality, and procedures to be followed before each storm event. BMPs would control short-term and long-term erosion and sedimentation effects and stabilize soils and vegetation in areas affected by construction activities. The SWPPP would contain a site map that shows the construction site perimeter, existing and proposed buildings, lots, roadways, stormwater collection and discharge points, drainage patterns across the project, and general topography both before and after construction. Additionally, the SWPPP would contain a visual monitoring program, a chemical monitoring program for "non-visible" pollutants that would be implemented if a BMP fails, and a sediment monitoring plan to be implemented if a particular site discharges directly to a water body listed on the CWA 303(d) list for sediment. BMPs for the project could include, but would not be limited to, silt fencing, straw bale barriers, fiber rolls, storm drain inlet protection, hydraulic mulch, and stabilized construction entrances.

Develop and Implement Erosion and Sediment Control Plan Reclamation would prepare and implement an erosion and sediment control plan to control short-term and long-term erosion and sedimentation effects, and to stabilize soils and vegetation in areas affected by construction activities. The plan would include all of the necessary local jurisdiction requirements regarding erosion control, and would implement BMPs for erosion and sediment control, as required. Types of BMPs may include, but would not be limited to, earth dikes and drainage swales, stream bank stabilization, and use of silt fencing, sediment basins, fiber rolls, and sandbag barriers.

Develop and Implement Feasible Spill Prevention and Hazardous Materials Management As part of the SWPPP, Reclamation and/or its contractors would develop and implement a spill prevention and control plan to minimize effects from spills of hazardous, toxic, or petroleum substances for project-related construction activities occurring in or near waterways. The accidental release of chemicals, fuels, lubricants, and nonstorm drainage water into water bodies would be prevented to the extent feasible. Spill prevention kits would always be close by when hazardous materials would be used (e.g., crew trucks and other logical locations). Feasible efforts would be implemented so that hazardous materials would be properly handled and the quality of aquatic resources would be protected by all reasonable means during work in or near any waterway. No fueling would be done within the ordinary high-water mark, immediate floodplain, or full pool inundation area, unless equipment stationed in these locations could not be readily relocated. Any equipment that could be

readily moved out of the water body would not be fueled in the water body or immediate floodplain. For all fueling of stationary equipment done at the construction site, containments would be installed so that any spill would not enter the water, contaminate sediments that may come in contact with the water, or damage wetland or riparian vegetation. Any equipment that could be readily moved out of the water body would not be serviced within the ordinary high-water mark or immediate floodplain.

Additional BMPs designed to avoid spills from construction equipment and subsequent contamination of waterways would also be implemented. These could include, but would not be limited to, the following:

- Storage of hazardous materials in double-containment and, if possible, under a roof or other enclosure.
- Disposal of all hazardous and nonhazardous products in a proper manner.
- Monitoring of on-site vehicles for fluid leaks and regular maintenance to reduce the chance of leakage.
- Containment (using a prefabricated temporary containment mat, a temporary earthen berm, or other feature can provide containment) of bulk storage tanks.

Haulers delivering materials to the project site would be required to comply with regulations on the transport of hazardous materials codified in Title 49, CFR Part 173; Title 49, CFR Part 177; and Title 26, California Code of Regulations (CCR) Division 6. These regulations provide specific packaging requirements, define unacceptable hazardous materials shipments, and prescribe safe-transit practices, including route restrictions, by carriers of hazardous materials.

Water Quality Protection for In-River Construction

The efforts discussed below would be implemented to minimize potential adverse effects to water quality.

Implement In-River Construction Work Windows All construction activities along the Sacramento River would be conducted during months when instream flows were managed outside the flood season (e.g., June to September). In-river work between Keswick Dam and the RBPP would be conducted to minimize impacts to Sacramento River winter-run Chinook salmon (i.e., mid-August through September).

Comply with All Water Quality Permits and Regulations Project activities would be conducted to comply with all additional requirements specified in required permits relating to water quality protection. Relevant permits

anticipated to be obtained for the proposed action include a CWA Section 401 certification and CWA Section 404 compliance through the USACE.

Implement Water Quality Best Management Practices BMPs that would be implemented to avoid and/or minimize potential impacts associated with construction and the 10-year-long spawning gravel augmentation program are described below.

Handle Spawning Gravel to Minimize Potential Water Quality Impacts Gravel would be sorted and transported in a manner that minimizes potential water quality impacts (e.g., management of fine sediments). Gravel would be washed at least once and have a cleanliness value of 85 or higher based on California Department of Transportation (Caltrans) Test No. 227. Gravel would also be completely free of oils, clay, debris, and organic material.

Minimize Potential Impacts Associated with Equipment Contaminants For in-river work, all equipment would be steam-cleaned every day to remove hazardous materials before the equipment entered the water. Biodegradable hydrocarbon products would be used in the heavy equipment in the stream channel.

Implement Feasible Spill Prevention and Hazardous Materials Management The accidental release of chemicals, fuels, lubricants, and non-storm drainage water into channels would be prevented to the extent feasible. Spill prevention kits would always be in close proximity when using hazardous materials (e.g., crew trucks and other logical locations). Feasible efforts would be implemented to ensure that hazardous materials are properly handled and the quality of aquatic resources is protected by all reasonable means. No fueling would be done within the ordinary high-water mark or immediate floodplain, unless equipment stationed in these locations was not readily relocated (i.e., pumps, generators). For stationary equipment that must be fueled on site, containments would be provided in such a manner that any accidental spill of fuel would not be able to enter the water or contaminate sediments that could come in contact with water. Any equipment that was readily moved out of the channel would not be fueled in the channel or immediate floodplain. All fueling done at the construction site would provide containment to the degree that any spill would be unable to enter the channel or damage wetland or riparian vegetation. No equipment servicing would be done within the ordinary high-water mark or immediate floodplain, unless equipment stationed in these locations could not be readily relocated (i.e., pumps, generators). Additional BMPs designed to avoid spills from construction equipment and subsequent contamination of waterways would also be implemented.

Minimize Potential Impacts Associated with Access and Staging Existing access roads would be used to the extent possible. Equipment staging areas would be located outside of the Sacramento River ordinary high water mark or the Shasta Dam full pool inundation area, and away from sensitive resources.

Remove Temporary Fills as Appropriate Temporary fill for access, side channel diversions, and/or side channel cofferdams, would be completely removed after completion of construction.

Remove Equipment from River Overnight and During High Flows Construction contractors would remove all equipment from the river on a daily basis at the end of the workday. Construction contractors would also monitor Reclamation's Central Valley Operations Office Web site daily for forecasted flows posted there to determine and anticipate any potential changes in releases. If flows were anticipated to inundate a work area that would normally be dry, the contractor would immediately remove all equipment from the work area.

Extend and Enhance Existing Fish Habitat Structures in Shasta Lake

Reclamation and USFS, in conjunction with resource management agencies, would identify areas at appropriate elevations to replace, extend, and enhance existing structural fish habitat. The structures would be installed concurrently with construction activities in the vicinity of construction sites or at locations identified by resource agencies. These activities would include maintaining shallow water and transitional riverine habitat with the placement of manzanita brush structures, large woody debris, and rock-boulder clusters. To the extent feasible, vegetation cleared for construction and borrow pit areas would be used to extend and enhance fish habitat structures. Excess vegetative materials cleared from construction and borrow pit areas would be stockpiled for future fish habitat enhancement. Additionally, areas within the enlarged reservoir having appropriate conditions to establish living plants, including willow (*Salix* sp.), buttonbush (*Cephalanthus* sp.), and cottonwood (*Populus* sp.), would be identified for the purposes of providing structural fish habitat when the established plants are inundated.

Fisheries Conservation

The efforts discussed below would be implemented to minimize potential adverse effects on fish species.

Implement In-Water Construction Work Windows Reclamation would identify and implement feasible in-water construction work windows in consultation with NMFS, USFWS, and CDFW. In-water work windows would be timed to occur when sensitive fish species were not present or would be least susceptible to disturbance.

Monitor Construction Activities A qualified biologist would monitor potential impacts to important fishery resources throughout all phases of project construction. Monitoring may not be necessary during the entire duration of the project if, based on the monitor's professional judgment (and with concurrence from Reclamation), a designated on-site contractor would suffice to monitor such activities and would agree to notify a biologist if aquatic organisms are in danger of harm. However, the qualified biologist would need to be available by phone and Internet and be able to respond promptly to any problems that arose.

Perform Fish Rescue/Salvage If spawning activities for sensitive fish species were encountered during construction activities, the biologist would be authorized to stop construction activities until appropriate corrective activities were completed or it was determined that the fish would not be harmed. A qualified biologist would identify any fish species that may be affected by the project. The biologist would facilitate rescue and salvage of fish and other aquatic organisms that become entrapped within construction structures and cofferdam enclosures in the construction area. Any rescue, salvage, and handling of listed species would be conducted under appropriate authorization (i.e., incidental take statement/permit for the project, Federal Endangered Species Act Section 4(d) scientific collection take permit, or a Memorandum of Understanding).

If fish were identified as threatened with entrapment in construction structures, construction would be stopped and efforts made to allow fish to leave the project area before resuming work. If fish were unable to leave the project area of their own volition, then fish would be collected and released outside the work area. Fish entrapped in cofferdam enclosures would be rescued and salvaged before the cofferdam area was completely dewatered. Appropriately sized fish screens would be installed on the suction side of any pumps used to dewater in-water enclosures.

Reporting A qualified biologist would prepare a letter report detailing the methodologies used and the findings of fish monitoring and rescue efforts. Monitoring logs would be maintained and provided, with monitoring reports. The reports would contain, but not be limited to, the following: summary of activities; methodology for fish capture and release; table with dates, numbers, and species captured and released; photographs of the enclosure structure and project site conditions affecting fish; and recommendations for limiting impacts during subsequent construction phases, if appropriate.

Survey and Monitor Fish Migration Between Shasta Lake and Squaw Creek

Reclamation would fund and implement an adaptive management effort to survey and monitor fish migration between Shasta Lake and Squaw Creek, within and immediately upstream from the new inundation zone, before and immediately after project completion, to determine if warm-water fish (bass) actively migrated into and cause adverse effects on native fish, amphibians, and mollusks. These study and monitoring activities would be warranted due to uncertainties associated with the potential for warm-water fish accessing tributary stream reaches currently isolated by passage barriers near the head of the existing reservoir. The surveys would document occurrences and abundances of warm-water fish species and USFS special-status species in lower Squaw Creek before and immediately after project completion to evaluate if reservoir enlargement coincides with increases in warm-water predator species and declines of special-status indicator species. If warm-water fish abundance increases or adverse effects attributed to warm-water fish predation

on native fish, amphibians or mollusks is documented within 3-5 years after the project was completed, a fish barrier or other acceptable feature would be implemented to prevent or minimize further invasions and colonization by warm-water fish.

Revegetation Plan

Reclamation, in conjunction with cooperating agencies and private landowners, would prepare a comprehensive revegetation plan to be implemented in conjunction with other management plans (e.g., SWPPP). This plan would apply to any area included as part of an action alternative, such as inundation, relocation, or mitigation activities. Overall objectives of the revegetation plan would be to reestablish native vegetation to control erosion, provide effective ground cover, minimize opportunities for nonnative plant species to establish or expand, and provide habitat diversity over time. Reclamation would work closely with cooperating agencies, private landowners, and revegetation specialists to develop the sources of native vegetation, site-specific planting patterns and species assemblages necessary for a revegetation effort of this magnitude.

Invasive Species Management

Reclamation would develop and implement a control plan to prevent the introduction of zebra/quagga mussels, invasive plants, and other invasive species to project areas. The control plan would cover all workers, vehicles, watercraft, and equipment (both land and aquatic) that would come into contact with Shasta Reservoir, the shoreline of Shasta Reservoir, the Sacramento River, and any riverbanks, floodplains, or riparian areas. Plan activities could include, but would not be limited to, the following:

- Preinspection and cleaning of all construction vehicles, watercraft, and equipment before being shipped to project areas
- Reinspection of all construction vehicles, watercraft, and equipment on arrival at project areas
- Inspection and cleaning of all personnel before work in project areas

All inspections would be conducted by trained personnel and would include both visual and hands-on inspection methods of all vehicle and equipment surfaces, up to and including internal surfaces that have contacted raw water.

Approved cleaning methods would include a combination of the following:

- **Precleaning** – Draining, brushing, vacuuming, high-pressure water treatment, thermal treatment
- **Cleaning** – Freezing, desiccation, thermal treatment, high-pressure water treatment, chemical treatment

On-site cleanings would require capture, treatment, and/or disposal of any and all water needed to conduct cleaning activities.

Fire Protection and Prevention Plan

Reclamation would prepare and implement a fire protection and prevention plan to minimize the risk of wildfire or threat to workers, property, and the public. The USFS will maintain a plan similar to this Fire Protection and Prevention Plan which addresses preventing and controlling wildfires in the NRA as described by the interagency agreement with the California Department of Forestry and Fire Protection (Cal Fire) and other associated entities. Reclamation's contractors would follow relevant safety standards/procedures related to fire prevention, which would be incorporated into the project design and used during construction activities and project operation and maintenance. Safety standards and procedures include the California Building Code; the Shasta County Fire Plan; USFS safety requirements regarding fire hazards; Cal Fire requirements for private lands; California Public Utilities Code General Order 95, which provides procedures for proper removal, disposal, and placement of poles, wires, and associated infrastructure; and the National Electric Safety Code (a voluntary code that provides safety procedures for electric utility installation and operation). Precautionary activities to prevent construction-related fires would include locating utilities a safe distance from vegetation and structures, proper construction of power lines, and construction worker safety training. Postconstruction infrastructure operation and maintenance would follow current safety practices associated with fire prevention and would include clearing vegetation from power utility facilities and other sources using combustion engines (e.g., water pumps) on a regular basis.

Construction Material Disposal

Reclamation's contractors would recycle or reuse demolished materials, such as steel or copper wire, concrete, asphalt, and reinforcing steel, as required and where practical. Other demolished materials would be disposed of in local or other identified permitted landfills in compliance with applicable requirements.

To reduce the risk to construction workers, the public, and the environment associated with exposure to hazardous materials and waste, Reclamation would implement the following:

- A Hazardous Materials Business Plan (HMBP) would be developed and implemented to provide information regarding hazardous materials to be used for project implementation and hazardous waste that would be generated. The HMBP would also define employee training, use of protective equipment, and other procedures that provide an adequate basis for proper handling of hazardous materials to limit the potential for accidental releases of and exposure to hazardous materials. All procedures for handling hazardous materials would comply with all Federal, State, and local regulations.

- Soil to be disposed of at a landfill or recycling facility would be transported by a licensed waste hauler.

- All relevant available asbestos survey and abatement reports and supplemental asbestos surveys would be reviewed. Removal and disposal of asbestos-containing materials would be performed in accordance with applicable Federal, State, and local regulations.

- A lead-based paint survey would be conducted to determine areas where lead-based paint is present and the possible need for abatement before construction.

Asphalt Removal

Per California Fish and Game Code 5650 Section (a), all asphaltic roadways and parking lots inundated by project implementation would be demolished and removed according to Shasta County standards. Asphalt would be disposed of at an approved and permitted waste facility. Dirt roads inundated by project implementation would remain in place.

Potential Benefits of the National Economic Development Plan

Major potential benefits of the NED Plan, related to the project objectives, are described below

Increase Anadromous Fish Survival

Water temperature is one of the most important factors in achieving recovery goals for anadromous fish in the Sacramento River. NED Plan would significantly increase the ability of Shasta Dam to make cold-water releases and regulate water temperature in the upper Sacramento River, primarily in dry and critical water years. This would be accomplished by raising Shasta Dam 18.5 feet, thus increasing the depth of the cold-water pool in Shasta Reservoir and resulting in an increase in seasonal cold-water volume below the thermocline (layer of greatest water temperature and density change). Cold water released from Shasta Dam significantly influences water temperature conditions in the Sacramento River between Keswick Dam and the Red Bluff Pumping Plant (RBPP). Hence, the most significant water temperature benefits to anadromous fish would occur upstream from the RBPP.

It is estimated that improved water temperature and flow conditions under the Proposed Plan could result in an average annual increase in Chinook salmon population of nearly 710,000 out-migrating juvenile fish.

Under the Proposed Plan, an increase in the cold-water pool would allow Reclamation to operate Shasta Reservoir to provide not only a more reliable source of water during dry and critical water years, but also to provide more cool water for release into the Sacramento River to improve conditions for

anadromous fish. Of the increased storage space for the Proposed Plan, about 191,000 acre-feet (30 percent) would be dedicated to increasing the cold-water supply for anadromous fish survival purposes.

In addition, the Proposed Plan includes a gravel augmentation program. Gravel augmentation would occur on average at one or more locations in the Sacramento River between Keswick Dam and the RBPP for a period of 10 years. On average, 5,000 to 10,000 tons of gravel would be placed each year, although the specific quantity of gravel placed in a given year may vary from that range. Spawning gravel augmentation is expected to positively influence anadromous fish populations in the Sacramento River.

Potential benefits to anadromous fish survival through conserving, restoring, and enhancing ecosystem resources are described below.

Increase Water Supply Reliability

The NED Plan would increase water supply reliability by increasing water supplies for CVP and SWP irrigation and M&I deliveries. This action would contribute to replacement of supplies redirected to other purposes in the CVPIA. The NED Plan would help reduce estimated future water shortages by increasing the reliability of dry and critical year water supplies for agricultural and M&I deliveries by at least 77,800 acre-feet per year and average annual deliveries by about 51,300 acre-feet per year. The majority of increased dry and critical year water supplies (67,100 acre-feet) would be for south-of-Delta agricultural and M&I deliveries. In addition, under the NED Plan, approximately $2.6 million would be allocated over an initial 10-year period to fund agricultural and M&I water conservation programs, focused on agencies benefiting from increased reliability of project water supplies. Water use efficiency could help reduce current and future water shortages by allowing a more effective use of existing supplies.

Develop Additional Hydropower Generation

Higher water surface elevations in the reservoir would result in a net increase in power generation of about 125 GWh for the NED Plan. This generation value is the expected increased generation from Shasta Dam and other CVP/SWP facilities. Other power benefits include additional capacity (i.e., the rate at which power can be generated) and ancillary services, which provide the ability to manage the electric grid in a reliable manner.

Conserve, Restore, and Enhance Ecosystem Resources

In the upper Sacramento River, the addition of spawning gravel and the restoration of riparian, floodplain, and side channel habitat would be expected to improve the complexity of aquatic habitat and its suitability for anadromous salmonid spawning and rearing habitat. Riparian areas would provide habitat for a diverse array of plant and animal communities along the Sacramento River, including several threatened or endangered species. Riparian areas would also provide shade and woody debris that increase the complexity of aquatic habitat

and its suitability for spawning and rearing. Lower floodplain areas, river terraces, and gravel bars would play an important role in the health and succession of riparian habitat. In addition, improved fisheries conditions as a result of cold-water carryover storage in the NED Plan, as described above, and increased flexibility to meet flow and temperature requirements, could also enhance overall ecosystem resources in the Sacramento River. Side channels could support important habitat for anadromous salmonids, including rearing and spawning habitat. Side channel habitats would also provide refuge from predators and productive foraging habitat for juvenile anadromous salmonids.

Maintain and Increase Recreation Opportunities

The NED Plan includes features to, at a minimum, maintain the existing recreation capacity at Shasta Lake. Although the NED Plan does not include specific features to further increase recreation capacity, benefits to the water-oriented recreation experience at Shasta Lake would likely occur because of the increase in average lake surface area, reduced drawdown during the recreation season, and modernization of recreation facilities. Under the NED Plan, the average surface area of the lake during the recreation season from May through September would increase by about 2,300 acres (10 percent), from 23,900 acres to 26,200 acres.

Benefits Related to Other Project Objectives

The NED Plan could also provide benefits related to flood damage reduction and water quality. Enlarging Shasta Dam would provide for incidental increased reservoir capacity to capture flood flows, which could reduce flood damage along the upper Sacramento River. The NED Plan may also contribute to improving Delta water quality through increased Delta emergency response capabilities. When Delta emergencies occur, additional water in Shasta Reservoir could improve operational flexibility for increasing releases to supplement existing water sources to reestablish Delta water quality. In addition to Delta emergency response, increased storage in Shasta Reservoir could increase emergency response capability for CVP/SWP water supply deliveries.

Net Increase Waters of the United States

As stated above, by raising Shasta Dam 18.5 feet, from a crest elevation of 1,077.5 feet to 1,096.0 feet (based on NGVD29), the NED Plan would increase the height of the reservoir full pool by 20.5 feet. This increase in full pool height would add approximately 634,000 acre-feet of storage to the reservoir's capacity. Accordingly, storage in the overall full pool would be increased from 4.55 MAF to 5.19 MAF. This is expected to have a net increase in waters of the United States by approximately 76 acres.

Meeting Project Objectives – Summary

The NED Plan meets both the primary and secondary objectives as described above and summarized below.

Primary Objectives

The additional storage created by the 18.5-foot dam raise would be used to improve the ability to meet water temperature objectives and habitat requirements for anadromous fish during drought years and increase water supply reliability. By raising Shasta Dam from a crest at elevation 1,077.5 to elevation 1,096.0 (NGVD29), in combination with spillway modifications, the NED Plan would increase the overall full pool storage from 4.55 MAF to 5.19 MAF. Of the increased reservoir storage space, about 191,000 acre-feet would be dedicated in the NED Plan. Operations of the cold-water pool would be subject to an adaptive management plan that may include operational changes to the timing and magnitude of release from Shasta Dam to benefit anadromous fish. Operations for the remaining portion of increased storage (approximately 443,000 acre-feet) would be 120,000 acre-feet reserved in dry years and 60,000 acre-feet reserved in critical years to specifically focus on increasing M&I deliveries.

Secondary Objectives

The NED Plan also addresses secondary planning objectives related to hydropower generation, recreation, flood damage reduction, ecosystem restoration, and water quality. Higher water surface elevations in the reservoir would result in an increase in power generation. The NED Plan includes features to at least maintain the existing recreation capacity at Shasta Lake, and water-oriented recreation experiences would be enhanced due to an increase in average lake surface area, reduced drawdown during the recreation season, and modernization of recreation facilities. Enlarging Shasta Dam would provide for incidental increased reservoir capacity to capture flood flows, which could reduce flood damage along the upper Sacramento River. Improved fisheries conditions as a result of the NED Plan, and increased flexibility to meet flow and temperature requirements, could also enhance overall ecosystem resources in the Sacramento River. Additional storage in Shasta Reservoir would also provide improved operational flexibility for meeting Delta water quality objectives through increased and/or high-flow releases to improve Delta water quality.

National Economic Development Plan Construction Activities

The NED Plan includes the construction associated with clearing vegetation from portions of the inundated reservoir area; constructing the dam, appurtenant structures, reservoir area dikes, and railroad embankments; relocating roadways, bridges, recreation facilities, utilities, and miscellaneous minor infrastructure; and gravel augmentation and restoring riparian, floodplain, and side channel habitat.

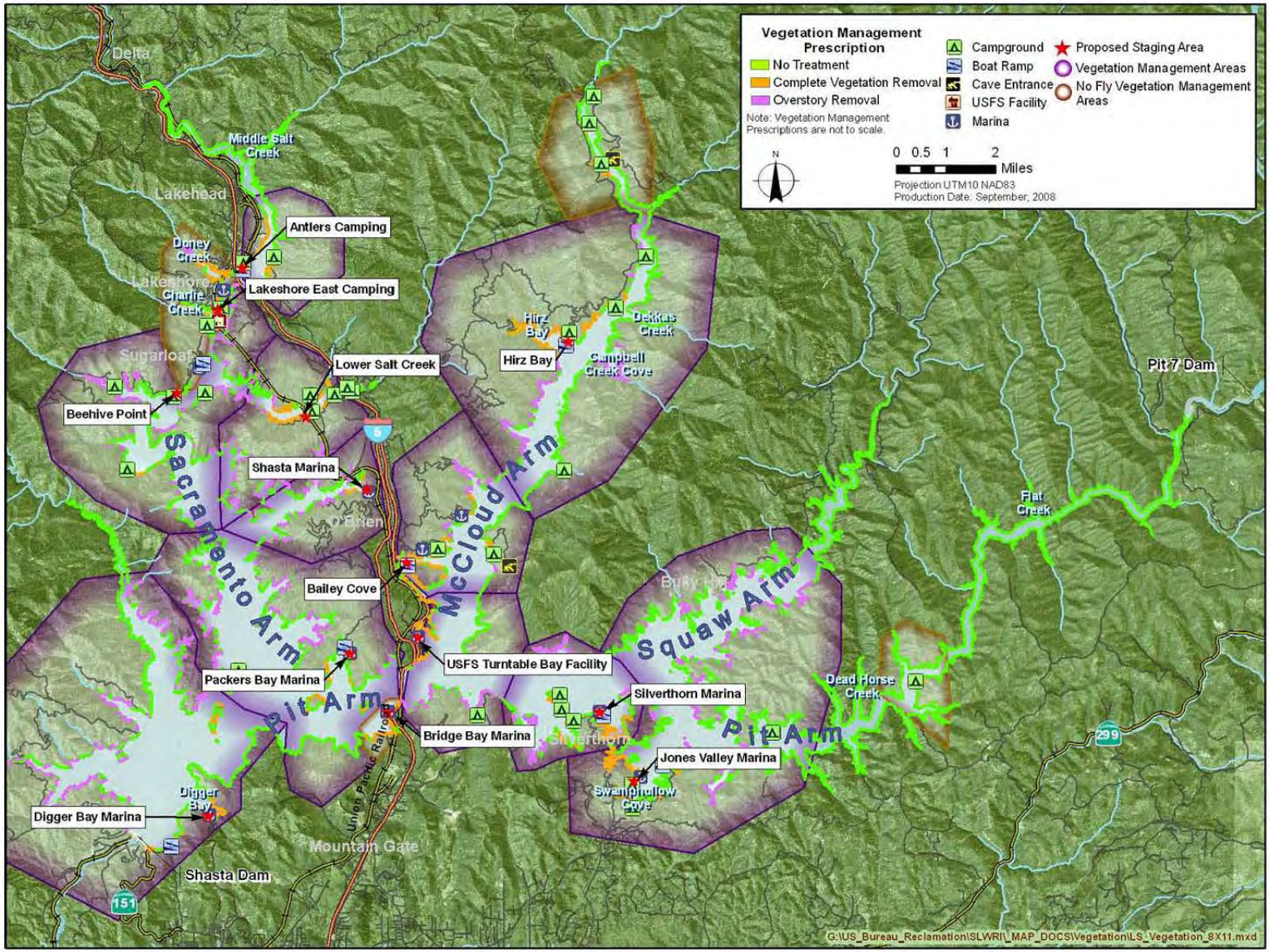
Clearing Portions of Inundated Reservoir Area

A portion of the acreage inundated at the new reservoir full pool would need to be cleared. This would involve removing trees and other vegetation from around

the reservoir shoreline at select areas. Willows, cottonwoods, and buttonbush would not be removed in and along riparian areas. Manzanita removed in cleared areas would be stockpiled and used for fish habitat structures placed in designated locations. Structures, utilities, and other infrastructure would also need to be removed and/or relocated, as described below in more detail.

Fifteen vegetation management areas have been delineated to facilitate efficient removal of vegetation around the reservoir perimeter, including 11 areas of complete vegetation removal and 4 areas of overstory removal (see Figure 3-2). The acreages of each vegetation management area affected by identified reservoir clearing treatments are summarized in Table 3-1 below.

Vegetation management activities would need to be complete before inundation of new areas created by enlarging the reservoir. A single staging area (landing) would serve each vegetation management area. Access for vegetation removal activities would most likely be limited to late summer and fall, when water levels are low and recreation use has decreased. Removal by helicopter would generally be limited to spring and fall because of the limited availability of helicopters during the summer fire season. Vegetation removal would also be limited during bird nesting season, typically early spring through mid-summer. Breeding bird surveys in suitable habitats would be performed to determine the appropriate time frame for vegetation removal activities. Because of distance and/or safety constraints, helicopters would not be used in the following vegetation management areas: Bridge Bay, Lakeshore East, Pit Arm, and McCloud Arm. Slash burning could take place during the winter seasons following vegetation treatment and would comply with all regulations set forth by the Shasta County Air Quality Management District. Methods for clearing the reservoir area are summarized below.



Key: USFS = U.S. Department of Agriculture, Forest Service

Figure 3-2. Vegetation Management Areas

Table 3-1. Reservoir Clearing Treatment Applied for CP4A

Landing Location	CP4A (NED Plan)			
	Complete Removal (acres)	Complete Removal Quantity (board feet)	Overstory Removal (acres)	Overstory Removal Quantity (board feet)
Antlers	17	109,300	12	75,100
Bailey Cove	37	333,700	15	91,300
Beehive Point	6	12,100	54	230,100
Bridge Bay	20	116,400	0	0
Digger Bay	19	62,400	70	208,300
Hirz Bay	49	474,900	49	381,200
Jones Valley	38	183,700	116	737,500
Lakeshore East	39	132,300	5	28,100
Lower Salt Creek	31	216,500	35	141,100
McCloud Arm	10	33,500	0	0
Packers Bay	16	65,600	50	177,100
Pit Arm	4	50,400	0	0
Shasta Marina	2	40,200	30	201,100
Silverthorn	37	265,200	41	258,800
Turntable	11	74,400	19	199,500
Total	**337**	**2,170,600**	**495**	**2,729,200**

Key:
CP = comprehensive plan

Complete Vegetation Removal Complete vegetation removal would clear all existing vegetation from the designated treatment area and would generally be applied to locations along and adjacent to developed recreation areas, including boat ramps, day use areas, campgrounds, marinas, and resorts. Exceptions would be made in areas with high shoreline erosion potential, or habitat for special-status species.

Timber would be harvested and removed to landings by ground-skidding equipment if road access is available and slopes are less than 35 percent; otherwise, trees would be yarded by helicopter and residual vegetation and activity-created slash would be piled and burned by hand. Where possible, trees would be felled into the reservoir during removal to minimize damage to reservoir embankments. Tree stumps would be cut to within 24 inches of the

ground surface and brush stumps would be cut flush to the ground. Stumps would be left in place to reduce shoreline erosion. Complete vegetation removal is intended to maximize shoreline access and minimize the risk to visitors from snags and water hazards.

Overstory Removal Overstory removal involves removing all trees from the treatment area that are greater than 10 inches in diameter at breast height, or 15 feet in height, generally in houseboat mooring areas or narrow arms of the reservoir where snags pose the greatest risk to boaters. Trees would be harvested and removed to landings by ground-skidding equipment if road access is available and slopes are less than 35 percent; otherwise, trees would be yarded by helicopter and activity-created slash would be piled and burned by hand. The remaining understory vegetation would be left in place. As for complete vegetation removal, where possible, trees would be felled into the reservoir during removal to minimize damage to reservoir embankments. Tree stumps would be cut to within 24 inches of the ground surface. Stumps would be left in place to reduce shoreline erosion. Overstory removal is intended to minimize the risk to visitors from snags and water hazards.

No Treatment Designated areas of the inundation zone would be left untreated with no vegetation removed. This prescription would generally be applied to stream inlets, the upper end of major drainages, the shoreline of wider arms of the reservoir, and special habitat areas. This treatment is intended to maximize the habitat benefits of inundated and residual vegetation.

Construction of Dam and Appurtenant Structures

This section summarizes major features associated with enlarging Shasta Dam and Reservoir and modifying its appurtenances for the NED Plan (see Table 3-2.) For more detailed explanations of design considerations, please refer to the Engineering Summary Appendix of the Final EIS.

Table 3-2. Physical Features for Proposed Modifications of Shasta Dam and Appurtenances for CP4A

Physical Features	CP4A (NED Plan)
Quantity of Concrete (cubic yards)	100,800
Quantity of Cement (tons)	213,000
Quantity of Metalwork (pounds)	21,751,200
Volume of Imported Fill Material (cubic yards)	130,500
Volume of Excavation to Waste Material (cubic yards)	1,600
Quantity of Demolished Material (cubic yards)	31,600
Area of Permanent Structures (square feet)	412,600
Area of Work Limits (square feet)	460,900

Key:
CP = comprehensive plan

Dam Crest Structure Removal

Before any enlargement of Shasta Dam, existing structures on the dam crest would need to be removed. These structures include the gantry crane, existing spillway drum gates and frames, the spillway bridge, concrete in the spillway crest and abutments, upstream parapet walls, sidewalks, curbing, crane rails, and control equipment.

Modifying the main dam would require the demolition, removal, and transportation of top-of-dam materials to an approved disposal area. This would include the demolition and removal of the upstream reinforced-concrete parapet wall and curb. Sawcuts would be used to aid in removing the upstream reinforced-concrete parapet wall and curb. In addition, sawcuts would be required along the upstream face and crest of the dam to embed a polyvinyl chloride waterstop. The existing dam crest would be prepared by using a high-pressure water jet on the concrete surface to facilitate bonding with the new concrete to be placed. Existing roadway drains would be backfilled with cement grout.

Drain holes would be drilled from two different locations: from the existing dam crest to drain the surface contact and from the existing dam crest for surface drainage at the downstream overhang. A vertical shaft would be excavated through the concrete from the existing dam crest to the hoist gallery to install electrical conduit.

The existing spillway drum gates and piers would require removal according to a phased construction plan that would minimize impacts to reservoir operations during construction. Two drum gates and one pier would be removed to construct three new piers and install three new sloping fixed-wheel gates. This would be followed by removal of the remaining drum gate and pier to construct two new piers and install three new sloping fixed-wheel gates.

The spillway bridge and dam crest access road would be out of service for an extended period of time (over two years) during construction of the new spillway and dam crest raise. A detour route would be provided below the dam across an existing bridge. Modifications to the TCD would be performed to minimize impacts to reservoir operations to the extent possible, but supplemental cold water releases may be required through the river outlets during a portion of the construction period. Control equipment for the TCD would be removed, stored, and reinstalled for the higher dam crest. The elevator tower would be out of service for about 4 months for construction of the dam crest raise and for replacement of the elevator car and hoist equipment.

Main Gravity Dam and Wing Dams

Enlargement of Shasta Dam would require raising Shasta Dam (the main gravity dam) and its left and right wing dams as indicated in Table 3-3. Construction activities to raise the main gravity dam and the left and right wing dams are summarized below.

Table 3-3. Physical Features for Proposed Modifications of Shasta Dam and Appurtenances for CP4A

Feature	CP4A (NED Plan)
Main Gravity Dam	
Crest Raise (feet)	18.5
Crest Elevation[1]	1,096.0
Upstream Parapet Wall Elevation[1]	1,099.5
Full Pool Elevation[2]	1,090.2
Left Wing Dam	
Crest Raise (feet)	20.5
Crest Elevation[1]	1,098.0
Upstream Parapet Wall Elevation[1]	1,101.5
Right Wing Dam	
Crest Raise (feet)	18.5
Crest Elevation[1]	1,096.0
Upstream Parapet Wall Elevation[1]	1,099.5
Spillway	
Crest Raise (feet)	12.5
Crest Elevation[1]	1,049.5

Notes:

[1] Main dam and wing dam crest elevations are based on the National Geodetic Vertical Datum of 1929 (NGVD29). All current feasibility-level designs and figures for Shasta Dam and appurtenant structures are based on NGVD29.

