Department of the Interior Final

# Shasta Lake Water Resources Investigation

## Feasibility Report

U.S. Department of the Interior

Bureau of Reclamation

July 2015

# Mission Statements

**Protecting America's Great Outdoors and Powering Our Future**

The Department of the Interior protects and manages the Nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its trust responsibilities or special commitments to American Indians, Alaska Natives, and affiliated island communities.

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

# Feasibility Report

**Shasta Lake Water Resources Investigation, California**

*Prepared by:*

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

**July 2015**

# Executive Summary

The purpose of this Shasta Lake Water Resources Investigation (SLWRI) Feasibility Report is to document the U.S. Department of Interior (Interior), Bureau of Reclamation (Reclamation) and cooperating agencies' evaluation of the potential enlargement of Shasta Dam and Reservoir to (1) improve anadromous fish survival in the upper Sacramento River, (2) increase water supply reliability in the Central Valley of California, and (3) address related water resource problems, needs, and opportunities.

This Final Feasibility Report presents the results of planning, engineering, environmental, social, economic, and financial studies and potential benefits and effects of alternative plans, and is a companion document to the Final Environmental Impact Statement (EIS), published under separate cover. This Final Feasibility Report, along with the Final EIS, will be used by the U.S. Congress to determine the type and extent of Federal interest in enlarging Shasta Dam and Reservoir.

The SLWRI is a feasibility study that was authorized by Congress in 1980 in Public Law 96-375 and is being conducted by Reclamation, in coordination with cooperating agencies, other resource agencies, stakeholders, and the public. The SLWRI is being conducted consistent with the 1983 U.S. Water Resources Council *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* (P&G), Reclamation directives and standards, National Environmental Policy Act (NEPA), and other pertinent Federal, State of California (State), and local laws and policies.

The SLWRI is one of five surface water storage studies recommended in the July 2000 CALFED Bay-Delta Program (CALFED) Programmatic Environmental Impact Statement/Report (PEIS/R) and August 2000 Programmatic Record of Decision (ROD). Preliminary studies in support of the CALFED PEIS/R considered more than 50 surface water storage sites throughout California and recommended more detailed study of the five sites identified in the CALFED Programmatic ROD. The Final EIS, accompanying this Final Feasibility Report, tiers to the CALFED PEIS/R.

## Key Updates Since Draft Feasibility Report

Reclamation completed the SLWRI Draft Feasibility Report, accompanying Preliminary Draft EIS (DEIS), and related appendices in November 2011. These documents were released to the public in February 2012 to share information generated since the completion of the SLWRI Plan Formulation Report in December 2007 and to provide additional opportunity for public and stakeholder input. Following the release of the Draft Feasibility Report and Preliminary DEIS, alternatives and evaluations were refined for the DEIS based on several factors, including updates to Central Valley Project (CVP) and State Water Project (SWP) water operations and stakeholder input. The DEIS was released for a 90-day public review and comment period in July 2013.

This Final Feasibility Report includes the following key updates since the release of the Draft Feasibility Report:

- Updated water operations modeling and related analyses for the No-Action Alternative and comprehensive plans, including operational constraints in the:
  - The U.S. Department of the Interior, Fish and Wildlife Service (USFWS) 2008 *Formal Endangered Species Act Consultation on the Proposed Coordinated Operations of the CVP and SWP* (2008 USFWS Biological Opinion (BO))
  - The National Marine Fisheries Service (NMFS) 2009 *BO and Conference Opinion on the Long-Term Operations of the CVP and SWP* (2009 NMFS BO)
- Refinement of comprehensive plans, including refined water operations, construction features, environmental commitments, and mitigation measures
- Refinement of operational scenarios focused on anadromous fish survival, and the development, evaluation, and incorporation of Comprehensive Plan 4A (CP4A)
- Refinement of a construction funding/repayment approach where a non-Federal cost-share is provided up-front and used to reduce the need for Federal appropriations. A final recommendation cannot be made until such a cost-share agreement and other relevant considerations are addressed.

Based on the above refinements and updated evaluations and comparisons of comprehensive plans, CP4A was identified as the National Economic Development (NED) Plan, consistent with guidance in the P&G. Nonetheless, as noted in the bullet above, no formal recommendation is being made at this time.

## Background

Reclamation completed constructing Shasta Dam and Reservoir in 1945. Reclamation operates Shasta Dam and Reservoir, in conjunction with other CVP facilities, to provide for the management of floodwater, storage of surplus winter runoff for irrigation and municipal and industrial (M&I) water supply, maintenance of navigation flows, protection of fish in the Sacramento River and the Sacramento-San Joaquin Delta (Delta), and hydropower generation. 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 CVP, with Shasta Reservoir representing about 40 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 (see Figure ES-1) within the Whiskeytown-Shasta-Trinity National Recreation Area (NRA). The dam and entire reservoir are within Shasta County. 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 Programmatic 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. 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.

Major existing projects that influence and could be influenced by modifications to Shasta Dam and Reservoir include the CVP and the SWP. In addition, several programs in the Central Valley significantly influence the SLWRI, including the CVPIA. Other programs and projects currently in the planning phase could influence future potential implementation of Shasta Dam and Reservoir enlargement. A prominent example includes the Bay Delta Conservation Plan (BDCP). This and similar projects and programs have not been included in the evaluation of the alternative plans for this Feasibility Report because there has not been a specific decision to implement them at this time.


**Figure ES-1. Location of Shasta Dam and Reservoir**

## Study Area

Shasta Dam and Reservoir are located on the upper Sacramento River in Northern California, about 9 miles northwest of the City of Redding. The SLWRI includes both a primary and extended study area because of the potential influence of the proposed modification of Shasta Dam and Reservoir, and subsequent system operations and water deliveries over a large geographic area.

As shown in Figure ES-2, the primary study area encompasses Shasta Dam and Lake; lower reaches of three primary tributaries flowing into Shasta Lake (Sacramento, McCloud, and Pit rivers) and all smaller tributaries flowing into the lake; Trinity and Lewiston reservoirs; and the Sacramento River downstream from Shasta Dam to about the Red Bluff Pumping Plant (RBPP) facilities, including tributaries at their confluence. The extended study area encompasses the Sacramento River downstream from RBPP, including portions of the lower American and Feather river basins, the Delta, parts of the lower San Joaquin River basin; and CVP and SWP facilities and water service areas (shown in Figure ES-3).

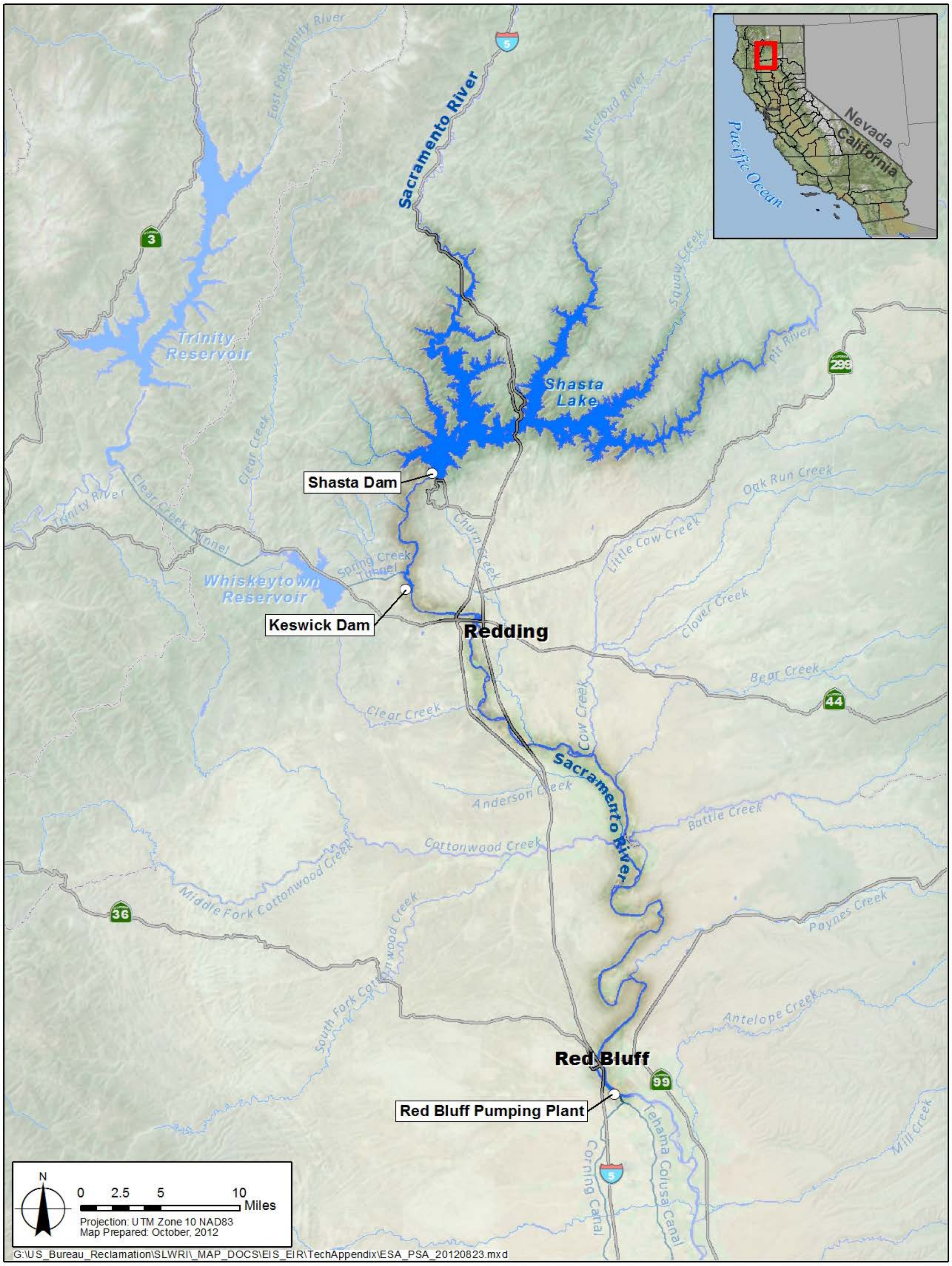



**Figure ES-2. Primary Study Area—Shasta Lake Area and Sacramento River from Shasta Dam to Red Bluff Pumping Plant**

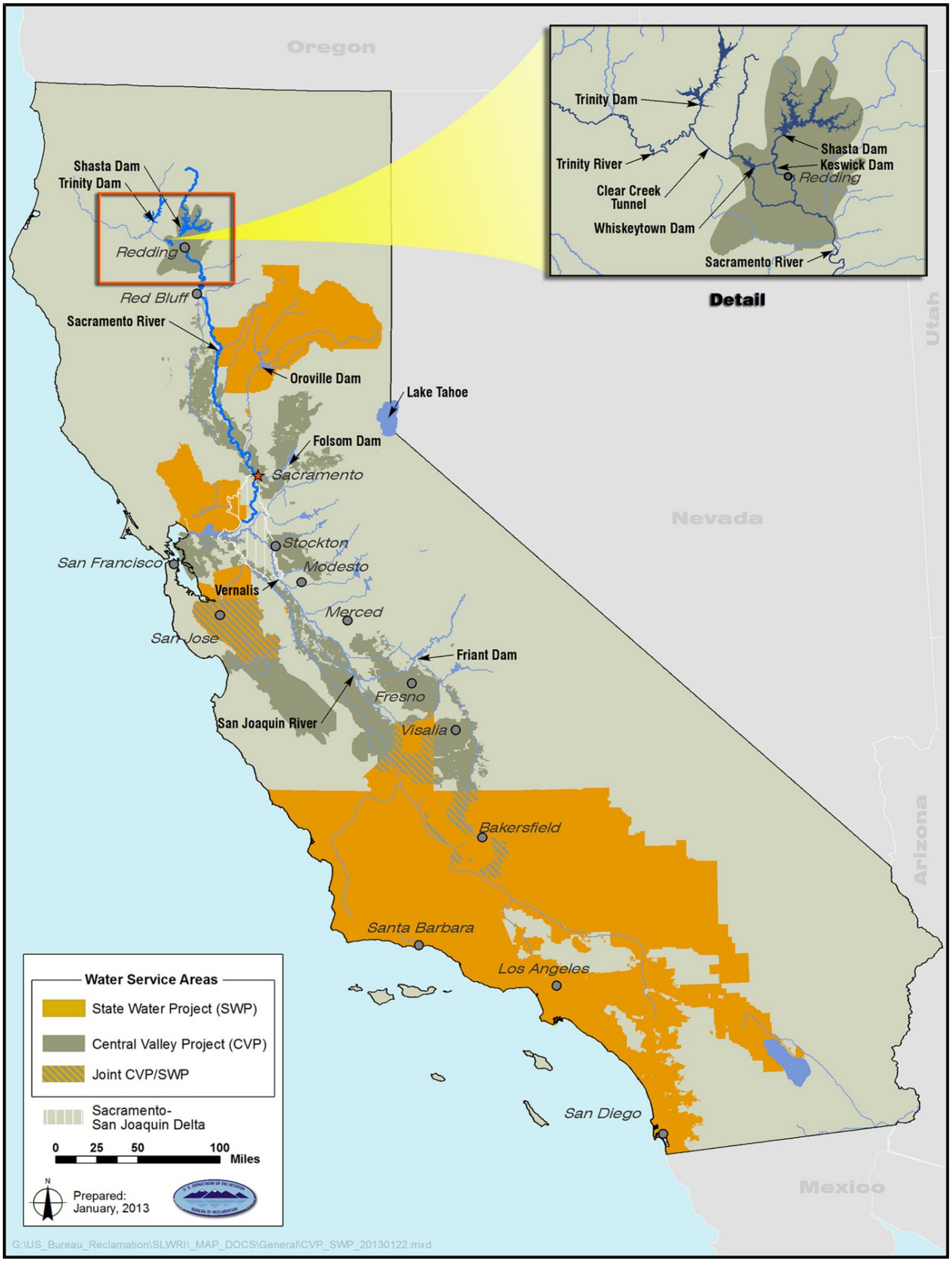



**Figure ES-3. Central Valley Project and State Water Project Water Service Areas**

# Problems, Needs, and Opportunities

Major identified water and related resources problems, needs, and opportunities in the primary study area include anadromous fish survival, water supply reliability, and other resource needs, as described below.

## Anadromous Fish Survival

A number of environmental factors have led to considerable declines in the populations of Chinook salmon and steelhead in the Sacramento River. One of the most significant factors contributing to the declines is unsuitable water temperature in the upper Sacramento River, especially in dry and critically dry years. Releases of cold water stored behind Shasta Dam can improve water temperatures in the Sacramento River for anadromous fish during critical periods.

The NMFS 2014 *Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-run Chinook Salmon and Central Valley Spring-run Chinook Salmon and the Distinct Population Segment of Central Valley Steelhead* states that prolonged droughts depleting the cold-water stored in Shasta Reservoir, or some related failure to manage cold-water storage, could put populations of anadromous fish at risk of severe population decline or extirpation in the long-term. Various actions ranging from minimum instream flow requirements to structural changes at Shasta Dam have been undertaken to address this problem. Despite these steps, there is still a need for additional effective actions to address anadromous fish survival in the Sacramento River, particularly upstream from the RBPP facilities.

## Water Supply Reliability

Demands for water in California exceed available supplies. Reclamation's 2008 *Water Supply and Yield Study* describes dramatic increases in statewide population, land use changes, regulatory requirements, and limitations on storage and conveyance facilities, resulting 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* 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 drought 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 changes in precipitation patterns, decreases in snowfall, and earlier snowmelt may further 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 critically dry water years. Similar needs and challenges are faced by the SWP and other water projects throughout the State. The SLWRI is being conducted as one of many efforts to improve the reliability of California's water supply.

### Other Resources

Other identified problems, needs, and opportunities include the need for restoring ecosystem resources in the Shasta Lake area and downstream along the Sacramento River; the need for additional flood management along the upper Sacramento River; the need for new energy generation, especially from renewable sources such as hydropower; the need for additional recreation opportunities in the north Sacramento Valley; and the need for improving water quality conditions in the Sacramento River downstream from Shasta Dam and in the Delta.

## Public Involvement and Outreach and Study Management

Public outreach, involvement, and support for development of the Feasibility Report and EIS included a wide range of activities. These activities were designed, in part, to meet requirements of NEPA, Executive Order 12898 (Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations), and President Clinton's April 29, 1994, memorandum regarding the engagement of Federally recognized tribal governments. Reclamation and the cooperating agencies achieve these objectives through continued implementation of the 2003 Reclamation *SLWRI Strategic Agency and Public Involvement Plan*, providing multiple opportunities for the public, stakeholders, and tribes to participate in development of the SLWRI.

Overall management of the SLWRI and regular engagement of cooperating agencies and other stakeholders occurred through a Project Coordination Team (PCT). Cooperating agencies for the SLWRI, pursuant to NEPA, include the USFS, Colusa Indian Community Council of the Cachil Dehe Band of Wintun Indians, U.S. Army Corps of Engineers (USACE), and U.S. Department of the Interior, Bureau of Indian Affairs. Other participants in the PCT include USFWS, NMFS, U.S. Bureau of Land Management, and other Federal and State agencies. The Study Management Team (SMT) consisted of key policy and decision makers with direct influence over policy guidance for the study. The SMT provided overall guidance, suggestions, and comments for the study, representing viewpoints from all participating agencies.

The 2003 Reclamation *SLWRI Strategic Agency and Public Involvement Plan* was designed to assist communication between the PCT and stakeholders. This plan addresses four objectives, including (1) stakeholder identification, (2) project transparency, (3) issues and concerns resolution, and (4) project implementation. The plan has five main outreach elements: (1) stakeholder and public meetings and workshops, (2) tribal coordination, (3) environmental justice, (4) Technical Working Group coordination, and (5) PCT and SMT activities.

Outreach and public involvement included Reclamation representatives attending public meetings at the request of agencies and stakeholder groups, including the California Water Commission, McCloud River Coordinated Resource Management Plan signatories, Shasta Lake Business Owners Association, City of Redding, and Lakehead Community Development Association.

As part of the public involvement plan, briefings and workshops were held in fall 2003 and summer and fall 2004. The 2003 and 2004 briefings and workshops were held primarily to discuss the study and the study objectives, management measures, and plans identified for further development. Public scoping meetings were held in fall 2005, and the *SLWRI Environmental Scoping Report* was completed in February 2006.

Reclamation released the Draft Feasibility Report and Preliminary DEIS in February 2012. This February 2012 release was followed by an October 2012 Reclamation news release requesting additional public comment on the Draft Feasibility Report for input on potential cost, benefits, and impacts of enlarging Shasta Dam and Reservoir. The SLWRI DEIS was released for public and agency review and comment on July 1, 2013 for a 90-day review period. Written and verbal comments on the DEIS were accepted at three public hearings, and written comments were accepted at three public workshops and throughout the comment period. The Feasibility Report and accompanying Final EIS have been revised in consideration of public and agency comments.

A Notice of Availability (NOA) has been released for the Final EIS. Elected officials and representatives, government agencies, private organizations, businesses, and individual members of the public on the mailing list have received a copy of this document or a notification of document availability.

## Planning Objectives, Constraints, and Considerations

The following sections describe national planning objectives and planning objectives, constraints, and considerations specific to the SLWRI.

## National Planning Objectives

The Federal objectives are guided by the 1983 U.S. Water Resources Council *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* and are consistent with the 2013 Council on Environmental Quality *Principles and Requirements for Federal Investments in Water Resources*.

## SLWRI-Specific Planning Objectives

Two primary and five secondary planning objectives were developed for the SLWRI on the basis of the identified water resources problems, needs, and opportunities; study authorities; and other pertinent direction, including information contained in the CALFED PEIS/R and Programmatic ROD. Primary planning objectives are those which specific alternatives are formulated to address. Secondary planning objectives are actions, operations, and/or features that should be considered in the plan formulation process, but only to the extent possible through pursuit of the primary planning objectives.

### *Primary Planning Objectives*

- Increase the survival of anadromous fish populations in the Sacramento River, primarily upstream from the RBPP.
- Increase water supply and water supply reliability for agricultural, M&I, and environmental purposes, to help meet current and future water demands, with a focus on enlarging Shasta Dam and Reservoir.

### *Secondary Planning Objectives*

- Conserve, restore, and enhance ecosystem resources in the Shasta Lake area and along the upper Sacramento River.
- Reduce flood damage along the Sacramento River.
- Develop additional hydropower generation capabilities at Shasta Dam.
- Maintain and increase recreation opportunities at Shasta Lake.
- Maintain or improve water quality conditions in the Sacramento River downstream from Shasta Dam and in the Delta.

## Planning Constraints

Planning constraints help guide the direction and scope of the feasibility study and the formulation and evaluation of alternatives plans. Some planning constraints can also assist in defining existing and likely future resource conditions. Some planning constraints are more rigid than others. Examples of more rigid constraints include congressional direction in study authorizations; other current applicable laws, regulations, and policies; and physical conditions (e.g., topography, hydrology). Other planning constraints are less restrictive but are still influential in guiding the process. Several key constraints identified for the SLWRI are as follows:

- **Study Authorization –** On August 30, 1935, in the Rivers and Harbors Bill, an initial amount of Federal funds was authorized for constructing Kennett (now Shasta) Dam. Initial authorization for the SLWRI derives from Public Law 96-375, and additional guidance is contained in Public Law 108-361. These legislative actions authorized an investigation of the potential benefits and costs of enlarging or replacing Shasta Dam and Reservoir.

- **CALFED PEIS/R and Programmatic ROD –** CALFED was established to "develop and implement a long-term comprehensive plan that would restore ecological health and improve water management for beneficial uses of the Bay-Delta system." The 2000 CALFED PEIS/R and Programmatic ROD include program goals, objectives, and projects primarily to benefit the San Francisco Bay/Sacramento-San Joaquin Delta (Bay-Delta) system. The objectives of the SLWRI are consistent with the CALFED Programmatic ROD for Shasta Dam enlargement, as follows:

  *Expand CVP storage in Shasta Lake by approximately 300 TAF. Such an expansion will 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.*

- **Laws, Regulations, and Policies –** Numerous laws, regulations, executive orders, and policies were considered, among them the P&G, NEPA, Fish and Wildlife Coordination Act, Clean Air Act, Clean Water Act, National Historic Preservation Act, California Public Resources Code (PRC), Federal and State Endangered Species Acts, California Environmental Quality Act (CEQA), and CVPIA. The CVPIA, including the associated Anadromous Fish Restoration Program, is pertinent because it identified specific actions for fish and wildlife mitigation, protection, restoration, and enhancement which influence water supply deliveries, river flows, and related environmental conditions in the primary and extended study areas.

### Statewide Water Operation Considerations

Reclamation and DWR use CalSim-II, a specific application of the Water Resources Integrated Modeling System to Central Valley water operations, to study operations, benefits, and effects of new facilities and operational parameters for the CVP and SWP. Operational assumptions for refinement, modeling, and evaluation of potential effects of alternatives in this Final Feasibility Report and accompanying EIS were derived from the following:

- The Reclamation 2008 *Biological Assessment on the Continued Long-Term Operations of the CVP and SWP* (2008 Long-Term Operation Biological Assessment (BA))
- The 2008 USFWS BO
- The 2009 NMFS BO
- The Coordinated Operations Agreement (COA) between Reclamation and DWR for the CVP and SWP, as ratified by Congress

Ongoing consultation processes related to the 2008 USFWS and 2009 NMFS BOs have resulted in some uncertainty in future CVP and SWP operational constraints. In response to lawsuits challenging the 2008 and 2009 BOs, the District Court for the Eastern District of California remanded the BOs to USFWS and NMFS and ordered preparation of new BOs. These legal challenges may result in changes to CVP and SWP operational constraints if the revised USFWS and NMFS BOs contain new or amended reasonable and prudent alternatives (RPA). Despite this uncertainty, the 2008 USFWS and 2009 NMFS BOs contain the most recent estimate of potential changes in water operations that could occur in the near future.

### Other Planning Considerations

Other planning considerations were specifically identified to help formulate, evaluate, and compare initial plans and, later, detailed alternatives, including items such as coordination with other Federal and State agencies, consistency with planning objectives, avoidance of adverse effects to environmental and cultural resources, consideration of existing projects and programs, and a 100-year period of analysis.