[2] Full pool elevations are based on the North American Vertical Datum of 1988 (NAVD88), which is 2.66 feet higher than NGVD29. All current feasibility-level designs and figures for reservoir area infrastructure modifications and relocations to accommodate increased water levels are based on a 2001 aerial survey of the reservoir using NAVD88.

Key:
CP = comprehensive plan

Shasta Dam would be raised by placing mass concrete corresponding in width to the existing dam monolith blocks on the existing dam crest (concrete gravity section and spillway crest section). Structural concrete would be placed for the top of the dam, including for the roadway, the upstream and downstream parapets, and the walkway. Reinforcing bars would be used around the utility gallery, and nominal temperature steel would be used for the exposed structural concrete surfaces. Steel top-of-dam drains would be furnished and installed in each block to drain to the upstream face. Surface area and features of the new dam crest would be similar to the existing dam crest, including gantry crane rails and surface drains. A new upstream parapet wall would provide flood protection. The dam raise would include a new utility gallery.

Zoned embankment wing dams were originally constructed on both abutments of the main dam to protect the contact between the concrete and the excavated foundation surface. The left wing dam would be raised to maintain the same height above the top of joint-use storage, as for existing conditions. This would involve extending the existing reinforced-concrete core wall to the raised dam crest, and placing a thick layer of large rockfill downstream from the core wall. The upstream face would consist of a reinforced concrete or mechanically stabilized earth wall, and a concrete parapet wall. The road from the concrete dam crest would be ramped up through the left wing dam to the new

embankment crest. Roadways and security features on the existing dam crest would be relocated to the new dam crest. The existing rotunda on the left abutment of the dam would be removed and reconstructed.

A building housing a visitor center and Reclamation offices, a parking lot, picnic areas, and vista points have been incorporated into the left abutment design. The visitor center building would provide adequate space for visitors, storage, staff, and security functions, and feature a panoramic view of all facilities. The existing roadways, lawns, sidewalks, trees, and other features on the left wing dam crest would be restored to a configuration similar to existing conditions. Existing facilities would be removed from the site before construction, and replaced after the raise is completed.

The right wing dam would be raised to match the main gravity dam crest. Concrete was selected for the right wing dam in lieu of embankment to facilitate construction. The new right wing dam crest would provide surface area and features similar to the existing dam crest, including gantry crane rails and surface drains. A new upstream parapet wall would provide additional flood protection. The right wing dam would include a new utility gallery and a foundation drainage curtain. Right abutment access roads would be modified to match the new dam crest.

Spillway

Structural concrete would be used to raise the existing spillway crest and to shape the raised spillway crest as indicated in Table 3-3. The existing spillway bridge, two existing spillway piers, cantilever wall sections, and three existing drum gates and operating equipment would be removed. Five new spillway piers would be constructed at locations within the spillway, designed to avoid existing overflow block contraction joints, and a new concrete spillway crest would be constructed between them. The locations of the new piers would result in different widths of spillway gates. The three existing 110-foot by 28-foot drum gates would be replaced with six sloping, fixed-wheel gates. The total spillway crest length would be reduced from 330 feet to 300 feet as a result. A new bridge would be required over the spillway to allow for vehicular traffic and for a gantry crane to travel from one end of the dam to the other.

Temperature Control Device

Modifications to the TCD would be needed for all action alternatives. Modifications would primarily involve extending the main steel structure to the new full pool elevation; raising the TCD operating equipment, including gate hoists, electrical equipment, miscellaneous metalwork, and hoist platform above the new top of joint-use elevation; installation of additional cladding on the existing and raised sections of the TCD; and lengthening/replacing shutter operating cables.

Shasta Powerplant Penstock Intake and Penstock Modifications

The centerline of the existing penstock intakes would remain at the current level, but the gate hoists would require relocation with a higher dam crest. The existing steel penstock pipes have been determined to be adequate for the higher reservoir loads and no penstock modifications are anticipated.

Pit 7 Facilities

The Pit 7 Dam and Powerhouse, which is owned and operated by Pacific Gas and Electric Company (PG&E), is located on the upper Pit River at the northeast end of Shasta Lake. The complex consists of three main features: a main dam with integral spillway, a two-unit hydroelectric powerhouse immediately downstream from the main dam, and an afterbay dam. The expected modifications to the Pit 7 facilities associated with any action alternative include main dam spillway, powerhouse, and afterbay dam modifications.

Pit 7 Dam spillway backwater conditions have the possibility of creating wave action that could undermine the powerhouse and dam when flows are released over the spillway. It is recommended that both the left and right concrete training walls be increased in height to prevent this from occurring.

For Pit 7 Powerhouse, new sump pumps and a tailwater depression system are recommended. To ensure that proper operation of equipment in the powerhouse, the dewatering capacity of the existing sump pumps will need to be increased to address any additional seepage. This can be achieved with the installation of a new submersible pump. A tailwater depression system will need to be installed. During high flows, a tailwater depression system would introduce compressed air into the turbine runner pit to depress the tailwater to a level that does not interfere with turbine operation, thereby allowing continued turbine operation. The tailwater depression system would include air compressors, air discharge piping with control valves, water-level sensors, power supply, and electrical controls. Air compressors would be of the high-volume, low-pressure type, referred to as “blowers.” Blowers would be driven by electric motors supplied with available power from the Pit 7 Powerhouse.

The Pit 7 Afterbay Dam may require the placement of rock dowels and rip rap for slope stability to meet the necessary safety standards. Ancillary facilities will need to be addressed near the Pit 7 Afterbay Dam including relocating the gaging station and cableway that would be inundated by the new high water line, extending the boat barriers, relocating security fences and signs, rehabbing the existing boat ramp, and relocating the warning siren.

Reservoir Area Dikes and Railroad Embankments

The physical features for the proposed dikes and railroad embankments are shown in Table 3-4. The proposed dikes would be constructed using common earthmoving equipment and methods. Additional excavation to provide working surfaces and keys for the embankment fill would be required along the slope of

the upstream foundation for some of the proposed dikes. Ground treatment and/or over-excavation may be necessary in some areas to remove and/or treat pervious material. Riprap would be placed on the upstream face of each dike to the crest of the dike to protect against wave run-up and erosion. Reservoir area dikes and railroad embankments are further described in the Engineering Summary Appendix of the Final EIS.

Table 3-4. Physical Features for Proposed Dikes and Railroad Embankments by CP4A

Dike Features	CP4A (NED Plan)
Lakeshore Dikes/Railroad Embankments	
Doney Creek Dike	
Volume of Fill Material (core, drain, filter) (cubic yards)	75,000
Volume of Riprap (cubic yards)	5,900
Volume of Excavated Material (cubic yards)	10,200
Site Clearing and Grubbing Below Dike (acres)	7.2
Antlers Dike	
Volume of Fill Material (core, drain, filter) (cubic yards)	4,900
Volume of Riprap (cubic yards)	400
Volume of Excavated Material (cubic yards)	300
Site Clearing and Grubbing Below Dike (acres)	0.9
North Railroad Embankment	
Volume of Fill Material (core, filter) (cubic yards)	17,100
Volume of Riprap (cubic yards)	400
Volume of Excavated Material (cubic yards)	1,500
Site Clearing and Grubbing Below Dike (acres)	1.2
Middle Railroad Embankment	
Volume of Fill Material (core, filter) (cubic yards)	13,400
Volume of Riprap (cubic yards)	300
Volume of Excavated Material (cubic yards)	4,000
Site Clearing and Grubbing Below Dike (acres)	2.9
South Railroad Embankment	
Volume of Fill Material (core, filter) (cubic yards)	101,900
Volume of Riprap (cubic yards)	2,500
Volume of Excavated Material (cubic yards)	8,500
Site Clearing and Grubbing Below Dike (acres)	6.2

Table 3-4. Physical Features for Proposed Dikes and Railroad Embankments by CP4A (contd.)

Dike Features	CP4A (NED Plan)
Bridge Bay Dikes	
West Dike	
Volume of Fill Material (core, drain, filter) (cubic yards)	69,000
Volume of Riprap (cubic yards)	23,600
Volume of Excavated Material (cubic yards)	15,300
Site Clearing and Grubbing Below Dike (acres)	2.2
East Dike	
Volume of Fill Material (core, drain, filter) (cubic yards)	40,100
Volume of Riprap (cubic yards)	7,400
Volume of Excavated Material (cubic yards)	16,900
Site Clearing and Grubbing Below Dike (acres)	1.1

Key:
CP = comprehensive plan

Reservoir Area Relocations

As a result of the proposed Shasta Dam raise under the NED Plan, the following major features would be inundated by the increase in full pool elevation:

- Roadways
- Vehicle bridges
- Railroad bridges
- Recreation facilities
- Utilities and miscellaneous minor infrastructure

Existing infrastructure affected by enlarging Shasta Dam and Reservoir would need to be removed and/or relocated.

Roadways

Physical features associated with proposed road relocations are shown by major focus area in Table 3-5. Road design criteria and construction characteristics are discussed in detail in the Engineering Summary Appendix of the Final EIS.

Table 3-5. Physical Features for Proposed Road Relocations by Major Road Focus Area for CP4A

Road Relocation Features	CP4A (NED Plan)
Lakeshore Drive	
Number of Road Segments Affected	8
Length (linear feet)	13,700
Clearing and Grubbing (acres)	7
Excavation to Embankment (cubic yards)	55,500
Embankment Fill (cubic yards)	174,900
Closure Expected	No
Turntable Bay Area	
Number of Road Segments Affected	3
Length (linear feet)	6,200
Clearing and Grubbing (acres)	2
Excavation to Embankment (cubic yards)	19,000
Embankment Fill (cubic yards)	76,200
Closure Expected	Yes
Gillman Road	
Number of Road Segments Affected	3
Length (linear feet)	1,200
Clearing and Grubbing (acres)	1
Excavation to Embankment (cubic yards)	0
Embankment Fill (cubic yards)	22,800
Closure Expected	Yes
Jones Valley and Silverthorn Area	
Number of Road Segments Affected	3
Length (linear feet)	1,600
Clearing and Grubbing (acres)	1
Excavation to Embankment (cubic yards)	1,500
Embankment Fill (cubic yards)	13,200
Closure Expected	Yes
Salt Creek Road	
Number of Road Segments Affected	5
Length (linear feet)	5,100
Clearing and Grubbing (acres)	1
Excavation to Embankment (cubic yards)	5,500
Embankment Fill (cubic yards)	33,100
Closure Expected	Yes
Remaining Road Relocations	
Number of Road Segments Affected	8
Length (linear feet)	5,200
Clearing and Grubbing (acres)	2
Excavation to Embankment (cubic yards)	600
Embankment Fill (cubic yards)	81,000
Closure Expected	Yes

Key:
CP = comprehensive plan

Roadway construction activities would involve, but not be limited to, demolition of existing roadways as required; clearing, grubbing, and site preparation of work areas, as required; grading road alignments to meet finished grades; placing road subgrade; paving operations; installing storm drain culverts; constructing retaining wall systems; installing road appurtenances such as guardrails; performing construction-related traffic control; and establishing and maintaining a SWPPP. Noisy equipment, such as pile drivers, is anticipated for road construction work. Typical noise would result from trucks and diesel-powered equipment.

Replacement roadways would be constructed by excavating the existing up-grade slope to provide fill material for the embankment fill portion of road construction; bench-excavating into the up-grade slope above the existing roadway to establish the new road finished grade; building the new road on an engineered fill embankment from imported borrow material; or building the new road directly above the existing road on an engineered fill embankment from imported borrow material. A road alignment may either use a single method of construction for the entire alignment, or use all four methods at different locations along an alignment. To limit impacts on existing roadways, road closures would be avoided whenever possible.

Estimated work limits for road segment relocation are described in the Engineering Summary Appendix. Estimated work limits depend on the surrounding terrain, and vary from a minimum of 5 feet to 30 feet wide, measured from the extent of earthwork. Where the road would be constructed as an embankment fill against an existing steep hillside, a 5-foot-wide minimum work area would be used. Where the terrain beyond the limit of earthwork was flat enough to be used as work areas for construction equipment, the work limits would range from 15 feet to 30 feet wide.

Vehicle Bridges As a result of raising Shasta Dam, the following local road vehicle bridges would be replaced:

- Charlie Creek Bridge
- Doney Creek Bridge
- McCloud River Bridge
- Didallas Creek Bridge

Criteria and assumptions considered in determining structure type and length for the replacement structures are included in the Engineering Summary Appendix of the Final EIS. Based on the design criteria and assumptions, and considering preliminary horizontal alignments and profile grades developed for the relocated roadways, Table 3-6 summarizes proposed bridge characteristics for the four road bridges requiring replacement for the NED Plan.

Table 3-6. Physical Features of Proposed Vehicular Bridge Relocations for CP4A

Bridge Feature	Charlie Creek Bridge	Doney Creek Bridge	McCloud River Bridge	Didallas Creek Bridge
Bridge Length (linear feet)	782	760	490	115
Number of Abutments	2	2	2	2
Number of Piers	4	4	4	0
Pier Diameter (linear feet)	14	14	6	N/A
Volume of Backfill (cubic yards)	480	400	530	180
Volume of Concrete (cubic yards)	3,530	3,320	2,320	760
Quantity of Steel (tons)	575	516	380	104
Number of Class 140 Piles	24	24	24	24
Number of 24-inch Cast-In-Steel-Shell Piles	72	72	32	N/A
Volume of Excavated Material (cubic yards)	1,200	550	820	440
Quantity of Demolished Material (cubic yards)	3,500	3,300	2,300	800

Key:
N/A = not applicable
SLWRI = Shasta Lake Water Resources Investigation

Construction would take place during the low-water season, and is expected to last between 6 and 8 months. The waterway would remain clear for navigation during construction. Bridge construction would begin with piers and abutments. To allow underwater construction of pier foundations, steel pile shells would be driven into the lake bed to create a temporary cofferdam. It may be necessary to dewater the shells during drilling if water seeps in. A hole would then be drilled to the specified foundation depth. Reinforcing steel would be installed within the shells before concrete was poured. After completion of the piers and abutments, construction of the superstructure and bridge deck would begin via the balanced cantilever method. This process entails forming and constructing the horizontal structure outward from the piers in each direction, in equal (balanced) proportions, until the superstructure/deck segments meet at midspan.

Traffic would continue on the existing bridges during construction. It is likely that barges would be used extensively for vehicular bridge foundation construction, bridge assembly, transport of materials, workers, and equipment, and demolition of the existing bridges. Concrete would be poured from barges. A staging area would be required on the lakeshore, from which barges could be loaded and unloaded.

Although Fender's Ferry Bridge would not need to be replaced as a result of the Shasta Dam raises, modifications to the bridge would be necessary. The Fender's Ferry Bridge is a three-span structure with a steel plate girder superstructure supported on riveted steel tower bents and reinforced concrete piers with spread footings. As a result of differences in east and west riverbank topography, the western pier steel tower is supported at a much lower elevation

than the eastern pier tower. Thus, at the proposed full pool elevations, the eastern pier steel tower would be inundated.

The existing reinforced concrete pier and footing would be enlarged and extended, and the existing steel tower modified to prevent inundation as a result of the higher full pool levels associated with the dam raise alternatives under consideration. Proposed modifications include the following:

- Enlarging the existing reinforced concrete footing
- Enlarging and extending the existing reinforced concrete columns and pier wall
- Removing some of the lower portion of the eastern pier steel tower (based on location of existing cross bracing)
- Reusing the existing steel bearing assemblies

Quantities for the major items of work are estimated in the Engineering Summary Appendix of the Final EIS.

Construction activities would likely be completed from the existing embankment without constructing cofferdams around the pier because average water surface elevations are below the existing eastern pier bottom-of-footing elevation for all months, with the exception of April and May. Construction of temporary bents to support the superstructure would be necessary to facilitate construction of the pier modifications. During construction activities, temporary traffic controls may be needed to facilitate delivery of materials and construction of temporary support bents.

Railroad Bridges

Pit River Bridge Pier Modification The Pit River Bridge is a multipurpose structure, carrying both United Pacific Railroad (UPRR) and Interstate-5 traffic. The bridge is both a steel-through truss and a deck truss. UPRR and Caltrans have joint operation and maintenance responsibility. The new full pool elevations would inundate the existing bridge bearings and low-chord steel truss members. To prevent the existing steel bearings and lower portions of the steel truss members from being submerged, a watertight concrete tub structure (bearing protection structure) would be required. The reinforced concrete structure would be attached to the top of two existing concrete piers. The structure footprint would be rectangular, with the top of the structure above the full pool elevation. Elevations for the top of the bearing protection structure and material quantities for Pit River Bridge modifications are shown in Table 3-7.

Table 3-7. Physical Features for Proposed Bearing Protection Structure for CP4A

Item	CP4A (NED Plan)
Top of Bearing Protection Structure Elevation (feet)[1]	1094.2
Concrete (cubic yards)	4,000
Reinforcing Steel (pounds)	1,200,000

Notes:
[1] Bearing protection structure elevations are based on the North American Vertical Datum of 1988 (NAVD88), which is 2.66 feet higher than the National Geodetic Vertical Datum of 1929. All current feasibility-level designs and figures for reservoir area infrastructure modifications and relocations to accommodate increased water levels are based on a 2001 aerial survey of the reservoir using NAVD88.

Key:
CP = comprehensive plan

Because the existing bridge superstructure and top-of-pier are exposed to the elements, a structure cover would not be required; however, two submersible sump pumps would be installed to keep the water level in the new concrete protective structure from rising near the bearings. Check valves and ball valves would prevent pumped water from draining out of the line back into the sump. Protective grates would prevent large objects from entering the sump area.

Union Pacific Railroad Bridges 2nd Crossing and Doney Creek Bridge Replacement The superstructures for the existing Sacramento River Second Crossing and Doney Creek railroad bridges consist of deck truss bridges with a single track. The piers and abutments were designed to accommodate a future parallel single-track superstructure. Portions of both bridges would be submerged for any reservoir raise and would need to be replaced with new, higher superstructures. Structural analyses of the existing bridge piers under design earthquake loads indicated that new bridge piers would be required. Therefore, the existing bridges will be removed and replaced with new bridges. The feasibility designs would permit uninterrupted rail service during construction.

The proposed new bridge superstructures would be composite superstructures consisting of steel plate girders and a reinforced concrete deck. In general, the bridge superstructures would be designed to be continuous over the piers. However, with a requirement for 16 feet of vertical clearance between the two westernmost piers for the Sacramento River 2nd Crossing railroad bridge (with a minimum width of 30 feet), to allow for the passage of houseboats, this span is a simply supported span. No minimum clearance for houseboat traffic would be required for the Doney Creek railroad bridge; large-diameter concrete columns with drilled shafts would support the superstructure and be founded on bedrock. The Sacramento River Second Crossing railroad bridge would require nine spans, with a total length of 982 feet between concrete abutments. The Doney Creek railroad bridge would require five spans, with a total length of 537.5 feet between concrete abutments. Construction quantities for major items of work for these features are summarized in Table 3-8.

Table 3-8. Physical Features of Proposed Railroad Bridges for CP4A

Item	Sacramento River Second Crossing Bridge Quantities	Doney Creek Bridge Quantities
Steel Truss Bridge Removal (lb)	3,300,000	2,000,000
Concrete Removal (cubic yards)	15,310	4,570
Excavation (cubic yards)	2,100	630
Backfill (cubic yards)	1,900	2,200
Concrete, including Shafts (cubic yards)	11,700	7,080
Reinforcing Steel (lb)	3,420,000	1,760,000
Structural Steel in Girders (lb)	4,750,000	2,250,000

Key:
lb = pound
SLWRI = Shasta Lake Water Resources Investigation

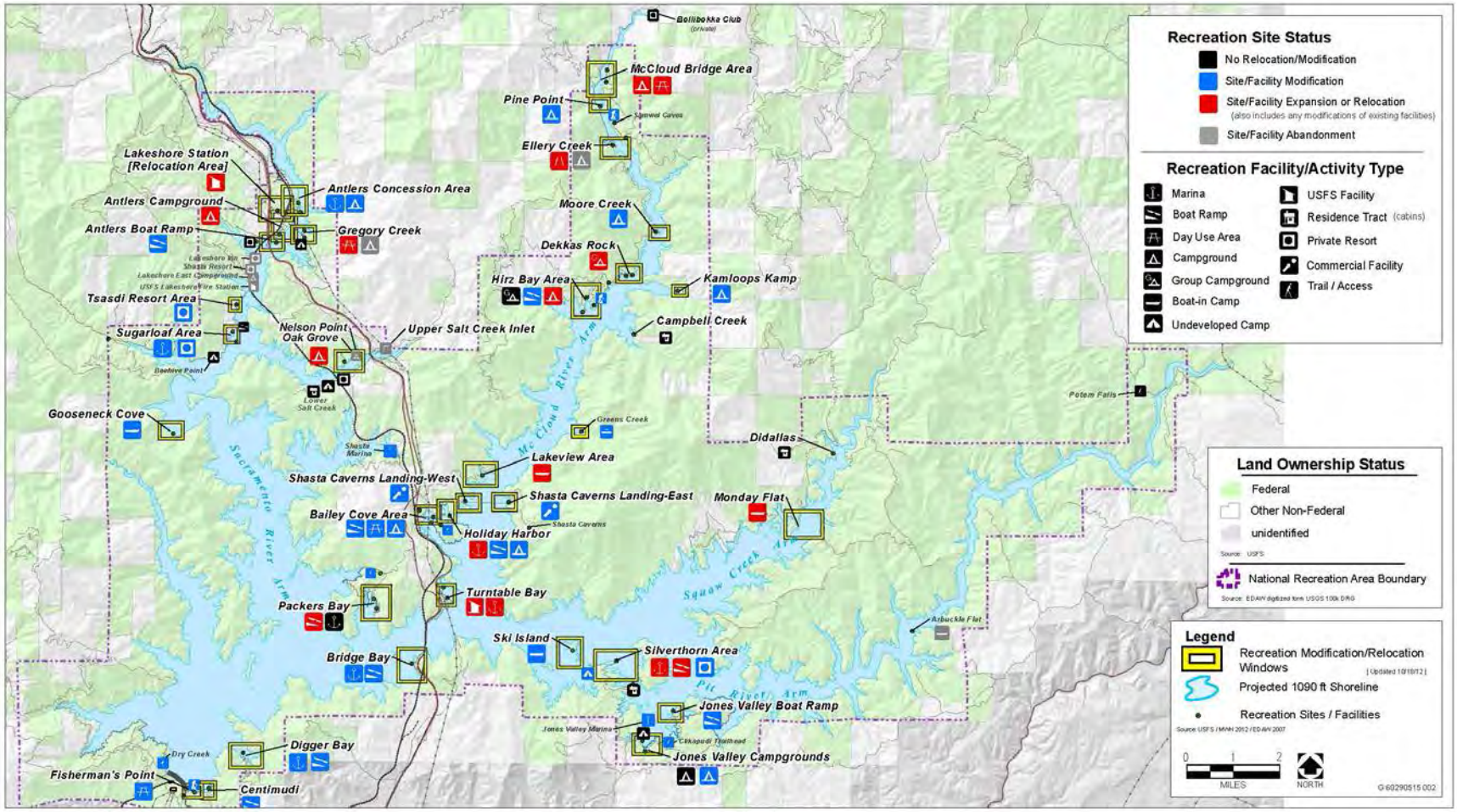
The proposed relocation of the UPRR bridges would require that the railroad tracks be realigned between the two bridges. This realignment would parallel the existing tracks with a 25-foot offset to the east. Construction quantities for major items of work for the railroad realignment between the UPRR bridges are summarized in Table 3-9. Any required embankments for this realignment are described under the "Reservoir Area Dikes and Railroad Embankments" section above.

Table 3-9. Physical Features of Proposed Railroad Realignment for CP4A

Item	Railroad Realignment Between Bridges
Length of Track Realignment (linear feet)	8,400
Railroad Track Removal (tons)	370
Ballast Removal (tons)	6,400
Excavation (cubic yards)	35,000
Compacted Backfill (cubic yards)	7,500
Railroad Track (tons)	390
Ballast (tons)	26,500

Key:
SLWRI = Shasta Lake Water Resources Investigation

Recreation Facilities Any raise of Shasta Dam would have some effect on the many recreation features found along the reservoir shoreline. These features include marinas/boat ramps, resorts, campgrounds/day use areas, cabins, trails, and USFS facilities. Areas for potential recreation relocations (referred to as windows) and corresponding relocation plans for each window have been developed. Figure 3-3 details the location of these windows and existing recreation sites with proposed modification, expansion, or relocation activities.



Source: AECOM 2012

Exhibit: Recreation Mitigation Sudy – Summary

Figure 3-3. Recreation Study Windows

The primary goal of the relocation plans is to verify that with any dam raise, the existing recreation capacity could be maintained. Reclamation and USFS will continue to work together to refine recreation relocations and develop a recreation plan that is suitable for the NRA. For recreation facilities on Federal lands, the USFS will consider relevant laws, regulations, policy, special use permits and master development plans to develop and/or provide final approval for any proposed recreation facility relocations. Action alternatives would, at minimum, maintain the existing recreation capacity at Shasta Lake. Inundated recreation facilities and associated utilities would be relocated before demolition to the extent practicable. Scheduling and sequencing of recreation facility relocation construction activities will strive to minimize or avoid interruption to public recreation activities and access to recreation sites. Recreation facilities proposed for relocation are included below in the detailed description of each action alternative. Table 3-10 presents a summary of the recreation facilities to be modified or relocated. Quantities of demolition and construction materials associated with modification and relocation of recreation facilities are listed in Table 3-11.

Table 3-10. Recreation Facilities to be Modified or Relocated Under CP4A

Recreation Facilities	CP4A (NED Plan)
Marinas/Public Boat Ramps	
Number of Affected Facilities (marinas/boat ramps)	9/6
Relocation Needed[1] (acres)	8.5
Replacement Structures (square feet)	49,900
Campsites and Day-Use Sites	
Number of Affected Facilities (resorts/campsites and day-use sites)	328
Relocation Needed[1] (acres)	39
Replacement Structures (square feet)	6,200
Resorts/USFS Facilities	
Number of Affected Facilities (resorts/USFS facilities)	6/2
Relocation Needed[1] (acres)	19
Replacement Structures (square feet)	68,900
Trailheads/Trails	
Number of Affected Facilities (trailheads/trails)	2/9
Relocation Needed[1] (miles)	11.6
Recreation Enhancement[3] (trailheads/trails[miles])	-

Note:
[1] Does not include on-site modification of facilities.
[2] For some trails, trailheads are integrated into other recreation facilities. Estimates for standalone trailheads only.
[3] Additional recreation facilities for Alternative CP5 only.
Key:
- = not applicable
CP = comprehensive plan
USFS = U.S. Department of Agriculture, Forest Service

Table 3-11. Recreation Demolition and Construction Material Quantities for CP4A

Material	CP4A (NED Plan)
Recreation Facilities	
Imported Fill (cubic yards)	552,800
Excavation to Waste (cubic yards)	315,400
Structure Demolition (square feet)	164,200
Demolition Waste (cubic yards)	105,200

Key:
CP = comprehensive plan

Marina Modifications Several marinas around Shasta Lake would be affected by raising Shasta Dam. Typically, marinas consist of a parking area, a boat ramp, various structures (e.g., retail, restrooms, maintenance facilities, storage, administration), and utilities (power, water, and septic). Most of the effects of the dam raise would result from the inundation of boat ramps, parking lots, structures, and utilities. Boat ramps would be modified in place, on fill, where possible. Parking areas would be replaced on fill, or relocated above the new reservoir elevation. Existing structures that would be inundated would be demolished, and either replaced above the reservoir elevation (upslope or on placed fill), or moved to a floating structure on the water to provide better access for recreational users. Any access roads would be relocated above the new full pool for continued access around the marinas. Existing septic systems that would be inundated would be demolished and removed from the area or relocated. New facilities could also be connected to new localized wastewater treatment facilities. Power lines would be installed to accommodate new structures.

To maintain shoreline accessibility and facility distribution around the lake, each affected marina would be relocated in the immediate vicinity of its existing location. Relocation of marinas in their existing location is the most cost effective approach to maintaining marina-related recreation capacity at Shasta Lake. If unforeseen circumstances prevent affected marinas from being maintained in their current location, relocating or consolidating with other marinas would be reconsidered. Although not anticipated, potential new or expanded areas that could be used include:

- Silverthorn Marina Area
- Turntable Bay Area
- Holiday Harbor Marina Area

Public Boat Ramp Modifications Six public boat ramps that could be inundated would be modified or relocated in the immediate vicinity. Public boat ramps that could not be modified in place would be relocated to adjacent areas that can provide the necessary grade and access for ramps. To maintain current

recreation capacity of public boat ramps the following potential new or expanded areas could be used:

- Antlers Public Boat Ramp Area
- Packers Bay Public Boat Ramp Area

Resort Modifications Raising Shasta Dam would affect approximately six resorts around the reservoir to some degree. Inundated structures and structures within 3 vertical feet of the new full pool would be demolished. Septic systems would also be demolished, and remaining structures would either be connected to new localized wastewater treatment facilities or be relocated to other septic systems. To maintain the current recreation capacity of the resorts, the Antlers Concession Area could be used.

Campground/Day Use Area Modifications Many undeveloped areas have been identified as potential campgrounds to replace capacity lost because of inundation. While some inundated campgrounds would be relocated on fill at their existing location, others would be moved around the reservoir to new locations identified as potential campground sites. To maintain the current recreation capacity of campgrounds, the following potential new or expanded areas could be used:

- Antlers Campground
- Oak Grove Campground
- Hirz Bay Campground
- McCloud Bridge Area

The following potential new or expanded areas could be used to meet the need for boat-in campgrounds:

- Former Lakeview Marina Area
- Monday Flat Boat-In Camp

The following potential new or expanded areas could be used to meet the need for day-use areas:

- Ellery Creek Campground
- Gregory Creek Campground
- McCloud Bridge Area

USFS Facilities Modifications Recreation within the NRA is managed by USFS, which has several facilities located throughout the reservoir area. USFS facilities consist of various storage and maintenance buildings and equipment, fire protection equipment, customer service facilities, office space, and employee living facilities. Two USFS facilities would be inundated and would require relocation or replacement. The station located in the Lakeshore area would be inundated by a Shasta Dam raise, and would be relocated to an area above the new full pool. The new facility would contain all of the features that exist at the current facility. The inundated facility would be demolished, and hauled to waste. Turntable Bay, another USFS facility, would be inundated by a Shasta Dam raise. Additional space at Turntable Bay would allow the facility to be relocated on fill in its current location.

Nonrecreation Structures Nonrecreational residential and commercial structures affected by inundation would require demolition. These structures would be demolished by appropriately licensed contractors. All utilities would be disconnected, capped, and/or removed per permit requirements and governing utility standards. The structure and foundation would then be demolished. Asbestos material, if discovered, would be removed and taken to an approved landfill for disposal per permit requirements. General demolition waste would also be removed and trucked to an approved landfill. Table 3-12 shows the total volume of demolished material for nonrecreational structures.

Table 3-12. Nonrecreation Structures Demolition Quantities for CP4A

Demolition	CP4A (NED Plan)
Structure Demolition (square feet)	27,000
Total Volume of Material (cubic yards)	4,000

Key:
CP = comprehensive plan

Utilities and Miscellaneous Minor Infrastructure Gas/petroleum facilities, potable water facilities, power and telecommunications infrastructure, and wastewater facilities would be relocated if affected physically by inundation or if the facilities (such as septic systems) would no longer meet Shasta County Development Standards. The relocation numbers or lengths of facility features to be relocated during proposed utility relocations are shown in Table 3-13. New facilities would be designed and constructed in accordance with applicable Federal, State, and local codes and requirements. Relocated facilities would be of the same types, sizes, and materials as existing facilities where feasible. For relocation of wastewater treatment facilities, new septic systems may be constructed on the property if they meet Shasta County requirements for separating septic systems from the lake. Otherwise, the NED Plan includes facilities for pressurized sewer collection systems to transport wastewater flows to centralized package wastewater treatment plants.

Demolished facilities would not be reused to construct relocated facilities. Demolished and relocated utilities are summarized as part of the detailed description of each action alternative. The approach and methodology for demolition, design, and relocation criteria for each category of utilities are discussed in greater detail in the Engineering Summary Appendix of the Final EIS.

Table 3-13. Physical Features for Proposed Utilities Relocations for CP4A

Utility Type	CP4A (NED Plan)
Potable Water Facilities	
Length of Waterlines Relocated (linear feet)	11,000
Wells/Tanks Relocated (number)	10
Pump Stations Relocated (number)	3
Length of Waterline Demolished (linear feet)	14,800
Wells/Tanks Demolished (number)	25
Pump Stations Demolished (number)	3
Gas/Petroleum Facilities	
Tanks Relocated (number)	10
Tanks Demolished (number)	10
Wastewater Facilities	
Septic Systems Relocated[1] (number)	19
Vault/Pit Toilets Relocated (number)	2
Pump Stations Relocated (number)	1
Length of Wastewater Pipe Relocated (linear feet)	430
Septic Systems Demolished[2] (number)	266
Vault/Pit Toilets Demolished (number)	2
Pump Stations Demolished (number)	2
Length of Wastewater Pipe Demolished (linear feet)	2,400
Package Wastewater Treatment Plants[3] (number)	Up to 6
Power Distribution Facilities	
Power Lines Relocated (linear feet)	42,050
Power Towers Relocated (number)	11
Power Lines Demolished (linear feet)	43,045
Power Towers Demolished (number)	26

Table 3-13. Physical Features for Proposed Utilities Relocations for CP4A (contd.)

Utility Type	CP4A (NED Plan)
Telecommunications	
Copper Wire Relocated (linear feet)	33,400
Fiber-Optic Cable Relocated (linear feet)	5,800
Copper Wire Demolished (linear feet)	31,200
Fiber-Optic Cable Demolished (linear feet)	5,200

Note:
[1] Does not include septic systems replaced with new sewer connections.
[2] Includes demolition of septic systems to be relocated, replaced with new sewer connections, and removed without relocation or replacement.
[3] Includes additional lift stations, force main, laterals, and holding tank pumps/valves not shown.
Key:
CP = comprehensive plan

Augmenting Spawning Gravel in the Upper Sacramento River

Gravel augmentation would occur at one to three locations between Keswick Dam and the RBPP every year for a period of 10 years, unless unusual conditions or agency requests precluded placement during a single year. Construction activities would vary significantly by location, but generally would include clearing, grubbing, and some grading of new access routes to allow construction vehicles to access the river. At several locations, clearing and grubbing of the riverbank would be required to allow gravel to be placed on the bank for recruitment. Gravel would be delivered to the locations by dump trucks. In most cases, gravel would be stockpiled in a staging area and moved with bulldozers, loaders, and/or excavators. Dust control trucks would be present during all construction activities.

Several locations would require in-water construction work. Generally, this involves building gravel out into the river channel "step-wise," meaning that gravel is dumped and leveled, and the leveled area serves as a working platform for the next step of construction. This practice is common for spawning gravel placement, and minimizes the extent to which construction vehicles drive directly through an active river channel. One or two locations, however, would require construction activity in the active river channel, where construction vehicles would deposit gravel and raise the grade of the river near existing riffles.

Restoring Riparian, Floodplain, and Side Channel Habitat in the Upper Sacramento River

Riparian, floodplain, and side channel habitat restoration would be constructed at one or more suitable locations along the upper Sacramento River to benefit anadromous fish and other aquatic and riparian species. Several potential sites exist along the upper Sacramento River between Keswick Dam and RBPP that

would be suitable for these restoration measures. Construction activities for riparian, floodplain, and side channel habitat restoration would vary depending on the location or locations selected and type of restoration measure to be implemented at the site. In general, construction activities would include earth moving activities with bulldozers, loaders, excavators, and/or compactors. Vegetation removal may also be necessary at some sites, either for channel deepening/widening, or where water with aquatic vegetation is present in a channel pending modification.

Special precautions for restoration at these sites will primarily involve:

- Maintaining the active spawning areas in proximity to the site
- Avoiding the creation of habitat for predacious fish
- Minimal disruptions to navigability of the river
- Preventing the spread of invasive, non-native plant species
- Ensuring the safety of homes located along the Sacramento River downstream from the sites

The following are examples of construction measures proposed for restoration of riparian, floodplain, and side channel habitat at each of the potential restoration sites.

Henderson Open Space

An existing side channel to the main stem of the Sacramento River would be enhanced to activate the frequency and duration of flows for Chinook salmon spawning habitat throughout a portion of Henderson Open Space Park. The enhancement would involve modifying the northern opening to the existing side channel to restore connectivity with the river at flows greater than 8,000 cubic feet per second (cfs). Minor grading and channel slope modification would be necessary to rework the existing (sometimes inundated) channel to a point at which flows may be activated for spawning habitat.

The existing Henderson Open Space side channel is heavily vegetated. Floodplain terraces and adjacent riparian areas would be replanted with native vegetation after the completion of earth-moving activities. A more detailed site analysis would determine the mix, composition, and density of the riparian vegetation plantings. To varying degrees, temporary fencing and irrigation would be necessary to protect and sustain newly established riparian vegetation.

Tobiasson Island

A regularly flowing side channel would be created to increase spawning habitat for all runs of Chinook salmon at Tobiasson Island. Creating this side channel would involve excavating a trapezoidal-shaped channel, the base of which would correspond to an elevation that would allow flows of 5,000 cfs or greater

to enter the side channel, hence hydraulically connecting it to the Sacramento River. If created, this new side channel would add approximately 1,350 linear feet of salmonid spawning habitat to this section of the Sacramento River.

The potential site for the channel to be cut does not currently have flowing water or riparian vegetation: therefore, vegetation removal would not be necessary. However, upon completion of earth-moving activities, it would be necessary to establish native vegetation throughout the side channel on the newly created floodplain terraces. A more detailed site analysis would determine the mix, composition, and density of the riparian vegetation plantings. Temporary irrigation and fencing for vegetation planting at this site is not feasible because the site lacks water supply and electricity.

Shea Island Complex

Restoration at the Shea Island Complex would involve lowering a section of the upstream end of the major side channel through the site. The objective would be to keep water moving through the channel when the Sacramento River reaches flows of 10,000 cfs or greater, thus enhancing salmonid spawning habitat.

Additionally, removal of vegetation and debris would be necessary in both the excavated portion of the channel and other portions of the channel to insure the connectivity of flows. Minor grading activity could increase channel complexity along the length of the corridor. Upon completion of earth-moving activities, it would be necessary to establish native vegetation throughout the side channel on the newly created floodplain terraces. A more detailed site analysis would determine the mix, composition, and density of the riparian vegetation plantings. Temporary irrigation and fencing for vegetation planting at this site is because the site lacks a water supply and electricity.

Kapusta Island

An existing side channel on Kapusta Island would be enhanced to increase spawning habitat for winter-run and spring-run Chinook salmon in the Sacramento River. This enhancement would involve lowering the channel bed so that the channel may be hydraulically connected to the Sacramento River when the river is flowing in excess of 10,000 cfs.

A trapezoidal cut would need to occur along the course of the side channel, which is inundated only infrequently; in addition, vegetation and debris would need to be removed. Upon completion of earth-moving activities, establishing vegetation on new floodplain terraces and adjacent riparian areas with native plants would be necessary. A more detailed site analysis would determine the mix, composition, and density of the riparian vegetation plantings. Temporary fencing or irrigation at this site for newly established riparian vegetation is highly infeasible and a planting mix would need to be selected with this limitation in mind.

Anderson River Park

Restoring floodplain, riparian and side channel habitat at Anderson River Park would involve altering a relic Sacramento River side channel located in the southeastern portion of the park at river flows of, or above 8,000 cfs or more. The side channel rearing habitat would be created by altering the upstream end of the side channel to capture flows. At present, the side channel is seasonally inundated, but likely by way of seepage from the river through alluvial material. Riparian vegetation and appurtenant biota are at this site; therefore, removal of vegetation to lower the channel bed would be necessary, followed by post excavation replanting of native riparian vegetation.

Reading Island

Restoring floodplain, riparian, and side channel habitat at Reading Island would involve hydraulically reconnecting Anderson Creek with the Sacramento River at flows ranging between 4,000 cfs and 6,000 cfs. To restore Sacramento River flows through Anderson Creek, it would first be necessary to breach the levee that creates Anderson Slough. Additionally, clearing and excavation of the side channel would be necessary to ensure flows through the channel. This would involve removing vegetation and debris and deepening the existing channel.

After excavation, floodplain terraces and adjacent riparian areas would need to be vegetated with native plants. This would require temporary irrigation and fencing to sustain plantings and keep livestock off site. A more detailed site analysis would determine the mix, composition, and density of the riparian vegetation plantings.

Construction Staging

Reclamation would establish staging areas for equipment storage and maintenance, construction materials, fuels, lubricants, solvents, and other possible contaminants in coordination with the resource agencies. Staging areas would likely be located within disturbed areas or at existing facilities that are expected to be inundated, such as campgrounds, recreation parking facilities, the top of Shasta Dam, and the parking area along the left wing dam, where feasible.

Staging areas would have a stabilized entrance and exit and would be located at least 100 feet from bodies of water, if possible. Should an off-road site be chosen, qualified biological and cultural resources personnel would survey the selected site to verify that no sensitive resources would be disturbed by staging activities. Should sensitive resources be found, an appropriate spatial and temporal buffer zone would be staked and flagged to avoid impacts. Where possible, no equipment refueling or fuel storage would take place within 100 feet of a body of water.

Construction Schedule, Equipment, and Workforce

The total duration of construction for major facilities is estimated to be 5 years. An overlap is expected in the timing of a majority of the construction

components. Construction would be phased, when feasible, to avoid environmental impacts. Depending on the amount of concurrent work allowed, the critical work elements that would allow for additional storage of water in the reservoir could be completed in 3.5 years.

Construction would typically occur during daylight hours, Monday through Friday. However, construction contractors may extend these hours and schedule construction work on weekends, if necessary, to complete aspects of the work within a given time frame. Construction would require typical heavy construction equipment including excavators, backhoes, bulldozers, scrapers, graders, water trucks, front-end loaders, dump trucks, drill rigs, pump trucks, truck-mounted cranes, pickup trucks, barges, helicopters, and miscellaneous equipment.

Daily highway truck trips would be required to bring construction material to the site, and carry construction debris and waste material to a suitable landfill. Estimated daily highway truck trips are shown in Table 3-14. Table 3-14 also shows the estimated construction period and annual construction labor force.

Table 3-14. Estimated Construction Period, Truck Trips, and Construction Labor Force for CP4A

Construction Item	CP4A (NED Plan)
Construction Period (years)	5
Construction Labor Force (number/year)	350
Daily Truck Trips for Materials (trips/day)	175
Daily Truck Trips for Waste (trips/day)	53
Total Daily Truck Trips (trips/day)	228

Key:
CP = comprehensive plan

Borrow Sources

Multiple borrow sources are available to meet project needs for concrete, sand and gravel, core and homogenous fill, shell fill, riprap, and filter and drain materials for reservoir area embankments. Potential borrow sources were examined at a preliminary level and would need further sampling and testing to determine suitability and refine quantity estimates. Potential borrow sources include areas of the dike construction sites, areas located below the reservoir's inundation zone, and commercial sources. Commercial sources are located within approximately 2 to 30 miles of the Bridge Bay site, and within approximately 15 to 43 miles of the Lakeshore sites. Potential borrow sources are identified in Figure 3-4. Available fill material from potential borrow sources are described in the Engineering Summary Appendix of the Final EIS.

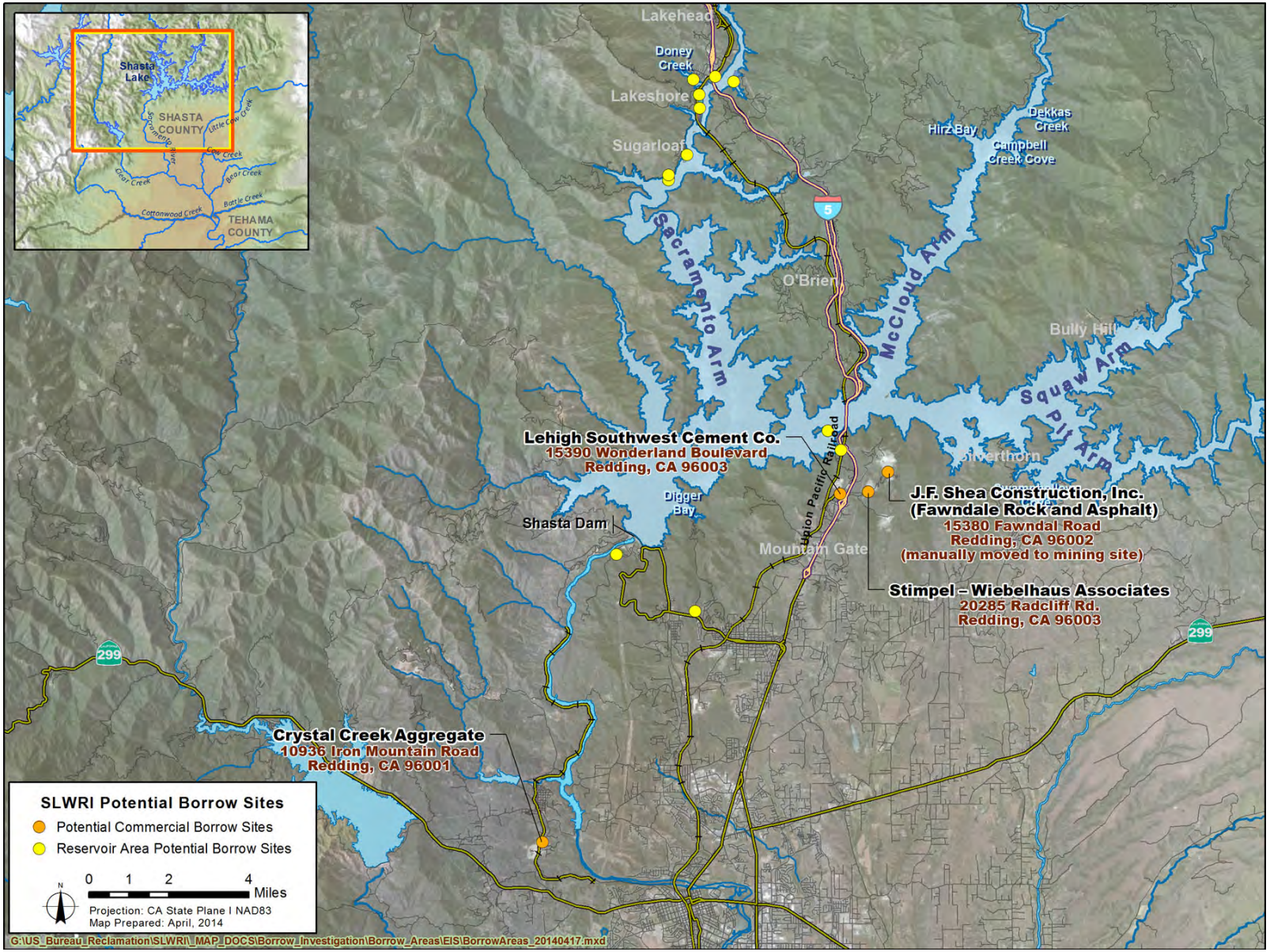


Figure 3-4. Potential Borrow Sources

Construction Schedule

The overall project construction duration for major facilities is estimated to be 5 years, excluding small features such as gravel augmentation, which would extend past the completion of the dam raise.

The construction schedule was based on a logical sequencing of work activities and interdependencies between features, as applicable, and allowing concurrent construction activities for a majority of the features. The construction schedule for each feature was determined based on timing of work, location, and type of construction. The features of the dam raise were divided into individual "work packages" to identify discrete projects that could be constructed and/or contracted independently. Generally, the work packages contain the dam raise with related operational modifications; bridge, road, railroad, and other recreation and utility construction and relocations related to the expanding reservoir perimeter.

Activities in the construction schedule were assigned calendars that allow the work to be performed in accordance with the calendar details. Most construction activities occur based on a normal five-day work week with major holidays as non-work days, and would be phased, when feasible, to avoid environmental impacts. Submittals and fabrication activities had durations assuming a seven-day week in lieu of "work days" that are used for the majority of activities.

NED Analysis

In general, Federally financed water resource projects are to enhance national economic development, the quality of the environment, the well-being of people in the United States, and regional economic development. NED costs and benefits are the decrease or increase in the value of the national output of goods and services expressed in dollars. NED figures measure the costs and benefits to the Nation, rather than to a particular region.

As described in the *Federal Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* (P&G), water resources project plans shall be formulated to alleviate problems and take advantage of opportunities in ways that contribute to the NED. The alternative plan with the greatest net economic benefit (the NED plan) determines the greatest potential Federal investment in the project.

The NED account includes the following categories of goods and services: M&I water supply; agricultural floodwater, erosion, and sediment reduction; agricultural drainage and irrigation; urban flood damage reduction; power (hydropower); transportation (including both inland navigation and deep draft navigation); recreation; and commercial fishing. While multipurpose projects may provide additional types of benefits, these categories coincide with project purposes in which an established Federal financial interest exists. Other

categories of benefits may be allowed or may be included in Congressional authorization for a specific project.

NED costs are the opportunity costs of resource use, and require consideration of the private and public uses that producers and consumers are making of available resources, now and in the future. For goods and services produced in a competitive market, price is often used to reflect opportunity cost. Consequently, market prices should be used to determine NED costs provided the market prices reflect the full economic value of a resource to society. The market price approach should reflect the interaction of supply and demand. If market prices do not reflect total resource values, surrogate values may be used that approximate opportunity costs based on an equivalent use or condition.

For M&I water supplies, the conceptual basis for evaluating benefits is society's willingness to pay (WTP) for the increase in goods and services attributable to the water supply. According to the P&G, when the market price reflects the marginal cost of water, that price should be used to calculate WTP for additional water supply. In the absence of a direct measure of the WTP, the benefits are instead measured by the cost of the alternative most likely to be implemented in the absence of the project.

Other direct benefits in the NED evaluation are those direct effects of a project that are incidental to the purposes or objectives for which the project is being formulated. Other direct benefits may include improvement in commercial/industrial production possibilities (such as reduced water treatment process costs at industrial facilities) or increases in recreational opportunities. For the SLWRI, other direct benefits include hydropower, and recreation.

The two primary decision criteria used in a Federal economic analysis are net benefits and the benefit-cost ratio. The net benefit is the difference between the net present value of benefits and costs, and it measures the extent to which benefits to the Nation exceed project costs. The benefit-cost ratio is calculated by dividing annual project benefits by annual project costs. The net benefits and costs of alternative plans are compared to identify the plan that reasonably maximizes net benefits, or the NED plan. This is not necessarily the plan with the most benefits, but rather the plan that reasonably maximizes net benefits while protecting the environment given the cost to the Nation. Section 1.10.2 of the P&G requires that the NED plan be selected unless the Secretary of the Interior grants an exception.

Table 3-15 provides a summary of annual costs, annual benefits and net benefits for the NED Plan.

Table 3-15. Summary of Annual Costs, Annual Benefits, and Net Benefits for the NED Plan[1]

Item	CP4A ($ millions)
Annual Cost	
Total Annual Cost	59.0
Annual Benefits	
Estimated Value (at inflation)[2]	88.9
Estimated Value (2% above inflation)[3]	124.1
Benefit/Cost Ratio	
Estimated Value (at inflation)[2]	1.51
Estimated Value (2% above inflation)[3]	2.10
Net (NED) Benefits	
Estimated Value (at inflation)[2,4]	29.9
Estimated Value (2% above inflation)[3,4]	65.1

Notes:
[1] January 2014 price levels, 100-year period of analysis, and 3-1/2 percent interest rate.
[2] Assumes the costs of water supplies and hydropower increases at the same rate as inflation.
[3] Includes increase of water supply and hydropower costs at 2 percent above inflation to account for growing scarcity in the future. Sensitivity analyses for change in water supply and hydropower benefits are included in the Economic Valuation and Cost Allocation Appendix.
[4] All numbers are rounded for display purposes; therefore, line items may not sum to totals.
Key:
CP = comprehensive plan

Chapter 4
Waters of the United States and Other Biological Resources

This section describes the existing waters of the United States and other biological resources in the study area.

Waters of the United States in the Primary Study Area

This section describes the existing waters of the United States in the primary study area: Shasta Lake and vicinity, relocation areas, and potential Sacramento River Downstream restoration areas.

Shasta Lake and Vicinity

The botanical resources, wetlands and other waters of the United States setting for the Primary Study Area, including Shasta Lake and vicinity portion of the primary study area consists of the impoundment area (five arms and the Main Body of Shasta Lake, as described below) and the relocation areas.

Reclamation delineated wetlands and other waters of the United States under Federal jurisdiction (jurisdictional waters) in the impoundment area between 2004 and 2010. Between 2009 and 2013, jurisdictional waters in the relocation areas were delineated on all public lands and on private lands where access was granted. These data will be provided in a wetland delineation report prepared for submittal to the USACE. The wetland delineation report is in preparation and has not been verified by the USACE. All information regarding jurisdictional waters is preliminary. Please see Attachment "Botanical Resources and Wetlands Technical Report," of the Final EIR for the complete report on botanical, wetlands and other waters of the United States.

Jurisdictional waters occur in the impoundment and relocation areas as wetlands and other waters. For wetlands, the impoundment area is defined as the area between 1,070 and 1,090 msl surrounding Shasta Lake. For other waters, the impoundment area includes the lacustrine waters associated with Shasta Lake below 1,070 msl. Wetlands include fresh emergent/riparian wetland, intermittent swale, riparian wetland, seasonal wetland, seep/spring wetland, and vegetated ditch. Other waters include ephemeral, intermittent, and perennial streams, roadside ditches, seep/spring waters, and lacustrine. Because some construction activities associated with the impoundment and relocation areas extend into Shasta Lake below the existing full pool elevation, the surface area of the lake is included in the delineation results. Approximately 46 acres of wetlands and 30,000 acres of other waters occur in the impoundment and

relocation areas. Total jurisdictional waters in the impoundment and relocation areas, excluding Shasta Lake at full pool, include approximately 46 acres of wetlands and 103 acres of other waters.

Jurisdictional waters occur in the potential Sacramento River downstream restoration areas as wetlands and other waters. Wetlands include fresh emergent wetlands, pond, riparian wetlands, and riparian/fresh emergent wetland complex. Other waters include ephemeral, intermittent, and perennial streams. Approximately 67 acres of wetlands and 100 acres of other waters occur in the potential Sacramento River downstream restoration areas.

The delineation was conducted in accordance with the routine on-site method identified in the Corps of Engineers Wetlands Delineation Manual (Environmental Laboratory 1987) and the Interim Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Arid West Region (USACE 2006). Each on-site wetland determination was based on field observations of soil, vegetation, and hydrologic characteristics. Delineation of "other waters" was based on the presence of an ordinary high-water mark (OHWM) and whether the feature is tributary to waters of the United States. Data points were characterized and documented for 10 percent of all wetland features delineated. In each relocation area, at least one pair of data points was recorded for each wetland feature type. Soil pits were dug to a depth sufficient to document the presence or confirm the absence of hydric soil or hydrology indicators. The indicator status of wetland plants was determined using the National List of Plant Species That Occur in Wetlands: California Region 0 (Reed 1988). Positive indicators of hydric soils were observed in the field in accordance with the criteria outlined in Field Indicators of Hydric Soils in the United States (NRCS 2006). The hydric status of each soil map unit located in the Shasta Lake and vicinity portion of the primary study area was reviewed using the Web Soil Survey (Soil Survey Staff 2010). Indicators of depth and duration of soil saturation, ponding, and drainage patterns and the OHWM were observed in the field. The boundaries of each wetland feature and the three-parameter data points were mapped using rectified color aerial photography and/or a Trimble Pathfinder Pro XH Global Positioning System capable of sub-foot accuracy.

Main Body

The wetland delineation of the impoundment area along the Main Body was conducted from January to April 2010. Jurisdictional waters include seep/spring, riparian, and vegetated ditch wetlands and ephemeral stream, intermittent stream, perennial stream, seep/spring, and roadside ditch waters. Total acres of jurisdictional waters occurring in the Main Body are summarized in Table 4-1.

Big Backbone Arm

The wetland delineation along the Big Backbone Arm was conducted during November 2006. Jurisdictional waters included seep/spring and riparian wetlands and ephemeral stream, intermittent stream, and perennial stream

waters. Total acres of jurisdictional waters occurring in the Big Backbone Arm are summarized in Table 4-1.

Sacramento Arm

The wetland delineation along the Sacramento Arm was conducted from September through early December 2010 and during March, April, and June 2010. Jurisdictional waters include seep/spring, riparian, seasonal, and riparian/fresh emergent wetlands and ephemeral stream, intermittent stream, perennial stream, seep/spring, and roadside ditch waters. Total acres of jurisdictional waters occurring in the Sacramento Arm are summarized in Table 4-1.

McCloud Arm

The wetland delineation along the McCloud Arm was conducted during December 2009 and in April, June, and November 2010. Jurisdictional waters include seep/spring, riparian, and vegetated ditch wetlands and ephemeral stream, intermittent stream, perennial stream, and seep/spring waters. Total acres of jurisdictional waters occurring in the McCloud Arm are summarized in Table 4-1.

Squaw Creek Arm

The wetland delineation along the Squaw Creek Arm was conducted from late August through September 2004. Jurisdictional waters include seep/spring, riparian, and seasonal wet meadow wetlands and ephemeral stream, intermittent stream, perennial stream, and seep/spring waters. Total jurisdictional acres of waters occurring in the Squaw Creek Arm are summarized in Table 4-1.

Pit Arm

The wetland delineation along the Pit Arm was conducted from late November 2006 through April 2007. Jurisdictional waters include riparian, seep/spring, seasonal, and intermittent swale wetlands and ephemeral stream, intermittent stream, and perennial stream waters. Total acres of jurisdictional waters occurring in the Pit Arm are summarized in Table 4-1.

Table 4-1. Jurisdictional Waters in the Impoundment Area

Jurisdictional Water Type	Area (Acres[1])						
	Main Body	Big Backbone Arm	Sacramento Arm	McCloud Arm	Squaw Creek Arm	Pit Arm	Total
Wetlands							
Fresh emergent/ riparian wetland	0.00	0.00	5.32	0.00	0.00	0.00	5.32
Intermittent swale	0.00	0.00	0.00	0.00	0.00	0.04	0.04
Riparian wetland	1.09	1.73	7.05	8.34	1.49	0.77	20.47
Seasonal wetland	0.00	0.00	0.42	0.00	0.14	0.02	0.58
Seep/spring wetland	0.77	0.23	0.80	0.41	0.16	0.47	2.84
Vegetated ditch	0.13	0.00	0.00	0.02	0.00	0.00	0.15
Total Wetlands	1.99	1.96	13.59	8.77	1.79	1.30	29.40
Other Waters of the United States							
Ephemeral stream	0.28	0.01	0.62	0.28	0.13	0.12	1.44
Intermittent stream	1.42	0.24	2.42	0.91	0.92	2.58	8.49
Perennial stream	1.55	3.00	9.78	20.27	2.39	1.57	38.56
Roadside ditch	0.00	0.00	0.01	0.00	0.00	0.00	0.01
Seep/spring other waters	0.03	0.00	0.001	0.01	0.0001	0.00	0.04
Lacustrine[2]	10,196.88	1,014.12	7,225.14	5,032.68	2,081.60	4,372.80	29,923.22
Total Other Waters	10,200.16	1,017.37	7,237.97	5,054.15	2,085.04	4,377.07	29,971.76
Total waters of the United States	10,202.15	1,019.33	7,251.56	5,062.92	2,086.83	4,378.37	30,001.16

Note:
[1] Acreage values are presented in acres and are approximate.

Relocation Areas

Wetland delineations at the relocation areas were conducted between January 2010 and March 2013. Jurisdictional waters include wetlands and other waters. Wetlands include fresh emergent, intermittent swale, riparian, seep/spring, and seasonal wetlands and vegetated ditches. Other waters present include ephemeral, intermittent, and perennial streams; seep/spring; and roadside ditches. Total acres of jurisdictional waters occurring in the relocation areas are summarized in Table 4-2.

Potential Sacramento River Downstream Restoration Areas

Wetland delineations at the potential Sacramento River downstream restoration areas were conducted between March and November 2013. Jurisdictional waters occur in the potential Sacramento River downstream restoration areas as wetlands and other waters. Wetlands include fresh emergent wetlands, pond, riparian wetlands, and riparian/fresh emergent wetland complex. Other waters

include ephemeral, intermittent, and perennial streams. Approximately 67 acres of wetlands and 100 acres of other waters occur in the potential Sacramento River downstream restoration areas. Total acres of jurisdictional waters occurring in the relocation areas are summarized in Table 4-3.

Table 4-2. Jurisdictional Waters (Acres[1]) in the Relocation Areas

Jurisdictional Water Type	Relocation Areas						
	Main Body	Big Backbone Arm	Sacramento Arm	McCloud Arm	Squaw Creek Arm	Pit Arm	Total
Wetlands							
Fresh emergent wetland	0.00	N/A	0.07	0.01	0.00	0.00	0.07
Fresh emergent /riparian wetland	0.00	N/A	0.40	0.00	0.00	0.00	0.40
Intermittent swale	0.00	N/A	0.78	0.00	0.00	0.001	0.78
Riparian wetland	0.15	N/A	3.55	0.39	0.17	0.13	4.39
Seasonal wetland	0.01	N/A	11.30	0.00	0.02	0.00	11.33
Seep/spring wetland	0.03	N/A	0.06	0.12	0.05	0.16	0.42
Vegetated ditch	0.06	N/A	0.002	0.01	0.002	0.00	0.07
Total wetlands	0.25	N/A	16.16	0.52	0.24	0.29	17.46
Other Waters of the United States							
Ephemeral stream	0.24	N/A	1.16	0.85	0.03	0.09	2.37
Intermittent stream	0.78	N/A	2.96	1.25	0.20	0.33	5.52
Perennial stream	0.00	N/A	0.28	0.54	0.24	0.002	1.06
Non-vegetated ditch	0.04	N/A	0.12	0.00	0.00	0.00	0.16
Roadside ditch	0.00	N/A	0.003	0.00	0.00	0.00	0.003
Seep/spring other waters	0.00	N/A	0.00	0.00	0.03	0.00	0.03
Total other waters	1.02	N/A	4.40	2.64	0.50	0.42	8.98
Total waters of the United States	1.31	N/A	20.68	3.16	0.74	0.71	26.60

Note:
[1] Acreage values are presents in acres and are approximate.

Table 4-3. Jurisdictional Waters (Acres[1]) in the Potential Sacramento River Downstream Restoration Areas

Jurisdictional Water Type	Potential Sacramento River Downstream Restoration Areas					
	Henderson Open Space	Tobiasson Island	Shea Island Complex	Kapusta Island	Anderson River Park	Reading Island
Wetlands						
Fresh emergent wetland	1.16	0.68	1.07	0.15	9.19	5.14
Pond	3.51	N/A	N/A	N/A	N/A	N/A
Riparian wetland	1.88	1.58	4.64	10.23	12.09	15.24
Riparian/fresh emergent wetland complex	N/A	N/A	0.05	N/A	3.62	N/A
Total Wetlands	6.55	2.26	5.76	10.38	24.9	17.38
Other Waters of the United States						
Ephemeral stream	0.01	N/A	N/A	N/A	N/A	N/A
Intermittent stream	N/A	N/A	N/A	N/A	0.02	0.02
Perennial stream	1.34	3.12	10.93	8.83	0.68	4.59
Total Other Waters	1.35	3.12	10.93	8.83	0.70	4.61
Total Waters of the U.S.	7.89	5.38	16.69	19.21	25.59	24.99

Note:
[1] Acreage values are approximate.

Other Biological Resources

This section describes the existing special-status plant and wildlife species in the primary and extended study areas. See Attachment "Botanical Resources and Wetlands Technical Report," of the SLWRI Final EIS for the complete report on vegetation communities in the primary study area.

Special-status Plant Species

Special-status species include plants that are legally protected or are otherwise considered sensitive by Federal, State, or local resource conservation agencies and organizations. These include species that are State listed and/or Federally listed as rare, threatened, or endangered; those considered as candidates or proposed for listing as threatened or endangered; species identified by CDFW as Species of Special Concern or USFS as sensitive, endemic, or needing additional survey or management actions; and plants considered jointly by CDFW and CNPS to be rare, threatened, or endangered; and species afforded protection under local planning documents, including the CALFED Multi-Species Conservation Strategy (MSCS).

Primary Study Area

Shasta Lake and Vicinity Within the Shasta Lake and vicinity portion of the primary study area are a wide variety of vegetative communities and habitat components that support a large diversity of plant species. To aid in determining

the potential impacts of the project, a list of potential plant species of concern was developed.

For the purposes of this evaluation, botanical species of concern are plants, lichen, and fungi that fall into any of the following categories:

- Designated as rare or listed as threatened or endangered by the State or Federal government
- Proposed for designation as rare or listing as threatened or endangered by the State or Federal government
- Candidate species for State or Federal listing as threatened or endangered
- Ranked as California Rare Plant Rank (CRPR) 1A, 1B, 2, 3, or 4 (formerly CNPS List 1A, 1B, 2, 3, or 4)
- Considered sensitive or Forest Plan Endemic by the USFS
- Considered a Northwest Forest Plan Survey and Manage (S&M) species by the USFS or BLM
- Designated as an MSCS covered species by CALFED (see California Bay-Delta Authority, Section 12.2.4)

Potentially occurring plant species of concern were determined by performing several database searches, reviewing USFWS and CDFW special-status species lists for Shasta County, reviewing other appropriate literature, discussions with resource agency personnel, and professional experience in the region. Additionally, results from the various vegetation habitat mapping efforts, botanical surveys, and wildlife surveys conducted in the area by Reclamation since 2002 were used in developing the list of species of concern.

Table 4-4 summarizes special-status plant species identified as having a potential to occur in the Shasta Lake and vicinity portion of the primary study area. Potentially occurring special-status plant species in the potential Sacramento River downstream restoration sites are summarized in Table 4-5.

Table 4-4. Plant Species of Concern with Potential to Occur in the Shasta Lake and Vicinity Portion of the Primary Study Area

Common Name	Scientific Name	Status[1]
Shasta ageratina	*Ageratina shastensis*	CRPR 1B.2, FPE
Sanborn's onion	*Allium sanbornii* var. *sanbornii*	CRPR 4.2
Bent-flowered fiddleneck	*Amsinckia lunaris*	CRPR 1B.2, BLMS
Mallory's manzanita	*Arctostaphylos malloryi*	CRPR 4.3
Shasta County arnica	*Arnica venosa*	CRPR 4.2, FPE
Marbled ginger	*Asarum marmoratum*	CRPR 2B.3
Depauperate milk-vetch	*Astragalus pauperculus*	CRPR 4.3
Moonwort, grape-fern	*Botrychium subgenus Botrychium*	USFS S, S&M
Yellow-twist horsehair	*Bryoria tortuosa*	BLMS
Green bug moss	*Buxbaumia viridis*	USFS S, BLMS, S&M
Callahan's mariposa lily	*Calochortus syntrophus*	CRPR 1B.1
Butte County morning-glory	*Calystegia atriplicifolia ssp. buttensis*	CRPR 4.2
Castle Crags harebell	*Campanula shetleri*	CRPR 1B.3, USFS S, BLM S
Buxbaum's sedge	*Carex buxbaumii*	CRPR 4.2
Bristly sedge	*Carex comosa*	CRPR 2B.1, MSCS r
Shasta clarkia	*Clarkia borealis ssp. arida*	CRPR 1B.1, MSCS m, BLM S
Northern clarkia	*Clarkia borealis ssp. borealis*	CRPR 1B.3, BLM S
Silky cryptantha	*Cryptantha crinita*	CRPR 1B.2, MSCS m, BLM S
California lady's-slipper	*Cypripedium californicum*	CRPR 4.2
Clustered lady's-slipper	*Cypripedium fasciculatum*	CRPR 4.2, USFS S, BLM S, S&M
Mountain lady's-slipper	*Cypripedium montanum*	CRPR 4.2, USFS S, BLM S, S&M
Four-angled spike rush	*Eleocharis quadrangulata*	MSCS m
Shasta limestone monkeyflower	*Erythranthe taylori*	CRPR 1B.1
	Erythronium sp. *nov*.	New species of fawn lilly endemic to Shasta Lake region; occurs in shady, northerly aspect forest habitats and below limestone outcrops; taxonomic treatment in preparation. Considered a special-status species for the purposes of this evaluation.
Butte County fritillary	*Fritillaria eastwoodiae*	CRPR 3.2, USFS S
Dubious pea	*Lathyrus sulphureus* var. *argillaceus*	CRPR 3
Broad-lobed linanthus	*Leptosiphon latisectus*	CRPR 4.3
Cantelow's lewisia	*Lewisia cantelovii*	CRPR 1B.2, USFS S, BLM S
Howell's lewisia	*Lewisia cotyledon* var. *howellii*	CRPR 3.2
Bellinger's meadowfoam	*Limnanthes floccosa* ssp. *bellingeriana*	CRPR 1B.2, MSCS m, BLM S
Awl-leaved navarretia	*Navarretia subuligera*	CRPR 4.3
Shasta snow-wreath	*Neviusia cliftonii*	CRPR 1B.2, USFS S, MSCS m, BLM S
Thread-leaved beardtongue	*Penstemon filiformis*	CRPR 1B.3, MSCS m, BLM S

Table 4-4. Plant Species of Concern with Potential to Occur in the Shasta Lake and Vicinity Portion of the Primary Study Area (contd.)