## Formulation of Alternative Plans

Over the course of the feasibility study, consistent with P&G and NEPA, the plan formulation and evaluation process for the SLWRI was accomplished in multiple phases, as shown in Figure ES-4. All phases were conducted in coordination and collaboration with stakeholders, cooperating agencies, affected communities, and decision makers and consistent with study authorizations. All phases were also completed in consideration of Reclamation and other pertinent Federal planning procedures, requirements, directives, standards, policy, laws, and executive orders.

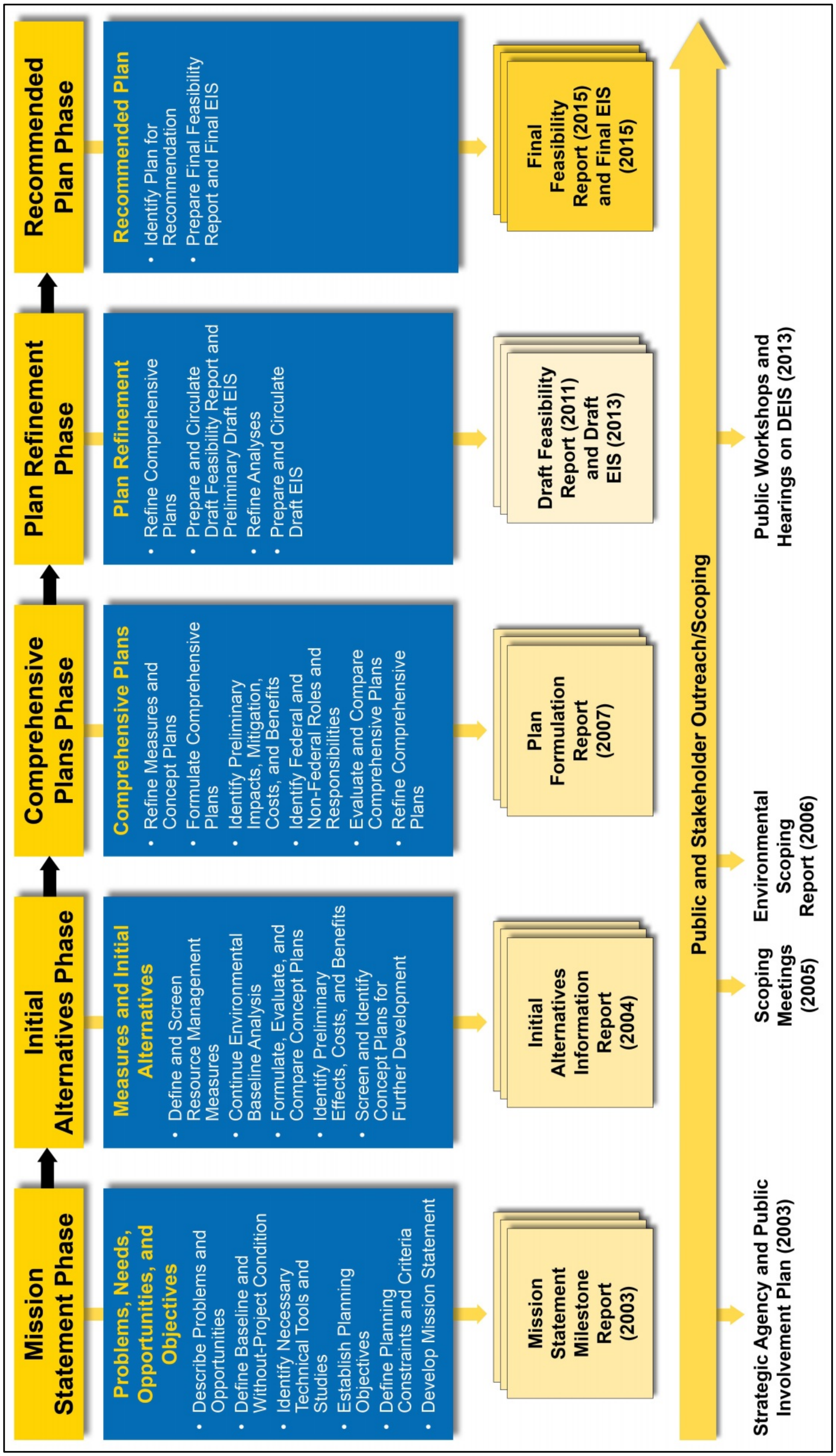



Figure ES-4. Plan Formulation Phases

Plans were developed based on two initial deliberative and iterative steps. First, problems, needs, opportunities, and constraints were specified. Second, a variety management measures were identified that could be combined into alternative plans. A management measure is a project action or feature that addresses a specific planning objective. Numerous management measures were identified for each planning objective of the SLWRI. Of the management measures considered, eight measures addressing primary planning objectives were identified for further consideration and potential inclusion in alternative plans. Additionally, eight measures addressing the secondary planning objectives were identified for further consideration and inclusion, to the extent possible, in alternative plans. Table ES-1 summarizes the 16 management measures carried forward to address the SLWRI primary and secondary planning objectives.

Concept plans (plans that are conceptual in scope) were formulated from the management measures carried forward. The purpose of this phase of the formulation process was to (1) explore an array of different strategies to address the primary planning objectives, constraints, and considerations, and (2) identify concepts that warranted possible further development. The concept plans were intended to promote discussion and provide a background for the formulation of comprehensive plans in the remainder of the feasibility study, with input from participating agencies, stakeholders, and the public.

The next step in the plan formulation process was development of comprehensive plans through combining and continuing to refine management measures and concept plans carried forward. Five comprehensive plans and a No-Action Alternative were developed for the Draft Feasibility Report and Preliminary DEIS. These comprehensive plans were further refined for the DEIS, Final Feasibility Report and Final EIS based on several factors, including updates to CVP and SWP water operations and stakeholder input. Based on comments on the Draft Feasibility Report and DEIS, a refined operational scenario (CP4A) was developed for the anadromous fish focused plan and included in the Final Feasibility Report and Final EIS.

## Alternatives Considered and Eliminated from Detailed Study

Formulation of a range of alternatives for evaluation in this feasibility study began with a review of problems, needs, and opportunities, study authorities, and other pertinent direction, followed by development of primary and secondary planning objectives, and, finally, development of comprehensive plans (action alternatives) to meet the project objectives. Some project alternatives suggested during this process (e.g., raising Shasta Dam by up to 200 feet) were not retained because they did not adequately meet, or were beyond the scope of, the purpose and need statement, did not contribute to both primary planning objectives, had extremely high costs, had high social or environmental impacts, or were previously analyzed in or rejected from consideration by the CALFED agencies in the CALFED PEIS/R.

**Table ES-1. Retained Management Measures to Address Planning Objectives**

| Planning Objective | Resources Management Measure | |
|---|---|---|
| | **Feature/Activity** | **Description** |
| **Primary Planning Objectives** | | |
| Increase Anadromous Fish Survival | Construct Instream Aquatic Habitat | Construct instream aquatic habitat downstream from Keswick Dam |
| | Replenish Spawning Gravel | Replenish spawning gravel in the Sacramento River |
| | Modify Temperature Control Device | Make additional modifications to Shasta Dam for temperature control |
| | Enlarge Shasta Lake Cold-Water Pool | Enlarge Shasta Dam and Reservoir to increase the cold-water pool in the lake to benefit anadromous fish |
| | Modify Storage and Release Operations at Shasta Dam | Modify storage and release operations at Shasta Dam to increase anadromous fish survival |
| Increase Water Supply and Water Supply Reliability | Increase Conservation Storage | Increase conservation storage space in Shasta Reservoir by raising Shasta Dam |
| | Reoperate Shasta Dam | Increase the effective conservation storage space in Shasta Reservoir by increasing the efficiency of reservoir operation for water supply reliability |
| | Reduce Demand | Identify and implement, to the extent possible, water use efficiency methods |
| **Secondary Planning Objectives** | | |
| Conserve, Restore, and Enhance Ecosystem Resources | Restore Shoreline Aquatic Habitat | Construct shoreline fish habitat around Shasta Lake |
| | Restore Tributary Aquatic Habitat | Construct instream fish habitat on tributaries to Shasta Lake |
| | Restore Riparian Habitat | Restore riparian and floodplain habitat along the upper Sacramento River |
| Reduce Flood Damage | Modify Flood Operations Guidelines | Update Shasta Dam and Reservoir flood management operations to improve system-wide reliability and public health and safety, and system-wide reliability |
| Develop Additional Hydropower Generation | Modify Hydropower Facilities | Modify existing/construct new generation facilities at Shasta Dam to take advantage of increased head |
| Maintain and Increase Recreation | Maintain and Enhance Recreation Facilities | Maintain and enhance recreation capacity, facilities, and opportunities |
| | Reoperate Reservoir | Increase recreation use by stabilizing early season filling in Shasta Lake |
| Maintain or Improve Water Quality | Maintain or Improve Water Quality | Improve operational flexibility for Delta water quality by increasing storage in Shasta Reservoir |

Key:
Delta = Sacramento-San Joaquin Delta

# No-Action Alternative and Comprehensive Plans

The No-Action Alternative and the comprehensive plans are described briefly below.

## No-Action Alternative (No Additional Federal Action)

Under the No-Action Alternative, the Federal Government would continue to implement reasonably foreseeable actions, but would not take additional actions toward implementing a plan to raise Shasta Dam to help increase anadromous fish survival in the upper Sacramento River; help address water supply reliability issues in California; or 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. Reasonably foreseeable actions include actions with current authorization, secured funding for design and construction, and environmental permitting and compliance activities that are substantially complete. The No-Action Alternative provides a basis for comparing the potential benefits and effects of the comprehensive plans.

## Comprehensive Plans

Each of the comprehensive plans includes enlarging Shasta Dam and Reservoir and a variety of management measures to address, in varying degrees, all of the SLWRI planning objectives. All of the comprehensive plans include eight common management measures:

- Enlarge the Shasta Lake cold-water pool by raising Shasta Dam to enlarge Shasta Reservoir.
- Modify the Shasta Dam temperature control device by raising the existing structure and modifying the shutter control.
- Increase conservation storage by raising Shasta Dam.
- Reduce demand through a water conservation program to augment current water use efficiency practices.
- Modify Shasta Dam flood operations by adjusting the 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 to enable their continued efficient use.
- Maintain and increase recreation opportunities at Shasta Lake.

- Maintain or improve water quality by increasing Delta outflow during drought years and reducing salinity during critical periods, providing additional operational flexibility for responses to Delta emergencies.

In addition, Reclamation has incorporated environmental commitments into each of the comprehensive plans to avoid or minimize potential impacts. Each comprehensive plan also includes mitigation measures where feasible to avoid, minimize, rectify, reduce, or compensate for significant and potentially significant impacts.

### *Comprehensive Plan 1 (CP1) – 6.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability*

| | *CP1* |
|---|---|
| *Dam Raise* | *6.5 feet* |
| *Increased Storage* | *256,000 acre-feet* |
| *Focus* | *Anadromous Fish Survival & Water Supply Reliability* |
| *Major Components* | *Dam Modifications & Reservoir Area Relocations* |
| | *Environmental Commitments & Mitigation Measures* |

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 eight common management measures described above. CP1 also includes implementing environmental commitments and mitigation measures. Raising Shasta Dam by 6.5 feet, in conjunction with spillway modifications, would result in an increase in full pool depth of 8.5 feet and an additional 256,000 acre-feet of storage capacity in Shasta Reservoir. 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. 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 and flows for fish in the upper Sacramento River during critical periods. CP1 would also help reduce future water shortages through increasing water supply reliability for irrigation and M&I deliveries primarily during drought periods.

### *Comprehensive Plan 2 (CP2) – 12.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability*

| *CP2* | |
|---|---|
| *Dam Raise* | *12.5 feet* |
| *Increased Storage* | *443,000 acre-feet* |
| *Focus* | *Anadromous Fish Survival & Water Supply Reliability* |
| *Major Components* | *Dam Modifications & Reservoir Area Relocations* |
| | *Environmental Commitments & Mitigation Measures* |

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 eight common management measures described above. CP2 also includes implementing environmental commitments and mitigation measures. Raising Shasta Dam by 12.5 feet, in conjunction with spillway modifications, would result in an increase in full pool depth of 14.5 feet and an additional 443,000 acre-feet of storage capacity in Shasta Reservoir. 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. CP2 would increase the ability of Shasta Dam to regulate seasonal water temperatures and flows for fish, primarily during critical periods, and would help reduce future water shortages through increasing water supply reliability for irrigation and M&I deliveries.

### *Comprehensive Plan 3 (CP3) – 18.5-Foot Dam Raise, Agricultural Water Supply Reliability and Anadromous Fish Survival*

| *CP3* | |
|---|---|
| *Dam Raise* | *18.5 feet* |
| *Increased Storage* | *634,000 acre-feet* |
| *Focus* | *Agricultural Water Supply Reliability & Anadromous Fish Survival* |
| *Major Components* | *Dam Modifications & Reservoir Area Relocations* |
| | *Environmental Commitments & Mitigation Measures* |

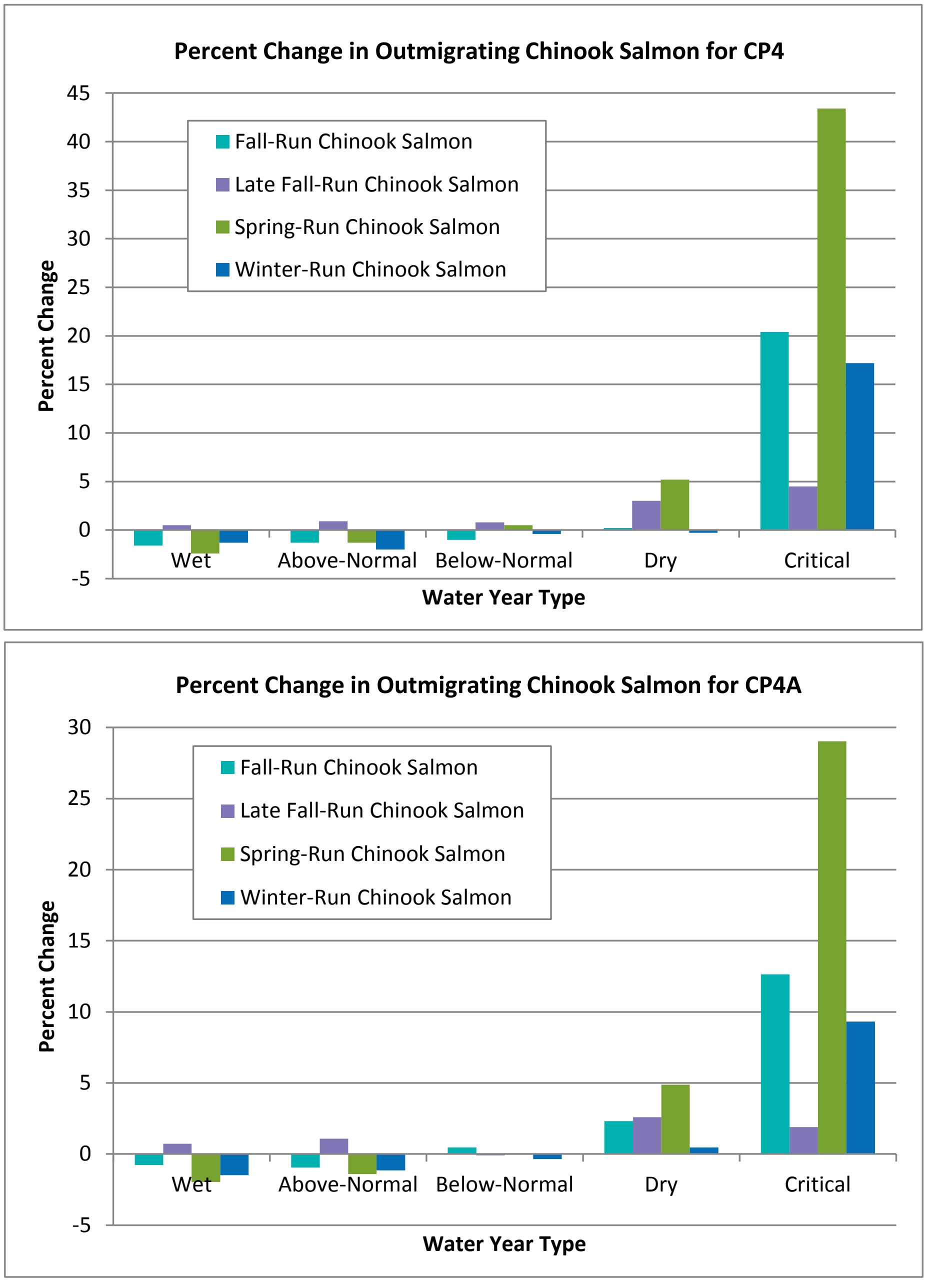
CP3 focuses on both agricultural water supply reliability and anadromous fish survival. This alternative primarily consists of enlarging Shasta Dam by raising the dam crest 18.5 feet and implementing the eight common management measures described above. CP3 also includes implementing environmental commitments and mitigation measures. Although higher dam raises are technically 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. Raising Shasta Dam by 18.5 feet, in conjunction with spillway modifications, would result in an increase in full pool depth of 20.5 feet and an additional 634,000 acre-feet of storage capacity in Shasta Reservoir. 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. CP3 would increase the ability of Shasta Dam to regulate seasonal water temperatures and flows for fish, primarily during critical periods, and would help reduce future water shortages through increasing water supply reliability for irrigation deliveries.

***Comprehensive Plan 4 (CP4) and CP4A – 18.5-Foot Dam Raise, Anadromous Fish Focus with Water Supply Reliability***

CP4 and CP4A focus 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 and CP4A* |
|---|---|
| *Dam Raise* | *18.5 feet* |
| *Increased Storage* | *634,000 acre-feet* |
| *Focus* | *Anadromous Fish Survival with Water Supply Reliability* |
| *Major Components* | *Dam Modifications & Reservoir Area Relocations* |
| | *Adaptive Management*<br>*CP4 – Reserving 378,000 acre-feet of Storage for Cold-Water Pool*<br>*CP4A – Reserving 191,000 acre-feet of Storage for Cold-Water Pool* |
| | *Augment Spawning Gravel* |
| | *Restore Riparian, Floodplain, & Side Channel Habitat* |
| | *Environmental Commitments & Mitigation Measures* |

CP4 and CP4A primarily consist of enlarging Shasta Dam by raising the dam crest 18.5 feet and implementing the eight common management measures. CP4 and CP4A also include implementing environmental commitments and mitigation measures.  As with CP3, this raise would increase the full pool depth by 20.5 feet and enlarge total reservoir storage capacity by 634,000 acre-feet. The additional storage created by the dam raise would be used to improve the ability to meet water temperature objectives and habitat requirements for anadromous fish during drought years (see Figure ES-5) and increase water supply reliability. 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 in CP4; about 191,000 acre-feet would be dedicated in CP4A. For CP4, operations for the remaining portion of increased storage (approximately 256,000 acre-feet) would be the same as for CP1. For CP4A, operations for the remaining portion of increased storage (approximately 443,000 acre-feet) would be the same as for CP2. Similar to CP1 and CP2, the remaining 256,000 acre-feet and 443,000 acre-feet of storage capacity for CP4 and CP4A, respectively, would further increase the ability of Shasta Dam to regulate seasonal water temperature and flow conditions for fish, and help reduce future water shortages through increasing water supply reliability for irrigation and M&I deliveries. CP4 and CP4A also include augmenting spawning gravel and restoring riparian, floodplain, and side channel habitat in the upper Sacramento River.




Note: Changes in outmigrating Chinook salmon simulated using SALMOD; Water Year types based on the Sacramento Valley Water Year Hydrologic Classification

**Figure ES-5. Percent Change in Outmigrating Chinook Salmon for CP4 and CP4A**

***Comprehensive Plan 5 (CP5) – 18.5-Foot Dam Raise, Combination Plan***

| *CP5* | |
|---|---|
| *Dam Raise* | *18.5 feet* |
| *Increased Storage* | *634,000 acre-feet* |
| *Focus* | *Water Supply Reliability, Anadromous Fish Survival, Ecosystem Restoration, and Recreation* |
| *Major Components* | *Dam Modifications & Reservoir Area Relocations*<br>*Construct Resident Fish Habitat at Shasta Lake & along Tributaries*<br>*Augment Spawning Gravel*<br>*Restore Riparian, Floodplain, & Side Channel Habitat*<br>*Increase Recreation Opportunities*<br>*Environmental Commitments & Mitigation Measures* |

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 by 18.5 feet; implementing the eight common management measures; 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 mitigation measures. 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. CP5 would increase the ability of Shasta Dam to regulate seasonal water temperatures and flows for fish, primarily during critical periods, and would help reduce future water shortages through increasing water supply reliability for irrigation and M&I deliveries.

***Major Components of Comprehensive Plans***

Each of the comprehensive plans involves raising Shasta Dam by 6.5 feet to 18.5 feet, increasing the storage capacity in Shasta Reservoir by 256,000 acre-feet to 634,000 acre-feet, and constructing a common set of features, as shown in Table ES-2. Features and related construction activities under all comprehensive plans would include the following:

- Clearing vegetation from portions of the inundated reservoir area
- Constructing the dam raise, appurtenant structures, reservoir area dikes, and railroad embankments

- Relocating vehicular and railroad bridges, roadways, recreation facilities, utilities, and other infrastructure

CP4, CP4A, and CP5 would also include features and related construction activities associated with gravel augmentation and restoring riparian, floodplain, and side channel habitat along the upper Sacramento River. Additional features and related construction activities associated with Shasta Lake and tributary shoreline enhancements and features to increase Shasta Lake recreation opportunities are included under CP5. Figure ES-6 illustrates major features in the Shasta Lake area common to all comprehensive plans.

**Table ES-2. Summary of Physical Features of Comprehensive Plans**

| Main Features | CP1 | CP2 | CP3 | CP4 | CP4A | CP5 |
|---|---|---|---|---|---|---|
| | **Comprehensive Plans** | | | | | |
| **Dam and Appurtenant Structures** | | | | | | |
| Shasta Dam | | | | | | |
| *Crest Raise (feet)* | 6.5 | 12.5 | 18.5 | 18.5 | 18.5 | 18.5 |
| *Full Pool Height Increase (feet)* | 8.5 | 14.5 | 20.5 | 20.5 | 20.5 | 20.5 |
| *Elevation of Dam Crest (feet)*[1] | 1,084.0 | 1,090.0 | 1,096.0 | 1,096.0 | 1,096.0 | 1,096.0 |
| *Elevation of Full Pool (feet)*[2] | 1,078.2 | 1,084.2 | 1,090.2 | 1,090.2 | 1,090.2 | 1,090.2 |
| *Capacity Increase (acre-feet)* | 256,000 | 443,000 | 634,000 | 634,000 | 634,000 | 634,000 |
| *Main Dam* | Raise dam crest. Construct new parapets and utility gallery. Raise existing elevator tower and hoist tower. | Raise dam crest. Construct new parapets and utility gallery. Raise existing elevator tower and hoist tower. | Raise dam crest. Construct new parapets and utility gallery. Raise existing elevator tower and hoist tower. | Raise dam crest. Construct new parapets and utility gallery. Raise existing elevator tower and hoist tower. | Raise dam crest. Construct new parapets and utility gallery. Raise existing elevator tower and hoist tower. | Raise dam crest. Construct new parapets and utility gallery. Raise existing elevator tower and hoist tower. |
| *Wing Dams* | Raise to meet dam crest.<br>Build new visitor center along left wing dam.<br>Relocate gantry crane on right wing dam. | Raise to meet dam crest.<br>Build new visitor center along left wing dam.<br>Relocate gantry crane on right wing dam. | Raise to meet dam crest.<br>Build new visitor center along left wing dam.<br>Relocate gantry crane on right wing dam. | Raise to meet dam crest.<br>Build new visitor center along left wing dam.<br>Relocate gantry crane on right wing dam. | Raise to meet dam crest.<br>Build new visitor center along left wing dam.<br>Relocate gantry crane on right wing dam. | Raise to meet dam crest.<br>Build new visitor center along left wing dam.<br>Relocate gantry crane on right wing dam. |
| *Spillway* | Raise crest and extend piers. Replace 3 drum gates with 6 sloping fixed-wheel gates. | Raise crest and extend piers. Replace 3 drum gates with 6 sloping fixed-wheel gates. | Raise crest and extend piers. Replace 3 drum gates with 6 sloping fixed-wheel gates. | Raise crest and extend piers. Replace 3 drum gates with 6 sloping fixed-wheel gates. | Raise crest and extend piers. Replace 3 drum gates with 6 sloping fixed-wheel gates. | Raise crest and extend piers. Replace 3 drum gates with 6 sloping fixed-wheel gates. |
| *River Outlets* | Replace 4 lower-tier tube valves with jet flow gates. | Replace 4 lower-tier tube valves with jet flow gates. | Replace 4 lower-tier tube valves with jet flow gates. | Replace 4 lower-tier tube valves with jet flow gates. | Replace 4 lower-tier tube valves with jet flow gates. | Replace 4 lower-tier tube valves with jet flow gates. |
| *Temperature Control Device* | Raise/modify controls. | Raise/modify controls. | Raise/modify controls. | Raise/modify controls. | Raise/modify controls. | Raise/modify controls. |
| **Shasta Powerplant/ Penstocks** | Raise penstock hoists. | Raise penstock hoists. | Raise penstock hoists. | Raise penstock hoists. | Raise penstock hoists. | Raise penstock hoists. |
| **Pit 7 Dam/Powerhouse** | Increase height of training walls on dam spillway. Install a tailwater depression system. Modify other Pit 7 ancillary facilities. | Increase height of training walls on dam spillway. Install a tailwater depression system. Modify other Pit 7 ancillary facilities. | Increase height of training walls on dam spillway. Install a tailwater depression system. Modify other Pit 7 ancillary facilities. | Increase height of training walls on dam spillway. Install a tailwater depression system. Modify other Pit 7 ancillary facilities. | Increase height of training walls on dam spillway. Install a tailwater depression system. Modify other Pit 7 ancillary facilities. | Increase height of training walls on dam spillway. Install a tailwater depression system. Modify other Pit 7 ancillary facilities. |

**Table ES-2. Summary of Physical Features of Comprehensive Plans (contd.)**

| | Comprehensive Plans | | | | | |
|---|---|---|---|---|---|---|
| **Main Features** | **CP1** | **CP2** | **CP3** | **CP4** | **CP4A** | **CP5** |
| **Reservoir Area Clearing** | Clear 150 acres completely and 220 acres with overstory removal. | Clear 240 acres completely and 350 acres with overstory removal. | Clear 340 acres completely and 500 acres with overstory removal. | Clear 340 acres completely and 500 acres with overstory removal. | Clear 340 acres completely and 500 acres with overstory removal. | Clear 340 acres completely and 500 acres with overstory removal. |
| **Reservoir Area Dikes and Railroad Embankments** | Construct 3 railroad embankments and 2 new dikes. | Construct 3 railroad embankments and 3 new dikes. | Construct 3 railroad embankments and 4 new dikes. | Construct 3 railroad embankments and 4 new dikes. | Construct 3 railroad embankments and 4 new dikes. | Construct 3 railroad embankments and 4 new dikes. |
| **Relocations** | | | | | | |
| Roadways | Match replacement widths to existing paved roads to be replaced. | Match replacement widths to existing paved roads to be replaced. | Match replacement widths to existing paved roads to be replaced. | Match replacement widths to existing paved roads to be replaced. | Match replacement widths to existing paved roads to be replaced. | Match replacement widths to existing paved roads to be replaced. |
| *Length of Relocated Roadway (linear feet)* | 16,700 | 28,400 | 33,100 | 33,100 | 33,100 | 33,100 |
| *Number of Road Segments Affected* | 10 | 21 | 30 | 30 | 30 | 30 |
| Vehicle Bridges | Relocate 4 bridges, modify 1 bridge. | Relocate 4 bridges, modify 1 bridge. | Relocate 4 bridges, modify 1 bridge. | Relocate 4 bridges, modify 1 bridge. | Relocate 4 bridges, modify 1 bridge. | Relocate 4 bridges, modify 1 bridge. |
| Railroad | Relocate 2 bridges and realign track in-between, modify 1 bridge | Relocate 2 bridges and realign track in-between, modify 1 bridge | Relocate 2 bridges and realign track in-between, modify 1 bridge | Relocate 2 bridges and realign track in-between, modify 1 bridge | Relocate 2 bridges and realign track in-between, modify 1 bridge | Relocate 2 bridges and realign track in-between, modify 1 bridge |
| Recreation Facilities | Modify or replace 9 marinas, 6 public boat ramps, 6 resorts, 202 campsites/day-use sites/RV sites, 2 USFS facilities, 8.1 miles of trail, and 2 trailheads. | Modify or replace 9 marinas, 6 public boat ramps, 6 resorts, 261 campsites/ day-use sites/RV sites, 2 USFS facilities, 9.9 miles of trail, and 2 trailheads. | Modify or replace 9 marinas, 6 public boat ramps, 6 resorts, 328 campgrounds/day-use areas/RV sites, 2 USFS facilities, 11.6 miles of trail, and 2 trailheads. | Modify or replace 9 marinas, 6 public boat ramps, 6 resorts, 328 campgrounds/day-use areas/RV sites, 2 USFS facilities, 11.6 miles of trail, and 2 trailheads. | Modify or replace 9 marinas, 6 public boat ramps, 6 resorts, 328 campgrounds/day-use areas/RV sites, 2 USFS facilities, 11.6 miles of trail, and 2 trailheads. | Modify or replace 9 marinas, 6 public boat ramps, 6 resorts, 328 campgrounds/day-use areas/RV sites, 2 USFS facilities, 11.6 miles of trail, and 2 trailheads. Add 6 trailheads and 18 miles of new hiking trails. |
| Utilities | Relocate inundated utilities. Construct wastewater treatment facilities. | Relocate inundated utilities. Construct wastewater treatment facilities. | Relocate inundated utilities. Construct wastewater treatment facilities. | Relocate inundated utilities. Construct wastewater treatment facilities. | Relocate inundated utilities. Construct wastewater treatment facilities. | Relocate inundated utilities. Construct wastewater treatment facilities. |

**Table ES-2. Summary of Physical Features of Comprehensive Plans (contd.)**

| | Comprehensive Plans | | | | | |
|---|---|---|---|---|---|---|
| **Main Features** | **CP1** | **CP2** | **CP3** | **CP4** | **CP4A** | **CP5** |
| Ecosystem Enhancements | None | None | None | Reserve 378 TAF of the additional storage for cold-water supply for anadromous fish. Implement adaptive management plan to benefit anadromous fish. Augment spawning gravel in the upper Sacramento River at the rate of up to 10,000 tons per year. Restore riparian, floodplain, and side channel habitat along the upper Sacramento River. | Reserve 191 TAF of the additional storage for cold-water supply for anadromous fish. Implement adaptive management plan to benefit anadromous fish. Augment spawning gravel in the upper Sacramento River at the rate of up to 10,000 tons per year. Restore riparian, floodplain, and side channel habitat along the upper Sacramento River. | Construct shoreline fish habitat around Shasta Lake. Enhance aquatic habitat in tributaries to Shasta Lake to improve fish passage. Augment spawning gravel in the upper Sacramento River at the rate of up to 10,000 tons per year. Restore riparian, floodplain, and side channel habitat along the upper Sacramento River. |

Notes:

[1] 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

RV = recreational vehicle

TAF = thousand acre-feet

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

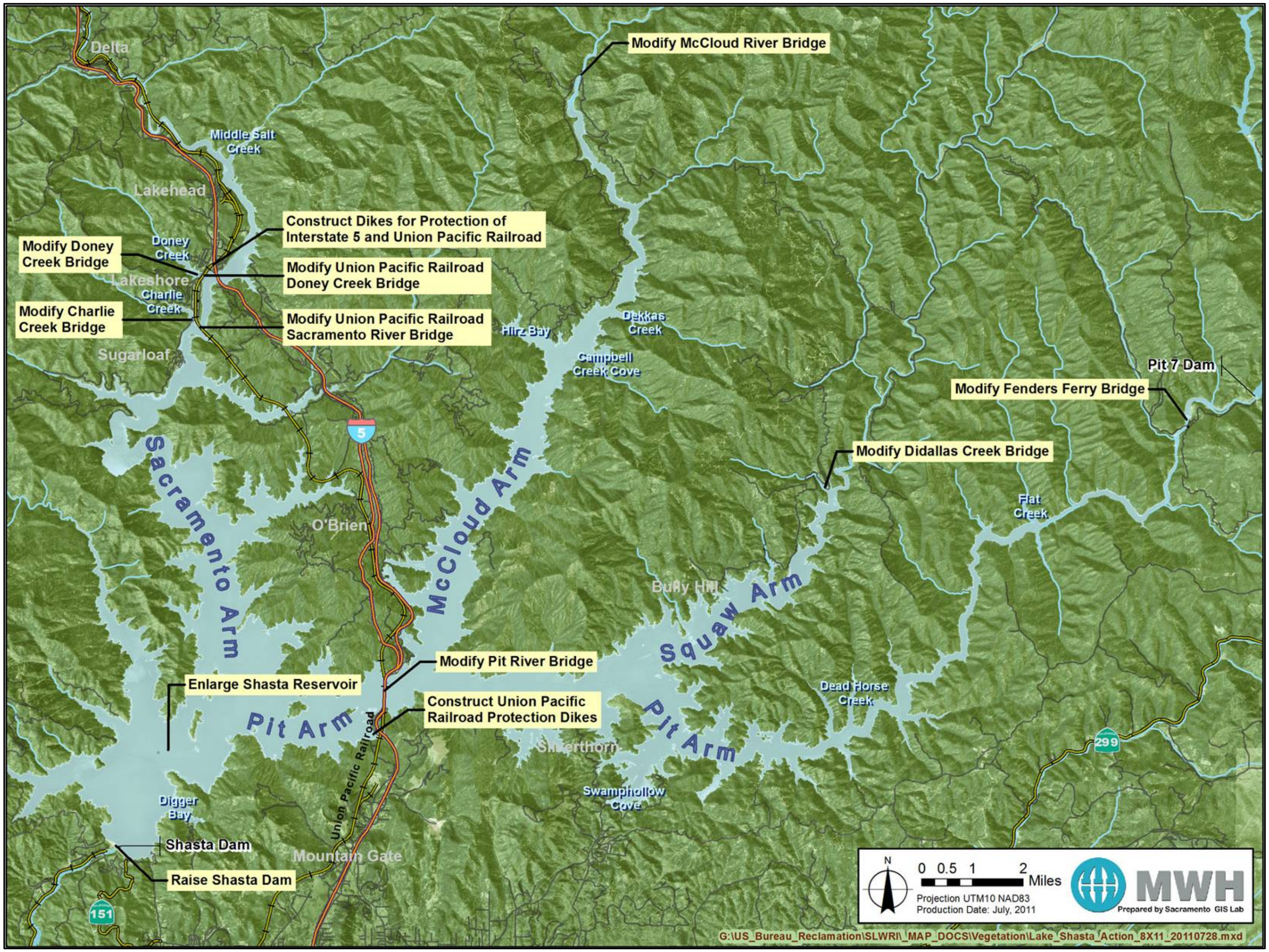
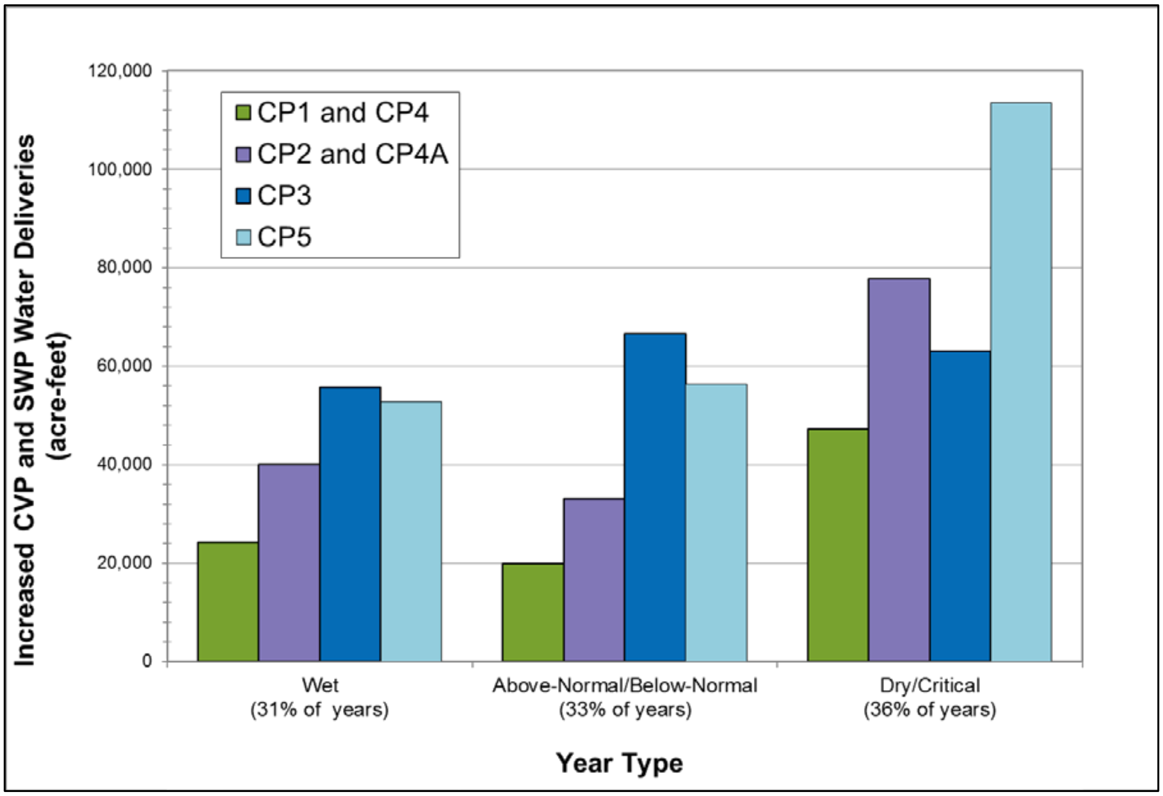



**Figure ES-6. Major Features Common to All Comprehensive Plans**

***Summary of Comprehensive Plan Benefits and Costs***

Each of the comprehensive plans would contribute in varying degrees to all of the primary and secondary planning objectives. For all of the comprehensive plans, the additional storage in Shasta Reservoir would be used to increase the ability of Reclamation to regulate water temperatures for anadromous fish and increase water supply reliability (Figure ES-7), primarily in drought periods. Table ES-3 summarizes the potential benefits and costs for each comprehensive plan. All comprehensive plans except CP1 and CP3 would have net economic benefits.




Note: Deliveries were simulated using CalSim-II and water year types were based on the Sacramento Valley Water Year Hydrologic Classification.

**Figure ES-7. Comparison of Increased CVP and SWP Water Deliveries by Water Year Type for Comprehensive Plans**

**Table ES-3. Summary of Potential Benefits and Costs of Comprehensive Plans**

| Item | CP1 | CP2 | CP3 | CP4 | CP4A | CP5 |
|---|---|---|---|---|---|---|
| **Shasta Dam Raise (feet)** | **6.5** | **12.5** | **18.5** | **18.5** | **18.5** | **18.5** |
| Total Increased Reservoir Storage (TAF) | 256 | 443 | 634 | 634 | 634 | 634 |
| **Benefits** | | | | | | |
| Increase Anadromous Fish Survival | | | | | | |
| Dedicated Reservoir Storage (TAF) | - | - | - | 378 | 191 | - |
| Increase in Outmigrating Chinook Salmon (thousand fish)[1] | 61 | 379 | 207 | 813 | 710 | 378 |
| Spawning Gravel Augmentation (tons)[2] | - | - | - | 10,000 | 10,000 | 10,000 |
| Side Channel Rearing Habitat Restoration | | | | Yes | Yes | Yes |
| Increase Water Supply Reliability | | | | | | |
| Total Increased Dry and Critical Year Water Supplies (TAF/year)[3] | 47.3 | 77.8 | 63.1 | 47.3 | 77.8 | 113.5 |
| Increased NOD Dry and Critical Year Water Supplies NOD (TAF/year)[3] | 4.5 | 10.7 | 35.2 | 4.5 | 10.7 | 25.2 |
| Increased SOD Dry and Critical Year Water Supplies SOD (TAF/year)[3] | 42.7 | 67.1 | 28.0 | 42.7 | 67.1 | 88.3 |
| Increased Water Use Efficiency Funding | Yes | Yes | Yes | Yes | Yes | Yes |
| Increased Emergency Water Supply Response Capability | Yes | Yes | Yes | Yes | Yes | Yes |
| Reduce Flood Damages | | | | | | |
| Increased Reservoir Storage Capacity | Yes | Yes | Yes | Yes | Yes | Yes |
| Additional Hydropower Generation | | | | | | |
| Increased Hydropower Generation (GWh/year)[4] | 52 - 54 | 87 - 90 | 86 - 90 | 127 - 133 | 125 - 130 | 112 - 117 |
| Ecosystem Restoration | | | | | | |
| Shoreline Enhancement (acres) | - | - | - | - | - | 130 |
| Tributary Aquatic Habitat Enhancement (miles)[5] | - | - | - | - | - | 6 |
| Riparian, Floodplain, and Side Channel Habitat Restoration | - | - | - | Yes | Yes | Yes |
| Increased Ability to Meet Flow and Temperature Requirements Along Upper Sacramento River | Yes | Yes | Yes | Yes | Yes | Yes |
| Improve Water Quality | | | | | | |
| Improved Delta Water Quality | Yes | Yes | Yes | Yes | Yes | Yes |
| Increased Delta Emergency Response Capability | Yes | Yes | Yes | Yes | Yes | Yes |
| Increase Recreation | | | | | | |
| Recreation (user days, thousands)[6] | 85 - 89 | 116 - 134 | 201 - 205 | 307 - 370 | 246 - 259 | 142 - 175 |
| Modernization of Recreation Facilities | Yes | Yes | Yes | Yes | Yes | Yes |
| **Economics** | | | | | | |
| Cost[7] | | | | | | |
| Construction Cost ($ millions) | 990 | 1,089 | 1,257 | 1,264 | 1,265 | 1,283 |
| Interest During Construction ($ millions) | 83 | 91 | 105 | 105 | 105 | 108 |
| Total Capital Cost ($ millions) | 1,073 | 1,180 | 1,362 | 1,370 | 1,371 | 1,391 |
| Annual Cost ($ millions/year)[7] | 45.1 | 51.2 | 53.8 | 57.1 | 59.0 | 61.0 |
| Annual NED Benefits ($ millions/year) [7,8] | | | | | | |
| Estimated Value (at inflation) [9] | 29.7 | 61.6 | 42.6 | 86.0 | 88.9 | 74.2 |
| Estimated Value (2% above inflation) [10] | 48.4 | 93.3 | 60.7 | 111.6 | 124.1 | 115.2 |
| Net NED Benefits ($ millions/year)[7,8] | | | | | | |
| Estimated Value (at inflation)[9] | -15.4 | 10.5 | -11.2 | 28.9 | 29.9 | 13.2 |
| Estimated Value (2% above inflation)[10] | 3.3 | 42.1 | 6.9 | 54.5 | 65.1 | 54.2 |

**Table ES-3. Summary of Potential Benefits and Costs of Comprehensive Plans (contd.)**

Notes:

[1] 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 the RBPP.

[2] Average amount per year for 10-year period.

[3] Total increased CVP and SWP deliveries during dry and critical years (based on the Sacramento Valley Water Year Hydrologic Water Classification). Does not reflect benefits related to water use efficiency actions included in all comprehensive plans.

[4] Annual increases in hydropower generation were estimated using two methodologies – at load center (accounting for transmission losses) and at-plant (no transmission losses). To provide a more conservative estimate of potential hydropower benefits, load center generation values were used to estimate potential benefits of increased hydropower generation under comprehensive plans. However, increased generation values reported in Chapter 23 of the accompanying EIS are based on at-plant generation values to capture the largest potential effects from changes in hydropower generation and pumping.

[5] Tributary aquatic enhancement provides for the connectivity of native fish species and other aquatic organisms between Shasta Lake and its tributaries. Estimates of benefits reflect only connectivity with perennial streams and do not reflect additional miles of connectivity with intermittent streams.

[6] Annual recreation visitor user days were estimated using two methodologies. The minimum user day value was used to estimate potential recreation benefits to provide a more conservative estimate of the potential benefits of increased recreation under comprehensive plans. However, in the accompanying EIS, the maximum user value was used for direct and indirect effects evaluations in each resource area chapter to capture the largest potential effects from increased visitation. These values do not account for increased visitation due to modernization of recreation facilities associated with all comprehensive plans.

[7] Based on January 2014 price levels, 3-1/2 discount rate, and 100-year period of analysis.

[8] Economic benefits reflect increases in anadromous fish production, water supplies for CVP and SWP deliveries, hydropower generation and ancillary services/capacity benefits, and recreation (increased user days). Does not include monetized annual benefits for ecosystem restoration, flood damage reduction, or water quality.

[9] Assumes the costs of water supplies and hydropower increase at the same rate as inflation.

[10] Includes increase of water supply and hydropower costs at 2 percent above inflation to account for growing scarcity in the future.

[11] All numbers are rounded for display purposes; therefore, line items may not sum to totals.

Key:

- = not applicable
CVP = Central Valley Project
Delta = Sacramento-San Joaquin Delta
EIS = Environmental Impact Statement
GWh/year = gigawatt-hours per year
NED = National Economic Development
NOD = north of Delta
SALMOD = Salmonid Population Model
SOD = south of Delta
SWP = State Water Project
TAF = thousand acre-feet

# Summary of Potential Environmental Effects

A thorough evaluation of environmental effects was performed as part of the NEPA process. Potential environmental impacts of the comprehensive plans, the duration and quantification of each impact, the level of significance of each impact before mitigation, recommended mitigation measures, and the level of significance of each impact after mitigation are described in detail in each resource area chapter of the accompanying EIS. The EIS also describes the environmental commitments common to all comprehensive plans, short-term use of the human environment, maintenance and enhancement of long-term productivity, and potential irreversible or irretrievable commitments of resources for the comprehensive plans.

The comprehensive plans would affect environmental resources in the primary and extended study areas. All comprehensive plans are similar in terms of their potential environmental effects, although some adverse effects would be exacerbated by larger dam raises and by the associated scale of the effects, such as expanded construction areas and increased area of inundation around Shasta Lake. Generally, adverse effects would be mitigated to less-than-significant levels with prescribed mitigation measures. Some adverse effects for all of the comprehensive plans would remain unavoidable despite mitigation measures.

Altered flow regimes along the upper Sacramento River, changes to the areas inundated by Shasta Lake, and disturbances associated with construction activities have the potential to affect environmental resources. However, these adverse effects would be mitigated to the extent practicable.

## Plan Evaluation and Comparison

The effects of the alternatives are organized and displayed in four categories that are referred to as accounts: (1) NED, (2) Environmental Quality (EQ), (3) Regional Economic Development (RED), and (4) Other Social Effects (OSE). These four accounts can encompass all significant effects of a plan on the human environment, as required by NEPA (Title 42, U.S. Code Section 4321 et seq.).

As shown in Table ES-4, and based on SALMOD and other models, all comprehensive plans except CP1 and CP3 would be cost-efficient, providing net NED benefits. CP4A would generate the maximum net economic benefits, $29.9 million annually, assuming the cost of water supply increases at the same rate as inflation. A sensitivity analysis was also performed assuming that water supply and hydropower costs would increase above the inflation rate, to account for potential growing scarcity of water and energy supplies in the future and increasing demands. Assuming an increase of water supply and hydropower costs at 2 percent above inflation, CP4A would generate $65.1 million in net benefits.