Common Name	Scientific Name	Status[1]
Narrow-petaled rein orchid	*Piperia leptopetala*	CRPR 4.3
Bidwell's knotweed	*Polygonum bidwelliae*	CRPR 4.3
Eel-grass pondweed	*Potamogeton zosteriformis*	CRPR 2B.2, MSCS m
Pacific fuzzwort	*Ptilidium californicum*	BLM S, S&M
Hoary gooseberry	*Ribes roezlii* var. *amictum*	CRPR 4.3
Bug on a stick	*Schistostega pennata*	S&M
Brownish beaked-rush	*Rhynchospora capitellata*	CRPR 2B.2
Sanford's arrowhead	*Sagittaria sanfordii*	CRPR 1B.2, MSCS m, BLM S
Marsh skullcap	*Scutellaria galericulata*	CRPR 2B.2, MSCS m
Canyon Creek stonecrop	*Sedum obtusatum* ssp. *paradisum*	CRPR 1B.3, USFS S, BLM S
English Peak greenbriar	*Smilax jamesii*	CRPR 1B.3, MSCS m, BLM S

[1] Notes:

Status Codes

S&M = Survey and Manage Species

CRPR 2 = Plants rare, threatened, or endangered in California but more common elsewhere (includes rare plant ranks 2B.1, 2B.2, and 2B.3)

CRPR 3 = Plants for which more information is need – a review list

CRPR 4 = Plants of limited distribution – a watch list

CRPR Threat Ranks

0.1 = Seriously threatened in California

0.2 = Fairly threatened in California

0.3 = Not very threatened in California

MSCS (Multi Species Conservation Strategy) covered species

R = Recovery. Recover species' populations within the MSCS focus area to levels that ensure the species' long-term survival in nature.

r = Contribute to recovery. Implement some of the actions deemed necessary to recover species' populations within the MSCS focus area.

m = Maintain. Ensure that any adverse effects on the species that could be associated with implementation of CALFED actions will be fully offset through implementation of actions beneficial to the species (CALFED 2000c).

Key:
BLMS = BLM sensitive
CRPR = California Rare Plant Rank
USFS = U.S. Forest Service
FPE = USFS Forest Plan Endemic Species
USFS S = USFS Sensitive Species
S&M = Survey and Manage Species
MSCS = Multi Species Conservation Strategy

Table 4-5. Plant Species of Concern with Potential to Occur in the Potential Sacramento River Downstream Restoration Sites

Common Name	Scientific Name	Status[1]
Red-flowered bird's-foot trefoil	*Acmispon rubriflorus*	CRPR 1B.1, BLM S
Henderson's bent grass	*Agrostis hendersonii*	CRPR 3.2, MSCS m
Cleveland's milk-vetch	*Astragalus clevelandii*	CRPR 4.3
Jepson's milk-vetch	*Astragalus rattanii var. jepsonianus*	CRPR 4.3, BLM S
Big-scale balsamroot	*Balsamorhiza macrolepis*	CRPR 1B.2, BLM S
Sulphur Creek brodiaea	*Brodiaea matsonii*	CRPR 1B.1
Bristly sedge	*Carex comosa*	CRPR 2B.1, MSCS r
Silky cryptantha	*Cryptantha crinita*	CRPR 1B.2, BLM S, MSCS m
Four-angled spikerush	*Eleocharis quadrangulata*	MSCS m
Boggs Lake hedge-hyssop	*Gratiola heterosepala*	CE, CRPR 1B.2, BLM S, MSCS m
California satintail	*Imperata brevifolia*	CRPR 2B.1
Red Bluff dwarf rush	*Juncus leiospermus var. leiospermus*	CRPR 1B.1, BLM S, MSCS m
Bellinger's meadowfoam	*Limnanthes floccosa ssp. bellingeriana*	CRPR 1B.2, BLM S, MSCS m
Shield-bracted monkeyflower	*Mimulus glaucescens*	CRPR 4.3
Slender Orcutt grass	*Orcuttia tenuis*	FT, CE, CRPR 1B.1, MSCS m
Ahart's paronychia	*Paronychia ahartii*	CRPR 1B.1, BLM S, MSCS m
Sanford's arrowhead	*Sagittaria sanfordii*	CRPR 1B.2, BLM S, MSCS m
Greene's Tuctoria	*Tuctoria greenei*	FE, CR, CRPR 1B.1, MSCS m

Notes:

[1] Status Codes

CE = California endangered

CR = California rare

FE = Federally endangered

FT = Federally threatened

CRPR (California Rare Plant Rank)

CRPR 1B = Plants rare, threatened, or endangered in California and elsewhere (includes rare plant ranks 1B.1, 1B.2, and 1B.3)

CRPR 2A, 2B = Plants rare, threatened, or endangered in California but more common elsewhere (includes rare plant ranks 2B.1, 2B.2, and 2B.3)

CRPR 3 = Plants for which more information is need – a review list

CRPR 4 = Plants of limited distribution – a watch list

CRPR Threat Ranks

0.1 = Seriously threatened in California

0.2 = Fairly threatened in California

0.3 = Not very threatened in California

BLM (Bureau of Land Management):

S = Sensitive

MSCS (Multi Species Conservation Strategy) covered species

R = Recovery. Recover species' populations within the MSCS focus area to levels that ensure the species' long-term survival in nature.

r = Contribute to recovery. Implement some of the actions deemed necessary to recover species' populations within the MSCS focus area.

m = Maintain. Ensure that any adverse effects on the species that could be associated with implementation of CALFED actions will be fully offset through implementation of actions beneficial to the species (CALFED 2000c).

Key:

CRPR = California Rare Plant Rank

MSCS = Multi Species Conservation Strategy

Botanical Surveys Reclamation conducted several botanical surveys for special-status plant species in the Shasta Lake and vicinity portion of the primary study area. Botanical surveys were conducted in between 2002 and 2014. A list of species observed during the surveys is provided as Attachment 2 to the Botanical Resources and Wetlands Technical Report in the Biological Resources Appendix. Detailed survey information is provided as Attachment 6 to the Botanical Resources and Wetlands Technical Report in the Biological Resources Appendix.

Upper Sacramento River (Shasta Dam to Red Bluff) Based on review of California Natural Diversity Database (CNDDB) and CNPS database searches, a USFWS list of species that could be potentially affected in this portion of the primary study area, and previously prepared biological reports for the area, 25 special-status plant species were identified as possibly occurring in the primary study area between Shasta Dam and RBPP, and thus their potential to occur in this portion of the study area was evaluated further. These special-status plant species, along with the legal status, habitat, and potential for occurrence of each species, are provided in Table 4-6.

Sixteen of the special-status plant species listed in Table 4-6 have the potential to occur within habitat present along the Sacramento River between Shasta Dam and RBPP. Many of these species, such as Bogg's Lake hedge hyssop (*Gratiola heterosepala*; State endangered, MSCS m, CRPR 1B.2), Ahart's dwarf rush (*Juncus leiospermus* var. *ahartii*; MSCS m, CRPR 1B.2), Ahart's paronychia (*Paronychia ahartii*; MSCS m, CRPR 1B.1), dwarf downingia (*Downingia pusilla*; CRPR 2B.2), Greene's legenere (*Legenere limosa*; MSCS m, CRPR 1B.1), Henderson's bent grass (*Agrostis hendersonii*; MSCS m, CRPR 3.2), Red Bluff dwarf rush (*Juncus leiospermus* var. *leiospermus*; CRPR 1B.2), and slender Orcutt grass (*Orcuttia tenuis*; Federal endangered, state endangered, MSCS m, CRPR 1B.1), typically occur in vernal pools, which are generally not present within the active floodplain of regulated rivers in the extended study area. Other special-status plants, however, could occur in the extended study area in the freshwater marshes, swamps, and riparian woodlands that are found along the river corridor. These species include rose mallow (*Hibiscus lasiocarpus* var. *occidentalis*; MSCS m, CRPR 2B.2) and silky cryptantha (*Cryptantha crinita*; USFS SM, CRPR 1B.2). The remaining five species may occur in annual grassland, chaparral, cismontane woodland, and lower montane coniferous forest vegetation communities along the river corridor, including adobe-lily (*Fritillaria pluriflora*; MSCS m, CRPR 1B.2), Butte County fritillary (*Fritillaria eastwoodiae*; USFS S, CRPR 3.2), dubious pea (*Lathyrus sulphureus* var. *agillaceous*; CRPR 3), mountain lady's slipper (*Cypripedium fasciculatum*; USFS SM, CRPR 4.2), and oval-leaved viburnum (*Viburnum ellipticum*; CRPR 2B.3).

Of the special-status species that could occur along the upper Sacramento River, four are known to occur along the edge of the Sacramento River channel, or along a Sacramento River tributary within 0.2 mile of the river proper, and their

establishment and reproduction could potentially be affected by changes in flow regime: silky cryptantha, rose mallow, and Ahart's paronychia (CNDDB 2007, University of California 2011).

Table 4-6. Special-Status Plant Species Known or with Potential to Occur in the Primary Study Area, Along the Sacramento River from Shasta Dam to Red Bluff Pumping Plant

Species	Legal Status[1]					Habitat and Blooming Period	Potential for Occurrence
	USFWS	CDFW	MSCS	USFS	CRPR		
Shasta ageratina *Ageratina shastensis*		–		E	1B.2	Rocky carbonate outcrops in chaparral and lower montane coniferous forest; 1,300–5,900 feet elevation. Blooms June–October.	Could occur near Shasta Dam if suitable outcrops are present. Potential is low because most of the primary study area is below species' known elevation range.
Henderson's bent grass *Agrostis hendersonii*	–	–	m	–	3.2	Mesic sites in valley and foothill grassland, vernal pools; 230–1,000 feet elevation. Blooms April–May.	Could occur along the Sacramento River if suitable vernally mesic habitat is present.
Shasta County arnica *Arnica venosa*	–	–	–	E	4.2	Cismontane woodlands and lower montane coniferous forests, often in disturbed areas and roadcuts; 1,300–4,900 feet elevation. Blooms May–July.	Could occur along the Sacramento River and tributaries within the primary study area. Potential is low because most of the study area is below species' known elevation range.
Sulphur Creek Brodiaea *Brodiaea matsonii*	–	–	–	–	1B.1	Rocky, metamorphic amphibolite schist. Cismontane woodland (streambanks), meadows, and seeps; 640-700 feet elevation. Blooms May–June.	Could occur along the Sacramento River and tributaries within the primary study area.
Silky cryptantha *Cryptantha crinita*	–	–	m	–	1B.2	Gravelly streambeds within cismontane woodland, lower montane coniferous forest, riparian forest, riparian woodland, valley and foothill grassland; 275–4,000 feet elevation. Blooms April–May.	Could occur along the Sacramento River and tributaries within the primary study area.
Clustered lady's slipper *Cypripedium fasciculatum*	–	–	–	SM	4.2	Lower montane coniferous forest, North Coast coniferous forest; often in serpentinite seeps or on streambanks; 300–8,000 feet elevation. Blooms March–July.	Unlikely; no coniferous forest known in the primary study area.

Table 4-6. Special-Status Plant Species Known or with Potential to Occur in the Primary Study Area, Along the Sacramento River from Shasta Dam to Red Bluff Pumping Plant (contd.)

Species	Legal Status[1]					Habitat and Blooming Period	Potential for Occurrence
	USFWS	CDFW	MSCS	USFS	CRPR		
Mountain lady's slipper *Cypripedium montanum*	–	–	–	SM	4.2	Broadleaved upland forest, cismontane woodland, lower montane coniferous forest, North Coast coniferous forest; 500–7,000 feet elevation. Blooms March–July.	Could occur at Shasta Dam or along the Sacramento River and tributaries.
Dwarf downingia *Downingia pusilla*	–	–	–	–	2.2	Mesic sites in valley and foothill grassland, vernal pools. Blooms March–May.	Could occur along the Sacramento River if suitable vernally mesic habitat is present.
Butte County fritillary *Fritillaria eastwoodiae*	–	–	–	S	3.2	Openings and sometime serpentine areas in chaparral, cismontane woodland, and lower montane coniferous forest; 160–4,900 feet elevation. Blooms March–June.	Could occur along the Sacramento River and tributaries within the primary study area.
Adobe-lily *Fritillaria pluriflora*	–	–	m	–	1B.2	Chaparral, cismontane woodland, valley and foothill grassland; often in adobe soils; 200–2,300 feet elevation. Blooms February–April.	Could occur at Shasta Dam and along the Sacramento River.
Bogg's Lake hedge hyssop *Gratiola heterosepala*	–	E	m	–	1B.2	Marshes and swamps, vernal pools; 30–8,000 feet elevation. Blooms April–August.	Could occur along the Sacramento River and tributaries.
Rose mallow *Hibiscus lasiocarpus* var. *occidentalis*	–	–	m	–	1B.2	Freshwater marshes and swamps.	Could occur along the Sacramento River and tributaries.
Ahart's dwarf rush *Juncus leiospermus* var. *ahartii*	–	–	m	–	1B.2	Mesic sites in valley and foothill grassland; 100–300 feet elevation. Blooms March–May.	Could occur along the Sacramento River if suitable vernally mesic habitat is present. Shasta Dam is higher than species' known elevation range.
Red Bluff dwarf rush *Juncus leiospermus* var. *leiospermus*	–	–	–	–	1B.1	Vernally mesic sites in chaparral, cismontane woodland, meadows and seeps, valley and foothill grassland, vernal pools; 100–3,350 feet elevation. Blooms March–May.	Could occur at Shasta Dam or along the Sacramento River if suitable vernally mesic habitat is present.

Table 4-6. Special-Status Plant Species Known or with Potential to Occur in the Primary Study Area, Along the Sacramento River from Shasta Dam to Red Bluff Pumping Plant (contd.)

Species	Legal Status[1]					Habitat and Blooming Period	Potential for Occurrence
	USFWS	CDFW	MSCS	USFS	CRPR		
Dubious pea *Lathyrus sulphureus* var. *argillaceous*	–	–	–	–	3	Cismontane woodland, lower montane coniferous forest, upper montane coniferous forest; 500–1,000 feet elevation. Blooms in April.	Could occur at Shasta Dam and along the Sacramento River.
Greene's legenere *Legenere limosa*	–	–	m	–	1B.1	Vernal pools; 1–3,000 feet elevation. Blooms April–June.	Could occur along Sacramento River if suitable vernal pool habitat is present.
Cantelow's lewisia *Lewisia cantelovii*	–	–	–	S	1B.2	Mesic granitic sites within broadleaved upland forest, chaparral, cismontane woodland, and lower montane coniferous forest; 1,250–4,500 feet. Sometimes in serpentinite seeps. Blooms May–October.	Could occur in the Shasta Dam area. The remainder of the primary study area is below species' known elevation range.
Bellinger's meadowfoam *Limnanthes floccosa* ssp. *bellingeriana*	–	–	m	–	1B.2	Mesic sites in cismontane woodland, meadows and seeps; 950–3,600 feet elevation. Blooms April–June.	Could occur at Shasta Dam. Potential along Sacramento River is low because majority of the primary study area is below species known elevation range.
Shasta snow-wreath *Neviusia cliftonii*	–	–	m	S	1B.2	Carbonate substrates in lower montane coniferous forest and riparian woodland; 1,000–1,600 feet elevation. Blooms May–June.	Could occur in Shasta Dam area. Unlikely to occur along Sacramento River because the primary study area is lower than species known elevation range.
Slender orcutt grass *Orcuttia tenuis*	E	E	m	–	1B.1	Vernal pools; 100–6,000 feet elevation. Blooms May–October.	Could occur along the Sacramento River if suitable vernal pool habitat is present. Federally designated critical habitat for this species occurs east of the Sacramento River, east of Cottonwood (Units 3A and 3B) and northeast of Anderson (Units 2C and 2D).

Table 4-6. Special-Status Plant Species Known or with Potential to Occur in the Primary Study Area, Along the Sacramento River from Shasta Dam to Red Bluff Pumping Plant (contd.)

Species	Legal Status[1]					Habitat and Blooming Period	Potential for Occurrence
	USFWS	CDFW	MSCS	USFS	CRPR		
Ahart's paronychia *Paronychia ahartii*	–	–	m	–	1B.1	Cismontane woodland, valley and foothill grassland, vernal pools; 100–1,700 feet elevation. Blooms March–June.	Could occur at Shasta Dam and along the Sacramento River.
Pacific fuzzwort *Ptilidium californicum*	–	–	–	SM	4.3	An epiphytic on bark at the base of standing mature to old-growth trees or recently fallen logs; rarely on other organic substrates such as decaying logs and stumps, or humus covering boulders; 1,275–5,725 feet elevation.	Could occur along the Sacramento River and tributaries within the primary study area. Potential is low because most of the study area is below species' known elevation range.
Canyon Creek stonecrop *Sedum obtusatum* ssp. *paradisum*	–	–	–	S	1B.3	Granitic, rocky areas in broadleafed upland forest, chaparral, lower montane coniferous forest, subalpine coniferous forest; 980–6,100 feet elevation. Blooms May–June.	Could occur along the Sacramento River and tributaries within the primary study area. Potential is low because most of the study area is below species' known elevation range.
English Peak greenbriar *Smilax jamesii*	–	–	m	-	1B.3	Found along streambanks and lake margins in broadleafed upland forest, lower montane, upper montane, and north coast coniferous forests, and marshes and swamps; 1,600–8,200 feet elevation. Blooms May–July, rarely through August.	Could occur along the Sacramento River and tributaries within the primary study area. Potential is low because most of the study area is below species' known elevation range.
Oval-leaved viburnum *Viburnum ellipticum*	–	–	–	–	2.3	Chaparral, cismontane woodland, lower montane coniferous forest; 800–4,600 feet elevation. Blooms May–June.	Could occur at Shasta Dam and along the Sacramento River.

Sources: CNDDB 2007, CNPS 2011, USFS 2007, USFWS 2011

Note: [1]Legal Status

U.S. Fish and Wildlife Service (USFWS) Federal Listing Categories:
T = Threatened
E = Endangered

U.S. Forest Service (USFS) Listing Categories:
E = Endemic to specific region or National Forest
S = Sensitive
SM = Species considered rare or threatened and recommended for survey and management per Northwest Forest Plan 2002

California Department of Fish and Wildlife (CDFW) State Listing Categories:
R = California Rare
T = California Threatened
E = California Endangered

California Rare Plant Rank (CRPR) Categories:
1B = Plants rare, threatened, or endangered in California and elsewhere
2A, 2B = Plants rare, threatened, or endangered in California but more common elsewhere
3 = Plants for which more information is needed—a review list
4 = Plants of limited distribution—a watch list

Multi-Species Conservation Strategy (MSCS) Listing Categories:
R = recovery r = contribute to recovery m = maintain

Special Status Plant Species in the Extended Study Area

Lower Sacramento River and Delta Most of the special-status plant species listed in Table 12-6 have the potential to occur within the extended study area (lower Sacramento River and Delta and CVP/SWP service areas). Numerous additional special-status plant species could occur in the extended study area. Attachment 4 of the *Botanical Resources and Wetlands Technical Report* contains comprehensive lists of all sensitive plant species in the extended study area that have been reported to the CNDDB, or that otherwise have the potential to occur in the extended study area.

A number of special-status plant species could be affected in the lower Sacramento River and Delta by changes in hydrology (CALFED 2000c). These include species associated with vernal pool, riparian, marsh, and aquatic plant communities; and several other species with restricted distributions on or near channel banks, active floodplains, flood bypasses, and Delta waterways. These assemblages of special-status species are described below.

Species of Vernal Pool Communities In addition to species that are potentially present in the primary study area (Table 4-6), special-status plant species that may be associated with vernal pools along the lower Sacramento River and in the Delta region include alkali milk-vetch (*Astragalus tener* var. *tener*; MSCS r, CRPR 1B.2), brittlescale (*Atriplex depressa*; MSCS m, CRPR 1B.2), Hoover's spurge (*Euphorbia hooveri*; Federal threatened, MSCS m, CRPR 1B.2), Contra Costa goldfields (*Lasthenia conjugens*; Federal endangered, MSCS m, CRPR 1B.1), hairy orcutt grass (*Orcuttia pilosa*; Federal endangered, MSCS m, CRPR 1B.1), slender Orcutt grass (*Orcuttia tenuis*; Federal threatened, MSCS m, CRPR 1B.1), bearded popcornflower (*Plagiobothrys hystriculus*; CRPR 1B.1), Delta woolly-marbles (*Psilocarphus brevissimus* var. *multiflorus*; CRPR 4.2), Crampton's tuctoria (*Tuctoria mucronata*; Federal and State endangered, MSCS r, CRPR 1B.1), and Greene's tuctoria (*Tuctoria greenei*; Federal endangered, MSCS m, CRPR 1B.1). The primary threats affecting most of these species at multiple locations are habitat loss because of development, nonnative species, and incompatible grazing practices. Additional threats affecting some of these species at one or more location include game management practices (e.g., inundation of land for waterfowl during the growing season), off-road vehicle use and trampling, incompatible agricultural practices, and hydrological alterations.

Species of Riparian and Marsh Communities In addition to species considered potentially present in the primary study area (Table 4-6), special-status plant species associated with riparian and marsh communities along the lower Sacramento River or in the Delta region include bristly sedge (*Carex comosa*; MSCS r, CRPR 2B.1), Suisun thistle (*Cirsium hydrophilum* var. *hydrophilum*; Federal endangered, MSCS R, CRPR 1B.1), Soft bird's-beak (*Chloropyron molle* ssp. *molle*; Federal endangered, State rare, MSCS R, CRPR 1B.2), Delta button-celery (*Eryngium racemosum*; MSCS r, CRPR 1B.1), Northern California black walnut (*Juglans hindsii*; MSCS r, CRPR 1B.1), Delta

tule pea (*Lathyrus jepsonii* var. *jepsonii*; MSCS r, CRPR 1B.2), Mason's lilaeopsis (*Lilaeopsis masonii*; MSCS R, CRPR 1B.1), Delta mudwort (*Limosella australis*; MSCS r, CRPR 2B.1), Sanford's arrowhead (*Sagittaria sanfordii*; MSCS m, CRPR 1B.2), Marsh skullcap (*Scutellaria galericulata*; MSCS m, CRPR 2B.2), blue skullcap (*Scutellaria lateriflora*; MSCS m, CRPR 2B.2), and Suisun Marsh aster (*Symphyotrichum lentum*; CRPR 1B.2) (CNDDB 2007, CRPR 2011). The primary threats affecting these species are habitat loss, competition from nonnative species, and alterations to hydrology (including trenching and diking). Additional threats include grazing and trampling, installation of riprap, and anthropogenic disturbances (e.g., off-road vehicles; road, utility, and levee maintenance).

Species of Aquatic Communities Eel-grass pondweed (*Potamogeton zosteriformis*; MSCS m, CRPR 2B.2), a submerged aquatic plant of assorted freshwater habitats, is rare in California but more common elsewhere (CNPS 2011). Overall, the distribution, abundance, and threats affecting this species in California are not well known.

CVP/SWP Service Areas Special-status plants are not likely to occur in a substantial portion of the CVP and SWP service areas because the agricultural and urban land uses tend to preclude suitable habitat for most native species. Although agricultural and developed land uses account for most of the CVP and SWP service areas, a portion of these areas still remains in natural vegetation, Because of the large size of the CVP and SWP service areas, this natural vegetation is distributed over a wide range of climate and soils, and is varied in structure and species composition. Consequently, a large number of special-status plant species has the potential to occur in the natural vegetation that remains within the CVP and SWP service areas (see the *Botanical Resources and Wetlands Technical Report*).

Special-Status Wildlife Species

Special-status species addressed in this section include animals that are legally protected or are otherwise considered sensitive by Federal, State, or local resource conservation agencies and organizations. Specifically, these include species that are Federally listed and/or State-listed as rare, threatened, or endangered; those considered as candidates or proposed for listing as threatened or endangered; species identified by CDFW as fully protected or species of special concern; species identified by USFS as sensitive, or endemic; species identified by the BLM as sensitive; species designated by the *Northwest Forest Plan* (NWFP) as S&M; other animals protected by the California Fish and Game Code; and those designated as MSCS covered species by the CALFED.

Primary Study Area

Shasta Lake and Vicinity For the purposes of this evaluation, wildlife species of concern include species that are any of the following:

- Designated as threatened or endangered by the State or Federal government
- Proposed or petitioned for Federal listing as threatened or endangered
- State or Federal candidates for listing as threatened or endangered
- Identified by CDFW as a species of special concern
- Considered sensitive or endemic by USFS
- Considered sensitive by BLM
- Considered S&M species by NWFP
- Designated as MSCS-covered species by CALFED

Special-status wildlife species with the potential to occur in the Shasta Lake and vicinity portion of the primary study area were determined using several database searches; review of USFWS and CDFW special-status species lists for Shasta County; review of the CALFED MSCS list; review of other appropriate literature; discussions with BLM, CDFW, DWR, USFS, and USFWS personnel; and professional experience in the area. All special-status wildlife species potentially occurring in the Shasta Lake and vicinity portion of the primary study area are discussed in Attachment 1 of the *Wildlife Resources Technical Report*, which provides a general comparison of habitat requirements for each species and the general habitats in the primary study area above Shasta Dam. For those special-status species for which generally suitable habitat was determined to be present, results from the various vegetation habitat mapping and wildlife surveys conducted in the area by Reclamation since 2002 were used to determine the likelihood of their presence in the primary study area above Shasta Dam (Table 4-7).

The S&M species include all species included in the *January 2001 Record of Decision and Standards and Guidelines for Amendments to the Survey and Manage, Protection Buffer, and Other Mitigation Measures Standards and Guidelines* (U.S. Department of Agriculture and U.S. Department of the Interior 2001) (2001 ROD) The current S&M species list is from the 2001 ROD and includes species listed in the 2001 ROD *Survey and Manage Standards and Guidelines and Category Assignment* (BLM December 2013). For the purposes of this evaluation, S&M species of concern include taxa that are designated as Category A and C by the current category assignment. These categories include taxa that require what are known as pre-disturbance (i.e., pre-project) surveys.

The CNDDB was reviewed for records of special-status plant species in or near the Shasta Lake and vicinity portion of the primary study area. The CNDDB is a database consisting of historical observations of special-status plant species,

wildlife species, and natural communities. The CNDDB is limited to reported sightings and is not a comprehensive list of special-status species that could occur in a particular area.

Table 4-7. Wildlife Species of Concern in the Shasta Lake and Vicinity Portion of the Primary Study Area

Common Name	Scientific Name	Status[1]	Potential for Occurrence
Western bumble bee	*Bombus occidentalis*	USFS S	Various habitats with abundant flowering vegetation from spring through fall.
Church's sideband	*Monadenis churchi*	S&M	Potentially occurring in mixed conifer and conifer/woodland habitats. Many known occurrences in the Shasta Lake and vicinity portion of the study area.
Shasta sideband	*Monadenia troglodytes troglodytes*	FP, USFS S, S&M, MSCS m	Endemic to Shasta County. Potentially occurring in mixed conifer and woodland habitats, especially near limestone. Species occurs in limestone on the McCloud Arm.
Wintu sideband	*Monadenia troglodytes wintu*	FP, USFS S, S&M	Endemic to Shasta County. Potentially occurring in mixed conifer and woodland habitats, especially near limestone. Known to occur between the Pit and Squaw Creek arms and at Mountain Gate.
Oregon shoulderband	*Helminthoglypta hertlenii*	S&M	Potentially occurring in mixed conifer and conifer/woodland habitats. Many known occurrences in the Shasta Lake and vicinity portion of the study area.
Shasta chaparral	*Trilobopsis roperi*	FP, USFS S, S&M	Endemic to Shasta County. Potentially occurring in mixed conifer and conifer/woodland habitats. Known occurrences in the Shasta Lake and vicinity portion of the study area.
Shasta hesperian	*Vespericola shasta*	FP, USFS S, S&M	Endemic to the southeastern Klamath Mountains. Potentially occurring in mixed conifer and conifer/woodland habitats (riparian and/or riverine habitats). Known occurrences in the Shasta Lake and vicinity portion of the study area.
Shasta salamander	*Hydromantes shastae*	CT, USFS S, S&M, MSCS m, BLMS	Only known from the southeastern Klamath Mountains. Potentially occurring in mixed conifer, woodland, and chaparral habitats, especially near limestone. Known occurrences in the Shasta Lake and vicinity portion of the study area.
Tailed frog	*Ascaphus truei*	CSC	Potentially occurring in stream habitats in the Shasta Lake and vicinity portion of the study area. Known occurrences in the McCloud Arm and the upper Sacramento Arm tributaries outside the study area boundaries (CDFG 2003).

Table 4-7. Wildlife Species of Concern in the Shasta Lake and Vicinity Portion of the Primary Study Area (contd.)

Common Name	Scientific Name	Status[1]	Potential for Occurrence
California red-legged frog	*Rana draytonii*	FT, CSC, MSCS m	Requires aquatic habitat for breeding; also uses a variety of other habitat types, including riparian and upland areas. The Shasta Lake and vicinity portion of the study area is outside the current species range. A USFWS habitat assessment is in preparation to determine habitat suitability.
Foothill yellow-legged frog	*Rana boylii*	CSC, USFS S, MSCS m, BLMS	Potentially occurring in stream habitats. Known occurrences scattered throughout the Shasta Lake and vicinity portion of the primary study area.
Northwestern pond turtle	*Actinemys marmorata*	CSC, USFS S, MSCS m	Potentially occurring in stream or other wetland habitats. Adjacent upland habitats are potential nesting areas. Known occurrences scattered throughout the Shasta Lake and vicinity portion of the primary study area.
Great blue heron	*Ardea herodias*	MSCS m	Known to breed in nearshore wooded habitat in the Turntable Bay area of Shasta Lake.
Cooper's hawk	*Accipiter cooperi*	MSCS m	Potentially occurring in mixed conifer and conifer/woodland habitats.
Northern goshawk	*Accipiter gentilis*	CSC, USFS S, BLMS	Potentially occurring in mixed conifer habitats. Known to occur in the upper McCloud Arm.
Bald eagle	*Haliaeetus leucocephalus*	FD, FB, CE, CP, USFS S, MSCS m, BLMS	Occur in riverine and lacustrine habitats. Common at Shasta Lake, and a substantial number of nests occur in the Shasta Lake and vicinity portion of the primary study area and vicinity. Shasta Lake has the highest density of breeding bald eagles in the continental United States.
Osprey	*Pandion haliaetus*	MSCS m	Occur in riverine and lacustrine habitats. Common at Shasta Lake, and many known nests occur in the Shasta Lake and vicinity portion of the primary study area and vicinity.
American peregrine falcon	*Falco peregrinus anatum*	FD, CD, CP, MSCS m	Potentially occurring in mixed conifer and conifer/woodland habitats. Nesting sites in the study area unlikely due to lack of suitable eyrie sites; however, potential eyrie sites occur adjacent to the Shasta Lake and vicinity portion of the primary study area. A historical nest site occurs in the cliffs near Shasta Caverns and a "new" nest site is believed to occur in cliffs along the Sacramento Arm of Shasta Lake. Another nest site is located south of Shasta Lake at Gray Rocks, near Mountain Gate.
Long-eared owl	*Asio otus*	CSC, MSCS m	Potentially occurring in coniferous forest habitats.

Table 4-7. Wildlife Species of Concern in the Shasta Lake and Vicinity Portion of the Primary Study Area (contd.)

Common Name	Scientific Name	Status[1]	Potential for Occurrence
Northern spotted owl	*Strix occidentalis caurina*	FT, MSCS m	Potentially occurring in coniferous forest habitats. The species has been recorded within 0.5 mile of the study area along the Squaw Creek Arm. Potential dispersal habitat occurs in the Shasta Lake and vicinity portion of the primary study area. No designated critical habitat occurs in the Shasta Lake and vicinity portion of the primary study area.
Vaux's swift	*Chaetura vauxi*	CSC	Potentially occurring in coniferous forest and conifer/woodland habitats. Known to occur in the Shasta Lake and vicinity portion of the study area.
Willow flycatcher	*Empidonax traillii*	CE, USFS S, MSCS r	Uncommon migrant in riparian habitat; unlikely to nest in the Shasta Lake and vicinity portion of the primary study area.
Purple martin	*Progne subis*	CSC	Potentially occurring in conifer, woodland, and riparian habitats. Foraging habitat occurs throughout Shasta Lake and vicinity portion of the primary study area. Nests along the Pit River Arm. Shasta Lake is one of the few known breeding sites in interior northern California.
Yellow warbler	*Dendroica petechia brewsteri*	CSC, MSCS r	Potentially occurring in riparian habitats. Known occurrences in and near the Shasta Lake and vicinity portion of the primary study area.
Yellow-breasted chat	*Icteria virens*	CSC, MSCS m	Potentially occurring in riparian habitats. Known occurrences in and near the Shasta Lake and vicinity portion of the primary study area.
Pallid bat	*Antrozous pallidus*	CSC, USFS S, BLMS	Potentially occurring in mixed conifer and conifer/woodland habitat throughout the study area.
Townsend's big-eared bat	*Plecotus townsendii*	CSC, USFS S	Potentially occurring in mixed conifer and conifer/woodland habitat throughout the study area. Known occurrence from a cave on the Backbone Arm in the Shasta Lake and vicinity portion of the primary study area.
Spotted bat	*Euderma maculatum*	CSC, BLMS	Potentially occurring in mixed conifer and conifer/woodland habitat throughout the study area. Species has been recorded on Squaw Creek within approximately 6 miles of the Shasta Lake and vicinity portion of the primary study area.
Western red bat	*Lasiurus blossevillii*	CSC	Potentially occurring in mixed conifer and conifer/woodland habitat throughout the Shasta Lake and vicinity portion of the primary study area.
Long-eared myotis	*Myotis evotis*	BLMS	Potentially occurring in a wide variety of forest habitats throughout the study area.
Yuma myotis	*Myotis yumanensis*	BLMS	Potentially occurring in a wide variety of forest habitats throughout the study area.

Table 4-7. Wildlife Species of Concern in the Shasta Lake and Vicinity Portion of the Primary Study Area (contd.)

Common Name	Scientific Name	Status[1]	Potential for Occurrence
Fringed myotis	*Myotis thysanodes*	USFS S	Potentially occurring in mixed conifer and conifer/woodland habitat throughout the Shasta Lake and vicinity portion of the primary study area.
Western mastiff bat	*Eumops perotis*	CSC, MSCS m (*californicus* subspecies only), BLMS	Potentially occurring in mixed conifer and conifer/woodland habitat throughout the Shasta Lake and vicinity portion of the primary study area.
Ringtail	*Bassariscus astutus*	CP, MSCS m	Potentially occurring in mixed conifer and conifer/woodland habitats. Known occurrences in and near the Shasta Lake and vicinity portion of the primary study area.
American marten	*Martes americana*	USFS S	Potentially occurring in mixed conifer habitats.
Pacific fisher	*Martes pennanti*	FC, CSC, USFS S, BLMS	Potentially occurring in mixed conifer and conifer/woodland habitats. Known occurrences in and near the Shasta Lake and vicinity portion of the primary study area.

Note:
[1]Status Definitions

Key:
BLMS = U.S. Department of the Interior, Bureau of Land Management sensitive
CD= California delisted
CE = California endangered
CP = California fully protected
CSC = California species of special concern
CT = California (State) listed as threatened
FB = Federal Bald and Golden Eagle Protection Act
FC = Federal candidate for listing
FD = Federally delisted
FP = Federally petitioned for listing
FPD = Proposed for Federal delisting
FT = Federally listed as threatened
m = Maintain. Ensure that any adverse effects on the species that could be associated with implementation of CALFED Bay-Delta Program actions will be fully offset through implementation of actions beneficial to the species.
MSCS = Multi-Species Conservation Strategy covered species
r = Contribute to recovery. Implement some of the actions deemed necessary to recover species' populations in the Multi-Species Conservation Strategy focus area.
USFS M = U.S. Forest Service survey and manage species
USFS S = U.S. Forest Service sensitive

Upper Sacramento River (Shasta Dam to Red Bluff) The following section provides a detailed discussion of wildlife species of concern specific to the potential Sacramento River downstream habitat restorations areas, as well as the wildlife species of concern known to occur or with potential to occur along the Sacramento River throughout the rest of the primary study area.