**Table ES-4. Summary of Estimated Annual Costs, Annual Benefits, and Net Benefits for Comprehensive Plans[1]**

| Item | CP1 | CP2 | CP3 | CP4 | CP4A | CP5 |
|---|---|---|---|---|---|---|
| **Annual Cost ($ millions/year)** | | | | | | |
| Total Annual Cost | 45.1 | 51.2 | 53.8 | 57.1 | 59.0 | 61.0 |
| **Annual Economic Benefits ($ millions/year)** | | | | | | |
| Estimated Value (at inflation)[2] | 29.7 | 61.6 | 42.6 | 86.0 | 88.9 | 74.2 |
| Estimated Value (2% above inflation)[3] | 48.4 | 93.3 | 60.7 | 111.6 | 124.1 | 115.2 |
| **Benefit/Cost Ratio** | | | | | | |
| Estimated Value (at inflation)[2] | 0.66 | 1.20 | 0.79 | 1.51 | 1.51 | 1.22 |
| Estimated Value (2% above inflation)[3] | 1.07 | 1.82 | 1.13 | 1.95 | 2.10 | 1.89 |
| **Net Economic Benefits ($ millions/year)[4]** | | | | | | |
| Estimated Value (at inflation)[2] | -15.4 | 10.5 | -11.2 | 28.9 | 29.9 | 13.2 |
| Estimated Value (2% above inflation)[3] | 3.3 | 42.1 | 6.9 | 54.5 | 65.1 | 54.2 |

Notes:
[1] Based on 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.
[4] All numbers are rounded for display purposes; therefore, line items may not sum to totals.
Key:
CP = comprehensive plan

The comprehensive plans were also compared based on the planning objectives and the four P&G criteria of completeness, effectiveness, efficiency, and acceptability (Table ES-5). Each of the plans is estimated to be complete and each appears to be effective in achieving its intended objectives. Each comprehensive plan also would be consistent with the objectives of the CVPIA, and also would contribute directly and indirectly, to varying degrees, to the four CALFED objectives of water quality, water supply reliability, ecosystem quality, and Delta levee integrity.

**Table ES-5. Summary Comparison of No-Action Alternative and Comprehensive Plans**

| Alternative | Effectiveness | Efficiency | Completeness | Acceptability | Combined Ranking |
|---|---|---|---|---|---|
| No-Action Alternative | None | None | Very Low | Very Low | Very Low |
| CP1 | Low | Low | Very High | High | Moderate |
| CP2 | Moderate | Moderate to High | Very High | Moderate to High | Moderate to High |
| CP3 | Moderate | Low | Very High | Moderate to High | Moderate |
| CP4 | High | Very High | High | Moderate to High | High |
| CP4A | Very High | Very High | High | High | Very High |
| CP5 | High | High | High | Moderate to High | High |

Key:
CP = comprehensive plan

Three comprehensive plans with an 18.5-foot dam raise, CP4, CP4A, and CP5, best address the planning objectives, based on benefits and costs derived. This is primarily because of (1) a high certainty (completeness) that the plans could achieve their intended benefits, and (2) relatively high effectiveness and economic efficiency. CP1 and CP2 would have less of an adverse effect on land uses within the dam inundation area than the other comprehensive plans because CP1 and CP2 would raise the dam by 6.5 feet and 12.5 feet, respectively, compared to the 18.5-foot increase proposed for CP3, CP4, CP4A, and CP5. However, a majority of the construction activities, annual costs, and reservoir area relocations would be required under any dam raise. In addition, the smaller Shasta Dam raise alternatives would provide only a portion of the increased storage capacity of an 18.5-foot raise.

Of the three highest ranking plans, CP4A is ranked highest because it is the most effective in meeting both of the primary planning objectives, the most cost-effective, and would likely be ranked the highest in overall acceptability considering a broad range of stakeholders.

## Rationale for Plan Selection

At this stage of the Federal planning and NEPA processes, the potential physical accomplishments and the benefits and costs of the alternative plans have been evaluated and compared based on established criteria.

As required by the P&G, the plan with the greatest NED benefits is to be identified as the NED Plan and is usually selected for recommendation to Congress for approval, unless the Secretary of the Interior grants an exception based on overriding considerations and merits of another plan. If another plan is recommended instead of the NED Plan, such as a locally preferred plan, the NED Plan is still presented as a basis of comparison to define the extent of Federal financial interest in the plan for recommendation.

Based on the evaluation of the potential physical accomplishments and the benefits and costs of the alternative plans, CP4A is the alternative that would achieve the highest net NED benefits while protecting the environment and is ranked the highest among the comprehensive plans in meeting the P&G criteria. Consistent with the P&Gs, since CP4A generates maximum net NED benefits, CP4A is identified as the NED Plan. CP4A is also identified as the Preferred Alternative in the Final EIS pursuant to NEPA. In addition, consistent with Department of the Interior climate change policy, CP4A is anticipated to provide benefits under a wide range of future climate scenarios and to provide additional flexibility to adapt to potential changes in hydrology under climate change. However, we are unable to make a final recommendation due to unresolved considerations as discussed in Chapter 9. Specifically, an agreement with project participants must be negotiated that addresses an up-front cost-share consistent with the beneficiary pays principle. There are also potential conflicts with State law, fish and wildlife concerns, and tribal considerations that must also be addressed.

## Feasibility Determination for the National Economic Development Plan

Feasibility determination includes the following four elements:

- Technical feasibility, consisting of engineering, operations, and constructability analyses verifying that it is physically and technically possible to construct, operate, and maintain the project

- Environmental feasibility, consisting of analyses verifying that constructing or operating the project will not result in unacceptable environmental consequences to the environment

- Economic feasibility, consisting of analyses verifying that constructing and operating the project would result in net NED benefits

- Financial feasibility, consisting of examining and evaluating the project beneficiaries' ability to repay their allocated portion of the Federal investment in the project over a period of time, consistent with applicable law

The following summarizes the technical, environmental, economic, and financial feasibility of the NED Plan.

### Technical Feasibility

The NED Plan is projected to be technically feasible. Designs and cost estimates for CP4A have been developed to a feasibility level. A Design, Estimating, and Construction (DEC) Review was performed in August 2008. Based on recommendations from the DEC review, designs and costs were refined to bring all construction features to a feasibility level. In April 2014, a Special Assessment was performed to verify completion of DEC recommendations.

### Environmental Feasibility

The NED Plan is evaluated in the accompanying Final EIS. Environmental effects were evaluated and mitigation measures were identified. CP4A was identified as the Preferred Alternative, consistent with NEPA, in the Final EIS.

The NED Plan would affect environmental resources in the primary and extended study areas. Beneficial effects correspond to the following resource areas: hydrology, hydraulics, and water management; water quality; fisheries and aquatic resources; socioeconomics, population, and housing; recreation and public access; transportation and traffic; and power and energy. Some of the adverse effects anticipated for raising Shasta Dam would be temporary, construction-related effects that would be less than significant or would be reduced to less-than-significant levels through mitigation. Other adverse effects would be long-term, such as effects on botanical, wildlife, and cultural resources, within newly inundated areas of Shasta Lake. Some adverse effects would remain unavoidable despite mitigation measures.

Reclamation will incorporate environmental commitments and best management practices to avoid or minimize potential effects. Reclamation will, contingent on Congressional authorization, coordinate the planning, engineering, design and construction, and operations and maintenance (O&M) phases of the project with applicable resource agencies.

### Economic Feasibility

The NED Plan provides the greatest net NED benefits of the alternatives evaluated while protecting the environment. As shown in Table ES-6, the NED Plan is projected to be economically feasible, generating net benefits of $29.9 million annually, assuming water supply and hydropower costs increase at the same rate as inflation. Assuming an increase of water supply and hydropower costs at 2 percent above inflation to account for growing scarcity of water and energy supplies in the future and increasing demand, the CP4A would generate $65.1 million annually in net benefits.

**Table ES-6. Estimated Costs and Benefits for the NED Plan[1]**

| Item | NED Plan |
|---|---|
| **Costs** | |
| Total Construction Cost ($ millions) | 1,265 |
| Interest During Construction ($ millions) | 105 |
| Annual Cost ($ millions/year) | 59.0 |
| **Annual Benefits ($ millions/year)** | |
| Estimated Value (at inflation)[2] | 88.9 |
| Estimated Value (2% above inflation)[3] | 124.1 |
| **Net Economic Benefits ($ millions/year)** | |
| Estimated Value (at inflation)[2] | 29.9 |
| Estimated Value (2% above inflation)[3] | 65.1 |
| **Benefit/Cost Ratio** | |
| Estimated Value (at inflation)[2] | 1.51 |
| Estimated Value (2% above inflation)[3] | 2.10 |

Note:
[1] Based on 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.
Key:
NED = National Economic Development

## Financial Feasibility

Under the traditional Reclamation construction paradigm, where appropriated funds are used to support construction and then repaid over time, a traditional financial feasibility determination during the planning stage consists of (1) allocating costs to project purposes, (2) assigning reimbursable and nonreimbursable costs, (3) identifying potential project beneficiaries, and (4) determining project beneficiaries' potential ability to pay their allocated and assigned costs, including capital and long-term operation, maintenance, and replacement costs. The analysis and financial feasibility of the NED Plan will help inform this discussion.

### *Initial Cost Allocation*

A separable costs-remaining benefits (SC-RB) analysis was performed for the NED Plan.  The largest portion of construction costs would be expended to implement plan features required to accomplish the primary planning objectives.  The allocation of costs using the SC-RB method and a 100-year period of analysis is summarized in Table ES-7.

**Table ES-7. Initial Construction Cost Allocation Summary for CP4A ($ millions)[1, 2]**

| Item/ Calculation | Irrigation Water Supply | M&I Water Supply | Fish and Wildlife Enhancement | Hydro-power | Total |
|---|---|---|---|---|---|
| **Allocated Total Annual Costs** | | | | | |
| Average Annual Benefits | 5.1 | 21.8 | 33.3 | 14.4 | 74.6 |
| Single-Purpose Projects | 43.6 | 44.5 | 42.2 | 14.4 | - |
| Justifiable Expenditure (Lessor of Benefits/Single Purpose Alt Costs) | 5.1 | 21.8 | 33.3 | 14.4 | 74.6 |
| Separable Annual Costs | 4.5 | 7.0 | 6.5 | 0.0 | 18.0 |
| Remaining Benefits/Justifiable Expenditure | 0.6 | 14.8 | 26.8 | 14.4 | 56.6 |
| % Remaining Benefits | 1% | 26% | 47% | 25% | 100% |
| Allocated Joint Cost | 0.5 | 10.7 | 19.4 | 10.4 | 41.0 |
| Total Allocated Costs | 4.9 | 17.7 | 25.9 | 10.4 | 59.0 |
| **Allocated Construction Costs** | | | | | |
| Construction Cost | 103.8 | 303.6 | 614.5 | 243.6 | 1,265.5 |
| % of Total Construction Cost | 8% | 24% | 49% | 19% | 100% |

Notes:
[1] January 2014 price level, 3.5 percent interest rate, and 100-year period of analysis.
[2] All numbers are rounded for display purposes, and therefore line items may not sum to totals.
Key:
- = not applicable
IDC = interest during construction
M&I = municipal and industrial
O&M = operations and maintenance

### *Cost Assignment*

Table ES-8 shows an estimate of costs assigned to reimbursable and nonreimbursable project purposes consistent with existing Federal law for illustrative purposes. The assignment percentages are based on the cost allocation shown in Table ES-7. The final assignment of costs will be negotiated in the up-front cost-share agreement with project participants that must be completed prior to any recommendation being made.

**Table ES-8. Initial Construction Cost Assignment for the NED Plan ($millions)[1]**

| Purpose /Action | Total | | Cost Assignment | | | |
|---|---|---|---|---|---|---|
| | | | Nonreimbursable | | Reimbursable | |
| | Percent | Cost | Percent | Cost | Percent | Cost |
| **Study Objectives** | | | | | | |
| Irrigation Water Supply | 8% | 103.8 | 0% | 0.0 | 100% | 103.8 |
| M&I Water Supply | 24% | 303.6 | 0% | 0.0 | 100% | 303.6 |
| Fish & Wildlife Enhancement | 49% | 614.5 | 100% | 614.5 | 0% | 0.0 |
| Hydropower | 19% | 243.6 | 0% | 0.0 | 100% | 243.6 |
| **Total** | 100% | 1,265.5 | 49% | 614.5 | 51% | 651.0 |

Notes:
[1] All numbers are rounded for display purposes, and therefore line items may not sum to totals.
[2] Final cost allocation and assignment would occur following completion of project construction.
Key:
M&I = municipal and industrial
NED = National Economic Development

**Financial Analyses** For illustrative purposes, an assessment of the financial repayment capacity of different types of project beneficiaries was conducted. For irrigation water supply, an initial ability to pay analysis was conducted for contractors in four regions of the CVP. Due to the significant level of effort and associated cost to develop district level ability to pay analyses, a representative district was evaluated for each region in lieu of detailed analyses for each of the over 250 current contracting entities within the CVP service area. Based on this analysis, if water supplies and costs are fully integrated into the CVP to meet existing contracts, all four representative contractors would have the ability to pay allocated project costs. Further, increasing crop prices, transition to more valuable permanent crops, and repayment of existing CVP facility capital costs by 2030 indicate that the ability to pay is increasing for irrigation districts with the potential to benefit from the NED Plan. Increases in population and a large average annual payment capacity of municipal users indicate that potential M&I contractors that would benefit from CP4A will be able to repay the allocated project costs. Financial feasibility for hydropower beneficiaries was evaluated based on comparison of historical and projected future CVP power costs relative to market rates in the region. Based on these evaluations, power market rates have and will likely continue to exceeded CVP power costs on a long-term average annual basis, and it is expected that CVP power will remain an attractive component of power contractors' electricity generation portfolios with changes in repayment obligations associated with implementing the NED Plan.

## Implementation Considerations

The following sections discuss key considerations related to implementing the NED Plan, including risk and uncertainty, unresolved issues, major topics of interest identified through public outreach, implementation requirements, and Federal and non-Federal responsibilities.

### Risk and Uncertainty

Certain assumptions were made for aspects of the feasibility study based on engineering, economic, and scientific judgment. Careful consideration was given to the methodologies and evaluations for hydrology and system operations, biological analyses, economics, and cost estimates. Analyses were developed with advanced modeling and estimating tools using historical data and trends. While this is effective in helping predict outcomes for future operations, biological conditions, benefits, and costs, many uncertainties could affect the findings in this Feasibility Report. Various risks and uncertainties associated with the SLWRI and potential modification of Shasta Dam include the following:

- **Hydrology and Climate Change –** Uncertainty exists regarding the potential for, and magnitude of, climate change affecting temperature, precipitation, and snow levels. The Climate Change Modeling Appendix to the accompanying EIS discusses potential implications of climate change for California water resources and documents sensitivity analyses of the potential for SLWRI alternatives to address primary project objectives under climate change.  These evaluations indicate that the comprehensive plans are robust and would provide benefits under a range of future climate scenarios.

- **Water Supply Reliability and Demands –** Although demands are expected to exceed supplies in the future, predicting the absolute value of future water supplies and/or shortages in California is not possible. Such predictions would depend upon numerous variables, with differing opinions regarding each variable, such as anticipated population growth scenarios, land use patterns, and water use efficiency actions.

- **Anadromous Fish Populations –** Predictions of fish survival require assumptions with various levels of uncertainty, including the future number of spawners returning each year, future habitat conditions outside the project area, and potential effects of climate change. Adaptive management measures can be applied to reduce uncertainty by deliberately and iteratively designing, implementing, monitoring, and adjusting system operations to minimize adverse impacts and increase beneficial effects to fisheries.

- **Water System Operations Analysis –** Predictions of future water system operations depend on assumptions about future facilities, operational constraints, hydrology, and changes in Delta exports based on Federal regulations, including the ongoing consultation process on the long-term operations of the CVP and SWP and planning policies that are subject to change.

- **Cost Estimates –** All cost estimates, even at a feasibility-level, have inherent risks and uncertainties, including labor costs, materials availability, competitive bidding environments, unidentified field conditions, financial and/or commodity market conditions, and changing regulatory environments.  Of primary consideration, varying uncertainties are associated with the material and unit costs used to develop the estimates.  In particular, price volatility in the construction market in the last several years, particularly between 2002 and 2009, has resulted in uncertainty in the price of construction materials and labor costs.  Trends from the past few years were used to develop  cost estimates for materials and labor, but other factors could further influence price changes.

- **Construction Schedule and Funding –** The construction schedule and associated costs for the NED Plan are based on receiving appropriations consistent with the schedule.  As noted above and in Chapter 9, a negotiated cost-share agreement with participants, addressing up-front financing, is necessary prior to a recommendation. Even with such an agreement, it may be difficult to obtain Federal appropriations for the Federal share. Delays in any funding may potentially extend the construction schedule, resulting in increased costs.

- **Monetizing Project Benefits –** Varying uncertainties are associated with each valuation method for the NED benefit categories. For example, uncertainties in projections of future population estimates and cropping patterns could affect estimates of economic benefits for water supply reliability. Further, due to increasing demands on a relatively fixed water supply system, water storage capacity is likely to become increasingly valuable as water shortages become more frequent and severe. To address the risk and uncertainty related to valuation of benefits, alternate valuation methods are presented for each benefit category as a sensitivity analysis for the NED Plan, CP4A. Based on this sensitivity analysis of CP4A, the resulting total economic benefits would be approximately four times higher than the benefits used in the NED analysis. This would result in a benefit/cost ratio for CP4A of approximately 5.74, in comparison to the 1.51 benefit/cost ratio based on the benefits used in the NED analysis. We note, however, that a change in fish production modeling methodology will likely also change the NED analysis.

## Major Topics of Interest

Members of the public, stakeholders, other Federal agencies, and State and local agencies identified several areas of concern during the SLWRI planning process. The focus of interest varied among participants, but a common theme centered on potential impacts in the Shasta Lake area that could result from enlargement of the reservoir. Key topics of concern included the following:

- Potential effects on cultural resources in the Shasta Lake area
- Potential effects on recreation and recreation providers in the Whiskeytown-Shasta-Trinity NRA
- Potential effects on special-status species around Shasta Lake, including terrestrial and aquatic species
- Potential effects on the lower McCloud River
- Potential effects on Central Valley hydrology below CVP and SWP reservoirs and related facilities and resulting effects on water supplies for water contractors and other water users

## Implementation Requirements

After this Final Feasibility Report is completed, a number of requirements will remain before a project can be implemented. These requirements are described below.

### *Agreement on Up-Front Cost-Share with Project Participants*

A cost-share agreement addressing an up-front cost share must be negotiated prior to any recommendation being made. As noted, current Federal budget conditions and the impacts those conditions have on Reclamation's budgetary resources significantly constrain Reclamation's ability to fully fund new construction activities of the scope and magnitude required by the SLWRI. As a result, the traditional model under Federal reclamation law, with Congress providing funding from annual appropriations to cover all the costs of construction over a relatively short period of time, and a portion of those funds being repaid to the Treasury over 40 – 50 years, is unrealistic for the identified SLWRI NED Plan. Alternative means of financing (primarily non- Federal) for a majority of the construction costs of the NED Plan would have to be identified and secured in order for the Secretary of the Interior to be able to recommend a construction authorization to Congress.

### *Project Authorization*

The proposed project, in light of any potential agreement on up-front cost-share as discussed above, would then be considered for authorization by Congress. Congress may (1) approve the NED Plan or any other plan, with or without further modification; (2) decide not to approve any action alternative; or (3) request additional information from the Secretary. If authorized, Congress may provide further direction through legislation and provide appropriations to implement the authorized project.

### *Project Funding/Appropriations*

If authorized, a separate appropriation authorization would be required. Unless otherwise established by law, funding for construction of an authorized project is typically included in the President's budget based on (1) national priorities, (2) magnitude of the Federal commitment, (3) level of local support, (4) willingness of the non-Federal sponsor to fund its share of the project costs, and (5) budgetary constraints that may exist at the time of construction. The source, availability, appropriation process, and timing may affect the estimated construction schedule included in this Final Feasibility Report, Final EIS and supporting documents.

### *Regulatory and Related Requirements for Environmental Compliance*

Modifications to Shasta Dam and Reservoir would be subject to the requirements of Federal, State, and local laws, policies, and environmental regulations, as described in this Feasibility Report and accompanying Final EIS and/or as supplemented or modified by authorizing legislation. Reclamation or a CEQA lead agency, assuming one is identified in the future, would need to obtain various permits and regulatory authorizations before any project construction could begin. If Congress authorizes and funds construction to enlarge Shasta Dam and Reservoir, then preconstruction activities will be conducted to refine the designs and costs of project features and mitigation commitments, finalize implementation responsibilities, and complete supplemental documentation before preparing and submitting various permit applications to regulatory agencies for approval. Table ES-9 identifies the likely permits, responsible agencies, and their responsibilities that are required before the start of any physical project implementation activities. After the approval of all required permits, and/or waivers as may be appropriate, then the implementation of mitigation measures may proceed before, or consistent with other physical features, in compliance with NEPA and standard Federal practices.

#### *Advanced Planning and Design Activities*

If Congress authorizes and appropriates funds for construction of a project to enlarge Shasta Dam and Reservoir, then Reclamation would initiate activities in coordination with project partners and stakeholders to conduct and complete required advanced planning and design activities before implementation of the project. Several key activities include: (1) developing a post-authorization report to present the results of subsequent advanced planning actions, refinement of designs, cost estimates, updated analyses of potential effects and economics, and related NEPA and/or CEQA analyses and documentation, if necessary; (2) preparing detailed plans, specifications, and bid packages; (3) establishing agreements for reimbursable project purposes; (4) developing and/or revising operations, maintenance, and related plans; and (5) acquiring required lands, easements, and rights-of-way.

#### *Project Construction and Transfer to O&M Status*

After the feasibility study and resultant decision making, post-authorization environmental compliance, advanced planning and design efforts described above, then project implementation efforts would transition to the preparing and executing construction contracts, starting implementation of mitigation measures and/or construction activities, completing such construction activities, commissioning new facilities, and, finally, operating and establishing and/or transferring O&M responsibilities.

**Table ES-9. Summary of Potential Major Permits and Approvals for Project Implementation**

| Agency Permit/Approval | Recommended Prerequisites for Submittal[1] |
|---|---|
| **Federal** | |
| **USACE**<br>Clean Water Act Section 404 | • Application<br>• ESA compliance document for submittal to USFWS/NMFS/CDFW<br>• Section 401 Water Quality Certification permit or application<br>• NEPA documentation (environmental compliance documents)<br>• Section 106 compliance documentation<br>• Wetland delineation<br>• Section 404 (b)(1) evaluation and identification of Least Environmentally Damaging Practical Alternative<br>• Mitigation and monitoring plan |
| **USFWS/NMFS**<br>Endangered Species Act Section 7 Consultation | • Regular informal technical consultation<br>• ESA compliance document<br>• Draft environmental compliance documents |
| **USFWS/NMFS/CDFW**<br>Fish and Wildlife Coordination Act | • Regular informal technical consultation<br>• ESA compliance document<br>• Draft environmental compliance documents |
| **SHPO[2]/ACHP**<br>National Historic Preservation Act, Section 106 | • Historic Property Inventory Report<br>• Native American consultation |
| **State** – PRC 5093.542 (c) and (d), pertaining to the McCloud River, may limit the ability of State agencies to review and process permits and related approvals for modifications of Shasta Dam and Reservoir. | |
| **RWQCB**<br>Clean Water Act Section 401 | • Application<br>• Fish and Game Code Section 1602 application<br>• CWA Section 404 permit or application<br>• Draft environmental compliance documents<br>• Mitigation and monitoring plan (if needed) |
| **CDFW**<br>California Endangered Species Act Section 2081 – Incidental Take Permit<br>or<br>2080.1 Consistency Determination | • Informal technical consultation<br>• Application, if requesting a 2081 Incidental Take Permit<br>• Biological Opinion and incidental take statement, if requesting a consistency determination (preferred approach) |
| **CDFW**<br>Fish and Game Code Section 1600 Streambed Alteration Agreement | • Application<br>• Section 401 Water Quality Certification permit or application<br>• CWA Section 404 permit or application<br>• Draft environmental compliance documents<br>• Mitigation plan |
| **Central Valley Flood Protection Board**<br>California Code, Title 23 – Encroachment Permit | • Application |
| **State Lands Commission**<br>Land Use Lease | • Application<br>• Draft environmental compliance documents |
| **State of California Department of Transportation**<br>Encroachment Permit | • Application<br>• Permit Engineering Evaluation Report |
| **Local** | |
| **SCAQMD**<br>Authority to Construct and Permit to Operate | • Application<br>• Preapplication meeting (encouraged) |

**Table ES-9. Summary of Potential Major Permits and Approvals for Project Implementation (contd.)**

Notes:
[1] All permit applications require detailed project description information.
[2] PRC 5093.542 (c) and (d), pertaining to the McCloud River, may limit the ability of State agencies to review and process permits and related approvals for modifications of Shasta Dam and Reservoir.

Key:
ACHP = Advisory Council on Historic Preservation
CDFW = California Department of Fish and Wildlife
CWA = Clean Water Act
ESA = Endangered Species Act
NEPA = National Environmental Policy Act
NMFS = National Marine Fisheries Service
PRC = Public Resources Code
RWQCB = Regional Water Quality Control Board
SCAQMD = Shasta County Air Quality Management District
SHPO = State Historic Preservation Office
State = State of California
State Water Board = State Water Resources Control Board
USACE = U.S. Army Corps of Engineers
USFWS = U.S. Fish and Wildlife Service

## Federal Responsibilities

If recommended for implementation, Reclamation and/or future project partners or beneficiaries would perform preconstruction and design studies for the NED Plan, which may require updated economic and/or environmental analyses and documentation. After project cooperation agreements are signed and non-Federal sponsors have provided any required financial contributions and assurances, the Federal Government would likely construct the project modifications and related mitigation requirements. Reclamation and other Federal agencies (e.g., USFS) would be responsible for various operations and maintenance activities.

## Non-Federal Responsibilities

Before implementation, the non-Federal sponsor(s) (i.e., beneficiaries) for reimbursable costs would agree to perform items of local and state cooperation specific to the authorized purposes of the project. One or more non-Federal sponsors needs to be identified for each of the reimbursable project purposes. For most and possibly all of the reimbursable purposes, the non-Federal sponsor would need to share in the cost of the NED Plan.

## Potential Implementation Timeline

A timeline of major milestones, documents, and actions to complete the feasibility study, preconstruction planning and design, and construction phases is shown in Figure ES-8. If and when congressional authorization and related appropriations occur, project implementation would take place in two phases. The initial phase would span approximately five years and would include developing detailed project designs, acquiring necessary permits, and acquiring required real estate interests and/or relocating displaced parties according to Public Law 91-646. Once these initial phase activities are complete, construction of major project features would begin. Construction activities would likely span approximately five years. Estimated timelines are based upon availability of sufficient funding on an annual basis.

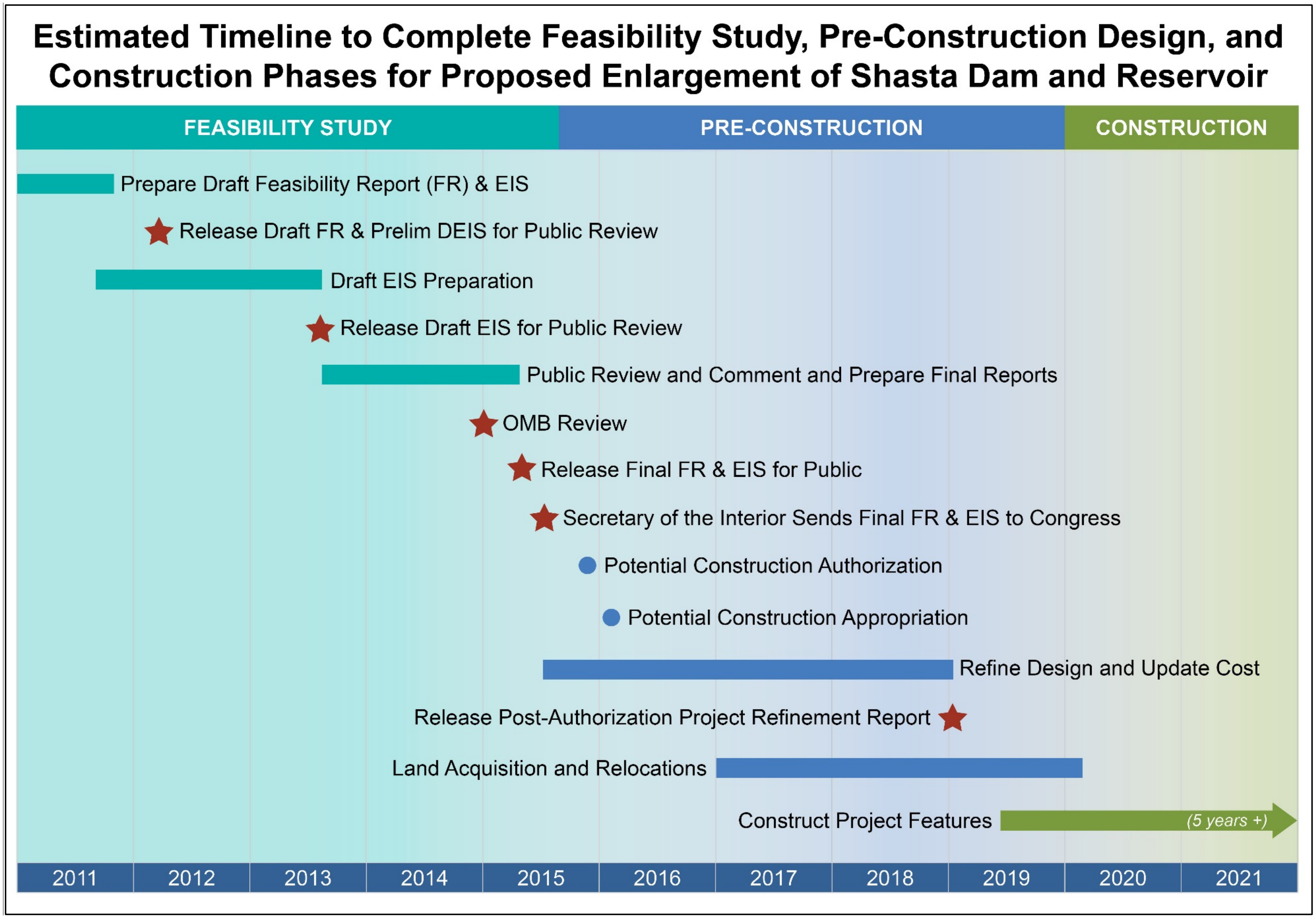



**Figure ES-8. Shasta Lake Water Resources Investigation Project Timeline**

# Considerations and Recommendations

In light of the outstanding considerations articulated below, the Secretary is unable to provide a recommendation for implementation of the SLWRI NED Plan until these considerations are addressed. Although there is no recommendation at this time for Congressional action, all of the alternatives analyzed are feasible from an engineering standpoint. Based on the economic analysis of the alternatives, alternative CP4A has the highest net NED benefits.

## Outstanding Considerations

***Funding Concerns***

Current Federal budget conditions and the impacts those conditions have on Reclamation's budgetary resources significantly constrain Reclamation's ability to fully fund new construction activities of the scope and magnitude required by the SLWRI. As a result, the traditional model under Federal reclamation law, with Congress providing funding from annual appropriations to cover all the costs of construction over a relatively short period of time, and a portion of those funds being repaid to the Treasury over 40 – 50 years, is unrealistic for the identified SLWRI NED Plan. Alternative means of financing (primarily non-Federal) for a majority of the construction costs of the NED Plan would have to be identified and secured in order for the Secretary of the Interior to be able to recommend a construction authorization to Congress. These alternative financing arrangements are being actively explored at a conceptual level.

Significant concerns have been raised by existing CVP water service and repayment contractors regarding water supply benefits from the proposed project being made available to California SWP contractors outside the existing service area of the CVP. In part, their concern emanates from a desire to have water supply developed under any of the alternatives meet existing demands of Federal contractors within the existing CVP service area before being utilized to meet water supply needs of public water agencies that do not currently contract for delivery of CVP water. To address this concern, Reclamation will work with public water agencies that do currently contract for the delivery of CVP water, and other interested governmental and non-governmental organizations to explore alternative, non-traditional methods of financing. The alternative ultimately chosen as the recommended plan will need to include the use of new storage to provide increased cold water protection for anadromous fish in the Sacramento River. Additionally, it should include water supply benefits for those public water agencies that are willing to contribute non-Federal funds for the construction of the project, with preference given to those agencies that are within the existing service area of the CVP.

***State of California Support and Participation***

Section 103(d)B(i) of Public Law 108-361 makes clear the intent of Congress that the Secretary consult with the State prior submitting the report. From discussions with the State, it is our understanding there has been a determination that the PRC protecting the McCloud River prohibits State participation in the planning or construction of enlarging Shasta Dam other than participating in technical and economic feasibility studies.

#### *Environmental Considerations*

While the Fish and Wildlife Coordination Act process has been completed through the exchange of comments and responses outlined in an appendix to the EIS, there are listed species under both the Federal and State endangered species laws that may be affected by this action. While it is clear that a consultation under Section 7 of the Federal Endangered Species Act will be required prior to implementation of any alternative, until the financing issues are resolved, it is unclear whether California's endangered species laws and other State environmental statutes will apply. Should any State legal requirements apply, the costs of attaining compliance with these State laws shall be the responsibility of the non-Federal participant.

#### *Native American and Cultural Resources*

Numerous cultural resources would be significantly affected by all of the action alternatives. Reclamation has invited Federally recognized tribes and non-Federally recognized Native American groups to be consulting parties to the National Historic Preservation Act Section 106 process. No Federally recognized tribes reside in the immediate Shasta Lake area. However, the Winnemem Wintu continue to raise concerns about impacts of the original construction of Shasta Dam and potential impacts of enlarging Shasta Dam on sites they value for historical and cultural significance. The Winnemem Wintu would continue to have the opportunity to participate, and are anticipated to continue to provide input as an invited consulting party, through the Section 106 process.

### Process Considerations and Required Authorities

Prior to a recommendation, the Secretary is of the view that there must be resolution of the outstanding considerations raised. In the absence of a Congressional authorization to the contrary, resolution of these issues could be achieved through an agreement between the Secretary and appropriate non-Federal entities on a specific alternative and how the funding will be provided for that specific alternative. Any such agreement must address: total funding, payment up-front by the non-Federal partner, ability to use the non-Federal funds in the construction process, a plan to meet all environmental commitments, and agreement on the operations of the revised facility and conveyance of the associated water to the intended beneficiary. Such an agreement would then be presented to Congress for authorization.

If Congress were to authorize construction based on an agreement that addresses the Secretary's outstanding concerns, additional technical issues would need to be considered and addressed regarding Federal appropriations and the associated ceiling, treatment of additional operations and maintenance costs, completion of applicable State and Federal permitting actions, and Congressional authorization of required authorities.

# Contents

# Tables

# Figures

# Appendices



# Abbreviations and Acronyms

| | |
|---|---|
| °F | degrees Fahrenheit |
| 2004 NMFS BO | 2004 Biological Opinion on the Long-Term CVP and SWP OCAP |
| 2004 OCAP | 2004 Long-Term CVP Operations Criteria and Plan |
| 2004 OCAP BA | 2004 Long-Term CVP and SWP OCAP Biological Assessment |
| 2005 USFWS BO | 2005 Reinitiation of Formal and Early Section 7 ESA Consultation on the Coordinated Operations of the CVP and SWP and the OCAP to Address Potential Critical Habitat Issues |
| 2008 Long-Term Operation Biological Assessment | 2008 Biological Assessment on the Continued Long-Term Operations of the CVP and SWP |
| 2008 USFWS BO | 2008 Proposed Coordinated Operations of the CVP and SWP |
| 2009 NMFS BO | 2009 BO and Conference Opinion on the Long-Term Operations of the CVP and SWP |
| ACHP | Advisory Council on Historic Preservation |
| ACID | Anderson-Cottonwood Irrigation District |
| AF | acre-feet |
| AFRP | Anadromous Fish Restoration Program |
| APA | Administrative Procedure Act |
| AFS | anadromous fish survival |
| BA | biological assessment |
| Bay Area | San Francisco Bay Area |
| Bay-Delta | San Francisco Bay/Sacramento-San Joaquin Delta |
| BDCP | Bay Delta Conservation Plan |
| BIA | Bureau of Indian Affairs |

| | |
|---|---|
| BLM | Bureau of Land Management |
| BMP | best management practice |
| BO | biological opinion |
| CALFED | CALFED Bay-Delta Program |
| Cal Fire | California Department of Forestry and Fire Protection |
| CalSim-II | California Statewide Simulation Model |
| Caltrans | California Department of Transportation |
| CCR | California Code of Regulations |
| CDFW | California Department of Fish and Wildlife |
| CEQA | California Environmental Quality Act |
| CESA | California Endangered Species Act |
| CFR | Code of Federal Regulations |
| cfs | cubic feet per second |
| CNPS | California Native Plant Society |
| CO | combined objective |
| CP | Comprehensive Plan |
| cu-yd | cubic yard |
| CVP | Central Valley Project |
| CVPIA | Central Valley Project Improvement Act |
| CWA | Clean Water Act |
| CWC | California Water Code |
| Delta | Sacramento-San Joaquin Delta |
| DEC | Design, Estimating and Construction |
| DEIR/S | Draft Environmental Impact Report/Statement |
| DEIR | Draft Environmental Impact Report |
| DEIS | Draft Environmental Impact Statement |
| District Court | District Court for the Eastern District of California |
| DMC/CA | Delta-Mendota Canal/California Aqueduct |
| DOI | Department of the Interior |
| DWR | California Department of Water Resources |
| EIR | Environmental Impact Report |
| EIS | Environmental Impact Statement |
| elevation xxx | elevation in feet above mean sea level |
| EPA | U.S. Environmental Protection Agency |
| EQ | environmental quality |
| ERP | Ecosystem Restoration Program |
| ESA | Endangered Species Act |
| FR | Federal Register |

| | |
|---|---|
| FWCA | Fish and Wildlife Coordination Act |
| GIS | geographic information system |
| GWh | gigawatt-hour |
| GWh/yr | gigawatt-hour per year |
| hhld | household |
| HMBP | Hazardous Materials Business Plan |
| hp | horsepower |
| I-5 | Interstate 5 |
| IDC | interest during construction |
| IMPLAN | IMpact analysis for PLANning |
| Interior | U.S. Department of the Interior |
| Investigation | Shasta Lake Water Resources Investigation |
| I/O | input/output |
| IRWMP | Integrated Regional Water Management Plans |
| JPOD | joint points of diversion |
| kW | kilowatts |
| LEDPA | Least Environmentally Damaging Practicable Alternative |
| LTGen | LongTermGen |
| M&I | municipal and industrial |
| MAF | million acre-feet |
| MOA | Memorandum of Agreement |
| MW | megawatt |
| NA | not applicable |
| NAVD88 | North American Vertical Datum of 1988 |
| NED | national economic development |
| NEPA | National Environmental Policy Act |
| NGVD29 | National Geodetic Vertical Datum of 1929 |
| NMFS | National Marine Fisheries Service |
| NOA | Notice of Availability |
| NOD | north-of-Delta |
| NODOS | North-of-Delta Offstream Storage |
| NOI | Notice of Intent |
| NOP | Notice of Preparation |
| NRA | National Recreation Area |
| O&M | operations and maintenance |
| OMB | Office of Management and Budget |
| OSE | other social effects |

| | |
|---|---|
| P&G | Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies |
| PAM | Planning Aid Memorandum |
| PCA | Project Cooperation Agreement |
| PCT | Project Coordination Team |
| PEIS/R | Programmatic Environmental Impact Statement/Report |
| PG&E | Pacific Gas and Electric Company |
| PLSS | Public Land Survey System |
| PM | particulate matter |
| PRC | California Public Resources Code |
| R | river |
| RBPP | Red Bluff Pumping Plant |
| RCD | Resource Conservation District |
| Reclamation | U.S. Department of the Interior, Bureau of Reclamation |
| RED | regional economic development |
| Regional Water Board | Regional Water Quality Control Board |
| RM | River Mile |
| ROD | Record of Decision |
| RPA | Reasonable and Prudent Alternative |
| RV | recreational vehicle |
| RWQCB | Regional Water Quality Control Board |
| SALMOD | Salmonid Population Model |
| SB | Senate Bill |
| SCAQMD | Shasta County Air Quality Management District |
| SC-RB | Separable Costs-Remaining Benefits |
| SHPO | State Historic Preservation Office |
| SLWRI | Shasta Lake Water Resources Investigation |
| SMT | Study Management Team |
| SOD | south-of-Delta |
| sq-mi | square mile |
| SRCAF | Sacramento River Conservation Area Forum |
| SRTTG | Sacramento River Temperature Task Group |
| State | State of California |
| State Water Board | State Water Resources Control Board |
| STNF | Shasta-Trinity National Forest |
| SVAB | Sacramento Valley Air Basin |
| SVWMP | Sacramento Valley Water Management Program |
| SWP | State Water Project |

| | |
|---|---|
| SWPPP | Stormwater Pollution Prevention Plan |
| TAF | thousand acre-feet |
| TCD | temperature control device |
| TWG | Technical Working Groups |
| Uniform Act | Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, as amended |
| UPRR | Union Pacific Railroad |
| USACE | U.S. Army Corps of Engineers |
| USC | U.S. Code |
| USFS | U.S. Department of Agriculture, Forest Service |
| USFWS | U.S. Department of the Interior, Fish and Wildlife Service |
| WAPA | Western Area Power Administration |
| WRIMS | Water Resources Integrated Modeling System |
| WSR | water supply reliability |
| yr | year |

# Chapter 1 Introduction

## Purpose, Scope, and Organization of Final Feasibility Report

The Shasta Lake Water Resources Investigation (SLWRI or Investigation) is a feasibility study being conducted by the U.S. Department of the Interior, Bureau of Reclamation (Reclamation), in coordination with cooperating agencies, other resource agencies, stakeholders, and the public. The SLWRI is being conducted consistent with the *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* (P&G) (WRC 1983), Reclamation directives and standards, the National Environmental Policy Act (NEPA), and other pertinent local, State of California (State), and Federal laws and policies. This Final Feasibility Report evaluates the potential effects of alternative plans to modify the existing Shasta Division of the Central Valley Project (CVP) by enlarging Shasta Dam and Reservoir; a related Final Environmental Impact Statement (EIS), published under separate cover, is incorporated by reference. The primary purpose of the feasibility study documented herein is to (1) determine the potential type and extent of Federal and non-Federal interest in alterative plans to meet identified objectives to improve anadromous fish survival in the upper Sacramento River (see Figure 1-1), increase water supply reliability in the Central Valley of California, and address related water resources needs and opportunities, (2) evaluate benefits and effects of alternative plans, and (3) determine the engineering, environmental, social, economic, and financial feasibility of the National Economic Development (NED) Plan.


**Figure 1-1. Location of Shasta Dam and Reservoir**

## Study Overview and Status

The SLWRI is one of five surface water storage studies recommended in the CALFED Bay-Delta Program (CALFED) Programmatic Environmental Impact Statement/Report (PEIS/R) and Programmatic Record of Decision (ROD) of August 2000. Preliminary studies in support of the CALFED PEIS/R considered more than 50 surface water storage sites throughout California and recommended more detailed study of five sites identified in the CALFED Programmatic ROD (CALFED 2000a, 2000b, 2000c), including enlarging Shasta Lake. The Final EIS, accompanying this Final Feasibility Report, tiers to the CALFED PEIS/R.

Previous Reclamation studies and reports investigating potential enlargement of Shasta Dam and Reservoir include the *Enlarged Shasta Lake Investigation Preliminary Findings Report* (1983), *Shasta Dam and Reservoir Enlargement, Appraisal Assessment of the Potential for Enlarging Shasta Dam and Reservoir* (1999), *Strategic Agency and Public Involvement Plan* (2003a), *Mission Statement Milestone Report* (2003b), *Initial Alternatives Information Report* (2004a), *Environmental Scoping Report* (2006), *Plan Formulation Report* (2007a), *Draft Feasibility Report* (2011a), *Preliminary Draft Environmental Impact Statement* (2011b), and *Draft Environmental Impact Statement* (DEIS) (2013b).

Reclamation completed the Draft *SLWRI Feasibility Report* (Draft Feasibility Report), Preliminary Draft EIS (Preliminary DEIS), and related appendices in November 2011. These documents were subsequently released to the public in February 2012 to present the potential impacts, costs, and benefits of alternatives under evaluation at that time; to share information generated since the completion of the SLWRI *Plan Formulation Report* in December 2007; and to provide opportunity for public and stakeholder input. Comments received on the Draft Feasibility Report were considered in preparing this final report and supporting documents. Although Reclamation has not prepared or included herein formal responses to comments received on the Draft Feasibility Report, this final report does reflect changes resulting from public comments on both the Draft Feasibility Report and the DEIS, in compliance with the requirements of NEPA.

After the release of the Draft Feasibility Report and Preliminary DEIS, SLWRI alternatives (also referred to as comprehensive plans) were refined for evaluation in the DEIS based on several factors, including updates to CVP and State Water Project (SWP) water operations, and stakeholder input. Water operations modeling and related evaluations were updated for use in the DEIS, Final EIS, and this Final Feasibility Report to reflect the following:

- The 2008 *Biological Assessment on the Continued Long-Term Operations of the CVP and SWP* (2008 Long-Term Operation Biological Assessment (BA)) (Reclamation 2008a)

- The U.S. Department of Interior, Fish and Wildlife Service (USFWS) 2008 *Formal Endangered Species Act Consultation on the Proposed Coordinated Operations of the CVP and SWP* (2008 USFWS Biological Opinion (BO)) (USFWS 2008)
- The National Marine Fisheries Service (NMFS) 2009 *Biological Opinion and Conference Opinion on the Long-Term Operations of the CVP and SWP* (2009 NMFS BO) (NMFS 2009a)
- Additional changes in CVP and SWP facilities and operations, such as implementation of the San Joaquin River Restoration Program
- Additional changes in non-CVP/SWP facilities and operations, such as the addition of the Freeport Regional Water Project

Reclamation released the related DEIS for the SLWRI for public review and comment in June 2013. During the process of addressing public comments on the DEIS, SLWRI comprehensive plans and related designs and evaluations were further refined for the Final EIS and this Final Feasibility Report. Refinements primarily include the following:

- Refinement of operational scenarios focused on anadromous fish survival, and the development, evaluation, and incorporation of Comprehensive Plan 4A (CP4A)
- Refinement of facility plans for recreation relocations, Shasta Dam modifications, Pit 7 Dam and Powerhouse modifications, and other reservoir area relocations (e.g., power transmission lines)
- Refinement of facility and construction footprints and characterization of most likely affected areas
- Refinement of mitigation measures

## Organization of Final Feasibility Report

This Final Feasibility Report is organized as follows:

- Chapter 1 describes the study authorization; problems, needs, and opportunities; project background; study area; and prior studies, projects, and programs pertinent to the SLWRI.
- Chapter 2 describes the identified problems, needs, and opportunities, and existing and likely future resource conditions in the study area.
- Chapter 3 describes the plan formulation process, including planning objectives, management measures, and formulation and evaluation of concept plans and comprehensive plans.

- Chapter 4 describes the No-Action Alternative and Comprehensive Plans, including their potential benefits and costs, and the consistency of the comprehensive plans with other programs.
- Chapter 5 provides an evaluation and comparison of the comprehensive plans by P&G criteria, and presents the rationale for plan selection.
- Chapter 6 provides a description and determination of feasibility of the NED Plan, including discussion of considerations related to risk and uncertainty; unresolved issues; implementation requirements; roles and responsibilities; and implementation timeline.
- Chapter 7 provides an overview of the coordination and public involvement activities for the SLWRI, including agency coordination, stakeholder outreach, coordination with Tribal Governments and Native American tribal groups, and public and agency review and comment.
- Chapter 8 summarizes major findings and conclusions of this Final Feasibility Report.
- Chapter 9 provides recommendations and further considerations for the feasibility study.
- Chapter 10 contains the sources used to prepare this Final Feasibility Report.