A list of special-status wildlife species with the potential to occur in the primary study area from Shasta Dam to the Red Bluff Pumping Plant (Table 4-8) was compiled based on habitat suitability and known occurrences within the area covered in the Shasta Dam, Redding, Enterprise, Cottonwood, Balls Ferry,

Bend, and Red Bluff East U.S. Geological Survey 7.5-minute quadrangle maps (CNDDB 2012; USFWS 2011). This list also includes species that are identified by USFS as sensitive, or endemic; identified by BLM as sensitive; designated by the NWFP as S&M; or designated as MSCS covered species. See the *Wildlife Resources Technical Report* for a description of the life history of special-status wildlife species known or likely to occur in the area and figures depicting the recorded locations of special-status species.

Table 4-8. Special-Status Wildlife Species Known or with Potential to Occur in the Primary Study Area, Along the Sacramento River from Shasta Dam to Red Bluff Pumping Plant

Common Name	Scientific Name	Status[1]	Potential for Occurrence
Invertebrates			
Conservancy fairy shrimp	*Branchinecta conservatio*	FE, MSCS	Unlikely to occur. No suitable habitat is present along the river corridor.
Valley elderberry longhorn beetle	*Desmocerus californicus dimorphus*	FPD, FT, MSCS	Known to occur. Elderberry shrubs are present within the riparian woodland community along the Sacramento River.
Vernal pool tadpole shrimp Critical Habitat	*Lepidurus packardi*	FE, MSCS	Unlikely to occur. No suitable habitat is present along the river corridor. Critical habitat does not occur within the river corridor.
Vernal pool fairy shrimp Critical Habitat	*Branchinecta lynchi*	FT, MSCS	Unlikely to occur. No suitable habitat is present along the river corridor. Critical habitat does not occur within the river corridor.
Amphibians			
Shasta salamander	*Hydromantes shastae*	CT, BLM S, USFS S	Unlikely to occur. Suitable habitat generally is not found within the river corridor downstream from Shasta Dam.
California red-legged frog	*Rana aurora draytonii*	FT, CSC, MSCS	Could occur along the Sacramento River if suitable habitat is present
Foothill yellow-legged frog	*Rana boylii*	CSC, USFS S, MSCS	Could occur along the Sacramento River if suitable habitat is present
Western spadefoot toad	*Spea hammondii*	CSC, MSCS	Unlikely to occur. No suitable habitat is present along the Sacramento River corridor.
Reptiles			
Giant garter snake	*Thamnophis gigas*	FT, CT, MSCS	Unlikely to occur in the primary study area; however, known to occur in the extended study area.
Western pond turtle	*Actinemys (Clemmys) marmorata*	CSC, USFS S, MSCS	Known to occur. Suitable habitat is present in the primary study area.
Birds			
Cackling goose *(Aleutian Canada goose)*	*Branta hutchinsii leucopareia*	FD, MSCS	Unlikely to occur within the banks of the Sacramento River where flows could be altered.
American peregrine falcon *(nesting)*	*Falco peregrinus anatum*	CP, USFS S, MSCS	Unlikely to nest in this portion of the study area; however, may forage in areas of open water with large concentrations of waterbirds.

Table 4-8. Special-Status Wildlife Species Known or with Potential to Occur in the Primary Study Area, Along the Sacramento River from Shasta Dam to Red Bluff Pumping Plant (contd.)

Common Name	Scientific Name	Status[1]	Potential for Occurrence
Bald eagle (nesting and wintering)	*Haliaeetus leucocephalus*	FD, CE, CP, USFS S, MSCS	Known to occur along the Sacramento River in the primary study area.
Bank swallow (nesting)	*Riparia riparia*	CT, MSCS	Known to occur along the Sacramento River in the primary study area.
Black-crowned night heron (rookery)	*Nycticorax nycticorax*	BLM S, MSCS	Could nest in trees adjacent to the Sacramento River.
California gull (nesting colony)	*Larus californicus*	MSCS	Not within breeding range. Could occur in the study area during winter or migration.
Cooper's hawk (nesting)	*Accipiter cooperii*	MSCS	Could occur. Suitable nesting and foraging habitat is present in the primary study area.
Double-crested cormorant (rookery)	*Phalacrocorax auritus*	MSCS	Could nest in trees adjacent to the Sacramento River.
Golden eagle	*Aquila chrysaetos*	CP, BLM S, MSCS	No suitable nesting habitat along the Sacramento River. Unlikely to forage along the river corridor.
Great blue heron (rookery)	*Ardea herodius*	MSCS	Could nest in trees adjacent to the Sacramento River.
Great egret (rookery)	*Casmerodius albus*	MSCS	Could nest in trees adjacent to the Sacramento River.
Greater sandhill crane (nesting and wintering)	*Grus canadensis tabida*	CT, CP, MSCS	Unlikely to breed in the primary study area. Unlikely to use the Sacramento River corridor during winter or migration.
Least bittern (nesting)	*Ixobrychus exilis*	CSC, MSCS	Could nest along the Sacramento River if suitable habitat is present.
Lesser sandhill crane (wintering)	*Grus canadensis canadensis*	CSC	Does not breed in California. Unlikely to use the Sacramento River corridor during winter or migration.
Little willow flycatcher (nesting)	*Empidonax traillii brewsteri*	CE, MSCS	Unlikely to breed in the primary study area because of the area's elevation, but may use riparian woodlands during migration.
Loggerhead shrike (nesting)	*Lanius ludovidianus*	CSC	Likely to nest and forage in woodlands and scrub habitats in the primary study area.
Long-billed curlew (nesting)	*Numenius americanus*	MSCS	Does not breed in the primary study area. Unlikely to use the Sacramento River corridor during winter or migration.
Long-eared owl (nesting)	*Asio otus*	CSC, MSCS	Does not nest in lowland Central Valley areas. Unlikely to forage along the Sacramento River corridor where flows would be altered.
Northern harrier (nesting)	*Circus cyaneus*	CSC, MSCS	Likely to occur. Suitable nesting and foraging habitat is present in the primary study area.
Northern spotted owl (nesting) (critical habitat)	*Strix occidentalis caurina*	FT, MSCS	Unlikely to occur along the Sacramento River corridor because of a lack of suitable habitat. Critical habitat does not occur in the primary study area.

Table 4-8. Special-Status Wildlife Species Known or with Potential to Occur in the Primary Study Area, Along the Sacramento River from Shasta Dam to Red Bluff Pumping Plant (contd.)

Common Name	Scientific Name	Status[1]	Potential for Occurrence
Osprey (nesting)	*Pandion haliaetus*	MSCS	Known to nest along the Sacramento River in the primary study area.
Purple martin (nesting)	*Progne subis*	CSC	Could occur. Potentially suitable habitat is present along the Sacramento River corridor.
Short-eared owl (nesting)	*Asio flammeus*	CSC, MSCS	Could occur. Potentially suitable habitat is present in the primary study area.
Snowy egret (rookery)	*Egretta thula*	MSCS	Could nest in trees adjacent to the Sacramento River.
Swainson's hawk (nesting)	*Buteo swainsoni*	CT, USFS S, MSCS	Could occur. Suitable nesting and foraging habitat is present in the primary study area.
Tricolored blackbird (nesting colony)	*Agelaius tricolor*	CSC, MSCS	Could occur. Potentially suitable habitat is present in the primary study area.
Western yellow-billed cuckoo (nesting)	*Coccyzus americanus occidentalis*	FC, CE, USFS S, MSCS	Likely to nest and forage in the primary study area.
Western burrowing owl (burrow sites)	*Athene cunicularia hypugea*	CSC, MSCS	Unlikely to occur along the Sacramento River corridor because of a lack of suitable nesting habitat.
White-tailed kite (nesting)	*Elanus leucurus*	CP, MSCS	Likely to occur. Suitable nesting and foraging habitat is present in the primary study area.
Yellow-breasted chat (nesting)	*Icteria virens*	CSC, MSCS	Likely to nest and forage in the primary study area
Yellow warbler (nesting)	*Setophaga (Dendroica) petechia*	CSC, MSCS	Could nest and forage in the primary study area. Likely to use riparian woodlands during migration.
Pacific fisher	*Martes pennanti*	FC, CSC, USFS S	Unlikely to occur. No suitable habitat is available along the Sacramento River corridor.
Ringtail	*Bassariscus astutus*	CP, MSCS	Could occur. Potentially suitable habitat is present along the Sacramento River corridor.
Pallid bat	*Antrozous pallidus (roosting)*	CSC, BLM S, USFS S	Could occur. Potentially suitable habitat is present in woodland in the primary study area.
Western mastiff bat (roosting)	*Eumops perotis californicus*	CSC, BLM S, MSCS	Unlikely to roost along the Sacramento River corridor because suitable roost sites are lacking.

Key:
BLM = U.S. Department of the Interior, Bureau of Land Management
CE = California endangered
CSC = California Species of Special Concern
CP = California fully protected
CT = California threatened
FC = Federal candidate for listing
FD = Federally delisted
FE = Federally endangered
FPD = Proposed for Federal delisting
FT = Federally listed as threatened
S = Sensitive
MSCS = Multi Species Conservation Strategy
USFS = U.S. Department of Agriculture, Forest Service

Biological Resource Assessments for Potential Sacramento River Downstream Habitat Restoration Areas Reclamation conducted biological resource assessments at each of the six potential Sacramento River downstream habitat restoration areas during 2013. The assessments include botanical surveys for special-status plants and noxious weeds, vegetation and wildlife habitat mapping, general wildlife surveys, breeding bird surveys, California red-legged frog habitat assessments, and delineations of Waters of the United States (see Table 4-9). The biological resource assessment results are included as Attachments 12-17 to the *Wildlife Resources Technical Report* in the *Biological Resources Appendix*. Potentially occurring special-status wildlife species at the potential Sacramento River downstream habitat restoration areas are documented in Attachments 18-23 to the *Wildlife Resources Technical Report* in the *Biological Resources Appendix.*

Table 4-9. Wildlife Species of Concern in the Potential Sacramento River Downstream Habitat Restoration Areas

Common Name	Scientific Name	Status	Potential for Occurrence
Valley elderberry longhorn beetle	*Desmocerus californicus dimorphus*	FT	Potentially occurring in blue elderberry shrubs.
California red-legged frog	*Rana draytonii*	FT, CSC, MSCS m	Potentially occurring at restoration sites or locations in the vicinity with potential breeding habitat present.
Western pond turtle	*Actinemys marmorata*	CSC, USFS S, MSCS m	Potentially occurring in stream or other wetland habitats. Adjacent upland habitats are potential nesting areas.
Double-crested cormorant	*Phalacrocorax auritus*	MSCS m	Commonly occurs in the general vicinity in riverine and adjacent riparian habitats. No known rookery sites at any potential Sacramento River downstream habitat restoration areas.
Great egret	*Ardea alba*	MSCS m	Commonly occurs in the general vicinity in riverine and adjacent riparian habitats. No known rookery sites at any potential Sacramento River downstream habitat restoration areas.
Great blue heron	*Ardea herodias*	MSCS m	Commonly occurs in the general vicinity in riverine and adjacent riparian habitats. No known rookery sites at any potential Sacramento River downstream habitat restoration areas.
Black-crowned night heron	*Nycticorax nycticorax*	MSCS m	Commonly occurs in the general vicinity in riverine and adjacent riparian habitats. No known rookery sites at any potential Sacramento River downstream habitat restoration areas.
Cooper's hawk	*Accipiter cooperi*	MSCS m	Potentially occurring in forested riparian and woodland habitats.
Bald eagle	*Haliaeetus leucocephalus*	FD, FB, CE, CP, USFS S, MSCS m, BLMS	Occurs year-round in the vicinity. Two known nests in the general vicinity of the potential Sacramento River downstream habitat restoration areas

Table 4-9. Wildlife Species of Concern in the Potential Sacramento River Downstream Habitat Restoration Areas (contd.)

Common Name	Scientific Name	Status	Potential for Occurrence
Osprey	*Pandion haliaetus*	MSCS m	Commonly occurs in the general vicinity of the potential Sacramento River downstream habitat restoration areas. No known nests at any potential Sacramento River downstream habitat restoration areas.
Western yellow-billed cuckoo	*Coccyzus americanus occidentalis*	CE	Occurs only along the upper Sacramento Valley portion of the Sacramento River from Colusa to Red Bluff, the Feather River in Sutter Co., the South Fork Kern River in Kern Co., the Owen's River in Inyo Co., and along the Santa Ana, Amargosa, and lower Colorado Rivers. Riparian forest habitats in the potential Sacramento River downstream habitat restoration areas provide potential nesting habitat; however, these areas is located approximately 24 miles north of the northern extent of the known species geographic range.
Barrows goldeneye	*Bucephala islandica*	—/SC	Winter visitor to bays, lagoons, estuaries, freshwater lakes and large fast-moving rivers. Formerly nested in California at high mountain lakes. Regularly occurs on the Sacramento River in the Redding area during winter.
Willow flycatcher	*Empidonax traillii*	CE, USFS S, MSCS r	Uncommon migrant species in riparian habitat; may occur briefly during migration. No potentially nesting habitat present.
Yellow warbler	*Dendroica petechia brewsteri*	CSC, MSCS r	Potentially occurring in riparian habitats.
Yellow-breasted chat	*Icteria virens*	CSC, MSCS m	Potentially occurring in riparian habitats.
Pallid bat	*Antrozous pallidus*	CSC, USFS S, BLMS	Potentially occurring in riparian forest and woodland habitats.
Townsend's big-eared bat	*Plecotus townsendii*	CSC, USFS S	Potentially occurring in riparian forest and woodland habitats.
Western red bat	*Lasiurus blossevillii*	CSC	Potentially occurring in riparian forest and woodland habitats.
Ringtail	*Bassariscus astutus*	CP, MSCS m	Potentially occurring in riparian forest and woodland habitats.

Key:
BLM S = U.S. Department of the Interior, Bureau of Land Management sensitive
CD= California delisted
CE = California endangered
CP = California fully protected
CSC = California species of special concern
CT = California threatened
FB = Federal Bald and Golden Eagle Protection Act
FC = Federal candidate for listing
FD = Federally delisted
FP = Federally petitioned for listing
FPD = Proposed for Federal delisting
FT = Federally listed as threatened
m = Maintain. Ensure that any adverse effects on the species that could be associated with implementation of CALFED Bay-Delta Program actions will be fully offset through implementation of actions beneficial to the species.
MSCS = Multi-Species Conservation Strategy covered species
r = Contribute to recovery. Implement some of the actions deemed necessary to recover species' populations in the Multi-Species Conservation Strategy focus area.
USFS M = U.S. Department of Agriculture, Forest Service survey and manage species
USFS S = U.S. Department of Agriculture, Forest Service sensitive

Extended Study Area

Lower Sacramento River and Delta Numerous special-status wildlife species are associated with riparian, floodplain, and side-channel wetland habitats along the Sacramento River and in the Delta (Table 4-10). However, as stated above, the roughly 300 miles of the Sacramento River can be subdivided into distinct reaches. The reaches in the extended study area are discussed separately below because of differences in morphology, riparian vegetation, and habitat functions. The sensitive species discussed in this section are representative species selected from the many species present in the extended study area and are presented as examples to illustrate the breadth of resources. The *Wildlife Resources Technical Report* contains a comprehensive list of all sensitive wildlife species in the extended study area that have been reported to the CNDDB.

Table 4-10. Representative Sensitive Wildlife Species of Riparian and Perennial Wetland Communities Along the Sacramento River and in the Delta

Common Name	Scientific Name	Status[1]	Habitat Description
Invertebrates			
Valley elderberry longhorn beetle	*Desmocerus californicus dimorphus*	FT	Elderberries in riparian woodlands or savanna communities.
Reptiles			
Western pond turtle	*Actinemys (Clemmys) marmorata*	CSC	Ponds, lakes, rivers, streams, creeks, marshes, and irrigation ditches with abundant vegetation and either rocky or muddy bottoms, in woodland, forest, and grassland.
Giant garter snake	*Thamnophis giga*	FT CT	Marshes, sloughs, drainage canals, and irrigation ditches, especially around rice fields, and occasionally in slow-moving creeks from sea level to 400 feet. Prefers locations with vegetation close to the water for basking.
Birds			
Tricolored blackbird	*Agelaius tricolor*	CSC	*Foraging:* On ground in croplands, grassy fields, flooded land, and along edges of ponds. *Nesting:* Dense cattails, tules, or thickets near fresh water.
Swainson's hawk	*Buteo swainsoni*	CT	*Foraging:* Open desert, grassland, or cropland containing scattered, large trees or small groves. *Nesting:* Open riparian habitat, in scattered trees or small groves in sparsely vegetated flatlands. Usually found near water in the Central Valley.
Northern harrier	*Circus cyaneus*	CSC	*Nesting:* Tall grasses and forbs in emergent wetland, along rivers or lakes, grasslands, grain fields, or on sagebrush flats several miles from water.
Western yellow-billed cuckoo	*Coccyzus americanus occidentalis*	FC CE	*Nesting:* Extensive deciduous riparian thickets or forests with dense, low-level or understory foliage adjacent to slow-moving watercourses, backwaters, or seeps. Willow is almost always a dominant component of the vegetation. In the Sacramento Valley, also uses adjacent walnut orchards.
Yellow warbler	*Setophaga (Dendroica) petechia*	CSC	*Nesting*: Low, open-canopy riparian deciduous woodlands with a heavy brush understory; sometimes in montane shrubbery in open conifer forests.

Table 4-10. Representative Sensitive Wildlife Species of Riparian and Perennial Wetland Communities Along the Sacramento River and in the Delta (contd.)

Common Name	Scientific Name	Status[1]	Habitat Description
White-tailed kite	*Elanus leucurus*	FP	*Foraging:* Undisturbed, open grasslands, meadows, farmlands, and emergent wetlands. *Nesting:* Large groves of dense, broad-leafed deciduous trees close to foraging areas.
Greater sandhill crane	*Grus canadensis tabida*	CT FP	*Foraging: Open grasslands, grain fields, and open wetlands.* *Roosting: In flocks standing in moist fields or in shallow water.* *Nesting: Open habitats with shallow lakes and fresh emergent wetlands.*
Bald eagle	*Haliaeetus leucocephalus*	CE FP	*Foraging: Large bodies of water or free-flowing rivers with abundant fish and adjacent snags or other perches.* *Nesting: Large, old-growth trees or snags in remote, mixed stands near water.*
Yellow-breasted chat	*Icteria virens*	CSC	*Foraging and nesting:* Riparian thickets of willow and other brushy species near streams or other watercourses.
California black rail	*Laterallus jamaicensis coturniculus*	CT FP	*Foraging and nesting:* Tidal emergent wetlands dominated by pickleweed, in the high wetland zones near upper limit of tidal flooding, or in brackish marshes supporting bulrushes and pickleweed. In freshwater, usually found in bulrushes, cattails, and saltgrass adjacent to tidal sloughs.
Suisun song sparrow	*Melospiza melodia maxillaries*	CSC	*Foraging:* The bare surface of tidally exposed mud among tules and along slough margins in brackish marshes. *Nesting:* Along edges of sloughs and bays supporting mixed stands of bulrush, cattail, and other emergent vegetation.
Bank swallow	*Riparia riparia*	CT	*Foraging:* Open riparian areas, grassland, wetlands, water, and cropland. *Nesting:* Vertical banks and cliffs with fine-textured or sandy soils near streams, rivers, ponds, and lakes.
Yellow-headed blackbird	*Xanthocephalus xanthocephalus*	CSC	*Foraging:* Fresh emergent wetland and sometimes along shorelines and in nearby open fields, preferably on moist ground. *Nesting:* Dense emergent wetland of cattails and tules, often along border of lake or pond.

Table 4-10. Representative Sensitive Wildlife Species of Riparian and Perennial Wetland Communities Along the Sacramento River and in the Delta (contd.)

Common Name	Scientific Name	Status[1]	Habitat Description
Mammals			
Pallid bat	*Antrozous pallidus*	CSC	*Foraging:* Relatively open oak woodlands, over water near riparian and upland forests and woodlands, and orchards and vineyards. *Roosting:* Rocky outcrops, cliffs, and crevices.
Western mastiff bat	*Eumops perotis*	CSC	*Foraging:* Over water in broad, open areas near riparian and upland forests and woodlands. *Roosting:* Crevices in vertical cliffs, usually granite or consolidated sandstone, and in broken terrain with exposed rock faces.
Western red bat	*Lasiurus blossevillii*	CSC	*Foraging:* Over water edges in open areas near riparian and upland forests and woodlands; orchards. *Roosting:* Trees along edges or in habitat mosaics in a variety of habitats and orchards.
Townsend's big-eared bat	*Plecotus townsendii*	CSC	*Foraging:* Water edges in open areas near riparian and upland forests and woodlands. *Roosting:* Caves, mines, tunnels, buildings, or other human-made structures in woodlands. Prefers mesic habitats.
Salt-marsh harvest mouse	*Reithrodontomys raviventris*	FE CE FP	Salt marsh dominated by pickleweed and salt grass. Generally requires nonsubmerged, salt-tolerant vegetation for escape during high tides.

Source: CNDDB 2012

Note:

[1] Status definitions:

Key:

CE = California listed as endangered
CSC = California species of special concern
CT = California listed as threatened
FC = federal candidate for listing
FE = Federally listed as endangered
FP = California fully protected
FT = Federally listed as threatened

Sacramento River from Red Bluff Pumping Plant to the Delta Many of the special-status wildlife species described above for the upper Sacramento River have the potential to occur in the middle and lower reaches of the Sacramento River. Wildlife species listed under the Federal Endangered Species Act (ESA) and/or California Endangered Species Act (CESA) that have the potential to occur in a portion of the extended study area from Red Bluff Pumping Plant to the Delta include valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*), giant garter snake (*Thamnophis gigas*), bald eagle (*Haliaeetus leucocephalus*), Swainson's hawk (*Buteo swainsoni*), western yellow-billed cuckoo (*Coccyzus americanus occidentalis*), willow flycatcher (*Empidonax traillii*), and bank swallow (*Riparia riparia*).

Sacramento–San Joaquin River Delta Many special-status species are known or likely to occur in the Delta because of the presence of extensive wetland habitats. Tidal marshes and emergent wetlands support several special-status wildlife species: California black rail (*Laterallus jamaicensis coturniculus*), California clapper rail (*Rallus longirostris obsoletus*), greater sandhill crane (*Grus canadensis tabida*), salt marsh common yellowthroat

(*Geothlypis trichas sinuosa*), salt marsh harvest mouse (*Reithrodontomys raviventris*), Suisun ornate shrew (*Sorex ornatus sinuosus*), Suisun song sparrow (*Melospiza melodia maxillaris*), and tricolored blackbird (*Agelaius tricolor*). The giant garter snake is known to inhabit sloughs, canals, and low-gradient streams and freshwater marshes in the Delta. Vernal pools and other freshwater seasonal wetlands support several special-status crustaceans, including vernal pool tadpole shrimp (*Lepidurus packardi*) and vernal pool fairy shrimp (*Branchinecta lynchi*). The valley elderberry longhorn beetle has been found in the Delta region on McCormack-Williamson and New Hope tracts (CNDDB 2012).

San Joaquin River Basin to the Delta The current wildlife habitat value of this area is somewhat limited by the predominance of agricultural lands, which support a relatively low diversity of wildlife species. Remnant native vegetation patches are likely to support a high diversity of wildlife species. More than 100 special-status wildlife and plant species occur in the San Joaquin River region. Most of the special-status wildlife species are associated with grasslands (which include vernal pools), freshwater emergent wetlands, lakes, and rivers that occur on the valley floor. Many of the species have been listed by Federal and State wildlife agencies because of habitat losses associated with agricultural development and water projects.

CVP/SWP Service Areas The CVP and SWP service areas are dominated by agricultural land and urban development. These areas support many wildlife species, most of which are highly adapted to these altered environments. The conflict between urban growth and conservation of native habitat has resulted in the listing of a number of wildlife species that were threatened with extinction. The region also supports a variety of exotic species, some of which are detrimental to survival of native species.

The California condor (*Gymnogyps californianus*), lightfooted clapper rail (*Rallus longirostris levipes*), California least tern (*Sternula antillarum brownie*), least Bell's vireo (*Vireo bellii pusillus*), Belding's Savannah sparrow (*Passerculus sandwichensis beldingi*), southwestern willow flycatcher (*Empidonax traillii extimus*), California gnatcatcher (*Polioptila californica*), Mohave ground squirrel (*Spermophilus mohavensis*), and Morro Bay kangaroo rat (*Dipodomys heermanni morroensis*) are examples of species that have been listed as threatened or endangered under the ESA and/or CESA and that could occur within the CVP and SWP service areas.

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Chapter 5
Potential Impacts to Waters of the United States from the National Economic Development Plan

This section describes the potential impacts to waters of the United States (also known as "jurisdictional waters") and mitigation for unavoidable impacts to waters of the United States for the NED Plan.

Potential Impacts to Waters of the United States in Primary Study Area

Implementation of the project will result in the loss of jurisdictional waters caused by flooding the impoundment area and discharge of fill associated with the relocation of facilities and dam construction. Flooding caused by implementation of the project would result in the conversion of jurisdictional water types (e.g., wetlands and streams to lacustrine habitat).

Direct impacts would incur by conversion of jurisdictional waters (e.g., wetlands and streams) to lacustrine habitat with implementation of the NED Plan. All features within the impoundment area would be converted to lacustrine habitat. Approximately 29 acres of wetlands and 49 acres of other waters would be converted to lacustrine habitat (Table 5-1). This will result in a net loss of approximately 29 acres of wetlands and loss of approximately 49 acres of riverine waters by conversion to lacustrine waters.

The impacts associated with relocation are shown on Table 5-2. The relocation impacts to wetlands would result in the loss of approximately 2 acres of wetlands and 2 acres of other waters.

Table 5-1. Impacts to Jurisdictional Waters (Acres[1]) in the Impoundment Area (NED Plan)

Jurisdictional Water Type	Area (Acres)						
	Main Body	Big Backbone Arm	Sacramento Arm	McCloud Arm	Squaw Creek Arm	Pit Arm	Total
Wetlands							
Fresh emergent/ riparian wetland	0.00	0.00	5.30	0.00	0.00	0.00	5.30
Intermittent swale	0.00	0.00	0.00	0.00	0.00	0.04	0.04
Riparian wetland	1.09	1.73	7.05	8.33	1.49	0.77	20.46
Seasonal wetland	0.00	0.00	0.42	0.00	0.14	0.02	0.58
Seep/spring wetland	0.77	0.23	0.80	0.41	0.16	0.47	2.84
Vegetated ditch	0.13	0.00	0.00	0.02	0.00	0.00	0.15
Total Wetlands	1.99	1.96	13.57	8.76	1.79	1.30	29.37
Other Waters of the United States							
Ephemeral stream	0.28	0.01	0.62	0.28	0.13	0.12	1.44
Intermittent stream	1.42	0.24	2.42	0.91	0.92	2.58	8.50
Perennial stream	1.55	3.00	9.78	20.27	2.39	1.57	38.56
Roadside ditch	0.00	0.00	0.01	0.00	0.00	0.00	0.01
Seep/spring other waters	0.03	0.00	0.001	0.01	0.00	0.00	0.04
Total Other Waters	3.28	3.25	12.83	21.47	3.44	4.27	48.54
Total	5.27	5.21	26.40	30.23	5.23	5.57	77.91

Note:
[1] Acreage values are approximate

Table 5-2. Impacts to Jurisdictional Waters (Acres[1]) in the Relocation Areas (NED Plan)

Jurisdictional Water Type	Relocation Acres						
	Main Body	Big Backbone Arm	Sacramento Arm	McCloud Arm	Squaw Creek Arm	Pit Arm	Total
Wetlands							
Fresh emergent wetland	0.00	N/A	0.02	0.01	0.00	0.00	0.03
Intermittent swale	0.00	N/A	0.00	0.00	0.00	0.001	0.001
Riparian wetland	0.03	N/A	0.20	0.02	0.003	0.13	0.38
Seasonal wetland	0.01	N/A	1.75	0.00	0.0001	0.00	1.76
Seep/spring wetland	0.004	N/A	0.03	0.00	0.006	0.005	0.05
Vegetated ditch	0.05	N/A	0.00	0.004	0.00	0.00	0.05
Total Wetlands	0.094	N/A	2.00	0.03	0.009	0.136	2.27
Other Waters of the United States							
Ephemeral stream	0.06	N/A	0.08	0.12	0.001	0.02	0.281
Intermittent stream	0.26	N/A	0.78	0.09	0.007	0.08	1.22
Perennial stream	0.00	N/A	0.05	0.03	0.04	0.002	0.12
Roadside ditch	0.007	N/A	0.003	0.00	0.00	0.00	0.01
Non-vegetated ditch	0.01	N/A	0.003	0.00	0.00	0.00	0.01
Seep/spring other waters	0.00	N/A	0.00	0.00	0.004	0.00	0.004
Total Other Waters	0.337327	N/A	0.92	0.24	0.05	0.102	1.64
Total Waters of the U.S.	0.43	N/A	2.92	0.27	0.06	0.24	3.92

Note:
[1] Acreage values are approximate.
Key:
N/A = not applicable

Mitigation for Unavoidable Impacts to Waters of the United States

As discussed in Chapter 3, "National Economic Development Plan - CP4A," the NED Plan has been designed to avoid and minimize impacts to waters of the United States to the greatest extent feasible. However, for those impacts that can't be avoided or minimized, mitigation is proposed. The following section describes the history of how the mitigation measures were developed and the proposed mitigation plan. The plan addresses mitigation for waters of the United States and special-status plant species.

As described in Appendix 11, "Preliminary Environmental Commitments and Mitigation Framework," to the Final EIS, Reclamation convened an interagency working group to enhance mitigation measures. This working group had the benefit of additional information from recent investigations of nearby private lands available for mitigation and refined analyses of potential project impacts. Using this updated information, the working group developed and refined

mitigation measures for botanical and wetland resources, including include land acquisition, habitat management and enhancement, and other measures.

Reclamation will prepare a conceptual wetland mitigation plan following current USACE guidance and requirements. The mitigation plan will incorporate wetland habitats within lands acquired (described below), as appropriate, and may include additional mitigation lands. The wetland mitigation plan will also include measures for wetland habitat creation, restoration, and/or enhancement.

Reclamation will implement a program to acquire nearby private lands with similar habitat attributes and species composition as those impacted by the NED Plan. Reclamation has identified several willing private landowners and specific parcels for purchase in the SLWRI project area vicinity. Preliminary investigations of these lands have shown they contain similar and/or additional habitats and special-status species as those impacted by SLWRI. Additionally, the interagency working group identified other private parcels with similar biological resources in the vicinity of the SLWRI project area, some of which have owners willing to discuss purchase agreements.

As discussed during the interagency working group meetings, Reclamation will begin with a 3:1 minimum replacement ratio of acquired lands to impacted lands. The interagency working group also agreed that additional considerations will be made for other replacement ratios (more or less) depending on habitat quality at a particular site. Emphasis will be placed on lands containing high value habitats (e.g., riparian, wetland, limestone, blue oak woodlands) and/or special-status species populations.

This mitigation measure includes the following components intended to reduce impacts on USFS sensitive, BLM sensitive, and CRPR plants:

- When feasible in relocation areas, avoid or minimize actions that can result in harm or mortality to individuals or to the viability of populations.

- When feasible, Reclamation will relocate populations of USFS sensitive, BLM sensitive, and CRPR plants that will be directly affected to suitable habitat within undisturbed portions of the Shasta Lake and vicinity portion of the primary study area.

- When feasible, Reclamation will use seed banking and other *ex situ* (off site) conservation methods for USFS sensitive, BLM sensitive, and CRPR plant populations that will be directly affected.

- When feasible, Reclamation will restore/enhance populations of other USFS sensitive, BLM sensitive, and CRPR plants in the project vicinity.

- Reclamation will develop a mitigation and monitoring plan to monitor success of USFS sensitive, BLM sensitive, and CRPR plant populations that have been relocated or revegetated. The plan will identify suitable sites for mitigation, species to be planted, and numbers and sizes of plantings. It will describe planting techniques, prescribe methods to remove existing noxious weeds, and establish reasonable performance standards and contingency measures. Furthermore, it will establish conservation easements as appropriate. The vegetation restoration plan will be developed in consultation with cooperating and responsible agencies (e.g., USACE, USFWS, USFS).

- To the extent feasible, USFS sensitive, BLM sensitive, and CRPR plant species will be used for revegetation.

In addition, Reclamation will develop and implement a riverine ecosystem mitigation and adaptive management plan to mitigate to the extent feasible any identified impacts of an altered Sacramento River flow regime on existing riparian and wetland communities, and associated instream, riparian, and wetland habitat values for aquatic and terrestrial special-status species along the Sacramento River from Shasta Dam to Colusa (River Mile 144). The plan will be consistent with and will support implementation of the Senate Bill 1086 program, and will be developed in coordination with USFWS, NMFS, CDFW, and the Sacramento River Conservation Area Forum. The plan will be developed before project construction. The plan will be limited to the Sacramento River from Shasta Dam to Colusa (River Mile 144). The existing conditions as of 2010 will be the baseline conditions.

The goals of the plan, which will also serve as performance standards, will be to have no net reduction in the average amount of any of the following along the Sacramento River from Shasta Dam to Colusa:

- Channel migration in selected areas of natural vegetation dominated by native species

- Overbank inundation of natural vegetation dominated by native species in selected areas

- Regeneration of early-successional riparian vegetation (e.g., cottonwood regeneration) in selected areas

The riverine ecosystem mitigation plan will include all of the following elements:

- Modeling or monitoring at representative locations to quantify direct and indirect impacts resulting from adaptive management of project implementation. A method of quantifying impacts will be used that ensures repeatability.

- An evaluation of feasible modifications to the procedures for operating Shasta Dam (e.g., ramping rates) to accomplish any of the following:
  - Reduce or eliminate adverse impacts on ecologically important bankfull and overbank flows (as feasible within existing flood reduction constraints)
  - Reduce or eliminate adverse impacts (e.g., reduction) on meander migration rates
  - Facilitate establishment of cottonwoods and early-successional vegetation at intervals sufficient to sustain cottonwoods and early-successional riparian vegetation along the Sacramento River riparian corridor and floodplain (e.g., at 5- to 15-year intervals)
  - Avoid any increase in flood risk from implementing this mitigation measure. Feasible modifications to operational procedures are those not in conflict with applicable laws, agreements, and regulations, or with the purpose of the project
- A specific combination of mitigation actions will be developed and implemented to attain the plan's goals. Mitigation actions will consist of feasible modifications to dam operation procedures and/or funding of appropriate and feasible restoration actions that have been developed by Reclamation, other Federal agencies, State or local governments, or private nonprofits and received applicable Federal and State permits. Appropriate and feasible restoration actions could include actions to accomplish any of the following:
  - Enhance connectivity of river side channels (e.g., by modifying the elevation of secondary channels, remnant oxbows, or meander scars)
  - Expand the river meander zone at selected locations (e.g., by assisting in funding projects that meet this objective)
  - Increase floodplain connectivity (e.g., by assisting in funding projects that meet this objective)
  - Control and remove nonnative, invasive plant species from riparian areas to shift dominance to native species
  - Create riparian and wetland communities (e.g., through plantings)
  - Increase shaded riverine aquatic habitat (e.g., through plantings)

- The methods and results of an analysis demonstrating that a specified combination of mitigation actions will attain the plan's goals.