## Study Authorization and Guidance

Public Law 96-375 (1980) provides feasibility study authority for the SLWRI and allows the Secretary of the Interior to do the following:

> *(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.*

The CALFED Bay-Delta Authorization Act (Public Law 108-361, October 25, 2004) Title I, Section 103, Subsection (c), “Authorizations for Federal

Activities Under Applicable Law," authorizes the Secretary of the Interior to carry out the activities described in paragraphs (1) through (10) of Subsection (d), which include the following:

> *...(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.*

Public Law 108-361, Title I, Section 103, Subsection (a)(1) also 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.*

At the conclusion of the SLWRI, the Secretary may submit the Feasibility Report to Congress with a recommendation to construct with Federal funding, according to Public Law 108-361, Title I, Section 103, Subsection (d)(1)(B)(i):

> *If on completion of the feasibility study for a project described in clause (i) or (ii) of subparagraph (A), the Secretary, in consultation with the Governor, determines that the project should be constructed in whole or in part with Federal funds, the Secretary shall submit the feasibility study to Congress.*

Other Federal legislation also influences the SLWRI. Two laws of special note include the 1965 Public Law 89-336 and 1992 Public Law 102-575. Public Law 89-336 created the Whiskeytown-Shasta-Trinity National Recreation Area (NRA) and directed that the area be administered by the U.S. Department of Agriculture, Forest Service (USFS). Public Law 102-575, the Central Valley Project Improvement Act (CVPIA), directed numerous changes to the operation of the CVP. Among these changes was adding protection, restoration, and enhancement of fish and wildlife and associated habitats as project purposes, resulting in significant changes to water supply deliveries, river flows, and related environmental conditions in the study area. To minimize impacts to CVP water contractors, the CVPIA also directed the Secretary of the Interior to develop a least-cost plan to increase the yield of the CVP by the amount dedicated to fish and wildlife purposes.

### Guidance in the CALFED Programmatic Record of Decision

The principal objective of CALFED was to develop a comprehensive, long-term strategy to provide reliable water supplies to cities, agriculture, and the environment while restoring the overall health of the San Francisco Bay/Sacramento-San Joaquin Delta (Bay-Delta). The NEPA and California

The 2000 CALFED Programmatic ROD identified a 300,000 acre-foot expansion (approximately a 6.5-foot dam raise) as the most economical enlargement of Shasta Dam and Reservoir. This is primarily because at the time a 6.5-foot raise was believed to be the largest expansion that would not require relocation of the Pit River Bridge, including Highway 5 and the Union Pacific Railroad, as indicated below (CALFED 2000b):

*Preliminary water yield and economic evaluations shows that an option with a 6.5 foot raise of the existing Shasta Dam to produce the most economical water of any site investigated. This option maximizes storage without relocating Interstate Highway 5 and the Union Pacific Railroad…*

However, through more detailed evaluations during the SLWRI plan formulation process, it was determined that Shasta Dam could be raised by up to 18.5 feet without relocating the Pit River Bridge. Accordingly, SLWRI comprehensive plans include dam raises of up to 18.5 feet.

Environmental Quality Act (CEQA) lead agencies for the CALFED PEIS/R were Reclamation and DWR, respectively.

Several program elements were defined that, in combination, would help attain the overall goals of CALFED. The CALFED Programmatic ROD recommended numerous projects and actions to increase water supply reliability, improve ecosystem health, increase water quality, and improve Sacramento-San Joaquin Delta (Delta) levee stability (CALFED 2000a). Preliminary studies in support of the CALFED PEIS/R considered more than 50 surface water storage sites throughout California and recommended more detailed study of five sites in the Central Valley, including Shasta Lake. As part of the Storage Program element, the CALFED Programmatic ROD called for the Secretary of the Interior to conduct feasibility studies of expanding CVP storage in Shasta Lake by up to 300,000 acre-feet 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.*

### CALFED Tiering

The 2000 CALFED PEIS/R Preferred Program Alternative and associated CALFED Programmatic ROD recommended project specific studies of the potential enlargement of Shasta Lake. As described in the CALFED Programmatic ROD:

> *For actions contained within the Preferred Program Alternative that are undertaken by a CALFED Agency or funded with money designated for meeting CALFED purposes, environmental review will tier from the [CALFED] Final Programmatic EIS/R.*

Accordingly, since the SLWRI is an action contained within the CALFED Preferred Program Alternative, the accompanying EIS to this Feasibility Report tiers to the CALFED PEIS/R. The CALFED Programmatic ROD describes tiering as follows:

> *Whenever a broad environmental impact analysis has been prepared and a subsequent narrower analysis is then prepared on an action included within the entire program or policy, the subsequent analysis need only summarize the issues discussed in the broader analysis and incorporate discussions from the*

> *broader analysis by reference. This is known as tiering. Tiered documents focus on issues specific to the subsequent action and rely on the analysis of issues already decided in the broader programmatic review. Absent new information or substantially changed circumstances, documents tiering from the CALFED Final Programmatic EIS/R will not revisit the alternatives that were considered alongside CALFED's Preferred Program Alternative nor will they revisit alternatives that were rejected during CALFED's alternative development process.*

Consistent with the above guidance in the CALFED Programmatic ROD, this Final Feasibility Report utilized evaluations and alternatives development and screening included in the CALFED PEIS/R.

## Summary of Problems, Needs, Opportunities, and Planning Objectives

A number of water and related resources problems, needs, and opportunities were identified for the SLWRI on the basis of the study authorization and guidance; information from prior studies, projects, and programs; existing and likely future water resources conditions; and input to the study process through public outreach. Planning objectives were then developed on the basis of identified problems, needs, and opportunities, study authorities, and other pertinent direction, including information contained in the 2000 CALFED Programmatic ROD.

### Problems, Needs, and Opportunities

Water and related resources problems, needs, and opportunities include anadromous fish survival, water supply reliability, and other environmental resources, as summarized below and discussed in detail in Chapter 2.

#### *Anadromous Fish Survival*

The population of Chinook salmon in the Sacramento River has significantly declined over the last 40 years (CDFW 2014a). As with other Delta tributaries, water temperature is among the most significant factors affecting Chinook salmon abundance in the Sacramento River, especially in dry and critically dry years[1]. Various actions have been taken to address this problem, ranging from minimum flow requirements in the river to structural changes at Shasta Dam. Despite these steps, additional actions are needed to address anadromous fish survival in the upper Sacramento River.

[1] Throughout this document, water year types are defined according to the Sacramento Valley Water Year Hydrologic Classification unless specified otherwise. As defined by the Sacramento Valley Water Year Hydrologic Classification, water year types include wet, above normal, below normal, dry, and critical years.

#### *Water Supply Reliability*

Demands for water in the State exceed available supplies (Reclamation 2008b). Dramatic increases in statewide population, land use changes, regulatory requirements, and limitations on water storage and conveyance facilities have resulted in unmet water demands and subsequent increases in competition for water supplies among urban, agricultural, and environmental uses. Challenges are greatest during dry years when water becomes less available (DWR 2014b). As the population of California grows and the demand for adequate water supplies becomes more acute, the ability of the State to maintain a healthy and vibrant industrial and agricultural economy while protecting aquatic species will be increasingly difficult.

#### *Other Environmental Resources*

Other identified needs include growing demands for existing and new energy sources in California; the need to restore environmental values in the Shasta Lake area and downstream along the Sacramento River; the need for additional flood protection along the upper Sacramento River; the need for additional recreation opportunities in the north Sacramento Valley; and the need for improved water quality conditions in the Sacramento River downstream from Shasta Dam and in the Delta.

### SLWRI Planning Objectives

On the basis of the identified water resources problems, needs, and opportunities described above, and study authorities and other pertinent direction, including information contained in the CALFED PEIS/R and Programmatic ROD, primary and secondary planning objectives were developed for the SLWRI. Primary planning objectives are those for which specific alternatives are formulated to address. Secondary planning objectives are actions, operations, and/or features that should be considered in the plan formulation process, but only to the extent possible through pursuit of the primary planning objectives.

- **Primary Planning Objectives**
  - Increase the survival of anadromous fish populations in the Sacramento River, primarily upstream from the Red Bluff Pumping Plant (RBPP).
  - Increase water supply and water supply reliability for agricultural, municipal and industrial (M&I), and environmental purposes, to help meet current and future water demands, with a focus on enlarging Shasta Dam and Reservoir.
- **Secondary Planning Objectives**
  - Conserve, restore, and enhance ecosystem resources in the Shasta Lake area and along the upper Sacramento River.

- Reduce flood damage along the Sacramento River.
- Develop additional hydropower generation capabilities at Shasta Dam.
- Maintain and increase recreation opportunities at Shasta Lake.
- Maintain or improve water quality conditions in the Sacramento River downstream from Shasta Dam and in the Delta.

## Background

**Figure 1-2. Shasta Dam Under Construction**

Reclamation was established in 1902 to help meet the increasing water demands of the West. Today, Reclamation is the largest water provider in the country and the second largest producer of hydroelectric power in the western United States. Reclamation's Mid-Pacific Region is responsible for managing the CVP, which stores and delivers about 20 percent of California's developed water—7 million acre-feet (MAF) annually—to more than 250 long-term water contractors throughout California.

Shasta Dam and Reservoir were constructed from September 1938 to June 1945 (Figure 1-2). Storage of water in Shasta Reservoir began in December 1943. Installation of gates, valves, and other finish work was completed following World War II, and the project was fully operational in April 1949. Approximately 37 miles of the Union Pacific Railroad (UPRR) main line, and 21 miles of U.S. Highway 99 (Interstate 5 (I-5)) were relocated around the reservoir during construction. At the time, Shasta Dam, at 602 feet tall, was exceeded only by Hoover Dam (located in Clark County, Nevada) in height and Grand Coulee Dam (located in Grant County, Washington) in volume and surface area; today, multiple dams are larger in both respects worldwide.

Shasta Dam and Reservoir are integral elements of the CVP, with Shasta Reservoir representing about 40 percent of the total reservoir storage capacity of the CVP. Shasta Dam (Figure 1-3) is operated in conjunction with other CVP facilities to provide for the management of floodwater, storage of surplus winter runoff for irrigation in the Sacramento and San Joaquin valleys, M&I water supply, maintenance of navigation flows, protection of fish in the Sacramento River and Delta, and hydropower generation. The CVPIA 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.

**Figure 1-3. Present Shasta Dam**

Shasta Lake supports extensive water-oriented recreation. Shasta Dam and Reservoir are within the Shasta Unit of the Whiskeytown-Shasta-Trinity NRA. Recreation within these lands is managed by USFS.

Reclamation operates Shasta Dam and Reservoir facilities in accordance with guidelines provided by the U.S. Army Corps of Engineers (USACE) for flood damage reduction. All outflows from Shasta Dam flow into and through Keswick Reservoir, located about 5 miles west of Redding. Keswick Reservoir also receives inflows from Whiskeytown Reservoir on Clear Creek.

Shasta Reservoir and Shasta Lake are used interchangeably within this Feasibility Report. Generally, however, Shasta Reservoir is used in references related to water operations for water supply, flood control, and environmental and related regulatory requirements (e.g., operations of the reservoir). In addition, Shasta Reservoir is often used in discussions related to broader CVP and SWP operations or facilities. Members of the public often refer to both the reservoir and its location as Shasta Lake.

## Study Area

The SLWRI includes both a primary study area and an extended study area because of the potential influence of the proposed modification of Shasta Dam and Reservoir and subsequent system operations and water deliveries on resources over a large geographic area. The primary study area (see Figure 1-4) includes the following:

- Shasta Dam and Shasta Lake
- Lower reaches of three primary tributaries flowing into Shasta Lake (Sacramento, McCloud, and Pit rivers) and all smaller tributaries flowing into the lake
- Sacramento River between Shasta Dam and the RBPP, including tributaries at their confluence with the Sacramento River
- Trinity and Lewiston reservoirs

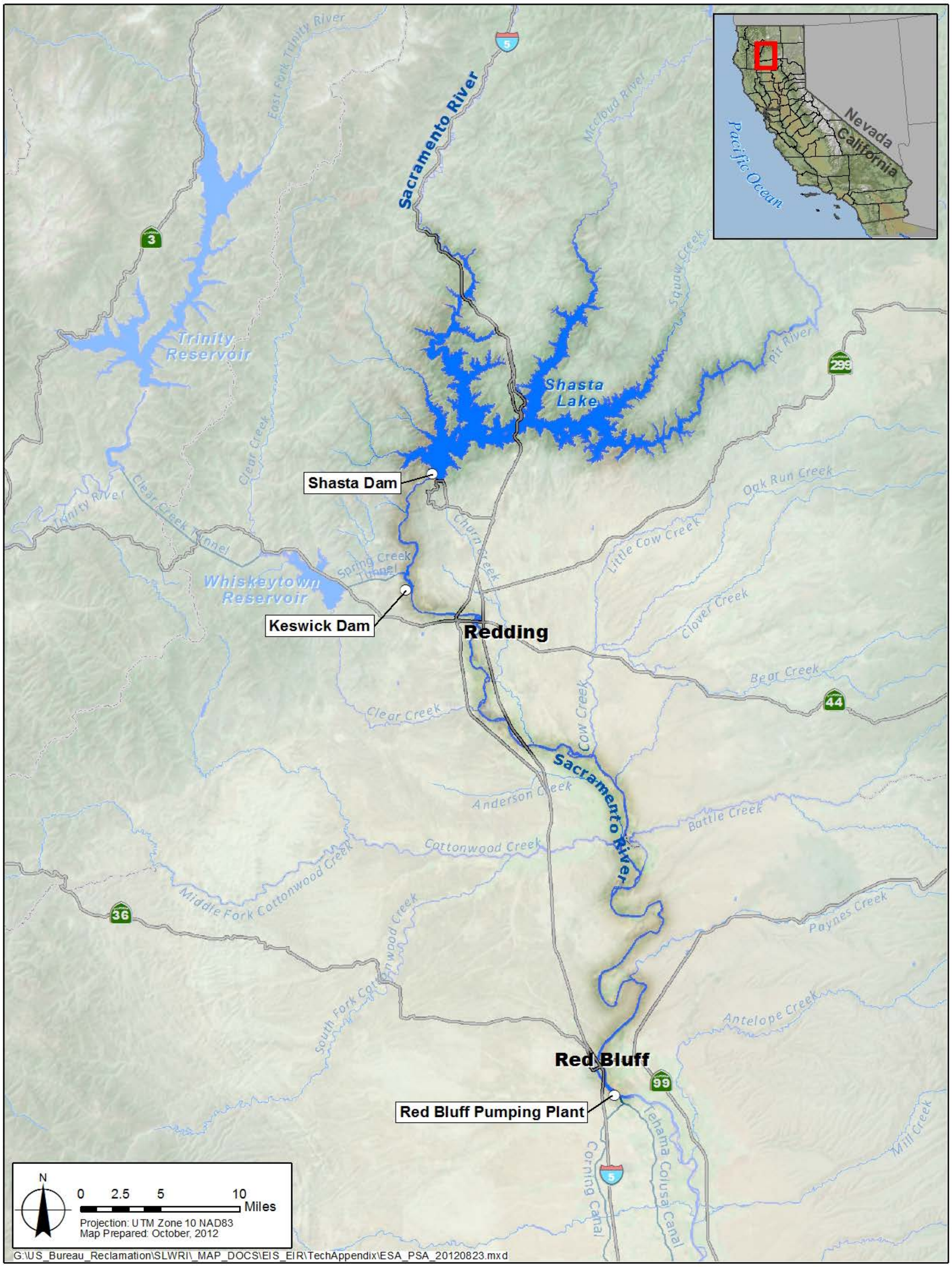



**Figure 1-4. Primary Study Area—Shasta Lake Area and Sacramento River from Shasta Dam to Red Bluff Pumping Plant**

The location of the RBPP was chosen as the downstream boundary of the primary study area because cold water released from Shasta Dam significantly influences water temperature conditions in the Sacramento River between Keswick Dam and the RBPP (NMFS 1993). Downstream from the RBPP, the Sacramento River landscape changes to that of a broader, alluvial stream system. The broader, slower nature of an alluvial stream system allows ambient air temperature to have a greater effect on water temperature.

The extended study area includes other areas of California that could potentially be indirectly influenced by modifying Shasta Dam and Reservoir. The extended study area encompasses the following:

- Sacramento River downstream from the RBPP facilities, including portions of major tributaries, namely the American and Feather river basins downstream from CVP and SWP reservoirs and related facilities
- Delta
- San Joaquin River basin at and downstream from CVP reservoirs and related facilities (Friant and New Melones reservoirs)
- Facilities and water service areas of the CVP and SWP (see Figures 1-5 and 1-6)

Detailed descriptions of the study area and existing conditions for physical, biological, cultural, and socioeconomic resources within the SLWRI study areas are included in Chapter 2.

The Central Valley of California is home to nearly 7 million people and a wide variety of fish and wildlife, including about 390 special-status plant and animal species (DOF 2014, DFW 2014b). The Central Valley river basins provide drinking water to over two-thirds of the Californian population. The robust economy of this region centers on an agricultural industry that is a major source of reliable, high-quality crops marketed to the Nation and the world.

Shasta Dam and Reservoir are located on the upper Sacramento River in Northern California (see Figure 1-4), about 9 miles northwest of the City of Redding; the entire lake is within Shasta County. At the top of the joint-use capacity[2] or full pool,[3] Shasta Reservoir stores 4.55 MAF and covers an area of about 29,500 acres with a shoreline of about 420 miles. The reservoir controls runoff from about 6,420 square miles. The four major tributaries to Shasta Lake are the Sacramento River, McCloud River, Pit River, and Squaw Creek, in addition to numerous minor tributary creeks and streams.

[2] Top of joint-use capacity is the reservoir water surface elevation at the top of the reservoir capacity allocated to joint use (i.e., flood control and conservation purposes).
[3] Full pool is the volume of water in a reservoir when the reservoir is fully used for all project purposes, including flood control.

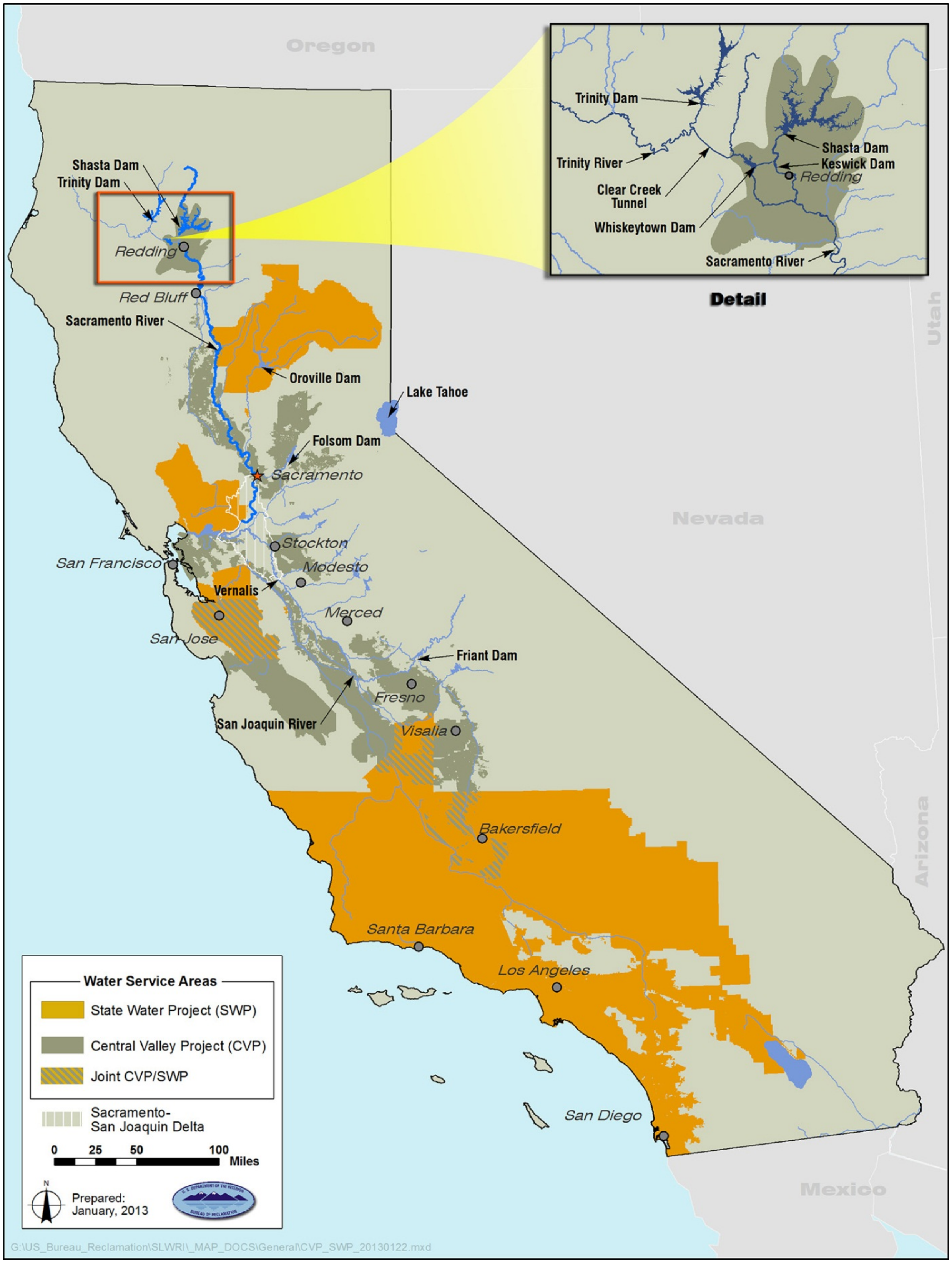


**Figure 1-5. Central Valley Project and State Water Project Water Facilities and Service Areas**


**Figure 1-6. Major Central Valley Project and State Water Project Facilities**

Most of the outflow from Shasta Dam travels south in the Sacramento River, joining runoff from tributaries such as the Feather and American rivers before entering the Delta. From the Delta, flows mingle with runoff, primarily from the San Joaquin River watershed, and travel to the Pacific Ocean through San Francisco Bay. The total drainage area of the Sacramento River at the Delta is about 26,300 square miles. The average annual runoff volume to the Delta from the Sacramento River watershed is about 17 MAF. This represents about 60 percent of the total 27.8 MAF inflow to the Delta (CALFED 1998).

# Related Studies, Projects, and Programs

Various Federal and State agencies, including Reclamation, USACE, and the California Department of Water Resources (DWR), and numerous local working groups and private organizations are conducting activities pertinent to the SLWRI. Following is a summary of these pertinent prior and ongoing activities in the study area.

## Activities of Federal Agencies

### *Department of the Interior – Bureau of Reclamation*

As the owner and operator of the CVP, including Shasta Dam and Reservoir, Reclamation has many ongoing projects or continuing programs and plans relevant to the SLWRI:

- **Central Valley Project –** The CVP, the largest surface water storage and delivery system in California (see Figure 1-6), supplies water to more than 250 long-term water contractors in the Central Valley, Tulare Lake basin, and San Francisco Bay Area (Bay Area) (Reclamation 2008b and 2011c). CVP service areas, shown in Figure 1-5, cover 29 of the State's 58 counties. Shasta Reservoir accounts for approximately 40 percent of the total storage capacity of the CVP and provides for over half of the total annual water supplies delivered by the CVP. Operated by Reclamation, the CVP consists of 20 reservoirs capable of storing over 11 MAF of water; 11 power plants; 500 miles of major canals and aqueducts; and many tunnels, conduits, and power transmission lines (Reclamation 2013a). Annually, the CVP has the potential to supply about 7 MAF for agricultural, M&I, and wildlife uses (Reclamation 2008b). The CVP also provides flood damage reduction, navigation, power, recreation, and water quality benefits.

- **Prior Studies of Enlarging Shasta Dam –** Several studies have been conducted to assess the feasibility of increasing storage space in Shasta Reservoir. Evaluations of raising Shasta Dam considered structural modifications, environmental and related impacts, water supply and hydropower benefits, costs, and Federal interest. Reclamation initiated the SLWRI based on these prior studies and conclusions in the 2000

CALFED Programmatic ROD, which established the need for additional studies focusing on limited dam raise/reservoir enlargement options.