- The location of restoration actions specified in the combination of mitigation actions. Restoration actions will be performed on preserved sites and with funding for management in perpetuity. (Preserved sites will include sites previously preserved by other entities.)

- Implementation mechanisms (i.e., mechanisms by which Reclamation will fund implementation) and criteria for implementing dam operation procedures that provide mitigation.

- Parameters for preparation and content of restoration and management plans, or existing applicable plans.

At a minimum, mitigation in this plan will include the following:

- Feasible modifications to dam operation procedures identified as reducing adverse impacts on meander migration or ecologically important bankfull and overbank flows, or as facilitating cottonwood establishment

- Either of the following elements:

  – Provide actions or funding to increase meander migration, side-channel connectivity, or floodplain connectivity along the Sacramento River, and creation (or conversion of nonnative-dominated to native-dominated) of riparian or wetland communities

    or

  – Provide mitigation that has been determined by USFWS, NMFS, and CDFW to be of comparable or greater value and is included in the terms and conditions of permits for impacts on species listed as threatened or endangered by the State or Federal governments

Reclamation will mitigate for the loss of approximately 29 acres of wetlands and 48 acres of other waters of the U.S. in the inundation area, and approximately 2 acres of wetlands and 2 acres of Other Waters of the U.S. in the relocation areas. Collectively, Reclamation will mitigate for the loss of approximately 31 acres of wetlands and approximately 50 acres of Other Waters of the U.S.

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Chapter 6
Alternative Development Process

This section describes the alternatives development process for the SLWRI. The SLWRI alternative development process started with CALFED and continued through the Plan Formulation and EIS process. A more detailed description of the Plan Formulation process is included in the Plan Formulation Appendix. This section also describes the alternatives retained for further analysis.

CALFED Alternatives Development Process

The SLWRI is one of five surface water storage studies recommended in the 2000 CALFED Programmatic Environmental Impact Statement/Environmental Impact Report (PEIS/R) Preferred Program Alternative and associated Programmatic ROD.

CALFED evaluated numerous alternatives, and the resulting Preferred Program Alternative in the Final PEIS/R identified surface storage projects to be pursued with project-specific studies, in particular expanding CVP storage in Shasta Lake by approximately 300 thousand acre-feet. The SLWRI Final EIS was revised to clarify that, consistent with guidance in the CALFED Programmatic ROD, this EIS tiers to the CALFED PEIS/R and relies on evaluations and alternatives development and screening included in the CALFED PEIS/R. The below discussion describes the CALFED alternatives development process and its relationship to the SLWRI alternatives development process.

CALFED is a consortium of federal and State agencies working to restore ecological health and improve water management for beneficial uses of the San Francisco Bay/Sacramento–San Joaquin River Delta estuary. The CALFED effort is a collaboration between these agencies and Bay-Delta "stakeholders"—urban and agricultural water users, fishing interests, environmental organizations, businesses, and others—who contribute to CALFED design, problem solving, and decision making (CALFED 2002).

The CALFED planning effort was divided into three phases. Phase I defined the problems and a range of solutions and Phase II included the selection of the Preferred Program Alternative. Phase III is implementation of the Preferred Program Alternative, which includes the project-specific environmental evaluation of projects, including SLWRI. Below describes the alternative development process associated with Phase I and Phase II of the CALFED planning process.

During Phase I of the CALFED planning effort, the CALFED participants identified actions to resolve Bay-Delta problems and developed these actions into a set of alternatives for programmatic environmental review. Early in Phase I, 50 categories of actions to resolve Bay-Delta problems and achieve program objectives were identified. Given the large number of categories and range of perspectives on solutions, thousands of potential alternatives could have been identified. Therefore, the program devised a methodology that defined the critical conflicts and defined approaches to those conflicts. Ultimately, 100 preliminary solution alternatives were identified. Continued consolidation and balancing of the alternatives brought the number to 20. These 20 alternatives were presented to stakeholders, and to the public at a workshop. Consolidation and refinement of the alternatives, based on the workshop, produced 10 alternatives which were then compared against the programs' solution principles and it was found that three basic alternative approaches could be formed around different configuration of Delta conveyance. Each approach included the same set of four programs that are common to all alternatives and involves water use efficiency, water quality, levee system integrity, and ecosystem quality. Storage for each alternative could be evaluated to support these programs and the Delta conveyance and seek a balance between attainment of program objectives and cost effectiveness and were considered variable program elements (CALFED 2000).

Three basic alternative approaches from Phase I were carried into Phase II of the CALFED planning effort. Seventeen variations of the three basic alternative approaches were then developed to further explore potential refinements for the two variable program elements, storage and conveyance. The narrowing process (which included focusing on technical deficiencies and conveyance options) refined the seventeen variations of the three basic alternative approaches to twelve variations. Impacts of the three basic alternative approaches were evaluated in the CALFED 1998 Draft PEIS/R. Some of the twelve variations were eliminated or consolidated for technical reasons, and four action alternatives, (including the Preferred Program Alternative), were evaluated in the CALFED Final PEIS/R. Each of the four action alternatives considered in the CALFED Final PEIS/R include the Ecosystem Restoration, Water Quality, Levee System Integrity, Water Use Efficiency, Water Transfer, Watershed Storage, and Conveyance elements. Each of the action alternatives included an assessment with additional storage up to 6 MAF and without storage.

The Phase II Report, included as an appendix in the Final PEIS/R, presented potential near-term and long-term implementation strategies for implementation of the Preferred Program Alternative. The report discusses how CALFED and its cooperating agencies had conducted a preliminary screening of potential surface storage locations and project configurations, and then selected a smaller number for more detailed evaluation. Shasta Lake Enlargement, among other storage projects, was retained for additional CALFED consideration as it appeared to be promising in helping to meet CALFED goals and objectives. In

addition, it was determined that Shasta Lake Enlargement would provide significant benefits and generally result in lower environmental impacts than the remaining sites. The Phase II Report states that CALFED will aggressively pursue Shasta Lake enlargement through full State and Federal commitment to the process and evaluations necessary for implementation.

Phase II concluded in August 2000 with the filing of the Programmatic ROD, including certification, for the CALFED PEIS/R (CALFED 2002). The CALFED Programmatic ROD states that expanding the CVP storage in Shasta Lake by approximately 300 thousand acre-feet would be pursed with a project-specific study.

The SLWRI Final EIS tiers to the CALFED Final PEIS/R. In developing the CALFED Final PEIS/R, the CALFED agencies, including Reclamation, evaluated a broad range of water management options (with and without storage) to be implemented to achieve the CALFED goals. The SLWRI EIS relied on evaluations and alternatives development and screening included in the CALFED PEIS/R.

CALFED Clean Water Act Section 404 Memorandum of Understanding

This Analysis of Consistency with Section 404 Clean Water Act Requirements relies on the "Clean Water Act Section 404 Memorandum of Understanding (MOU)." The Signatories (USACE, Reclamation, US EPA, and California Department of Water Resources) to the MOU agreed that the CALFED Program Purpose Statement is an acceptable statement of the purpose and need for the CALFED Program.

SLWRI Alternatives Development Process

The Plan Formulation Appendix of the Final EIS provides detailed background on the SLWRI alternatives formulation/development process and the development of the project's range of alternatives. This information is summarized in Chapter 2, "Alternatives" of the Final EIS and described below.

The SLWRI alternative formulation/development process and development of the project's range of alternatives started with the development of the purpose and need, planning objectives (also referred to as project objectives), constraints and criteria.

After development of the purpose and need, planning objectives, constraints, and criteria, the next major step in plan formulation was to define management measures. A management measure is any structural or nonstructural project action or feature that could address the planning objectives and satisfies the other applicable planning considerations.

More than 60 potential management measures, described in detail in Chapter 2 of the Plan Formulation Appendix, "Management Measures," were identified, evaluated, and screened as part of the SLWRI plan formulation process to address the primary and secondary planning objectives and satisfy the other applicable screening criteria (see Chapter 2 of the Plan Formulation Appendix "Planning Constraints, Considerations and Criteria"). The Plan Formulation Appendix includes a wide range of management measures representing diverse viewpoints and needs based on both planning processes internal to Reclamation and public scoping, including interaction with key regulatory and land management agencies. Reclamation looked at many management measures, beyond simply modifying or raising Shasta Dam, as further described below. The management measures included constructing instream fish habitat on tributaries to the Sacramento River; increased instream flows on Clear, Cow, and Bear creeks; constructing a migrating corridor from the Sacramento River to the Pit River; constructing new reservoirs in other locations, such as on the Sacramento River upstream from Shasta Reservoir, on tributaries downstream from Shasta Dam (e.g., Cottonwood Creek and Auburn Dam Projects); offstream storage near the Sacramento River downstream from Shasta Dam (e.g., Sites Reservoir); and many others. One important factor was the potential for a management measure to directly address a planning objective without adversely impacting other objectives. Management measures deleted from further consideration are described in detail in the Plan Formulation Appendix, along with the reasons for deleting measures from further consideration and development.

Many of the management measures evaluated during this process, including measures not related to the raising of Shasta Dam, were considered under CALFED. Since the SLWRI EIS tiers to the CALFED PEIS/R, it relies on the analysis and screening evaluations performed for the CALFED PEIS/R. While revisiting alternatives that were considered alongside CALFED's Preferred Program Alternative is not required, many of the management measures, including measures not related to the raising of Shasta Dam, were also evaluated in the *Initial Alternatives Information Repor*t (Reclamation 2004), the *Ecosystem Restoration Opportunities Report* (Reclamation 2003b), the *Plan Formulation Report* (Reclamation 2007).

Following management measures development and screening, the next phases of the plan formulation process involved combining retained management measures to formulate concept plans (plans which are conceptual in scope). The management measures and concept plans carried forward were then further refined and developed with more specificity to formulate comprehensive plans (i.e., alternatives) to address the planning objectives.

In addition to the No-Action Alternative, the Final EIS assesses a range of feasible alternatives (or comprehensive plans) that meets the project purpose and thoroughly describes the reasons why other potential actions were dismissed from further consideration. These alternatives provide decision

makers with a refined, but feasible, action with which the study objectives may be accomplished. The adverse or beneficial environmental impacts of each alternative are evaluated within each resource area chapter. The alternatives analyzed in the Final EIS are those that best meet the NEPA primary and secondary objectives, minimize negative effects, and are potentially feasible.

This development of SLWRI management measurement and alternative process was documented through a series of planning documents made available to the public, including:

- *Enlarged Shasta Lake Investigation Preliminary Findings Report* (1983)
- *Shasta Dam and Reservoir Enlargement, Appraisal Assessment of the Potential for Enlarging Shasta Dam and Reservoir* (1999a)
- *SLWRI Strategic Agency and Public Involvement Plan* (2003b)
- *SLWRI Mission Statement Milestone Report* (2003a)
- *Ecosystem Restoration Opportunities Report* (Reclamation 2003b)
- *SLWRI Initial Alternatives Information Report* (2004), *SLWRI Environmental Scoping Report* (2006), *and SLWRI Plan Formulation Report* (2007)

Water Dependency

As discussed in Chapter 2, "Purpose and Need" of this document, under Section 404(b)(1) Guidelines, SLWRI is not water dependent because it does not require access or proximity to, or siting within, waters of the U.S. to fulfill its basic purpose "*to improve operational flexibility of the Sacramento-San Joaquin Delta (Delta) watershed system to meet specified primary and secondary project objectives."* For projects that are not water-dependent, the 404(b)(1) guidelines establish a "rebuttable presumption." The applicant must demonstrate that there are no available, practicable alternatives that do not involve special aquatic sites. The applicant must also rebut the presumption in the guidelines that all practicable alternatives to the proposed discharge that do not involve discharge into a special aquatic site would have less adverse impact on the aquatic ecosystem.

As stated above, the overall project purpose is "*to improve operational flexibility of the Sacramento-San Joaquin Delta (Delta) watershed system to meet specified primary and secondary project objectives."* However, through the CALFED alternative and Plan Formulation Screening Process (described above) other options to raising Shasta Dam were considered, but the only

alternatives retained for further consideration for the Proposed Action in the EIS was the raising of Shasta Dam, which is water-dependent. Other options to raising Shasta Dam are not considered to be practicable. For additional information, see Chapter 2 of the Plan Formulation Appendix, "Management Measures."

In summary, all non-water dependent alternatives were eliminated from further consideration during the CALFED and plan formulation processes. The raising of Shasta Dam would necessitate the discharge of fill materials into wetlands through construction or inundation. These wetlands are classified as a special aquatic site; therefore, according to the Guidelines, the NED Plan is considered to be water dependent. Accordingly, there is no need in this alternatives analysis to rebut the presumption that there are practicable alternatives to the NED Plan that do not involve a discharge of dredged or fill material to a special aquatic site [see 40 CFR 230.10(a)(3)].

Alternatives Eliminated from Further Consideration

Initial Alternative Phase

This phase included developing a number of potential management measures, or project actions or features designed to address planning objectives. These measures were then used to formulate a set of plans that were conceptual in scope (concept plans). These initial plans were evaluated and compared to the planning objectives to identify the most suitable plans for further development.

The following concept plans were eliminated from further consideration as stand-alone plans.

AFS-1 – Increase Cold Water Assets with Shasta Operating Pool Raise (6.5 feet)

AFS-1 focused on maintaining cooler water temperatures in the upper Sacramento River by increasing the minimum end-of-October carryover storage target. This would allow additional cold water to be stored for use in the following year. No changes would be made to the existing seasonal temperature targets for anadromous fish on the upper Sacramento River, but the ability to meet these targets would be improved.

It was found that AFS-1 had a significant potential to benefit anadromous fish in the upper Sacramento River, but there would be no additional increase in water supply reliability. This plan had two major components: (1) Raising Shasta Dam by 6.5 feet for the primary purpose of enlarging the cold-water pool and regulating water temperature in the upper Sacramento River: and (2) increasing the size of the minimum operating pool to 880,000 acre-feet.

AFS-1 was not retained for further development as a stand-alone plan because, although it had considerable benefits for anadromous fish survival, it did not meet the primary planning objective of increasing water supply reliability.

AFS-2 – Increase Minimum Anadromous Fish Flow with Shasta Enlargement (6.5 feet)

AFS-2 focused on the primary planning objective of anadromous fish survival by using the additional reservoir storage to increase minimum seasonal flows in the upper Sacramento River from the current 3,250 cfs to about 4,200 cfs. The primary component of AFS-2 included raising Shasta Dam by 6.5 feet for the primary purpose of enlarging the volume of water available to meet minimum flows for winter-run Chinook salmon on the upper Sacramento River. No changes would be made to the carryover target volume or minimum operating pool.

Subsequent evaluation indicated that although increasing minimum flows would be beneficial for fish at various stages of development, it would be detrimental at other life stages. Accordingly, this plan was deleted from further development.

AFS-3 – Increase Minimum Anadromous Fish Flow with Shasta Enlargement (6.5 feet) and Restore Aquatic Habitat

AFS-3 was similar to AFS-2, except that it also involved acquiring, restoring, and reclaiming one or more inactive gravel mines along the upper Sacramento River to restore about 150 acres of aquatic and floodplain habitat. AFS-3 had two major plan components: (1) Raising Shasta Dam by 6.5 feet for the primary purpose of enlarging the volume of water available to meet minimum flows for winter-run Chinook salmon on the upper Sacramento River: and (2) acquiring, restoring, and reclaiming one or more inactive gravel mining operations along the upper Sacramento River to restore about 150 acres of aquatic and floodplain habitat.

Increasing minimum flows was not found to significantly benefit to anadromous fish, and concerns were expressed regarding significant uncertainties about offstream areas being able to successfully support viable fish spawning and rearing. Further, during public scoping activities in late 2005, little to no interest was demonstrated for restoring inactive gravel mines along the Sacramento River above the current location of the RBPP. Accordingly, this plan element was deleted from further consideration at this time.

WSR-3 – Increase Water Supply Reliability with Shasta Enlargement (High Level)

WSR-3 focused on water supply reliability by increasing the volume of water stored in Shasta Lake by the maximum amount technically feasible. WSR-3 had two major components: (1) Raising Shasta Dam by about 202.5 feet for the primary purpose of creating 9.3 MAF of additional storage available for water

supply: and (2) major modifications to or replacing, dam appurtenances, including hydropower facilities and the TCD.

Raising the dam to this level would require extensive and very costly reservoir area relocations such as moving the Pit River Bridge, Interstate-5, and UPRR tracks, and would require modifying Keswick Dam and its powerplant. This plan would provide a major increase in water supply reliability, anadromous fish, hydropower, flood damage reduction, and recreation resources. However, the plan is not financially feasible because the construction cost is estimated at more than $6 billion (at October 2008 price levels). Accordingly, WSR-3 was deleted from further development.

WSR-4 – Increase Water Supply Reliability with Shasta Enlargement (18.5 feet) and Conjunctive Water Management

WSR-4 focused on the primary objective of water supply reliability by raising Shasta Dam 18.5 feet in combination with conjunctive water management. WSR-4 had two major components: (1) Raising Shasta Dam by 18.5 feet for the primary purpose of creating 636,000 acre-feet of additional storage available for water supply and (2) implementing a conjunctive water management program, consisting largely of contracts between Reclamation and certain Sacramento River basin water users. The conjunctive water management component included downstream facilities, such as additional river diversions and transmission and groundwater pumping facilities, to facilitate exchanges. Reclamation would provide additional surface supplies to participating CVP users in wet and normal water years, in exchange for reducing deliveries in dry and critical years, when users would rely more on groundwater supplies.

Preliminary estimates of the conjunctive water management component associated with this alternative indicated that water supplies for CVP and SWP deliveries could be increased by between 10 and 20 percent. However, few to no fishery benefits would result and no strong indication of non-Federal participation in a conjunctive water management component was identified. Accordingly, WSR-4 was deleted from further consideration.

CO-1 and CO-2 – Increase Anadromous Fish Habitat and Water Supply Reliability with Shasta Enlargement (6.5 feet and 18.5 feet)

CO-1 and CO-2 addressed both primary objectives by restoring anadromous fish habitat and raising Shasta Dam. Both CO-1 and CO-2 would dedicate some of the added reservoir space from the dam raise to increasing the minimum carryover storage in Shasta Reservoir to make more cold-water releases for regulating water temperature in the upper Sacramento River. CO-1 and CO-2 had three major components: (1) Raising Shasta Dam by 6.5 feet (CO-1) or 18.5 feet (CO-2), for the purposes of expanding the cold-water pool and creating 260,000 acre-feet (CO-1) or 630,000 acre-feet (CO-2) of additional storage available for water supply; (2) acquiring, restoring, and reclaiming one or more inactive gravel mining operations along the upper Sacramento River to create about 150 acres of aquatic and floodplain habitat, and (3) revising flood control

operations to benefit water supply reliability by managing floods more efficiently.

For reasons similar to those described for AFS-3, both CO-1 and CO-2 were eliminated as stand-alone plans, and the gravel mine restoration components of both plans were deleted from further consideration.

CO-3

Increase Anadromous Fish Flow/Habitat and Water Supply Reliability with Shasta Enlargement (18.5 feet). CO-3 is similar to CO-2, except that a portion of the additional storage would be dedicated to managing flows for winter-run Chinook salmon on the upper Sacramento River. Under this preliminary plan, approximately 320,000 acre-feet would be dedicated to increasing minimum flows from approximately 3,250 cfs to about 4,200 cfs between October 1 and April 30.

Subsequent evaluation indicated that although increasing minimum flows would be beneficial for fish at various stages of development, it would be detrimental at other life stages. Accordingly, CO-3 was deleted from further development.

CO-4 – Multipurpose with Shasta Enlargement (6.5 feet)

This plan addressed both the primary and secondary objectives through a combination of measures, raising Shasta Dam, restoring habitat, and adding recreation facilities in the Shasta Lake area. Enlargement of the reservoir and limited reservoir reoperation would also help improve operations for flood management and recreation. Major components of CO-4 involved increasing water supply reliability with a 6.5-foot dam raise, increasing anadromous fish survival by increasing cold-water pool depth and volume in Shasta Reservoir, and restoring inactive gravel mines and floodplain habitat along the Sacramento River. CO-4 involved further investigation of and potential modifications to the existing TCD at Shasta Dam for enhanced temperature management, and increasing the operational efficiencies of Shasta Dam and Reservoir for water supply reliability and flood control. Finally, the plan involved implementing conjunctive water management, as in WSR-4, constructing shoreline and tributary fish habitat improvements in the Shasta Lake area, and restoring one or more riparian habitat areas between Redding and the current location of the RBPP on the Sacramento River.

CO-4 was eliminated from further consideration primarily because of its low effectiveness and efficiency and redundancies with WSR-1 and CO-5, both of which were recommended for further development.

Comprehensive Plan Phase

The measures and concept plans carried forward were further refined and developed with more specificity to formulate comprehensive plans to address the planning objectives. These plans were then evaluated and compared.

The scenarios presented in Tables 6-1 and 6-2, related to the formulation of the anadromous fish survival focus plan and were eliminated from further consideration during the comprehensive plans phase.

Table 6-1. Eliminated Scenarios Considered to Augment Flows – Anadromous Fish Survival Focus Plan

Scenario	Description	Reason for Elimination
1	Dam raise of 18.5 feet. Additional 634,000 acre-feet of storage. October – March AFRP flows or 500 cfs increase, whichever is less.	Analysis indicated limited benefits to fish compared with overall cost of the project.
2	Dam raise of 18.5 feet. Additional 634,000 acre-feet of storage. October – March AFRP flows or 750 cfs increase, whichever is less.	Analysis indicated limited benefits to fish compared with overall cost of the project.
3	Dam raise of 18.5 feet. Additional 634,000 acre-feet of storage. October – March AFRP flows or 1,000 cfs increase, whichever is less.	Analysis indicated limited benefits to fish compared with overall cost of the project.
4	Dam raise of 18.5 feet. Additional 634,000 acre-feet of storage. Increase August flows to 10,000 cfs and September flows to 6,000 cfs for temperature control.	Analysis indicated limited benefits to fish compared with overall cost of the project.

Source: USFWS 2001
Key:
AFRP = Anadromous Fish Restoration Plan
cfs = cubic feet per second

Table 6-2. Eliminated Scenarios Considered for Cold-Water Storage – Anadromous Fish Survival Focus Plan

Scenario	Description	Reason for Elimination
B	Dam raise of 6.5 feet. Additional 256,000 acre-feet of storage. Dedicating 256,000 acre-feet of water from increased storage to increase the size of the cold-water pool for fishery benefit.	Although this scenario had considerable benefits for anadromous fish survival, it did not considerably contribute to other objectives.
D	Dam raise of 12.5 feet. Additional 443,000 acre-feet of storage. Dedicating 187,000 acre-feet of the additional water from increased storage to increase the size of the cold-water pool for fishery benefit.	Although this scenario had considerable benefits for anadromous fish survival, it was not as cost-effective as an 18.5-foot raise.
E	Dam raise of 12.5 feet. Additional 443,000 acre-feet of storage. Dedicating 443,000 acre-feet of water from increased storage to increase the size of the cold-water pool for fishery benefit.	Although this scenario had considerable benefits for anadromous fish survival, it did not considerably contribute to other objectives.
I	Dam raise of 18.5 feet. Additional 634,000 acre-feet of storage. Dedicating 634,000 acre-feet of water from increased storage to increase the size of the cold-water pool for fishery benefit.	Although this scenario had considerable benefits for anadromous fish survival, it did not considerably contribute to other objectives.

Further information about the SLWRI plan formulation process, including detailed descriptions of deleted and retained measures, initial plans, and scenarios used to formulate CP4/CP4A, are presented in the Plan Formulation Appendix.

Chapter 7
Analysis of Retained Alternatives

As described in Chapter 6, "Alternative Development Process," Reclamation evaluated a wide-range of management measures and alternatives that could meet the project objectives. The chapter provides an overview of the retained action alternatives after the initial and comprehensive plan phases. This chapter also provides the retained alternatives screening process results using a four-step screening process described below.

Overview of the Retained Alternatives

This section provides an overview of the retained alternatives, including the management measures, avoidance and minimization measures, and environmental commitments common to all action alternatives.

Retained Alternatives

The following are the retained alternatives after the initial and comprehensive plan phases.

- No-Action Alternative
- Alternative / Comprehensive Plan 1 (CP1)
- Alternative / Comprehensive Plan 2 (CP2)
- Alternative / Comprehensive Plan 3 (CP3)
- Alternative / Comprehensive Plan 4 (CP4)
- Alternative / Comprehensive Plan 4A (CP4A) – See Chapter 3, "National Economic Development Plan - CP4A," for a detailed description of this alternative
- Alternative / Comprehensive Plan 5 (CP5)

Management Measures Common to All Action Alternatives

Eight of the management measures retained during the alternatives development process are included, to some degree, in all of the action alternatives. These measures were included because they (1) would either be incorporated or required with any dam raise, (2) were logical and convenient additions that would significantly improve any alternative, or (3) should be considered with any new water increment developed in California. The eight measures include

enlarging the Shasta Lake cold-water pool, modifying the TCD, increasing conservation storage, reducing demand, modifying flood operations, modifying hydropower facilities, maintaining or increasing recreation opportunities, and maintaining or improving water quality. These management measures are similar to those described in Chapter 3 "National Economic Development Plan - CP4A," "Major Project Components."

Enlarge Shasta Lake Cold-Water Pool

Cold water released from Shasta Dam significantly influences water temperature conditions in the Sacramento River between Keswick Dam and the RBPP. At a minimum, all comprehensive plans would include enlarging the cold-water pool by raising Shasta Dam to enlarge Shasta Reservoir. Some alternatives would also increase the seasonal carryover storage in Shasta Lake.

Modify Temperature Control Device

For all action alternatives, the TCD would be modified to account for an increased dam height and to reduce leakage of warm water into the structure. Minimum modifications to the TCD include raising the existing structure and modifying the shutter control. This measure would increase the ability of operators at Shasta Dam to meet downstream temperature requirements, and provide more operational flexibility to achieve desirable water temperatures during critical periods for anadromous fish.

Increase Conservation Storage

All action alternatives would include increasing the amount of space available for water conservation storage in Shasta Reservoir by raising Shasta Dam. Conservation storage is the portion of the reservoir capacity available to store water for subsequent release to increase water supply reliability for agricultural, M&I, and environmental purposes. All action alternatives would include a range of dam enlargements and increases in conservation space.

Reduce Demand

All action alternatives would include a water conservation program for new water supplies that would be created by the project to augment current water use efficiency practices. The proposed program would consist of a 10-year initial program to which Reclamation would allocate approximately $1.6 million to $3.8 million to fund water conservation efforts. Funding would be proportional to additional water supplies delivered and would focus on assisting project beneficiaries (agencies receiving increased water supplies because of the project), with developing new or expanded urban water conservation, agricultural water conservation, and water recycling programs. Program actions would be a combination of technical assistance, grants, and loans to support a variety of water conservation projects, such as recycled wastewater projects, irrigation system retrofits, and urban utilities retrofit and replacement programs. Reclamation, in collaboration with project beneficiaries, would identify and develop water conservation projects for funding under the program. Reclamation would then implement an investment strategy, in coordination with

project beneficiaries, to identify and prioritize projects which, in conjunction with other water conservation activities, would cost-effectively reduce water demand and increase water conservation. This process would result in developing, evaluating, and prioritizing projects for funding. The program could be established as an extension of existing Reclamation programs, or as a new program through teaming with cost-sharing partners. Combinations and types of water use efficiency actions funded would be tailored to meet the needs of identified cost-sharing partners, including consideration of cost-effectiveness at a regional scale for agencies receiving funding.

Modify Flood Operations

Potential modification of flood operations would be considered for all action alternatives. Enlargement of Shasta Reservoir would require alterations to existing flood operation guidelines or rule curves, to reflect physical modifications, such as an increase in dam/spillway elevation. The rule curves would be revised with the goal of reducing flood damage and enhancing other objectives to the extent possible.

Modify Hydropower Facilities

Under each action alternative, enlargement of Shasta Dam would likely require various minimum modifications, commensurate with the magnitude of the enlargement, to the existing hydropower facilities at the dam to enable their continued efficient use. These modifications, in conjunction with increased lake surface elevations, may provide incidental benefits to hydropower generation. Although modifications could also be included to further increase the power production capabilities of the reservoir (e.g., additional penstocks and generators), they are believed to be a detail beyond the scope of this investigation and are not considered further at this level of planning.

Maintain and Increase Recreation Opportunities

In addition to the measures described above, all action alternatives would address, to some extent, the secondary objective of maintaining or increasing recreation opportunities at Shasta Lake. Outdoor recreation, and especially recreation at Shasta Lake, represents a major source of enjoyment to millions of people annually and is a major source of income to the northern Sacramento Valley. Shasta Dam and Reservoir are within the Shasta Unit of the Whiskeytown-Shasta-Trinity NRA. Recreation within these lands is managed by USFS. As part of this administration, USFS either directly operates and maintains, or manages through special use permits, numerous public campgrounds, marinas, boat launching facilities, and related water-oriented recreation facilities. Enlarging Shasta Dam and Reservoir would affect some of these facilities. Consistent with the position of USFS, and planning conditions described in this chapter, all of the action alternatives would include features to, at a minimum, maintain the overall recreation capacity of the existing facilities. All action alternatives would also provide for modernization of relocated recreation facilities, including, at a minimum, modifications to comply with current standards of health and safety.

Maintain or Improve Water Quality

All action alternatives could contribute to improved Delta water quality conditions and Delta emergency response. Additional storage in Shasta Reservoir would provide improved operational flexibility. Shasta Dam has the ability to provide increased releases and high-flow releases to improve Delta water quality. Improved Delta water quality conditions could provide benefits for both water supply reliability and ecosystem restoration by potentially increasing Delta outflow during drought years and reducing salinity during critical periods.

Avoidance and Minimization Measures and Environmental Commitments Common to all Action Alternatives

The avoidance and minimization measures and environmental commitments discussed in Chapter 3, "National Economic Development Plan - CP4A," would be the same for any of the action alternatives.

Retained Alternatives Screening Process and Results

The retained alternatives (No-Action Alternative, CP1, CP2, CP3, CP4, CP4A, and CP5) were screened using a four-step screening process (see below), and consistent with criteria of completeness, effectiveness, efficiency, and acceptability as required in the P&G, and other pertinent Federal laws and policies.

- **Step 1** – Alternatives were screened to assess their ability to meet the overall project purpose, feasibility study authorization and specified planning objectives.
- **Step 2** – The practicability of the retained alternatives were assessed with respect to cost, logistics, and technology.
- **Step 3** – Practicable alternatives were evaluated with respect to other significant and unavoidable impacts.
- **Step 4** – Practicable alternatives were evaluated for benefits associated with an increase in waters of the United States if implemented.

Summary of Key Data Used in the Analysis

A summary of key data used in the screening analysis is presented in Table 7-1.

Table 7-1. Key Data Used in the Screening Analysis

Alternative	Meets Overall Purpose and Objectives as Compared to the NED Plan							Waters of the US			Practicability[1]			Benefits	
	Primary		Secondary					Waters of the US Impacted	Wetlands Impacted	Waters of the US increased (net)	Cost: Net NED Benefits ($ millions)[2]	Logistics[3] & Technology[4]	Overall Practicable?	Dry & Critical Year Water Supply (TAF/year)	Annual Fish Survival (Production Increase)[5]
	Increase Anadromous Fish Survival	Increase Water Supply Reliability	Reduce Flood Damage	Hydropower Generation	Ecosystem Resources	Water Quality	Recreation								
No Action	Less	Less	Less	Less	Less	Less	Less	None	None	None	0	Yes	No	0	0
CP1	Less	Less	Less	Less	Less	Less	Less	21 acres	16 acres	+31 acres	- 15.4	Yes	No	47.3	61,300
CP2	Less	Same	Same	Less	Less	Less	Less	28 acres	21 acres	+43 acres	10.5	Yes	Yes	77.8	379,200
CP3	Less	Less	More	Less	Less	Same	Less	51 acres	31 acres	+76 acres	- 11.2	Yes	No	63.1	207,400
CP4	More	Less	Less	More	Same (physical)/More Water Temp	Same	More	51 acres	31 acres	+76 acres	28.9	Yes	Yes	47.3	812,600
CP4A	Meets	Meets	Meets	Meets	Meets	Meets	Meets	51 acres	31 acres	+76 acres	29.9	Yes	Yes	77.8	710,000
CP5	Less	More	More	Less	More (physical)/Less Water Temp	Same	Less	51 acres	31 acres	+76 acres	13.2	Yes	Yes	113.5	377,800

Notes:

[1] Practicable means available and capable of being done after taking into account cost, existing technology, and logistics in light of overall project purpose. As shown by the estimated net annual benefits, the No-Action Alternative, CP1 and CP3 would not be cost effective, and thus would not be practicable

[2] Estimated annual net benefits were derived from estimated average annual costs minus average estimated benefits.

[3] Technical feasibility means that current design and construction methods and mitigation techniques are available to implement a plan.

[4] Logistical feasibility means that a plan is implementable in terms of its completeness, effectiveness, efficiency, and acceptability

[5] Numbers were derived from SALMOD and represent an index of production increase, based on the estimated average annual increase in juvenile Chinook salmon surviving to migrate downstream from Red Bluff Pumping Plant.

Key:

LEDPA = Least Environmentally Damaging Practicable Alternative

NED = National Economic Development

SLWRI = Shasta Lake Water Resources Investigation

TAF = thousand acre feet

US = United States

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No Action Alternative

For the SLWRI, under the No-Action Alternative, the Federal Government would continue to implement reasonably foreseeable actions, including actions with current authorization, secured funding for design and construction, and environmental permitting and compliance activities that are substantially complete. However, the Federal Government would not take additional actions toward implementing a plan to raise Shasta Dam to help increase anadromous fish survival in the upper Sacramento River, nor help address the growing water supply and reliability issues in California.

Potential Impacts to Waters of the United States

Waters of the United States would not be lost as a result of inundation, vegetation removal, or construction activities.

Analysis Step 1: Ability to Meet Overall Project Purpose

Primary Objectives Under the No-Action Alternative, much has been done to address anadromous fish survival problems in the upper Sacramento River. Solutions have ranged from changes in the timing and magnitude of releases from Shasta Dam to constructing and operating the TCD at the dam. Actions also include site-specific projects, such as introducing spawning gravel to the Sacramento River, and work to improve or restore spawning habitat in tributary streams. However, some actions have had an adverse effect on Sacramento River habitat, including implementing requirements of the Trinity River ROD, as amended in 2000. Prolonged drought that depletes the cold-water pool in Shasta Reservoir could put populations of anadromous fish at risk of severe population decline or extinction in the long-term (NMFS 2014). Under the No-Action Alternative, it is assumed that actions to protect fisheries and benefit aquatic environments would continue, including maintaining the TCD, ongoing spawning gravel augmentation programs, and satisfying other existing regulatory requirements.