- ***Shasta Reservoir Enlargement Studies of the 1980s*** - In the 1980's Reclamation, in coordination with DWR, conducted studies that indicated that raising Shasta Dam by up to 200 feet was feasible from engineering, environmental, and economic perspectives. Shasta Reservoir enlargement also was found to provide the lowest cost of new water supplies for CVP and SWP deliveries compared with 24 other projects studied (Reclamation and DWR 1988). However, construction of Shasta Reservoir enlargement was considered financially untenable and politically infeasible at that time, given the demand for additional water and the related investment of public funding.

- ***1999 Appraisal Assessment of the Potential for Enlarging Shasta Dam and Reservoir –*** This appraisal-level study investigated three enlargement options to illustrate the potential costs, technical issues, and impacts associated with dam raises of 6.5, 102.5, and 202.5 feet (Reclamation 1999). The study recommended further evaluation of smaller raises (less than 200 feet) of Shasta Dam.

- **Central Valley Project Improvement Act –** Enacted in 1992, the CVPIA addresses conflicts over water rates, irrigation land limitations, and environmental impacts of the CVP. A major component of the CVPIA, established in Section 3406(a), is to provide equal priority and consideration to protection, restoration, and enhancement of fish, wildlife, and associated habitats of the Delta estuary and tributaries affected by the CVP.

  CVPIA Section 3406(a) included "amendments to Central Valley Project Authorizations Act of August 26, 1937." Specifically, these amendments included adding "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.

  The CVPIA Section 3406(b) contains specific actions and programs identified to mitigate, protect, restore, and enhance fish and wildlife. CVPIA Section 3406(b) states the following:

  > *Fish and Wildlife Restoration Activities.--The Secretary, immediately upon the enactment of this title, shall operate the Central Valley Project to meet all obligations under state and federal law, including but not limited to the federal Endangered Species Act, 16 U.S.C. s 1531, et seq., and all decisions of the California State Water Resources*

> *Control Board establishing conditions on applicable licenses and permits for the project. The Secretary, in consultation with other State and Federal agencies, Indian tribes, and affected interests, is further authorized and directed to:*
>
> *(1) Develop within three years of enactment and implement a program which makes all reasonable efforts to ensure that, by the year 2002, natural production of anadromous fish in Central Valley rivers and streams will be sustainable, on a long-term basis, at levels not less than twice the average levels attained during the period of 1967-1991; … Provided further, that the programs and activities authorized by this section shall, when fully implemented, be deemed to meet the mitigation, protection, restoration, and enhancement purposes established by subsection 3406(a) of this title…*

The program developed pursuant to this section to address the anadromous fish "doubling goal" is the Anadromous Fish Restoration Program (AFRP). In January 2001, the AFRP released the *Final Restoration Plan for the AFRP* (USFWS 2001), presenting the programmatic description of the AFRP, including a list of the prioritized actions and evaluations. The CVPIA and associated AFRP identified specific fish and wildlife restoration projects throughout the Central Valley, including habitat restoration projects and modifications to CVP facilities and operations. Many of these projects have either been completed or are currently underway, based on funding from a variety of sources. Some of the projects relevant to the SLWRI include the Red Bluff Diversion Dam (RBDD) Fish Passage Improvement Project and construction of the Shasta Dam temperature control device. The AFRP and other actions and programs identified under Section 3406(b), which are not already completed, continue to be implemented pursuant to the CVPIA, and these programs were generally included in CALFED baseline planning assumptions. Consistent with Section 3406(b)(1), these actions and programs, when fully implemented, will meet the mitigation, protection, restoration, and enhancement purposes established under the CVPIA.

The CVPIA also addresses the operational flexibility of the CVP and methods to expand the use of voluntary water transfers and improved water conservation, and initiated CVP yield studies (described below). The CVPIA dedicated approximately 1.2 MAF of water annually to fish, wildlife, and habitat restoration. Of this water, 800,000 acre-feet was dedicated to environmental needs as Section 3406(b)2 water, approximately 200,000 acre-feet was designated for wildlife refuges, and approximately 200,000 acre-feet was dedicated for increased Trinity River flows for fisheries restoration. Through operations flexibility, this results in a net reduction of 516,000 acre-feet per year on average, and 585,000 acre-feet in the driest years, previously available to CVP contractors (Reclamation 2008b).

- **CVP Yield Feasibility Investigation: Delivery Impact of CVPIA –** In May 2005, Reclamation quantified the water delivery impacts of the CVPIA on the CVP and analyzed a wide range of storage and conveyance projects to offset these impacts in *A CVP Yield Feasibility Investigation Report: The Delivery Impact of CVPIA* (Reclamation 2005). Total delivery impacts of the CVPIA to agricultural and M&I contractors were determined to be 516,000 acre-feet in average water years and 586,000 acre-feet in dry years, with impacts to south-of-Delta (SOD) contractors being much greater than impacts to north-of-Delta (NOD) contractors, and impacts to agricultural contractors being much greater than impacts to M&I contractors. In the report, Reclamation analyzed 90 different combinations of increased conveyance, increased NOD storage, and increased SOD storage. Reclamation recommended continued participation in CALFED programs, participation in regional and watershed integrated resource management planning activities, and continued CVP and SWP integrated operations to help offset the delivery impacts of the CVPIA.

- **Water Supply and Yield Study –** In March 2008, Reclamation prepared the *Water Supply and Yield Study*, which describes existing California statewide water demand and available supplies, as well as projected future demand, available supplies, and willingness to pay for CALFED storage and conveyance projects (Reclamation 2008b). Using demands from DWR's *California Water Plan Update 2005* (DWR 2005) and assuming no inter-basin transfers, statewide supply-demand gaps were estimated to be 2.3 MAF in average water years and 4.2 MAF in dry water years. Without investment in storage and conveyance projects, statewide supply-demand gaps were projected to grow to 4.9 MAF in average water years and 6.1 MAF in dry water years by 2030. The *Water Supply and Yield Study* also determined that if CALFED storage and conveyance projects, including the SLWRI, were constructed, the projected 2030 supply-demand gap would be reduced to 1.5 MAF in average water years and 2.2 MAF in dry water years.

- **Coordinated Long-Term Operation of the CVP and SWP –** In June 2004, Reclamation prepared the 2004 Operations Criteria and Plan (2004 OCAP) to provide a description of facilities and the operating environment of the CVP and SWP. Using operational information presented in the 2004 OCAP, Reclamation and DWR developed the

2004 OCAP Biological Assessment (2004 OCAP BA), prepared as part of the consultation process required by Section 7 of the Federal Endangered Species Act (ESA).

Reclamation consulted with NMFS and the U.S. Department of the Interior, Fish and Wildlife Service (USFWS) on the 2004 OCAP, and the two agencies issued the 2004 NMFS Biological Opinion (2004 NMFS BO) (NMFS 2004) and 2005 USFWS Biological Opinion (USFWS 2005 BO), respectively. In 2007, the District Court for the Eastern District of California (District Court), in *Natural Resources Defense Council v. Kempthorne*, found the 2005 USFWS BO to be unlawful and inadequate. In May 2008, in *Pacific Coast Federation of Fishermen's Associations v. Gutierrez,* the District Court found the 2004 NMFS BO to be unlawful and inadequate. The District Court remanded both BOs to the agencies.

In 2008, Reclamation provided the USFWS and NMFS the *Biological Assessment on the Continued Long-Term Operations of the CVP and SWP* (2008 Long-Term Operation BA). USFWS and NMFS released their BOs in 2008 and 2009, respectively.

In the 2008 USFWS BO, the USFWS concluded that the long-term operations of the CVP and SWP would jeopardize the continued existence of delta smelt and adversely modify its critical habitat. Consequently, the USFWS developed a Reasonable and Prudent Alternative (RPA) to avoid jeopardy.

In the 2009 NMFS BO, NMFS similarly concluded that the long-term operations of the CVP and SWP would jeopardize the continued existence of listed salmonids, steelhead, green sturgeon, and killer whales; it also developed an RPA to avoid jeopardy to the species. The RPA included conditions for revised water operations, habitat restoration and enhancement actions, and fish passage actions. Actions were brought challenging the USFWS and NMFS BOs (2008 and 2009) under ESA and the Administrative Procedure Act (APA), concerning the effects of the CVP and SWP on endangered fish species.

***2008 USFWS BO Litigation*** On December 27, 2010, the District Court entered an "Amended Order on Cross-Motions for Summary Judgment" (Doc. 761), remanding the 2008 USFWS BO to the USFWS without vacatur. On May 4, 2011, the District Court issued an amended Final Judgment, ordering the USFWS to complete a final revised BO by December 1, 2013.

In August 2011, the District Court enjoined implementation of USFWS RPA Component 3 (Action 4), the fall X2 requirements, which require a monthly average position of not greater than 74 km in wet years or 81 km in above normal water years eastward of the Golden Gate Bridge. That injunction is no longer in-effect.

The United States and NRDC appealed the District Court's decision invalidating the 2008 USFWS BO. NRDC also challenged the District Court's finding that Reclamation was required to prepare an EIS on its provisional acceptance of the RPA included in the 2008 USFWS BO. Water user plaintiffs cross-appealed the District Court's opinion. On March 13, 2014, the Ninth Circuit Court of Appeals reversed that part of the District Court's opinion that questioned the validity of the 2008 USFWS BO, but affirmed the District Court's finding that Reclamation violated in NEPA in failing to prepare an EIS on its provisional acceptance of the RPA included in the 2008 USFWS BO.

***2009 NMFS BO Litigation*** In September 2011, the District Court remanded the 2009 BO to NMFS, without vacatur, finding in favor of the Federal government on some counts and in favor of water contractor plaintiffs on other counts. The District Court has ordered NMFS to prepare a draft BO no later than October 1, 2016. To meet that schedule, Reclamation must issue a draft EIS evaluating the environmental impacts associated with implementing the draft NMFS BO by April 1, 2017 (six months after receiving the draft BO), and a final EIS no later than March 28, 2018. Reclamation must prepare an EIS on any RPA included in the draft NMFS BO by February 1, 2018; NMFS must release a final BO by that same date. Reclamation must issue a ROD, deciding whether to accept the RPA or an alternative, by April 29, 2018. The United States has appealed the District Court's decision, and that appeal is still pending in the Ninth Circuit Court of Appeals.

***Summary*** In February 2013, Reclamation requested reinitiation of ESA Section 7 consultation, to which USFWS and NMFS agreed.

Currently, although the Ninth Circuit Court of Appeals upheld the validity of the 2008 USFWS BO, the USFWS is obligated to issue (or reissue) a BO by December 1, 2015. On that same date, Reclamation must issue a Final EIS analyzing the environmental impacts associated with operating the CVP and SWP under the USFWS BO.

On the NMFS side, NMFS must issue a draft BO to Reclamation no later than October 1, 2016. Reclamation must issue a final EIS no later than February 1, 2018. On that same date, February 1, 2018, NMFS must release a final BO. Reclamation has until April 29, 2018 to issue a ROD.

***Operational and Modeling Assumptions for SLWRI*** These legal challenges have resulted in uncertainty with regard to operational constraints for the CVP and SWP. As a result, evaluations of potential effects of the alternatives in the SLWRI Preliminary DEIS were based on available modeling analysis at that time, which reflected operations described in the 2004 OCAP BA and the Coordinated Operations Agreement between Reclamation and DWR for the CVP and SWP. These analyses were suitable for comparison purposes, and reflected expected variation among the alternatives, including the type and relative magnitude of anticipated impacts and benefits.

In 2012 Reclamation updated the operational assumptions and modeling for the SLWRI to reflect operations described in the 2008 Long-Term Operation BA (as updated due to new facilities, the passage of time, legislation, and litigation), the 2008 USFWS BO, and the 2009 NMFS BO. These assumptions were used to guide refinement, modeling, and evaluation of alternatives and were used as the basis of analysis in the SLWRI DEIS, the Final EIS, and this Final Feasibility Report. Water operations defined in the RPA were included in existing and future conditions SLWRI modeling evaluations, as described in the Modeling Appendix to the accompanying EIS. As described in the Modeling Appendix, restoration and enhancement actions and fish passage actions for the Sacramento River and its tributaries were not included in existing or future conditions operations modeling.

Despite the uncertainty resulting from the ongoing consultation process, the 2008 Long-Term Operation BA and the 2008 and 2009 BOs issued by the fishery agencies contain the most recent estimate of potential changes in water operations that could occur in the near future.

- **Red Bluff Fish Passage Improvement Project –** The RBDD, now operated with gates raised year-round, is located on the Sacramento River downstream from Shasta Dam. The RBDD gates, when lowered, created Lake Red Bluff and provided for diversion of CVP irrigation water via the Tehama-Colusa and Corning canals. Ineffective fish passage at the RBDD led to development of the Fish Passage Improvement Project and the construction of the screened RBPP, completed in September 2012. The RBPP allows diversion of CVP water from the Sacramento River into the Tehama-Colusa and Corning canals while the RBDD gates remain locked in the raised position, providing unimpeded passage for threatened and endangered fish species (Reclamation 2011d).

- **Trinity River Restoration Program –** The 2.5 MAF Trinity Reservoir conveys water from the Trinity River to the Sacramento River basin for export to the Central Valley. The Trinity ROD proposes rehabilitation of the Trinity River through restoration activities to restore and maintain the river's fishery resources impacted by Trinity Dam and Reservoir (Reclamation 2000). One of the major elements of the Trinity River ROD is reducing the average annual water exports from the Trinity River basin into the Sacramento River basin. Ongoing actions related to implementing the Trinity River Restoration Program include seasonal flow management, channel rehabilitation, and sediment management along the Trinity River, which can affect conditions on the Sacramento River within the SLWRI primary study area.

- **Battle Creek Salmon and Steelhead Restoration Project** – The Battle Creek Salmon and Steelhead Restoration Project focuses on restoring the winter-run, spring-run, fall-run and late fall-run Chinook salmon and steelhead populations in Battle Creek, one of the most important anadromous fish spawning streams in the Sacramento Valley. Actions include removing dams; constructing fish screens, ladders, and bypass facilities; and augmenting flows to increase salmonid habitat (Reclamation 2014a). Construction of initial phases began in 2010 and is expected to continue through 2019.

#### *Department of the Interior – Bureau of Land Management*

The U.S. Department of the Interior, Bureau of Land Management (BLM) is responsible for administering natural resources, lands, and mineral programs on approximately 250,000 acres of public land in Northern California, and is involved in numerous restoration and conservation projects in the study area. An existing Memorandum of Agreement (MOA) between BLM and Reclamation defines the relationships and responsibilities of the agencies regarding the management of Federal interests in the study area.

#### *Department of the Interior – Fish and Wildlife Service*

USFWS has participated in numerous projects and programs within the study area because the upper Sacramento River is recognized as critical habitat for endangered winter-run Chinook salmon and other threatened or endangered species. The AFRP was developed in 1995 to accomplish the CVPIA goal of doubling natural production of anadromous fish in Central Valley streams on a long-term, sustainable basis through improvement of natural ecosystem functions (i.e., increased stream flows, eliminating entrainment at diversions) (USFWS 1995).

In early February 2007, as part of the Fish and Wildlife Coordination Act (FWCA) (48 statute 401, as amended, 16 U.S. Code (USC) 661 et seq.), USFWS provided Reclamation with a revised draft *Planning Aid Memorandum* (PAM). The PAM is intended to (1) summarize USFWS views and position on planning and implementation efforts under water resources legislation and programs such as the CVPIA and CALFED, (2) identify potential beneficial and adverse effects to fish and wildlife resources for further evaluation, and (3) provide recommendations to the SLWRI planning process to maximize project benefits for aquatic and terrestrial species, while congruent with the USFWS Mitigation Policy, as published in the *Federal Register*, Vol. 46, No. 15 January 23, 1981, and amended in the *Federal Register* of February 4, 1981. The 2007 PAM focuses on the SLWRI planning process, pertinent environmental analysis and protections, and allocation of project benefits should Shasta Lake be enlarged.

The USFWS has also prepared a Draft Coordination Act Report consistent with the FWCA, as provided for in Section 2(b) of the FWCA (48 stat. 401, as amended). The report assesses potential project effects on fish and wildlife resources and provides recommendations on how to avoid or minimize adverse effects.

#### *Department of the Interior – Bureau of Indian Affairs*

The Bureau of Indian Affairs (BIA) provides services directly or through contracts, grants, or compacts to Federally recognized tribes. Programs administered through the BIA include social services, natural resources management on trust lands, economic development programs, law enforcement and detention services, administration of tribal courts, implementation of land and water claim settlements, housing improvement, disaster relief, replacement and repair of schools, repair and maintenance of roads and bridges, and the repair of structural deficiencies on high hazard dams. Pursuant to NEPA, BIA is a cooperating agency for the accompanying EIS.

#### *Department of Commerce – National Marine Fisheries Service*

NMFS is required under the Federal ESA to assess factors affecting listed salmonid species in the Central Valley, identify recovery criteria, identify the entire suite of actions necessary to achieve these goals, and estimate the cost and time required to carry out the actions. One program to attain these goals, the *Proposed Recovery Plan for Sacramento River Winter-Run Salmon*, presents restoration goals and actions, including improved water quality and flows, some of which would be applied within the SLWRI study area (NMFS 1997). In addition, the *Public Draft Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-run Chinook Salmon and Central Valley Spring-run Chinook Salmon and the Distinct Population Segment of Central Valley Steelhead* (NMFS 2009b) *and Final Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-run Chinook Salmon and Central Valley Spring-run Chinook Salmon and the Distinct Population Segment of Central Valley Steelhead* (NMFS 2014) also present actions to help meet recovery goals.

#### *Department of Agriculture – Forest Service*

USFS manages recreation within the Whiskeytown-Shasta-Trinity NRA, which includes nearly all lands along the Shasta Lake shoreline. USFS is also involved in fire hazard and fuel reduction projects, forest health and ecosystem management, timber sales, conservation planning, wildlife monitoring, wildlife habitat improvement, recreation facilities, and administration of the *Aquatic*

*Conservation Strategy of the Northwest Forest Plan* (USFS 1994). Reclamation and the USFS entered into a MOA in 1986 for the coordinated administration of the Shasta and Trinity Units of the NRA with the CVP. Pursuant to NEPA, USFS is a cooperating agency for the accompanying EIS.

#### *Environmental Protection Agency*

The U.S. Environmental Protection Agency (EPA) develops standards and criteria for water quality pursuant to the Federal Clean Water Act (CWA), and issues permits for discharges under the CWA. Under CWA Section 404, the EPA develops regulations for USACE compliance and reviews permits issued by USACE to regulate the discharge of dredged or fill material into waters of the United States, including wetlands. Section 404(c) of the CWA authorizes EPA to veto a USACE decision to issue a permit if a proposed action would have an unacceptable effect on municipal water supplies, shellfish beds and fishery areas, wildlife, or recreational areas.

The EPA is involved in remediation and cleanup activities related to the Iron Mountain Mine Superfund site in the Spring Creek drainage, which is a tributary to Keswick Reservoir. These activities are significantly reducing acid and metal contamination in surface water entering the Sacramento River.

#### *Department of Defense – U.S. Army Corps of Engineers*

In 1977, USACE prescribed the operating space and developed the operating rules at Shasta Dam and Reservoir for flood damage reduction. In addition to Shasta Dam and Reservoir regulation rules, USACE has conducted various studies and implemented many projects and programs that affect the upper Sacramento River and its tributaries. Several key efforts include the March 1999 *Post-Flood Assessment* (USACE 1999) and the *Sacramento and San Joaquin River Basins Comprehensive Study* (USACE 2002). Additionally, under the CWA Section 404, USACE issues permits to regulate the discharge of dredged or fill material into waters of the United States, including wetlands, and conduct NEPA review of its permitting action.

### Activities of State Agencies

Following are State projects and plans relevant to the SLWRI.

#### *California Department of Water Resources*

DWR is the owner and operator of the SWP, and manages ongoing projects or continuing programs relevant to the SLWRI:

- **State Water Project** – The SWP delivers water to the Feather River Settlement Contractors and SWP contract entitlements in the Feather River basin, Bay Area, San Joaquin Valley, Tulare basin, and Southern California water service areas. The SWP has contracted a total of 4.23 MAF for average annual delivery: about 2.5 MAF for the Southern California Transfer Area; nearly 1.36 MAF for the San Joaquin Valley; and the remaining 370,000 acre-feet for the San Francisco Bay, central coast, and Feather River areas. Modifications of Shasta Dam and Reservoir could increase net water supplies for the SWP. The SWP is operated in conjunction with the CVP according to the 1986 *Agreement Between the United States and the State of California for the Coordinated Operation of the Central Valley Project and the State Water Project*, commonly known as the "Coordinated Operations Agreement." This agreement defines how Reclamation and DWR share their joint responsibility to meet Delta water quality standards and the water demands of senior water right holders, and how the two agencies share surplus flows.

- **California Water Plan –** DWR's *California Water Plan* provides a framework for water managers, legislators, and the public to consider options and make decisions regarding California's water future (DWR 2009). The plan, which is updated every 5 years, presents basic data and information on California's water resources, including water supply evaluations and assessments of agricultural, urban, and environmental water uses to quantify the gap between water supplies and uses. The plan also identifies and evaluates existing and proposed statewide demand management and water supply augmentation programs and projects to address the State's water needs.

  DWR's goal in preparing the plan is to meet requirements of the California Water Code (CWC), receive broad support among those participating in California's water planning, and be a useful document for the public, water planners throughout the State, legislators, and other decision-makers (DWR 2009). As a master plan, it guides the control, protection, conservation, development, management, and efficient use of the water resources of the State (CWC Section 10005(a)).

  DWR completed the *California Water Plan Update 2009* in December 2009 (DWR 2009), and released to public in March 2010. The implementation plan contained in the plan addresses 13 objectives supported by 92 related actions, which were taken in part from DWR's 2008 climate change white paper (DWR 2008a). Several other companion State plans were considered in preparing the draft objectives and related actions. Identified objectives address water conservation, recycling, and reuse; conjunctive management of water supply sources; environmental enhancement; flood protection and floodplain enhancement; and management for a sustainable Delta; and identifies several other objectives for management of water resources in California. Analysis and conclusions presented in the *California Water Plan Update 2009* were used in assessing the need for modification of Shasta Dam and Reservoir to provide additional water supply reliability outside the CVP.

Through rigorous public involvement and State and Federal agency coordination processes, DWR and other agencies developed and released the Draft *California Water Plan Update 2013* in December 2013 (DWR 2013b) and released the finalized *California Water Plan Update 2013* in October 2014 (DWR 2014b).

- **Integrated Regional Water Management Plans –** Integrated Regional Water Management Plans (IRWMP) are collaborative endeavors to manage diverse aspects of water resources in a regional approach. IRWMPs integrate planning for water supply, water quality, wastewater treatment, stormwater management, and flood control on a regional scale that involves multiple jurisdictions, watersheds, political regions, agencies, and stakeholders. To date, IRWMPs have been developed for 87 percent of the state's geographic area and 99 percent of the state's population (DWR 2014a).

  The Sacramento Valley IRWMP was formally adopted under CWC 10541 on December 12, 2006, as a framework to guide the management of water resources in the Sacramento Valley in an integrated and regional approach (Northern California Water Association 2006). Input from water agencies, landowners, local governments, and conservation organizations was used to develop the IRWMP, which was adopted with formal resolutions by more than 40 public water entities in the Sacramento Valley. The Sacramento Valley IRWMP region includes the Sacramento Valley floor and foothills area, overlies the Sacramento and Redding groundwater basins, and encompasses parts of ten counties.

#### *State Water Resources Control Board*

The State Water Resources Control Board (State Water Board) is responsible for allocating surface water rights, setting statewide policy to protect water quality, coordinating and supporting the State's nine Regional Water Quality Control Boards (Regional Water Boards), and enforcing laws and regulations protecting the State's waterways. Both the CVP and SWP operate pursuant to water right permits and licenses issued by the State Water Board for water storage, releases, and diversions.

Over time, the State Water Board has issued decisions that modify the terms and conditions of CVP and SWP water rights. In August 1978, the State Water Board adopted the Water Quality Control Plan (WQCP) for the Delta and Suisun Marsh and Water Right Decision 1485 (D-1485), requiring Reclamation and DWR to operate the CVP and SWP to meet all of the 1978 WQCP objectives, except a portion of the southern Delta salinity objectives. In 1991, the State Water Board issued revised water quality objectives in the *Delta Water Quality Control Plan for Salinity, Temperature, and Dissolved Oxygen* (State Water Board 1991). In May 1995, the State Water Board adopted the *Bay-Delta*

*Water Quality Control Plan* (State Water Board 1995) superseding both the 1978 and 1991 plans.