Demands for water in California exceed available supplies, and the need for additional supplies is expected to grow. Competition for available water supplies would intensify as water demands increase to support population growth. Water conservation and reuse efforts are expected to substantially increase, and forced conservation as the result of increasing water shortages would continue. It is likely that with continued and deepening shortages in available water supplies, adverse economic and socioeconomic impacts would increase over time in the Central Valley and elsewhere in California.

Secondary Objectives Under the No-Action Alternative, the Federal Government would continue to implement reasonably foreseeable actions, but would not take additional actions to help restore ecosystem resources, develop additional hydropower generation, reduce flood damage, increase recreation opportunities at Shasta Lake, or improve water quality in the Sacramento River and the Delta. This would result in the following conditions:

- As opportunities arise, some efforts would likely continue to improve environmental conditions on tributaries to Shasta Lake and along the upper Sacramento River. However, overall, future environmental-related conditions in these areas would likely be similar to existing conditions.

- The threat of flooding would continue, and may increase as population growth continues.

- California's demand for electricity is expected to increase substantially in the future. No actions would be taken to help meet this growing demand.

- As California's population continues to grow, demands would grow substantially for water-oriented recreation at and near the lakes, reservoirs, streams, and rivers of the Central Valley. This increase in demand would be especially pronounced at Shasta Lake.

- To address the impact of water quality deterioration on the Sacramento River basin and Delta ecosystems and endangered and threatened fish populations, several environmental flow goals have been established through legal mandates. Despite these efforts, these resources would continue to decline and ecosystems would continue to be impacted. In addition, Delta water quality may continue to decline.

Given that the No-Action Alternative does not meet the project objectives, it was eliminated from further evaluation.

Analysis Step 2: Practicability with Respect to Cost, Logistics, and Technology

This step was not applicable, because the No-Action Alternative would not meet the primary and secondary objectives.

Analysis Step 3: Other Potentially Significant Adverse Environmental Consequences

Because the No-Action Alternative was not passed from Step 1 to Step 2, this alternative could not be passed to Step 3. However, if the No-Action Alternative had been found to be practicable, its implementation would result in several adverse environmental consequences, including water quality in the Delta, direct and indirect conversion of important farmland to nonagricultural uses, and effects on cold-water habitat in Shasta Lake.

Analysis Step 4: Alternative Benefits Including an Increase in Waters of the United States

Because the No-Action Alternative was not passed from Step 2 to Step 3, this alternative could not be passed to Step 4. However, if the No-Action

Alternative had been found to be practicable, its implementation would not result in benefits, including an increase in waters of the United States.

Summary

The No-Action alternative was eliminated in Step 1 as a viable alternative as it would not meet the primary or secondary project objectives.

CP1

CP1 focuses on both anadromous fish survival and water supply reliability. This alternative primarily consists of enlarging Shasta Dam by raising the crest 6.5 feet and implementing the set of eight common management measures described above. CP1 also includes implementing environmental commitments and mitigation measures. By raising Shasta Dam from a crest at elevation 1,077.5 feet above mean sea level (elevation 1,077.5) to elevation 1,084.0 (based on the NGVD29), in combination with spillway modifications, this alternative would increase the height of the reservoir's full pool by 8.5 feet. This increase in full pool height would add approximately 256,000 acre-feet of additional storage to the overall reservoir capacity. Accordingly, the overall full pool storage would increase from 4.55 MAF to 4.81 MAF.

Potential Impacts to Waters of the United States

Implementation of CP1 would result in the loss of jurisdictional waters caused by flooding the impoundment area and discharge of fill associated with the relocation of facilities and dam construction. Flooding caused by implementation of the project would result in the conversion of jurisdictional water types (e.g., wetlands and streams to lacustrine habitat).

All features within the impoundment area would be converted to lacustrine habitat. Under CP1, approximately 14 acres of wetlands and 19 acres of other waters would be converted to lacustrine habitat (Table 7-2). This would result in a net loss of approximately 14 acres of wetlands. No net loss of other waters would occur under CP1, as lacustrine waters will replace riverine waters; however, lacustrine and riverine waters provide many different functions and values and are separate aquatic resources.

In addition, approximately 2 acres of wetlands and 2 acres of other waters would be impacted as a result of relocation of facilities or dam construction (Table 7-3).

In summary, the 16 acres of wetlands and 21 acres of other waters would be less than the NED Plan which would impact approximately 31 acres of wetlands and 51 acres of other waters.

Table 7-2. Impacts to Jurisdictional Waters (Acres[1]) in the Impoundment Area (CP1)

Jurisdictional Water Type	Main Body	Big Backbone Arm	Sacramento Arm	McCloud Arm	Squaw Creek Arm	Pit Arm	Total
Wetlands							
Fresh emergent/ riparian wetland	0.00	0.00	5.18	0.00	0.00	0.00	5.18
Intermittent swale	0.00	0.00	0.00	0.00	0.00	0.02	0.02
Riparian wetland	0.41	0.49	3.82	1.87	0.35	0.42	7.36
Seasonal wetland	0.00	0.00	0.25	0.00	0.00	0.02	0.27
Seep/spring wetland	0.43	0.14	0.45	0.24	0.05	0.25	1.56
Vegetated ditch	0.00	0.00	0.00	0.003	0.00	0.00	0.003
Total Wetlands	0.84	0.63	9.70	2.11	0.40	0.71	14.39
Other Waters of the United States							
Ephemeral stream	0.13	0.01	0.29	0.13	0.06	0.05	0.67
Intermittent stream	0.67	0.12	1.12	0.41	0.39	1.21	3.92
Perennial stream	0.82	1.00	5.12	5.77	1.10	0.76	14.57
Roadside ditch	0.00	0.00	0.003	0.00	0.00	0.00	0.003
Seep/spring other waters	0.01	0.00	0.001	0.01	0.00	0.00	0.021
Lacustrine	0.00	0.00	0.01	0.00	0.00	0.00	0.01
Total Other Waters	1.63	1.13	6.54	6.32	1.55	2.02	19.19
Total Waters of the U.S.	2.47	1.74	16.24	8.43	1.95	2.73	33.57

Note:
[1] Acreage values are approximate.

Table 7-3. Impacts to Jurisdictional Waters (Acres[1]) in the Relocation Areas (CP1)

Jurisdictional Water Type	Relocation Acres						
	Main Body	Big Backbone Arm	Sacramento Arm	McCloud Arm	Squaw Creek Arm	Pit Arm	Total
Wetlands							
Fresh emergent wetland	0.00	N/A	0.02	0.01	0.00	0.00	0.03
Intermittent swale	0.00	N/A	0.00	0.00	0.00	0.001	0.001
Riparian wetland	0.03	N/A	0.20	0.02	0.003	0.13	0.38
Seasonal wetland	0.01	N/A	1.75	0.00	0.0001	0.00	1.76
Seep/spring wetland	0.004	N/A	0.03	0.00	0.006	0.005	0.05
Vegetated ditch	0.05	N/A	0.00	0.004	0.00	0.00	0.05
Total Wetlands	0.094	N/A	2.00	0.03	0.009	0.136	2.27
Other Waters of the United States							
Ephemeral stream	0.06	N/A	0.08	0.12	0.001	0.02	0.281
Intermittent stream	0.26	N/A	0.78	0.09	0.007	0.08	1.22
Perennial stream	0.00	N/A	0.05	0.03	0.04	0.002	0.12
Roadside ditch	0.007	N/A	0.003	0.00	0.00	0.00	0.01
Non-vegetated ditch	0.01	N/A	0.003	0.00	0.00	0.00	0.01
Seep/spring other waters	0.00	N/A	0.00	0.00	0.004	0.00	0.004
Total Other Waters	0.337	N/A	0.92	0.24	0.05	0.102	1.64
Total Waters of the U.S.	0.43	N/A	2.92	0.27	0.06	0.24	3.92

Note:
[1] Acreage values are approximate.

Key:
N/A = not applicable

Analysis Step 1: Ability to Meet Overall Project Purpose

Primary Objectives Under CP1, the additional storage in Shasta Reservoir would be used to increase water supply reliability and to expand the cold-water pool for downstream anadromous fisheries. Enlarging Shasta Reservoir would increase the depth and volume of the cold-water pool, increasing the ability of Reclamation to release cold water from Shasta Dam and regulate seasonal water temperatures for fish in the upper Sacramento River during dry and critical years. This alternative (and all action alternatives) includes extending the existing TCD for efficient use of the expanded cold-water pool. CP1 would increase water supply reliability for agricultural, M&I, and environmental purposes. CP1 would also help reduce future water shortages through increasing irrigation and M&I deliveries, primarily during dry and critical years.

Secondary Objectives CP1 would also address secondary planning objectives related to hydropower generation, recreation, flood damage reduction, ecosystem restoration, and water quality. Higher water surface elevations in the reservoir would result in an increase in power generation. CP1 includes features to at least maintain the existing recreation capacity at Shasta Lake, and water-

oriented recreation experiences would be enhanced due to an increase in average lake surface area, reduced drawdown during the recreation season, and modernization of recreation facilities. Enlarging Shasta Dam would provide for incidental increased reservoir capacity to capture flood flows, which could reduce flood damage along the upper Sacramento River. Improved fisheries conditions as a result of CP1, and increased flexibility to meet flow and temperature requirements, could also enhance overall ecosystem resources in the Sacramento River. Additional storage in Shasta Reservoir would also provide improved operational flexibility for meeting Delta water quality objectives through increased and/or high-flow releases to improve Delta water quality.

Operations for water supply, hydropower, and environmental and other regulatory requirements would be similar to existing operations, except during dry and critical years when a portion of the increased storage in Shasta Reservoir would be reserved to specifically focus on increasing M&I deliveries. In dry years, 70,000 acre-feet of the 256,000 acre-feet increased storage capacity in Shasta Reservoir would be reserved for increasing M&I deliveries. In critical years, 35,000 acre-feet of the increased storage capacity would be reserved for increasing M&I deliveries.

CP1 would meet both the primary and secondary project objectives and was retained for further analysis.

Analysis Step 2: Practicability with Respect to Cost, Logistics, and Technology

Cost CP1 had a -$15.4 million estimated value of net benefits (at inflation) and, therefore, was not practicable with respect to cost (Table 7-4). This alternative was eliminated from further consideration.

Logistics Many of the logistical aspects of this alternative would be similar to those of the NED Plan (Table 7-5).

Existing Technology No obvious technological constraints would render this alternative impracticable.

Consideration of the results of the three evaluation criteria indicated that this alternative would be eliminated from further consideration due to the negative estimated value of net benefits as compared to the NED Plan.

Table 7-4. Summary of Annual Costs, Annual Benefits, and Net Benefits for CP1 as Compared to CP4A

Item	CP1 ($ millions)	CP4A ($ millions)
Annual Cost		
Total Annual Cost	45.1	57.1
Annual Benefits		
Estimated Value (at inflation)[2]	29.7	88.9
Estimated Value (2% above inflation)[3]	48.4	124.1
Benefit/Cost Ratio		
Estimated Value (at inflation)[2]	0.66	1.51
Estimated Value (2% above inflation)[3]	1.07	1.89
Net Benefits		
Estimated Value (at inflation)[2,4]	-15.4	29.9
Estimated Value (2% above inflation)[3,4]	3.3	54.2

Notes:
[1] January 2014 price levels, 100-year period of analysis, and 3-1/2 percent interest rate.
[2] Assumes the costs of water supplies and hydropower increases at the same rate as inflation.
[3] Includes increase of water supply and hydropower costs at 2 percent above inflation to account for growing scarcity in the future. Sensitivity analyses for change in water supply and hydropower benefits are included in the Economic Valuation and Cost Allocation Appendix.
[4] All numbers are rounded for display purposes; therefore, line items may not sum to totals.
Key:
CP = comprehensive plan

Table 7-5. Estimated Construction Period, Truck Trips, and Construction Labor Force for CP1 as Compared to CP4A

Construction Item	CP1 (6.5-Foot)	CP4A (18.5-Foot)
Construction Period (years)	4.5	5
Construction Labor Force (number/year)	300	350
Daily Truck Trips for Materials (trips/day)	95	175
Daily Truck Trips for Waste (trips/day)	75	53
Total Daily Truck Trips (trips/day)	170	228

Key:
CP = comprehensive plan

Analysis Step 3: Other Potentially Significant Adverse Environmental Consequences

Because the CP1 was not passed from Step 1 to Step 2, this alternative could not be passed to Step 3. However, if CP1 had been found to be practicable, its implementation would result in several significant and unavoidable environmental consequences, less than or similar to (depending on the resource area) the NED Plan.

Analysis Step 4: Alternative Benefits Including an Increase in Waters of the United States

Because the CP1 was not passed from Step 2 to Step 3, this alternative could not be passed to Step 4. However, if CP1 had been found to be practicable, its implementation would result in an increase of Waters of the United States.

Summary

CP1 would result in the lowest benefits of all of the action alternatives. CP1 was eliminated in Step 2 as a viable alternative as it had a -15.4 estimated value of net benefits.

CP2

CP2 focuses on both anadromous fish survival and water supply reliability. This alternative primarily consists of enlarging Shasta Dam by raising the crest 12.5 feet and implementing the set of eight common management measures described above. CP2 also includes implementing environmental commitments and mitigation measures. A dam raise of 12.5 feet was chosen because it represents a midpoint between the likely smallest dam raise considered and the largest practical dam raise that would not require relocating the Pit River Bridge. By raising Shasta Dam from a crest at elevation 1,077.5 to elevation 1,090.0 (NGVD29), in combination with spillway modifications, CP2 would increase the height of the reservoir's full pool by 14.5 feet. This increase in full pool height would add approximately 443,000 acre-feet of storage to the reservoir's capacity. Accordingly, storage in the overall full pool would increase from 4.55 MAF to 5.0 MAF.

Potential Impacts to Waters of the United States

Implementation of the project would result in the loss of jurisdictional waters caused by flooding the impoundment area and discharge of fill associated with the relocation of facilities and dam construction. Flooding caused by implementation of the project would result in the conversion of jurisdictional water types (e.g., wetlands and streams to lacustrine habitat). Therefore, this impact would be significant.

Direct impacts would incur by conversion of jurisdictional waters (e.g., wetlands and streams) to lacustrine habitat with implementation of CP2. All features within the impoundment area would be converted to lacustrine habitat. Under CP2, approximately 19 acres of wetlands and 27 acres of other waters would be converted to lacustrine habitat (Table 7-6). This would result in a net loss of approximately 19 acres of wetlands and loss of approximately 26 acres of riverine waters by conversion to lacustrine waters.

In addition, approximately 2 acres of wetlands and 2 acres of other waters would be impacted as a result of relocation of facilities or dam construction (Table 7.7).

In summary, the 21 acres of wetlands and 29 acres of other waters would be less than the NED Plan which would impact approximately 31 acres of wetlands and 49 acres of other waters.

Table 7-6. Impacts to Jurisdictional Waters (Acres[1]) in the Impoundment Area (CP2)

Jurisdictional Water Type	Area (Acres[1])						
	Main Body	Big Backbone Arm	Sacramento Arm	McCloud Arm	Squaw Creek Arm	Pit Arm	Total
Wetlands							
Fresh emergent/ riparian wetland	0.00	0.00	5.32	0.00	0.00	0.00	5.32
Intermittent swale	0.00	0.00	0.00	0.00	0.00	0.02	0.02
Riparian wetland	0.75	0.68	5.67	2.84	0.67	0.63	11.24
Seasonal wetland	0.00	0.00	0.29	0.00	0.08	0.02	0.39
Seep/spring wetland	0.58	0.17	0.60	0.21	0.10	0.37	2.03
Vegetated ditch	0.08	0.00	0	0.01	0.00	0.00	0.09
Total Wetlands	1.41	0.85	11.88	3.05	0.85	1.04	19.08
Other Waters of the United States							
Ephemeral stream	0.19	0.01	0.40	0.19	0.09	0.07	0.95
Intermittent stream	1.00	0.15	1.60	0.59	0.61	1.70	5.65
Perennial stream	1.15	1.32	7.46	7.56	1.57	0.94	20.00
Roadside ditch	0.00	0.00	0.004	0.00	0.00	0.00	0.04
Seep/spring other waters	0.02	0.00	0.001	0.01	0.00	0.00	0.03
Total Other Waters	2.36	1.48	9.47	8.35	2.27	2.71	26.64
Total Waters of the U.S.	3.77	2.33	21.35	11.40	3.12	3.75	45.72

Note:
[1] Acreage values are approximate.

Table 7-7. Impacts to Jurisdictional Waters (Acres[1]) in the Relocation Areas (CP2)

Jurisdictional Water Type	Relocation Acres						
	Main Body	Big Backbone Arm	Sacramento Arm	McCloud Arm	Squaw Creek Arm	Pit Arm	Total
Wetlands							
Fresh emergent wetland	0.00	N/A	0.02	0.01	0.00	0.00	0.03
Intermittent swale	0.00	N/A	0.00	0.00	0.00	0.001	0.001
Riparian wetland	0.03	N/A	0.20	0.02	0.003	0.13	0.38
Seasonal wetland	0.01	N/A	1.75	0.00	0.0001	0.00	1.76
Seep/spring wetland	0.004	N/A	0.03	0.00	0.006	0.005	0.05
Vegetated ditch	0.05	N/A	0.00	0.004	0.00	0.00	0.05
Total Wetlands	0.094	N/A	2.00	0.03	0.009	0.136	2.27

Table 7-7. Impacts to Jurisdictional Waters (Acres[1]) in the Relocation Areas (CP2) (contd.)

Jurisdictional Water Type	Relocation Acres						
	Main Body	Big Backbone Arm	Sacramento Arm	McCloud Arm	Squaw Creek Arm	Pit Arm	Total
Other Waters of the United States							
Ephemeral stream	0.06	N/A	0.08	0.12	0.001	0.02	0.281
Intermittent stream	0.26	N/A	0.78	0.09	0.007	0.08	1.22
Perennial stream	0.00	N/A	0.05	0.03	0.04	0.002	0.12
Roadside ditch	0.007	N/A	0.003	0.00	0.00	0.00	0.01
Non-vegetated ditch	0.01	N/A	0.003	0.00	0.00	0.00	0.01
Seep/spring other waters	0.00	N/A	0.00	0.00	0.004	0.00	0.004
Total Other Waters	0.337	N/A	0.92	0.24	0.05	0.102	1.64
Total Waters of the U.S.	0.43	N/A	2.92	0.27	0.06	0.24	3.92

Note:
[1] Acreage values are approximate.
Key:
N/A = not applicable

Analysis Step 1: Ability to Meet Overall Project Purpose

Primary Objectives Under CP2, the additional storage in Shasta Reservoir would be used to increase water supply reliability and to expand the cold-water pool for downstream anadromous fisheries. CP2 would increase the ability of Shasta Dam to regulate seasonal water temperatures for fish, primarily during dry and critical years, and would increase water supply reliability for agricultural, M&I, and environmental purposes. CP2 would also help reduce future water shortages through increasing irrigation and M&I deliveries, primarily during dry and critical years.

Secondary Objectives Alternative CP2 would also address secondary planning objectives related to hydropower generation, recreation, flood damage reduction, ecosystem restoration, and water quality. Higher water surface elevations in the reservoir would result in an increase in power generation. CP2 includes features to at least maintain the existing recreation capacity at Shasta Lake, and water-oriented recreation experiences would be enhanced due to an increase in average lake surface area, reduced drawdown during the recreation season, and modernization of recreation facilities. Enlarging Shasta Dam would provide for incidental increased reservoir capacity to capture flood flows, which could reduce flood damage along the upper Sacramento River. Improved fisheries conditions as a result of CP2, and increased flexibility to meet flow and temperature requirements, could also enhance overall ecosystem resources in the Sacramento River. Additional storage in Shasta Reservoir would also provide improved operational flexibility for meeting Delta water quality

objectives through increased and/or high-flow releases to improve Delta water quality.

Operations for water supply, hydropower, and environmental and other regulatory requirements would be similar to existing operations, except during dry and critical years when a portion of the increased storage in Shasta Reservoir would be reserved to specifically focus on increasing M&I deliveries. In dry years, 120,000 acre-feet of the 443,000 acre-feet increased storage capacity in Shasta Reservoir would be reserved for increasing M&I deliveries. In critical years, 60,000 acre-feet of the increased storage capacity would be reserved for increasing M&I deliveries.

Alternative CP2 would meet both the primary and secondary project objectives and was retained for further analysis.

Analysis Step 2: Practicability with Respect to Cost, Logistics, and Technology

Cost Alternative CP2 had a $10.5 million estimated value of net benefits (at inflation) and, therefore, would be practicable with respect to cost (Table 7-8).

Logistics Many of the logistical aspects of this alternative would be similar to those of the NED Plan (Table 7-9).

Existing Technology No obvious technological constraints would render this alternative impracticable.

Table 7-8. Summary of Annual Costs, Annual Benefits, and Net Benefits for CP2 as Compared to CP4A

Item	CP2 ($ millions)	CP4A ($ millions)
Annual Cost		
Total Annual Cost	51.2	59.0
Annual Benefits		
Estimated Value (at inflation)[2]	61.6	88.9
Estimated Value (2% above inflation)[3]	93.3	124.1
Benefit/Cost Ratio		
Estimated Value (at inflation)[2]	1.20	1.51
Estimated Value (2% above inflation)[3]	1.82	2.10
Net Benefits		
Estimated Value (at inflation)[2,4]	10.5	29.9
Estimated Value (2% above inflation)[3,4]	42.1	65.1

Notes:
[1] January 2014 price levels, 100-year period of analysis, and 3-1/2 percent interest rate.
[2] Assumes the costs of water supplies and hydropower increases at the same rate as inflation.
[3] Includes increase of water supply and hydropower costs at 2 percent above inflation to account for growing scarcity in the future. Sensitivity analyses for change in water supply and hydropower benefits are included in the Economic Valuation and Cost Allocation Appendix.
[4] All numbers are rounded for display purposes; therefore, line items may not sum to totals.
Key:
CP = comprehensive plan

Table 7-9. Estimated Construction Period, Truck Trips, and Construction Labor Force for CP2 as Compared to CP4A

Construction Item	CP2 (12.5-Foot)	CP4A (18.5-Foot)
Construction Period (years)	5	5
Construction Labor Force (number/year)	300	350
Daily Truck Trips for Materials (trips/day)	118	175
Daily Truck Trips for Waste (trips/day)	56	53
Total Daily Truck Trips (trips/day)	173	228

Key:
CP = comprehensive plan

Consideration of the results of the three evaluation criteria indicates that this alternative would be retained for further analysis.

Analysis Step 3: Other Potentially Significant Adverse Environmental Consequences

Alternative CP2 would result in several significant and unavoidable environmental consequences, as described below.

Geology, Geomorphology, Minerals and Soils With CP2, there would be loss of diminished availability of known mineral resources that would be of future value to the region. This impact would be the same as the NED Plan. [Impact Geo-3 in the Final EIS]

With CP2, there would be short-term and long-term loss or diminished soil biomass productivity and substantial soil erosion or loss of topsoil due to shoreline processes. This impact would be less than the NED Plan. [Impact Geo-4 & 5 in the Final EIS]

Air Quality and Climate With CP2, short-term NOx emissions greater than 137 lbs per day and possible ROG & PM10 emissions greater than 137 lbs per day would occur. This would be the same as the NED Plan. [Impact AQ-1 in the Final EIS]

Agricultural Resources With CP2, direct and indirect conversion of forest land to non-forest uses in the vicinity of Shasta Lake would occur. This impact would be less than the NED Plan. [Impact Ag-2 in the Final EIS]

Botanical Resources and Wetlands With CP2, all or portions of MSCS, USFS sensitive, BLM sensitive, and CRPR species plant populations could be permanently inundated in the inundation area of Shasta Lake. This impact would be less than the NED Plan. [Impact Bot-2 & 3 in the Final EIS]

With CP2, permanent loss of jurisdictional waters caused by flooding the impoundment area and discharge of fill associated with the relocation of facilities and dam construction could occur. This impact would be less than the NED Plan. [Impact Bot-4 in the Final EIS]

With CP2, permanent loss of general vegetation habitats because of inundation, vegetation removal, or construction activities could occur. This impact would be less than the NED Plan. [Impact Bot-5 in the Final EIS]

Wildlife Resources With CP2, loss of approximately 45 acres of limestone habitat and 4,436 acres of non-limestone habitat to the Shasta salamander could occur. This impact would be less than the NED Plan. [Impact Wild-1 in the Final EIS]

With CP2, long-term, short-term or permanent impacts could occur to special status species, habitats, prey habitats nests, or loss of wintering and fawning range due to inundation, ground-disturbing or construction activities could occur. This impact would be less than the NED Plan. [Impact Wild-2, 3, 5, 7, 8, 9, 10, 11, 12, 13, 14, & 15 in the Final EIS]

Cultural Resources With CP2, permanent inundation of traditional cultural properties could occur. This impact would be the same as the NED Plan. [Impact Culture-2 in the Final EIS]

Land Use and Planning With CP2, short and long-term disruption of existing land uses and conflict with existing land use goals and policies of affected jurisdictions (Shasta Lake and vicinity and Upper Sacramento River) could occur as a result of construction, relocation activities and/or project operations. This impact would be less than the NED Plan. [Impact LU-1 & 2 in the Final EIS]

Aesthetics and Visual Resources With CP2, short and long-term degraded visual character and quality could be inconsistent with guidelines for visual resources in the STNF LRMP (Shasta Lake and vicinity and Upper Sacramento River). This impact would be the same as the NED Plan. [Impact Vis-1 in the Final EIS]

With CP2, short-term degradation and/or obstruction of scenic view from key observation points (Shasta Lake and vicinity and Upper Sacramento River) and increased glare and/or nighttime lighting could occur. This impact would be less than the NED Plan. [Impact Vis-2 & 3 in the Final EIS]

Wild and Scenic River Considerations for McCloud River With CP2, impacts to 21 percent of the McCloud River's Segment 4 would be periodically inundated. This impact would be less than the NED Plan. [Impact WASR-1 in the Final EIS]

With CP2, increased inundation could potentially affect aquatic habitat and would conflict with the natural and free-flowing condition in and of the McCloud River, in conflict with the State Public Resources Code. This impact would be less than the NED Plan. [Impact WASR-3 & 4]

Overall, there would be slightly less significant and unavoidable impacts as a result of implementation of CP2 than the NED Plan. CP2 was retained for further analysis.

Analysis Step 4: Alternative Benefits Including an Increase in Waters of the United States

Increase in Other Waters As stated above, by raising Shasta Dam from a crest at elevation 1,077.5 to elevation 1,090.0 (NGVD29), in combination with spillway modifications, CP2 would increase the height of the reservoir's full pool by 14.5 feet. This increase in full pool height would add approximately 443,000 acre-feet of storage to the reservoir's capacity. Accordingly, storage in the overall full pool would increase from 4.55 MAF to 5.0 MAF. This is expected to have a net increase in waters of the United States by 43 acres, more than half that of the NED Plan.

Other Benefits Alternative CP2 would contribute 77.8 TAF of dry and critical year water supply, which would be the same as the NED Plan. Alternative CP2 is also anticipated to result in an average annual increase in the salmon population of about 379,200 out-migrating juvenile Chinook salmon (represented by an index of production increase, based on the estimated average annual increase in juvenile Chinook salmon surviving to migrate downstream from Red Bluff Pumping Plant.) This would be less than the NED Plan.

Summary

Alternative CP2 would meet the project objectives, would be practicable, and would have slightly reduced overall impacts to waters of the United States and slightly less significant and unavoidable impacts to other resource areas than the NED Plan. However, CP2 would have relatively low benefits when compared to NED Plan, including less of a net increase in other waters of the United States. In addition, CP2 does not include ecosystem restoration features as with the NED Plan. The NED Plan has the following ecosystem restoration features: (1) augmenting spawning gravel in the upper Sacramento River at targeted locations to provide either immediate spawning habitat or long-term recruitment, and (2) restoring riparian, floodplain, and side channel habitat in the upper Sacramento River to provide rearing habitat for juvenile salmonids. While these ecosystem restoration features may have an increase in impacts to Waters of the United States, there would be significant environmental benefits with these ecosystem restoration features.

In summary, greater project benefits could be recognized with a higher dam raise (as with the NED Plan) for a relatively low increase in costs.

CP3

CP3 focuses on both agricultural water supply reliability and anadromous fish survival. This alternative primarily consists of enlarging Shasta Dam and Reservoir by raising the dam crest 18.5 feet and implementing the set of eight

common management measures described above. CP3 also includes implementing environmental commitments and mitigation measures.

By raising Shasta Dam from a crest at elevation 1,077.5 to elevation 1,096.0 (NGVD29), in combination with spillway modifications, CP3 would increase the height of the reservoir's full pool by 20.5 feet. This increase in full pool height would add approximately 634,000 acre-feet of storage to the reservoir's capacity. Accordingly, storage in the overall full pool would be increased from 4.55 MAF to 5.19 MAF. Although higher dam raises are technically and physically feasible, 18.5 feet is the largest dam raise that would not require extensive and costly reservoir area relocations, such as relocating the Pit River Bridge, Interstate 5, and the Union Pacific Railroad tunnels.

Potential Impacts to Waters of the United States

Implementation of the project would result in the loss of jurisdictional waters caused by flooding the impoundment area and discharge of fill associated with the relocation of facilities and dam construction. Flooding caused by implementation of the project would result in the conversion of jurisdictional water types (e.g., wetlands and streams to lacustrine habitat). Therefore, this impact would be significant.

Direct impacts would incur by conversion of jurisdictional waters (e.g., wetlands and streams) to lacustrine habitat with implementation of CP3. All features within the impoundment area would be converted to lacustrine habitat. Under CP3, approximately 29 acres of wetlands and 49 acres of other waters would be converted to lacustrine habitat (Table 7-10). This would result in a net loss of approximately 29 acres of wetlands and loss of approximately 49 acres of riverine waters by conversion to lacustrine waters.

In addition, approximately 2 acres of wetlands and 2 acres of other waters would be impacted as a result of relocation of facilities or dam construction (Table 7-11).

In summary, the 31 acres of wetlands and 51 acres of other waters would be the same as the NED Plan.

Table 7-10. Impacts to Jurisdictional Waters (Acres[1]) in the Impoundment Area (CP3)

Jurisdictional Water Type	Area (Acres[1])						
	Main Body	Big Backbone Arm	Sacramento Arm	McCloud Arm	Squaw Creek Arm	Pit Arm	Total
Wetlands							
Fresh emergent/ riparian wetland	0.00	0.00	5.30	0.00	0.00	0.00	5.30
Intermittent swale	0.00	0.00	0.00	0.00	0.00	0.04	0.04
Riparian wetland	1.09	1.73	7.05	8.33	1.49	0.77	20.46
Seasonal wetland	0.00	0.00	0.42	0.00	0.14	0.02	0.58
Seep/spring wetland	0.77	0.23	0.80	0.41	0.16	0.47	2.84
Vegetated ditch	0.13	0.00	0.00	0.02	0.00	0.00	0.15
Total Wetlands	1.99	1.96	13.57	8.76	1.79	1.30	29.37
Other Waters of the United States							
Ephemeral stream	0.28	0.01	0.62	0.28	0.13	0.12	1.44
Intermittent stream	1.42	0.24	2.42	0.91	0.92	2.58	8.50
Perennial stream	1.55	3.00	9.78	20.27	2.39	1.57	38.56
Roadside ditch	0.00	0.00	0.01	0.00	0.00	0.00	0.01
Seep/spring other waters	0.03	0.00	0.001	0.01	0.00	0.00	0.04
Total Other Waters	3.28	3.25	12.83	21.47	3.44	4.27	48.54
Total	5.27	5.21	26.40	30.23	5.23	5.57	77.91

Note:
[1] Acreage values are approximate

Table 7-11. Impacts to Jurisdictional Waters (Acres[1]) in the Relocation Areas (CP3)

Jurisdictional Water Type	Relocation Acres						
	Main Body	Big Backbone Arm	Sacramento Arm	McCloud Arm	Squaw Creek Arm	Pit Arm	Total
Wetlands							
Fresh emergent wetland	0.00	N/A	0.02	0.01	0.00	0.00	0.03
Intermittent swale	0.00	N/A	0.00	0.00	0.00	0.001	0.001
Riparian wetland	0.03	N/A	0.20	0.02	0.003	0.13	0.38
Seasonal wetland	0.01	N/A	1.75	0.00	0.0001	0.00	1.76
Seep/spring wetland	0.004	N/A	0.03	0.00	0.006	0.005	0.05
Vegetated ditch	0.05	N/A	0.00	0.004	0.00	0.00	0.05
Total Wetlands	0.094	N/A	2.00	0.03	0.009	0.136	2.27
Other Waters of the United States							
Ephemeral stream	0.06	N/A	0.08	0.12	0.001	0.02	0.281
Intermittent stream	0.26	N/A	0.78	0.09	0.007	0.08	1.22
Perennial stream	0.00	N/A	0.05	0.03	0.04	0.002	0.12
Roadside ditch	0.007	N/A	0.003	0.00	0.00	0.00	0.01
Non-vegetated ditch	0.01	N/A	0.003	0.00	0.00	0.00	0.01
Seep/spring other waters	0.00	N/A	0.00	0.00	0.004	0.00	0.004
Total Other Waters	0.337	N/A	0.92	0.24	0.05	0.102	1.64
Total Waters of the U.S.	0.43	N/A	2.92	0.27	0.06	0.24	3.92

Note:
[1] Acreage values are approximate.
Key:
N/A = not applicable

Analysis Step 1: Ability to Meet Overall Project Purpose

Primary Objectives Because CP3 focuses on increasing agricultural water supply reliability and anadromous fish survival, none of the increased storage capacity in Shasta Reservoir would be reserved for increasing M&I deliveries. Operations for water supply, hydropower, and environmental and other regulatory requirements would be similar to existing operations. The additional storage would be retained for water supply reliability and to expand the cold-water pool for downstream anadromous fisheries. CP3 would increase the ability of Shasta Dam to regulate seasonal water temperatures for fish, primarily during dry and critical years, and would increase water supply reliability for agricultural and environmental purposes. CP3 would also help reduce future water shortages through increasing irrigation deliveries.

Secondary Objectives CP3 would also address secondary planning objectives related to hydropower generation, recreation, flood damage reduction, ecosystem restoration, and water quality. Higher water surface elevations in the reservoir would result in an increase in power generation. CP3 includes features to at least maintain the existing recreation capacity at Shasta Lake, and water-oriented recreation experiences would be enhanced due to an increase in average lake surface area, reduced drawdown during the recreation season, and

modernization of recreation facilities. Enlarging Shasta Dam would provide for incidental increased reservoir capacity to capture flood flows, which could reduce flood damage along the upper Sacramento River. Improved fisheries conditions as a result of CP3, and increased flexibility to meet flow and temperature requirements, could also enhance overall ecosystem resources in the Sacramento River. Additional storage in Shasta Reservoir would also provide improved operational flexibility for meeting Delta water quality objectives through increased and/or high-flow releases to improve Delta water quality.

Analysis Step 2: Practicability with Respect to Cost, Logistics, and Technology

Cost CP3 had a -$11.2 million estimated value of net benefits (at inflation) and, therefore, would not be practicable with respect to cost (Table 7-12). This alternative was eliminated from further consideration.

Logistics Many of the logistical aspects of this alternative would be similar to those of the NED Plan (Table 7-13).

Existing Technology No obvious technological constraints would render this alternative impracticable.

Consideration of the results of the three evaluation criteria indicated that this alternative would be eliminated from further consideration due to the negative estimated value of net benefits.

Table 7-12. Summary of Annual Costs, Annual Benefits, and Net Benefits for CP3 as Compared to CP4A[1]

Item	CP3 ($ millions)	CP4A ($ millions)
Annual Cost		
Total Annual Cost	53.8	59.0
Annual Benefits		
Estimated Value (at inflation)[2]	42.6	88.9
Estimated Value (2% above inflation)[3]	60.7	124.1
Benefit/Cost Ratio		
Estimated Value (at inflation)[2]	0.79	1.51
Estimated Value (2% above inflation)[3]	1.13	2.10
Net Benefits		
Estimated Value (at inflation)[2,4]	-11.2	29.9
Estimated Value (2% above inflation)[3,4]	6.9	65.1

Notes:
[1] January 2014 price levels, 100-year period of analysis, and 3-1/2 percent interest rate.
[2] Assumes the costs of water supplies and hydropower increases at the same rate as inflation.
[3] Includes increase of water supply and hydropower costs at 2 percent above inflation to account for growing scarcity in the future. Sensitivity analyses for change in water supply and hydropower benefits are included in the Economic Valuation and Cost Allocation Appendix.
[4] All numbers are rounded for display purposes; therefore, line items may not sum to totals.
Key:
CP = comprehensive plan

Table 7-13. Estimated Construction Period, Truck Trips, and Construction Labor Force for CP3 as compared to CP4A

Construction Item	CP3 (18.5-Foot)	CP4A (18.5-Foot)
Construction Period (years)	5	5
Construction Labor Force (number/year)	350	350
Daily Truck Trips for Materials (trips/day)	168	175
Daily Truck Trips for Waste (trips/day)	52	53
Total Daily Truck Trips (trips/day)	220	228

Key:
CP = comprehensive plan

Analysis Step 3: Other Potentially Significant Adverse Environmental Consequences

Because the CP3 was not passed from Step 1 to Step 2, this alternative could not be passed to Step 3. However, if the CP3 alternative had been found to be practicable, its implementation would result in several adverse environmental consequences.

Analysis Step 4: Alternative Benefits Including an Increase in Waters of the United States

Because the CP3 was not passed from Step 2 to Step 3, this alternative could not be passed to Step 4. However, if the CP3 Alternative had been found to be

practicable, its implementation would result in an increase of waters of the United States.

Summary

CP3, formulated to address both agricultural water supply reliability and anadromous fish survival, would greatly increase agricultural water supply reliability. CP3 would meet the project objectives; however, CP3 was eliminated in Step 2 as a viable alternative as it had a -11.2 estimated value of net benefits. In addition, CP3 would have no M&I water supply benefits and very low anadromous fish survival benefits when compared to the other 18.5-foot raises. Therefore, CP3 was eliminated as a viable alternative.

CP4

CP4 focuses on increasing anadromous fish survival, while also increasing water supply reliability. CP4 and CP4A are identical except for Shasta Dam and reservoir operations. CP4 and CP4A have similar reservoir operations in that they each dedicate a portion of the new storage in Shasta Lake for fisheries purposes; however, the portion of this dedicated storage varies.

CP4 primarily consists of enlarging Shasta Dam and Reservoir by raising the dam crest 18.5 feet and implementing the set of eight common management measures described above. CP4 also includes implementing environmental commitments and mitigations measures. In addition, CP4 would dedicate a portion of the increased storage in Shasta Reservoir for maintaining cold-water volumes to benefit anadromous fish in the upper Sacramento River. CP4 also includes two additional ecosystem restoration features: (1) augmenting spawning gravel in the upper Sacramento River at targeted locations to provide either immediate spawning habitat or long-term recruitment, and (2) restoring riparian, floodplain, and side channel habitat in the upper Sacramento River to provide rearing habitat for juvenile salmonids.

Potential Impacts to Waters of the United States

Implementation of the project would result in the loss of jurisdictional waters caused by flooding the impoundment area and discharge of fill associated with the relocation of facilities and dam construction. Flooding caused by implementation of the project would result in the conversion of jurisdictional water types (e.g., wetlands and streams to lacustrine habitat). Therefore, this impact would be significant.

Direct impacts would incur by conversion of jurisdictional waters (e.g., wetlands and streams) to lacustrine habitat with implementation of CP4. All features within the impoundment area would be converted to lacustrine habitat. Under CP4, approximately 29 acres of wetlands and 49 acres of other waters would be converted to lacustrine habitat (Table 7-14). This would result in a net loss of approximately 29 acres of wetlands and loss of approximately 49 acres of riverine waters by conversion to lacustrine waters.

In addition, approximately 2 acres of wetlands and 2 acres of other waters would be impacted as a result of relocation of facilities or dam construction (Table 7-15).

In summary, the 31 acres of wetlands and 51 acres of other waters would be the same as the NED Plan.

Table 7-14. Impacts to Jurisdictional Waters (Acres[1]) in the Impoundment Area (CP4)

Jurisdictional Water Type	Area (Acres[1])						
	Main Body	Big Backbone Arm	Sacramento Arm	McCloud Arm	Squaw Creek Arm	Pit Arm	Total
Wetlands							
Fresh emergent/ riparian wetland	0.00	0.00	5.30	0.00	0.00	0.00	5.30
Intermittent swale	0.00	0.00	0.00	0.00	0.00	0.04	0.04
Riparian wetland	1.09	1.73	7.05	8.33	1.49	0.77	20.46
Seasonal wetland	0.00	0.00	0.42	0.00	0.14	0.02	0.58
Seep/spring wetland	0.77	0.23	0.80	0.41	0.16	0.47	2.84
Vegetated ditch	0.13	0.00	0.00	0.02	0.00	0.00	0.15
Total Wetlands	1.99	1.96	13.57	8.76	1.79	1.30	29.37
Other Waters of the United States							
Ephemeral stream	0.28	0.01	0.62	0.28	0.13	0.12	1.44
Intermittent stream	1.42	0.24	2.42	0.91	0.92	2.58	8.50
Perennial stream	1.55	3.00	9.78	20.27	2.39	1.57	38.56
Roadside ditch	0.00	0.00	0.01	0.00	0.00	0.00	0.01
Seep/spring other waters	0.03	0.00	0.001	0.01	0.00	0.00	0.04
Total Other Waters	3.28	3.25	12.83	21.47	3.44	4.27	48.54
Total	5.27	5.21	26.40	30.23	5.23	5.57	77.91

Note:
[1] Acreage values are approximate

Table 7-15. Impacts to Jurisdictional Waters (Acres[1]) in the Relocation Areas (CP4)

Jurisdictional Water Type	Relocation Acres						
	Main Body	Big Backbone Arm	Sacramento Arm	McCloud Arm	Squaw Creek Arm	Pit Arm	Total
Wetlands							
Fresh emergent wetland	0.00	N/A	0.02	0.01	0.00	0.00	0.03
Intermittent swale	0.00	N/A	0.00	0.00	0.00	0.001	0.001
Riparian wetland	0.03	N/A	0.20	0.02	0.003	0.13	0.38
Seasonal wetland	0.01	N/A	1.75	0.00	0.0001	0.00	1.76
Seep/spring wetland	0.004	N/A	0.03	0.00	0.006	0.005	0.05
Vegetated ditch	0.05	N/A	0.00	0.004	0.00	0.00	0.05
Total Wetlands	0.094	N/A	2.00	0.03	0.009	0.136	2.27
Other Waters of the United States							
Ephemeral stream	0.06	N/A	0.08	0.12	0.001	0.02	0.281
Intermittent stream	0.26	N/A	0.78	0.09	0.007	0.08	1.22
Perennial stream	0.00	N/A	0.05	0.03	0.04	0.002	0.12
Roadside ditch	0.007	N/A	0.003	0.00	0.00	0.00	0.01
Non-vegetated ditch	0.01	N/A	0.003	0.00	0.00	0.00	0.01
Seep/spring other waters	0.00	N/A	0.00	0.00	0.004	0.00	0.004
Total Other Waters	0.337	N/A	0.92	0.24	0.05	0.102	1.64
Total Waters of the U.S.	0.43	N/A	2.92	0.27	0.06	0.24	3.92

Note:
[1] Acreage values are approximate.
Key:
N/A = not applicable

Analysis Step 1: Ability to Meet Overall Project Purpose

Primary Objectives The additional storage created by the 18.5-foot dam raise would be used to improve the ability to meet water temperature objectives and habitat requirements for anadromous fish during drought years and increase water supply reliability. By raising Shasta Dam from a crest at elevation 1,077.5 to elevation 1,096.0 (NGVD29), in combination with spillway modifications, CP4 would increase the overall full pool storage from 4.55 MAF to 5.19 MAF. Of the increased reservoir storage space, about 378,000 acre-feet would be dedicated to increasing the supply of cold water for anadromous fish survival purposes in CP4. Operations of the cold-water pool would be subject to an adaptive management plan that may include operational changes to the timing and magnitude of release from Shasta Dam to benefit anadromous fish. For CP4, operations for the remaining portion of increased storage (approximately 256,000 acre-feet) would be the same as for CP1, with 70,000 acre-feet reserved in dry years and 35,000 acre-feet reserved in critical years to specifically focus on increasing M&I deliveries.

Secondary Objectives CP4 would also address secondary planning objectives related to hydropower generation, recreation, flood damage reduction, ecosystem restoration, and water quality. Higher water surface elevations in the

reservoir would result in an increase in power generation. CP4 includes features to at least maintain the existing recreation capacity at Shasta Lake, and water-oriented recreation experiences would be enhanced due to an increase in average lake surface area, reduced drawdown during the recreation season, and modernization of recreation facilities. Enlarging Shasta Dam would provide for incidental increased reservoir capacity to capture flood flows, which could reduce flood damage along the upper Sacramento River. Improved fisheries conditions as a result of CP4, and increased flexibility to meet flow and temperature requirements, could also enhance overall ecosystem resources in the Sacramento River. Additional storage in Shasta Reservoir would also provide improved operational flexibility for meeting Delta water quality objectives through increased and/or high-flow releases to improve Delta water quality.

Analysis Step 2: Practicability with Respect to Cost, Logistics, and Technology

Cost CP4 had a $28.9 million estimated value of net benefits (at inflation) and, therefore, would be practicable with respect to cost (Table 7-16).

Logistics Many of the logistical aspects of this alternative would be similar to those of the NED Plan (Table 7-17).

Existing Technology No obvious technological constraints would render this alternative impracticable.

Table 7-16. Summary of Annual Costs, Annual Benefits, and Net Benefits for CP4 as Compared to CP4A[1]

Item	CP4 ($ millions)	CP4A ($ millions)
Annual Cost		
Total Annual Cost	57.1	59.0
Annual Benefits		
Estimated Value (at inflation)[2]	86.0	88.9
Estimated Value (2% above inflation)[3]	111.6	124.1
Benefit/Cost Ratio		
Estimated Value (at inflation)[2]	1.51	1.51
Estimated Value (2% above inflation)[3]	1.95	2.10
Net Benefits		
Estimated Value (at inflation)[2,4]	28.9	29.9
Estimated Value (2% above inflation)[3,4]	54.5	65.1

Notes:
[1] January 2014 price levels, 100-year period of analysis, and 3-1/2 percent interest rate.
[2] Assumes the costs of water supplies and hydropower increases at the same rate as inflation.
[3] Includes increase of water supply and hydropower costs at 2 percent above inflation to account for growing scarcity in the future. Sensitivity analyses for change in water supply and hydropower benefits are included in the Economic Valuation and Cost Allocation Appendix.
[4] All numbers are rounded for display purposes; therefore, line items may not sum to totals.
Key: CP = comprehensive plan

Table 7-17. Estimated Construction Period, Truck Trips, and Construction Labor Force for CP4 as Compared to CP4A

Construction Item	CP4 (18.5-Foot)	CP4A (18.5-Foot)
Construction Period (years)	5	5
Construction Labor Force (number/year)	350	350
Daily Truck Trips for Materials (trips/day)	175	175
Daily Truck Trips for Waste (trips/day)	53	53
Total Daily Truck Trips (trips/day)	228	228

Key:
CP = comprehensive plan

Consideration of the results of the three evaluation criteria indicated that this alternative would be retained for further analysis.

Analysis Step 3: Other Potentially Significant Adverse Environmental Consequences

CP4 would result in several significant and unavoidable environmental consequences, as described below.

Geology, Geomorphology, Minerals and Soils With CP4, there would be loss of diminished availability of known mineral resources that would be of future value to the region. This impact would be the same as the NED Plan. [Impact Geo-3 in the Final EIS]

With CP2, there would be be short-term and long-term loss or diminished soil biomass productivity and substantial soil erosion or loss of topsoil due to shoreline processes. This impact would be the same as the NED Plan. [Impact Geo-4 & 5 in the Final EIS]

Air Quality and Climate With CP4, short-term NOx emissions greater than 137 lbs per day and possible ROG & PM10 emissions greater than 137 lbs per day would occur. This would be the same as the NED Plan. [Impact AQ-1 in the Final EIS]

Agricultural Resources With CP4, direct and indirect conversion of forest land to non-forest uses in the vicinity of Shasta Lake would occur. This impact would be the same as the NED Plan. [Impact Ag-2 in the Final EIS]

Botanical Resources and Wetlands With CP4, all or portions of MSCS, USFS sensitive, BLM sensitive, and CRPR species plant populations could be permanently inundated in the inundation area of Shasta Lake. This impact would be the same as the NED Plan. [Impact Bot-2 & 3 in the Final EIS]

With CP4, permanent loss of jurisdictional waters caused by flooding the impoundment area and discharge of fill associated with the relocation of facilities and dam construction could occur. This impact would be the same as the NED Plan. [Impact Bot-4 in the Final EIS]

With CP4, permanent loss of general vegetation habitats because of inundation, vegetation removal, or construction activities could occur. This impact would be the same as the NED Plan. [Impact Bot-5 in the Final EIS]

Wildlife Resources With CP4, loss of approximately 45 acres of limestone habitat and 4,436 acres of non-limestone habitat to the Shasta salamander could occur. This impact would be the same as the NED Plan. [Impact Wild-1 in the Final EIS]

With CP4, long-term, short-term or permanent impacts could occur to special status species, habitats, prey habitats nests, or loss of wintering and fawning range due to inundation, ground-disturbing or construction activities could occur. This impact would be the same as the NED Plan. [Impact Wild-2, 3, 5, 7, 8, 9, 10, 11, 12, 13, 14, & 15 in the Final EIS]

Cultural Resources With CP4, permanent inundation of traditional cultural properties could occur. This impact would be the same as the NED Plan. [Impact Culture-2 in the Final EIS]

Land Use and Planning With CP4, short and long-term disruption of existing land uses and conflict with existing land use goals and policies of affected jurisdictions (Shasta Lake and vicinity and Upper Sacramento River) could occur as a result of construction, relocation activities and/or project operations. This impact would be the same as the NED Plan. [Impact LU-1 & 2 in the Final EIS]

Aesthetics and Visual Resources With CP4, short and long-term degraded visual character and quality could be inconsistent with guidelines for visual resources in the STNF LRMP (Shasta Lake and vicinity and Upper Sacramento River). This impact would be the same as the NED Plan. [Impact Vis-1 in the Final EIS]

With CP4, short-term degradation and/or obstruction of scenic view from key observation points (Shasta Lake and vicinity and Upper Sacramento River) and increased glare and/or nighttime lighting could occur. This impact would be the same as the NED Plan. [Impact Vis-2 & 3 in the Final EIS]

Wild and Scenic River Considerations for McCloud River With CP4, impacts to 21 percent of the McCloud River's Segment 4 would be periodically inundated. This impact would be the same as the NED Plan. [Impact WASR-1 in the Final EIS]

With CP4, increased inundation could potentially affect aquatic habitat and would conflict with the natural and free-flowing condition in and of the McCloud River, in conflict with the State Public Resources Code. This impact would be the same as the NED Plan. [Impact WASR-3 & 4]

Overall, there would be the same amount of significant and unavoidable impacts as a result of implementation of CP4 as the NED Plan. CP4 would be retained for further analysis.

Analysis Step 4: Alternative Benefits Including an Increase in Waters of the United States

Increase in Other Waters As stated above, by raising Shasta Dam from a crest at elevation 1,077.5 to elevation 1,096.0 (NGVD29), in combination with spillway modifications, CP4 would increase the overall full pool storage from 4.55 MAF to 5.19 MAF. This is expected to have a net increase in waters of the United States by 76 acres, the same as the NED Plan.

Other Benefits Alternative CP4 would contribute 47.3 TAF of dry and critical year water supply, which is less than the NED Plan. Alternative CP4 is also anticipated to result in an average annual increase in Chinook salmon population of nearly 812,600 out-migrating juvenile fish (represented by an index of production increase, based on the estimated average annual increase in juvenile Chinook salmon surviving to migrate downstream from Red Bluff Pumping Plant.) This would be slightly more than the NED Plan.

Summary

Alternative CP4 would meet the project objectives and would practicable. The potential impacts to waters of the United States, and other environmental consequences would be nearly identical to the NED Plan; therefore, it would not be considered less damaging. However, CP4 would not meet the objectives as well as the NED Plan, as water supply reliability would be compromised for increased anadromous fish survival. Therefore, CP4 was eliminated for consideration as the LEDPA.

CP5

CP5 focuses on anadromous fish survival, increased water supply reliability, ecosystem enhancements in the Shasta Lake area and the upper Sacramento River upstream from the RBPP, and increased recreation opportunities around Shasta Lake. This alternative primarily consists of raising Shasta Dam 18.5 feet; implementing the set of eight common management measures described above; constructing additional resident fish habitat in Shasta Lake and along the lower reaches of its tributaries (the Sacramento River, the McCloud River, and Squaw Creek); constructing shoreline fish habitat around Shasta Lake; augmenting spawning gravel in the upper Sacramento River; restoring riparian, floodplain, and side channel habitat in the upper Sacramento River; and increasing recreation opportunities at Shasta Lake. CP5 also includes implementing environmental commitments and mitigations measures.

By raising Shasta Dam from a crest at elevation 1,077.5 to elevation 1,096.0 (NGVD29), in combination with spillway modifications, CP5 would increase the height of the reservoir's full pool by 20.5 feet, increasing the overall full pool storage from 4.55 MAF to 5.19 MAF.

Potential Impacts to Waters of the United States

Implementation of the project would result in the loss of jurisdictional waters caused by flooding the impoundment area and discharge of fill associated with the relocation of facilities and dam construction. Flooding caused by implementation of the project would result in the conversion of jurisdictional water types (e.g., wetlands and streams to lacustrine habitat). Therefore, this impact would be significant.

Direct impacts would incur by conversion of jurisdictional waters (e.g., wetlands and streams) to lacustrine habitat with implementation of CP5. All features within the impoundment area would be converted to lacustrine habitat. Under CP5, approximately 29 acres of wetlands and 49 acres of other waters would be converted to lacustrine habitat (Table 7-18). This would result in a net loss of approximately 29 acres of wetlands and loss of approximately 49 acres of riverine waters by conversion to lacustrine waters.

In addition, approximately 2 acres of wetlands and 2 acres of other waters would be impacted as a result of relocation of facilities or dam construction (Table 7-19).

In summary, the 31 acres of wetlands and 51 acres of other waters would be the same as the NED Plan.

Table 7-18. Impacts to Jurisdictional Waters (Acres[1]) in the Impoundment Area (CP5)

Jurisdictional Water Type	Area (Acres[1])						
	Main Body	Big Backbone Arm	Sacramento Arm	McCloud Arm	Squaw Creek Arm	Pit Arm	Total
Wetlands							
Fresh emergent/ riparian wetland	0.00	0.00	5.30	0.00	0.00	0.00	5.30
Intermittent swale	0.00	0.00	0.00	0.00	0.00	0.04	0.04
Riparian wetland	1.09	1.73	7.05	8.33	1.49	0.77	20.46
Seasonal wetland	0.00	0.00	0.42	0.00	0.14	0.02	0.58
Seep/spring wetland	0.77	0.23	0.80	0.41	0.16	0.47	2.84
Vegetated ditch	0.13	0.00	0.00	0.02	0.00	0.00	0.15
Total Wetlands	1.99	1.96	13.57	8.76	1.79	1.30	29.37

Table 7-18. Impacts to Jurisdictional Waters (Acres[1]) in the Impoundment Area (CP5) (contd.)

Jurisdictional Water Type	Area (Acres[1])						
	Main Body	Big Backbone Arm	Sacramento Arm	McCloud Arm	Squaw Creek Arm	Pit Arm	Total
Other Waters of the United States							
Ephemeral stream	0.28	0.01	0.62	0.28	0.13	0.12	1.44
Intermittent stream	1.42	0.24	2.42	0.91	0.92	2.58	8.50
Perennial stream	1.55	3.00	9.78	20.27	2.39	1.57	38.56
Roadside ditch	0.00	0.00	0.01	0.00	0.00	0.00	0.01
Seep/spring other waters	0.03	0.00	0.001	0.01	0.00	0.00	0.04
Total Other Waters	3.28	3.25	12.83	21.47	3.44	4.27	48.54
Total	5.27	5.21	26.40	30.23	5.23	5.57	77.91

Note: [1] Acreage values are approximate

Table 7-19. Impacts to Jurisdictional Waters (Acres[1]) in the Relocation Areas (CP5)

Jurisdictional Water Type	Relocation Acres						
	Main Body	Big Backbone Arm	Sacramento Arm	McCloud Arm	Squaw Creek Arm	Pit Arm	Total
Wetlands							
Fresh emergent wetland	0.00	N/A	0.02	0.01	0.00	0.00	0.03
Intermittent swale	0.00	N/A	0.00	0.00	0.00	0.001	0.001
Riparian wetland	0.03	N/A	0.20	0.02	0.003	0.13	0.38
Seasonal wetland	0.01	N/A	1.75	0.00	0.0001	0.00	1.76
Seep/spring wetland	0.004	N/A	0.03	0.00	0.006	0.005	0.05
Vegetated ditch	0.05	N/A	0.00	0.004	0.00	0.00	0.05
Total Wetlands	0.094	N/A	2.00	0.03	0.009	0.136	2.27
Other Waters of the United States							
Ephemeral stream	0.06	N/A	0.08	0.12	0.001	0.02	0.281
Intermittent stream	0.26	N/A	0.78	0.09	0.007	0.08	1.22
Perennial stream	0.00	N/A	0.05	0.03	0.04	0.002	0.12
Roadside ditch	0.007	N/A	0.003	0.00	0.00	0.00	0.01
Non-vegetated ditch	0.01	N/A	0.003	0.00	0.00	0.00	0.01
Seep/spring other waters	0.00	N/A	0.00	0.00	0.004	0.00	0.004
Total Other Waters	0.337	N/A	0.92	0.24	0.05	0.102	1.64
Total Waters of the U.S.	0.43	N/A	2.92	0.27	0.06	0.24	3.92

Note:
[1] Acreage values are approximate.

Key:
N/A = not applicable

Analysis Step 1: Ability to Meet Overall Project Purpose

Primary Objectives Under CP5, the additional storage in Shasta Reservoir would be used to increase water supply reliability and to expand the cold-water pool for downstream anadromous fisheries. Enlarging Shasta Reservoir would increase the depth and volume of the cold-water pool, increasing the ability of Reclamation to release cold water from Shasta Dam and regulate seasonal water temperatures for fish in the upper Sacramento River during dry and critical years. This alternative includes extending the existing TCD for efficient use of the expanded cold-water pool. CP5 would increase water supply reliability for agricultural, M&I, and environmental purposes. CP5 would also help reduce future water shortages through increasing irrigation and M&I deliveries, primarily during drought periods.

Secondary Objectives CP5 would also address secondary planning objectives related to hydropower generation, recreation, flood damage reduction, ecosystem restoration, and water quality. Higher water surface elevations in the reservoir would result in an increase in power generation. CP5 includes features to at least maintain the existing recreation capacity at Shasta Lake, and water-oriented recreation experiences would be enhanced due to an increase in average lake surface area, reduced drawdown during the recreation season, and modernization of recreation facilities. Enlarging Shasta Dam would provide for incidental increased reservoir capacity to capture flood flows, which could reduce flood damage along the upper Sacramento River. Improved fisheries conditions as a result of CP5, and increased flexibility to meet flow and temperature requirements, could also enhance overall ecosystem resources in the Sacramento River. Additional storage in Shasta Reservoir would also provide improved operational flexibility for meeting Delta water quality objectives through increased and/or high-flow releases to improve Delta water quality.

Operations for water supply, hydropower, and environmental and other regulatory requirements would be similar to existing operations, except during dry and critical years when a portion of the increased storage in Shasta Reservoir would be reserved to specifically focus on increasing M&I deliveries. In dry years, 150,000 acre-feet of the 634,000 acre-feet increased storage capacity in Shasta Reservoir would be reserved for increasing M&I deliveries. In critical years, 75,000 acre-feet of the increased storage capacity would be reserved for increasing M&I deliveries.

Analysis Step 2: Practicability with Respect to Cost, Logistics, and Technology

Cost CP5 had a $13.2 million estimated value of net benefits (at inflation) and, therefore, would be practicable with respect to cost (Table 7-20).

Logistics Many of the logistical aspects of this alternative would be similar to those of the NED Plan (Table 7-21).

Existing Technology No obvious technological constraints would render this alternative impracticable.

Table 7-20. Summary of Annual Costs, Annual Benefits, and Net Benefits for CP5[1] as Compared to CP4A

Item	CP5 ($ millions)	CP4A ($ millions)
Annual Cost		
Total Annual Cost	61.0	59.0
Annual Benefits		
Estimated Value (at inflation)[2]	74.2	88.9
Estimated Value (2% above inflation)[3]	115.2	124.1
Benefit/Cost Ratio		
Estimated Value (at inflation)[2]	1.22	1.51
Estimated Value (2% above inflation)[3]	1.89	2.10
Net Benefits		
Estimated Value (at inflation)[2,4]	13.2	29.9
Estimated Value (2% above inflation)[3,4]	54.2	65.1

Notes:
[1] January 2014 price levels, 100-year period of analysis, and 3-1/2 percent interest rate.
[2] Assumes the costs of water supplies and hydropower increases at the same rate as inflation.
[3] Includes increase of water supply and hydropower costs at 2 percent above inflation to account for growing scarcity in the future. Sensitivity analyses for change in water supply and hydropower benefits are included in the Economic Valuation and Cost Allocation Appendix.
[4] All numbers are rounded for display purposes; therefore, line items may not sum to totals.
Key:
CP = comprehensive plan

Table 7-21. Estimated Construction Period, Truck Trips, and Construction Labor Force for CP5 as Compared to CP4A

Construction Item	CP6 (18.5-Foot)	CP4A (18.5-Foot)
Construction Period (years)	5	5
Construction Labor Force (number/year)	360	350
Daily Truck Trips for Materials (trips/day)	177	175
Daily Truck Trips for Waste (trips/day)	54	53
Total Daily Truck Trips (trips/day)	230	228

Key:
CP = comprehensive plan
SLWRI = Shasta Lake Water Resources Investigation

Consideration of the results of the three evaluation criteria indicated that this alternative would be retained for further analysis.

Analysis Step 3: Other Potentially Significant Adverse Environmental Consequences

Alternative CP5 would result in several significant and unavoidable environmental consequences, as described below.

Geology, Geomorphology, Minerals and Soils With CP5, there would be loss of diminished availability of known mineral resources that would be of future value to the region. This impact would be the same as the NED Plan. [Impact Geo-3 in the Final EIS]

With CP5, there would be short-term and long-term loss or diminished soil biomass productivity and substantial soil erosion or loss of topsoil due to shoreline processes. This impact would be the same as the NED Plan. [Impact Geo-4 & 5 in the Final EIS]

Air Quality and Climate With CP5, short-term NOx emissions greater than 137 lbs per day and possible ROG & PM10 emissions greater than 137 lbs per day would occur. This would be the same as the NED Plan. [Impact AQ-1 in the Final EIS]

Agricultural Resources With CP5, direct and indirect conversion of forest land to non-forest uses in the vicinity of Shasta Lake would occur. This impact would be the same as the NED Plan. [Impact Ag-2 in the Final EIS]

Botanical Resources and Wetlands With CP5, all or portions of MSCS, USFS sensitive, BLM sensitive, and CRPR species plant populations could be permanently inundated in the inundation area of Shasta Lake. This impact would be the same as the NED Plan. [Impact Bot-2 & 3 in the Final EIS]

With CP5, permanent loss of jurisdictional waters caused by flooding the impoundment area and discharge of fill associated with the relocation of facilities and dam construction could occur. This impact would be the same as the NED Plan. [Impact Bot-4 in the Final EIS]

With CP5, permanent loss of general vegetation habitats because of inundation, vegetation removal, or construction activities could occur. This impact would be the same as the NED Plan. [Impact Bot-5 in the Final EIS]

Wildlife Resources With CP5, loss of approximately 45 acres of limestone habitat and 4,436 acres of non-limestone habitat to the Shasta salamander could occur. This impact would be the same as the NED Plan. [Impact Wild-1 in the Final EIS]

With CP5, long-term, short-term or permanent impacts could occur to special status species, habitats, prey habitats nests, or loss of wintering and fawning range due to inundation, ground-disturbing or construction activities could occur. This impact would be the same as the NED Plan. [Impact Wild-2, 3, 5, 7, 8, 9, 10, 11, 12, 13, 14, & 15 in the Final EIS]

Cultural Resources With CP5, permanent inundation of traditional cultural properties could occur. This impact would be the same as the NED Plan. [Impact Culture-2 in the Final EIS]

Land Use and Planning With CP5, short and long-term disruption of existing land uses and conflict with existing land use goals and policies of affected jurisdictions (Shasta Lake and vicinity and Upper Sacramento River) could occur as a result of construction, relocation activities and/or project operations. This impact would be the same as the NED Plan. [Impact LU-1 & 2 in the Final EIS]

Aesthetics and Visual Resources With CP5, short and long-term degraded visual character and quality could be inconsistent with guidelines for visual resources in the STNF LRMP (Shasta Lake and vicinity and Upper Sacramento River). This impact would be the same as the NED Plan. [Impact Vis-1 in the Final EIS]

With CP5, short-term degradation and/or obstruction of scenic view from key observation points (Shasta Lake and vicinity and Upper Sacramento River) and increased glare and/or nighttime lighting could occur. This impact would be the same as the NED Plan. [Impact Vis-2 & 3 in the Final EIS]

Wild and Scenic River Considerations for McCloud River With CP5, impacts to 21 percent of the McCloud River's Segment 4 would be periodically inundated. This impact would be the same as the NED Plan. [Impact WASR-1 in the Final EIS]

With CP5, increased inundation could potentially affect aquatic habitat and would conflict with the natural and free-flowing condition in and of the McCloud River, in conflict with the State Public Resources Code. This impact would be the same as the NED Plan. [Impact WASR-3 & 4]

Overall, there would be the same amount of significant and unavoidable impacts as a result of implementation of CP5 as the NED Plan. CP5 was retained for further analysis.

Analysis Step 4: Alternative Benefits Including an Increase in Waters of the United States

Increase in Other Waters As stated above, by raising Shasta Dam from a crest at elevation 1,077.5 to elevation 1,096.0 (NGVD29), in combination with spillway modifications, CP4 would increase the overall full pool storage from 4.55 MAF to 5.19 MAF. This is expected to have a net increase in waters of the United States by 76 acres, the same as the NED Plan.

Other Benefits Alternative CP5 would contribute 113.5 TAF of dry and critical year water supply, which would be the same as the NED Plan. Alternative CP5 is also anticipated to result in an annual average increase in the Chinook salmon population of about 377,900 out-migrating juvenile fish (represented by an index of production increase, based on the estimated average annual increase in juvenile Chinook salmon surviving to migrate downstream from Red Bluff Pumping Plant.) This would less than the NED Plan.

Summary

Alternative CP5 would meet the project objectives and would be practicable. The potential impacts to waters of the United States, and other environmental consequences would be nearly identical to the NED Plan; therefore, it would not be considered less damaging. However, CP5 would have relatively low increased anadromous fish survival benefits in comparison with the NED Plan. Therefore, CP5 was eliminated for consideration as the LEDPA.

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Chapter 8
Identification of the Least Environmentally Damaging Practicable Alternative

In summary, using the step-wise approach described in Chapter 7 "Analysis of Retained Alternatives," it was found that CP1 and CP3 met the project objectives, but were impracticable due to costs as compared to the benefits. (See Chapter 3 "National Economic Development Plan - CP4A" on how the cost/benefit ratio and NED benefits are derived).

Alternative CP2, would meet the project objectives, would be practicable, and would have slightly reduced impacted to waters of the United States and slightly less significant and unavoidable impacts to other resource areas than the NED Plan. However, CP2 would have relatively low benefits when compared to NED Plan, including a lesser amount of a net increase in other waters of the United States. In addition, CP2 would not include ecosystem restoration features as with the NED Plan. The NED Plan would have the following ecosystem restoration features: (1) augmenting spawning gravel in the upper Sacramento River at targeted locations to provide either immediate spawning habitat or long-term recruitment, and (2) restoring riparian, floodplain, and side channel habitat in the upper Sacramento River to provide rearing habitat for juvenile salmonids. While these ecosystem restoration features may have an increase in impacts to Waters of the United States, there would be significant environmental benefits with these ecosystem restoration features.

Therefore, greater project benefits could be recognized with a higher dam raise (as with the NED Plan) for relatively low increases in costs. Therefore, CP2 was eliminated for consideration as the LEDPA.

Alternative CP4 and CP5 would meet the project objectives and are practicable. The potential impacts to waters of the United States, and other environmental consequences would be nearly identical to the NED Plan; therefore, they were not considered less damaging. However, CP4 would not meet the objectives as well as the NED Plan – water supply reliability would be compromised for increased anadromous fish survival. Alternative CP5 would have relatively low increased anadromous fish survival benefits in comparison with the NED Plan. Therefore, CP4 and CP5 were eliminated for consideration as the LEDPA.

This analysis identified Reclamation's rational for the NED Plan as the LEDPA, consistent with the CWA, while recognizing that USACE will ultimately be responsible for determining the LEDPA in connection with any related future permit action. The NED Plan would best balance and meet both of the primary and secondary objectives, maximize benefits relative to costs, incorporate

measures to minimize impacts to waters of the United States, and allow for a net increase in other waters of the United States. For these reasons, CP4A is identified and recommended by Reclamation as the LEDPA for the purposes of the SLWRI Final Feasibility Report, subject to confirmation and/or modification by the USACE.

Chapter 9
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