Beginning in 1996, the State Water Board engaged in proceedings to determine responsibility for meeting water quality standards in the Delta. Because the issues were so complex, the State Water Board divided the water right proceedings into eight phases. The State Water Board completed Phases 1 through 7 of these proceedings in 1999, leading to issuance of D-1641 in December of 1999. The State Water Board adopted D-1641 as part of the State Water Board's implementation of the 1995 *Bay Delta Plan.* D-1641 amended certain water rights, including temporarily amending certain terms and conditions of the CVP and SWP water rights, by assigning responsibilities to the persons or entities holding those rights to help meet certain water quality and flow requirements outlined in the 1995 *Bay Delta Plan*, including new protections for Delta fisheries. The goal of Phase 8 was to allocate permanent responsibility for satisfying the flow-related water quality objectives of the 1995 Bay-Delta WQCP among water right holders in the watersheds of the Sacramento, Cosumnes, and Calaveras rivers. As a result of the 2009 Delta Reform Act, the State Water Board has initiated a new administrative process to evaluate water outflow requirements on upstream tributaries to the Delta. This may, if implemented, significantly impact CVP and SWP operations, as well as those of other upstream reservoirs.

#### *California Department of Fish and Game*

The California Department of Fish and Wildlife (CDFW) manages California's fish and wildlife resources, overseeing the restoration and recovery of species listed by the California Endangered Species Act (CESA) as threatened and endangered. CDFW participates in conservation planning, environmental compliance and permitting, coordinated resources management planning, and restoration and recovery programs within the study area.

#### *Delta Stewardship Council*

The Delta Stewardship Council was established by the California Legislature as part of the comprehensive water legislation, Senate Bill (SB) 1, the 2009 Delta Reform Act, and is tasked with protecting the Delta and the critical role the Delta serves through implementing two "coequal goals." The coequal goals are (1) providing a more reliable water supply for California, and (2) protecting, restoring, and enhancing the Delta ecosystem. The coequal goals are to be achieved in a manner that protects and enhances the unique cultural, recreational, natural resource, and agricultural values of the Delta as an evolving place (CWC Section 85054). Members of the council include representatives from different areas of the State who offer diverse expertise in fields, such as agriculture, science, the environment, and public service.

The California Legislature established the Delta Stewardship Council to do the following:

> *"…provide for the sustainable management of the Sacramento-San Joaquin Delta ecosystem, to provide for a more reliable water supply for the state, to protect and enhance the quality of water supply from the Delta, and to establish a governance structure that will direct efforts across state agencies to develop a legally enforceable Delta Plan."*

The council is entrusted to integrate issues, such as water flows, water quality, environmental protection, emergency management, economics, the Delta as an evolving place, conveyance alternatives, upstream impacts, flood risk management, and climate change, into one coherent management system.

**Delta Plan** The Delta Plan is a comprehensive, long-term management plan for the Delta (Delta Stewardship Council 2013). Required by the 2009 Delta Reform Act, it creates new rules and recommendations to further the state's coequal goals for the Delta: Improve statewide water supply reliability, and protect and restore a vibrant and healthy Delta ecosystem, all in a manner that preserves, protects and enhances the unique agricultural, cultural, and recreational characteristics of the Delta.

Developed through eights drafts, hundreds of hours of public meetings and thousands of public comments over two years, the Delta Plan is guided by the best available science. The Delta Plan is founded on cooperation and coordination among affected agencies. The Delta Plan is also enforceable through regulatory authority, as spelled out in the Delta Reform Act that requires state and local agencies to be consistent with the Delta Plan.

The Delta Plan was unanimously adopted by the Delta Stewardship Council on May 16, 2013. Subsequently its 14 regulatory policies were approved by the Office of Administrative Law, a state agency that ensures the regulations are clear, necessary, legally valid, and available to the public. The Delta Plan became effective with legally-enforceable regulations on September 1, 2013.

The Delta Plan recommends timely completion of the Bay Delta Conservation Plan (BDCP). When completed, the BDCP must be incorporated into the Delta Plan if it meets certain statutory requirements described under CWC 85320 (Delta Stewardship Council 2013).

Implementing the Delta Plan in conjunction with the BDCP could change CVP and SWP operations and could possibly affect operations of Shasta Dam and Reservoir. However, the Delta Plan, as with the BDCP, is still in the planning phase, and no specific plan has been authorized for implementation.

#### *California Water Commission*

The California Water Commission is comprised of nine members, responsible for advising the Director of DWR, approving DWR rules and regulations, monitoring and reporting on SWP construction and operations, and holding public hearings on proposed SWP facilities. Additionally, the commission advises congressional appropriations committees on funding for USACE and Reclamation water resource projects in California. Under the Safe, Clean, and Reliable Drinking Water Supply Act, the commission is further tasked with selecting water storage projects for State bond funding toward project benefits "that improve the operation of the state water system, are cost effective, and provide a net improvement in ecosystem and water quality conditions."

California's 2009 Comprehensive Water Package included SB 1, which gave the Commission new responsibilities regarding the distribution of public funds set aside for the public benefits of water storage projects, and developing regulations for the quantification and management of those benefits. Projects that could be funded by a state water bond would be selected by the Commission through a competitive public process ranking potential projects based on the expected return for public investment as measured by the magnitude of the public benefits provided. These public benefit categories include:

> *(1) Ecosystem improvements, including changing the timing of water diversions, improvement in flow conditions, temperature, or other benefits that contribute to restoration of aquatic ecosystems and native fish and wildlife, including those ecosystems and fish and wildlife in the Delta.*
>
> *(2) Water quality improvements in the Delta, or in other river systems, that provide significant public trust resources, or that clean up and restore groundwater resources.*
>
> *(3) Flood control benefits, including, but not limited to, increases in flood reservation space in existing reservoirs by exchange for existing or increased water storage capacity in response to the effects of changing hydrology and decreasing snow pack on California's water and flood management system.*
>
> *(4) Emergency response, including, but not limited to, securing emergency water supplies and flows for dilution and salinity repulsion following a natural disaster or act of terrorism.*
>
> *(5) Recreational purposes, including, but not limited to, those recreational pursuits generally associated with the outdoors.*

California voters approved Proposition 1, "Water Bond. Funding for Water Quality, Supply, Treatment, and Storage Projects," on November 4, 2014, for $7.5 billion, which includes $2.7 billion for storage projects. Proposition 1 and the related AB 1471, passed by the California State Legislature in August 2014, replaced the previous water bond, SB 7, that was passed as part of 2009

Comprehensive Water Package. However, Proposition 1, section 79751 specifies:

> *Projects for which the public benefits are eligible for funding under this chapter consist of only the following:*
>
> *(a) Surface storage projects identified in the CALFED Bay-Delta Program Record of Decision, dated August 28, 2000, except for projects prohibited by Chapter 1.4 (commencing with Section 5093.50) of Division 5 of the Public Resources Code.*

Due to potential impacts on McCloud River resources (see Chapter 25, "Wild and Scenic River Considerations for McCloud River," of the accompanying Final EIS) and related provisions in Section 5093.50 of the California Public Resources Code (PRC), these provisions in Proposition 1 may limit bond funding for enlargement of Shasta Dam and Reservoir under the NED Plan, or any plan authorized for implementation, if the State or its agencies determine that such actions are prohibited by Chapter 1.4 of the PRC.

#### *CALTRANS*

Caltrans is the state agency responsible for highway, bridge, and rail transportation planning, construction, and maintenance. A major transportation route through the Shasta Lake area is Interstate 5. A new Antlers Bridge for Interstate 5 is currently under construction on the Sacramento River Arm of Shasta Lake. This bridge replacement project will accommodate increased water surface elevations associated with an enlarged Shasta Dam. The Pit River Bridge, constructed by Reclamation in 1938, is a multipurpose structure, carrying both Union Pacific Railroad and Interstate 5 traffic.

### Joint Activities of Federal and State Agencies

Following are programs and plans relevant to the SLWRI that were developed or are being developed as collaborations between Federal and State agencies.

#### *Sacramento Valley Water Management Program*

The Sacramento Valley Water Management Program (SVWMP) is a collaborative effort to increase water supplies for farms, cities, and the environment by responding to water rights issues associated with implementation of the 1995 Bay-Delta WQCP (State Water Board 1995). SVWMP originated from Phase 8 of the State Water Board water right proceedings.

Through the SVWMP, a *Short-Term Settlement Agreement* was executed in December 2002 by more than 40 water suppliers in the Sacramento Valley (Upstream Water Users), Reclamation, DWR, USFWS, CDFW, Contra Costa Water District, and SWP contractors representing agricultural and municipal water users in Southern California, the central coast, and the San Joaquin Valley. The *Short-Term Settlement Agreement* specifically identified an enlargement of Shasta Lake as a potential long-term project (SVWMP 2002). Execution of this agreement resulted in the State Water Board dismissing the Phase 8 process on January 31, 2003.

The *Short-Term Settlement Agreement* includes stipulations regarding implementing a series of short-term projects identified in the *Short-Term Workplan* (SVWMP 2001) to fill unmet demands in the Sacramento Valley, and to provide between 92,500 acre-feet and 185,000 acre-feet of water to off-set CVP and SWP water supplies used to meet Upstream Water Users' responsibilities for the 1995 *Bay Delta Plan*, respectively, during certain water year types. These projects would be owned and operated by the Upstream Water Users.

Reclamation and DWR issued a Notice of Intent (NOI) and Notice of Preparation (NOP), respectively, in August 2003 to prepare a PEIS/R to analyze the potential effects of implementing five categories of short-term projects: water management, reservoir reoperation, system improvements, surface water and groundwater planning, and other nonstructural actions such as water transfers. This PEIS/R is not yet available; therefore, a programmatic approach to implementing projects identified in the *Short-Term Workplan* has not been developed. However, some individual projects identified in the *Short-Term Workplan* are under development or have been implemented by various organizations participating in the SVWMP.

#### *CALFED Bay-Delta Program*

Following the 1994 Bay-Delta Accord, CALFED, a collaboration of numerous Federal, State, and local agencies, established a program to address water quality, ecosystem quality, water supply reliability, and levee system integrity. Major CALFED programs include the Conveyance, Water Transfer, Environmental Water Account, Water Use Efficiency, Water Quality, Levee System Integrity, Ecosystem Restoration and Watershed Management, and Storage programs.

The Preferred Program Alternative in the CALFED PEIS/R (CALFED 2000c) identified an enlargement of Shasta Lake as one of five surface water storage projects to be investigated and "aggressively pursue[d]" by CALFED:

> *Shasta Lake enlargement [that] would include a 6- to 8-foot raise of the existing dam, expanding capacity by approximately 300 TAF. The enlargement could help offset losses of Trinity River diversions to the Sacramento River, improve the cold water reserve in Shasta Lake to regulate Sacramento River water temperatures, and improve overall water supply reliability.*

The CALFED PEIS/R also addressed the California Public Resources Code's protection of the McCloud River, stating that:

*The most significant environmental impact appears to be inundation of a few hundred yards of the McCloud River; the California Public Resources Code Section 5093.542 seeks to protect the free-flowing McCloud River but also provides for investigations for potential enlargement of Shasta Dam.*

Following issuance of the CALFED Final PEIS/R in July 2000, the CALFED agencies issued the CALFED Programmatic ROD in August 2000 which identified 12 action plans. Specifically, plans were identified for the Governance, Ecosystem Restoration, Watersheds, Water Supply Reliability, Storage, Conveyance, Environmental Water Account, Water Use Efficiency, Water Quality, Water Transfer, Levees, and Science programs. The CALFED agencies then began implementing Stage 1 of the Programmatic ROD, including the first 7 years of a 30-year program to establish a foundation for long-term actions.

The CALFED Programmatic ROD identified project-specific study of expanding CVP storage in Shasta Lake by approximately 300,000 acre-feet, including work to accomplish the following:

- Resolve legal issues to allow State agency cooperation
- Complete feasibility study and preliminary design
- Complete environmental review and documentation, obtain Federal authorization and funding, and begin construction.

The CALFED Programmatic ROD also provided for tiering environmental review for actions included in the CALFED PEIS/R, as described previously in the chapter.

To provide historical background and context for development of the SLWRI, the following description is quoted from the 2000 CALFED Programmatic ROD:

<u>Introduction</u>*: The CALFED Bay-Delta Program is an unprecedented effort to build a framework for managing California's most precious natural resource: water. California and the Federal government in partnership are launching the largest, most comprehensive water management program in the world. This is the most complex and extensive ecosystem restoration project ever proposed. It is also one of the most intensive water conservation efforts ever attempted. It is the most far-reaching effort to improve the drinking water quality of millions of Californians as well as an unprecedented commitment to watershed restoration. And it is the most significant investment in storage and conveyance in decades.*

*The CALFED Bay-Delta Program began in May 1995 to address the complex issues that surround the Bay-Delta. The CALFED Bay-Delta Program is a cooperative, interagency effort of 18 State and Federal agencies with management or regulatory responsibilities for the Bay-Delta. The CALFED Program is a collaborative effort including representatives of agricultural, urban, environmental, fishery, and business interests, Indian tribes and rural counties who have contributed to the process.*

*The San Francisco Bay/Sacramento-San Joaquin Delta (Bay-Delta) estuary is the largest estuary on the West Coast. It is a maze of tributaries, sloughs, and islands and a haven for plants and wildlife, supporting over 750 plant and animal species. The Bay-Delta includes over 738,000 acres in five counties. The Bay-Delta is critical to California's economy, supplying drinking water for two-thirds of Californians and irrigation water for over 7 million acres of the most highly productive agricultural land in the world.*

*The Bay-Delta is also the hub of California's two largest water distribution systems - the Central Valley Project (CVP) operated by the U.S. Bureau of Reclamation (Reclamation) and the State Water Project (SWP) operated by the California Department of Water Resources (DWR). Together, these water development projects divert about 20 to 70 percent of the natural flow in the system depending on the amount of runoff available in a given year. These diversions, along with the effects of increased population pressures throughout California, exotic species, water pollution, and numerous other factors have had a serious impact on the fish and wildlife resources in the Bay-Delta estuary.*

*The droughts of 1987-92 demonstrated just how vulnerable California is to water shortages. More recent conflicts between water quality, fish protection and water supply also demonstrate how little flexibility there is in the current system. With the State's population expected to grow from 34 million today to 59 million in 2040, the need to conserve, to build our capacity, and to manage our water system more efficiently is no longer just a goal, it is a reality.*

*Before CALFED, all agreed on the importance of the Bay-Delta estuary for both fish and wildlife habitat and as a reliable source of water, but few agreed on how to manage and protect this valuable resource. The CALFED Bay-Delta Program was established to develop a long-term comprehensive plan that will* *restore ecological health and improve water management for beneficial uses of the Bay-Delta system. Over the last five years, hundreds of individuals have spent thousands of hours discussing and debating options for a long-term restoration and management plan for the Bay-Delta estuary. The task is fourfold: 1) to restore the ecological health of a fragile and depleted Bay-Delta estuary; 2) improve the water supply reliability for the State's farms, and growing cities that draw water from the Delta and its tributaries, including 7 million acres of the world's most productive farmland; 3) protect the drinking water quality of the 22 million Californians who rely on the Delta for their supplies; and 4) protect the Delta levees that ensure its integrity as a conveyance and ecosystem. Through the Bay-Delta Advisory Council, State and Federal agencies have worked with stakeholders and the public to shape these options into this framework for a comprehensive plan.*

*The CALFED Program and the CALFED Agencies have approached many ecosystem and water management issues from a regional perspective: what makes the most sense for the affected region. The regions, which include their respective watersheds, are the Sacramento Valley, the San Francisco Bay Area, the Delta, Westside San Joaquin Valley, San Joaquin River/South San Joaquin Valley, and Southern California. Although each region raises unique ecosystem and water management issues, each region's issues affect the health and function of the Bay-Delta system as a whole. Those regional issues nevertheless need regional solutions that contribute to overcoming the challenges facing the Bay-Delta system. In crafting regional solutions, the CALFED Program has also identified and considered the other, independent actions taken by Federal, State, and local agencies operating outside the CALFED Program. In addition, CALFED has taken into account its obligations to comply with ongoing commitments, such as the commitments included in the State's area of origin laws.*

*Consistent with the stated purposes of CALFED Bay-Delta Program since its outset in 1995, it is not the intent of this program to address or solve all of the water supply problems in California. The CALFED program is directly or indirectly tied to a number of specific project proposals that would help toward meeting California's water needs for a wide variety of beneficial uses. CALFED is an important piece of a much larger picture that is the continuing responsibility of local, regional, State and Federal jurisdictions.*

> <u>Bay-Delta Accord</u>: *Seeking solutions to the resource problems in the Bay-Delta, State and Federal agencies signed an agreement in June 1994 to (1) coordinate their actions to meet water quality standards to protect the Bay-Delta estuary; (2) coordinate the operation of the State Water Project (SWP); and the Central Valley Project (CVP) more closely with recent environmental mandates; and (3) develop a process to establish a long-term Bay-Delta solution to address four categories of problems: ecosystem quality, water quality, water supply reliability, and levee system vulnerability.*
>
> *This agreement laid the foundation for the Bay-Delta Accord and CALFED. The Accord, formally called the Principles for Agreement on Bay-Delta Standards between the State of California and the Federal Government, detailed interim measures for both environmental protection and regulatory stability in the Bay-Delta. On December 15, 1994, the Accord was signed by State and Federal resource agencies, as well as by stakeholders representing many local water agencies and environmental organizations. Under the terms of a December 1999 extension, the Accord formally expires when this ROD is executed* [August 28, 2000]. *Thereafter, the provisions in the Accord are replaced in their entirety by the provisions and agreements in this ROD and associated documents.*

In 2004, the federal CALFED Bay-Delta Authorization Act (Public Law 108-361) directed the Secretary of Interior to use the CALFED Programmatic ROD as a "general framework for addressing the CALFED Bay-Delta Program" (Section 103 (a) (1)). Further, Public Law 108-361 authorized the Secretary of the Interior to carry out the activities described in paragraphs (1) through (10) of Subsection (d), which includes "planning and feasibility studies for projects to be pursued with project-specific study for enlargement of (1) the Shasta Dam in Shasta County" (Section 103 (d) (1) (A) (i)).

#### CALFED Storage Program Element

As one of the primary CALFED program elements, the Water Storage Program addresses both surface water and groundwater storage opportunities and objectives. Results of initial evaluations to formulate this program were presented in the Integrated Storage Investigation Report – Initial Surface Water Storage Screening (CALFED 2000b), which assessed and screened numerous potential reservoir sites. Of many potential surface water storage projects considered, five were included in the Preferred Program Alternative for consideration during early phases of CALFED implementation. CALFED identified DWR and Reclamation as joint lead State and Federal agencies, respectively, for the site-specific planning and feasibility studies of the five potential surface storage projects; DWR was identified as the sole lead agency for addressing groundwater storage opportunities.

The five surface water storage projects are SLWRI, In-Delta Storage, Los Vaqueros Reservoir Enlargement, Sites Reservoir (also known as North-of-the-Delta Offstream Storage (NODOS)), and Upper San Joaquin River Basin Storage. For Shasta Dam and Reservoir, the CALFED Preferred Program Alternative included a proposed 6.5-foot raise of Shasta Dam, which would expand the reservoir by approximately 256,000 acre-feet. Potential benefits of an expanded reservoir include an increased pool of cold water available to maintain lower Sacramento River temperatures needed by certain fish, and other water management benefits, such as water supply reliability. In 2010, DWR developed the CALFED Surface Storage Investigations Progress Report (DWR 2010) to provide an overview of the status of and new analyses conducted for the CALFED surface storage investigations.

#### *Bay-Delta Conservation Plan*

The BDCP is being prepared through a collaboration of Federal, State, and local water agencies, Federal and State fish agencies, environmental organizations, and other interested parties. The BDCP consists of an array of conservation measures to achieve the biological goals and objectives, including: components for water conveyance facilities and operations; conservation components, including land acquisition for major habitat restoration efforts in the Delta; and components related to reducing other stressors on the Bay-Delta ecosystem. The conservation measures and effects assessment related to achieving the BDCP's overall planning goals are incorporated by reference into the December 2013 BDCP Draft Environmental Impact Report/DEIS (DEIR/S) (DWR 2013a). The BDCP conservation strategy consists of multiple components that are designed to collectively achieve the overall BDCP planning goals of ecosystem conservation and water supply reliability. The conservation strategy includes biological goals and objectives; conservation measures; avoidance and minimization measures; and a monitoring, research, and adaptive management program.

Four broad concepts have been studied to address urban water quality, water supply reliability, and environmental concerns in the Delta: physical barriers, hydraulic barriers, through-Delta facilities, and isolated facilities. Several alternative Delta conveyance facilities are being evaluated as part of the plan. Depending on the alternative, the water conveyance facility components could create a new conveyance mechanism to divert water from the north Delta to existing SWP and CVP export facilities in the south Delta, interacting with operational guidelines to achieve the planning goal outlined above. Modifications of Shasta Dam and Reservoir could allow for increased system flexibility and further use of new Delta conveyance facilities, providing for even greater water supply reliability benefits.

The Draft BDCP and BDCP DEIR/S were made available to the public for a review and comment period, effective December 13, 2013 through July 29, 2014. On August 27, 2014 it was announced that a partially Recirculated Draft BDCP, EIR/S, and Implementing Agreement will be published in early 2015.

The recirculated documents will include those portions of each document that warrant another public review before publication of final documents.

## Activities of Regional and Local Entities/Agencies

Following are regional and local activities relevant to the SLWRI.

### *Sacramento River Conservation Area Program*

The Sacramento River Conservation Area Forum (SRCAF) is a nonprofit organization formed in compliance with California’s 1986 SB 1086 legislation to manage aquatic resources along the upper Sacramento River from Keswick Dam to Verona. The program established and managed by SRCAF is responsible for preserving remaining riparian habitat, reestablishing a continuous riparian ecosystem along the Sacramento River between Redding and Chico, and reestablishing riparian vegetation along the river from Chico to Verona. The *Upper Sacramento River Fisheries and Riparian Habitat Management Plan* (Resources Agency 1989) identifies specific actions to help restore the Sacramento River fishery and riparian habitat between Keswick Dam and the confluence of the Feather River, including actions specific to the study area.

### *Iron Mountain Mine Restoration Plan*

The Iron Mountain Mine Trustee Council was formed to oversee restoration activities associated with the Iron Mountain Mine, and comprises representatives from five agencies (USFWS, CDFW, NMFS, BLM, and Reclamation). The Iron Mountain Mine complex is a Superfund site in the Spring Creek drainage, which is a tributary to Keswick Reservoir. A restoration plan identifies actions to address injuries to, or lost use of, natural resources resulting from acid mine drainage from the Iron Mountain Mine complex (USFWS, DFG, NOAA, BLM, Reclamation 2002). The plan includes restoration of salmonid populations, riparian habitat, and instream ecological functions.

### *Riparian Habitat Joint Venture*

The Riparian Habitat Joint Venture promotes conservation and restoration of riparian habitat to support native bird populations. Recommended conservation efforts in the SLWRI study area include conservation of lower Clear Creek as a prime breeding area for yellow warblers and song sparrows. The Sacramento River is targeted for restoration of riparian habitat to support the yellow-billed cuckoo, bank swallow, Swainson's hawk, and yellow-breasted chat.

### *Resource Conservation Districts*

Resource Conservation Districts (RCD) are locally governed agencies responsible for conserving resources within their districts by implementing projects on public and private lands, and educating landowners and the public about resource conservation. Activities include resources management, watershed management, conservation, and restoration programs. In the primary study area, districts include the Western Shasta County RCD and Tehama

County RCD. To the east are the Fall River and Pit River RCDs, and to the west and north are the Trinity County and Shasta Valley RCDs.

#### *Other Public and Private Organizations and Programs*

Other public and private organizations, programs, and plans related to the SLWRI include the following:

- Battle Creek Watershed Conservancy
- California Trout
- Cantara Trustee Council
- Clear Creek Coordinated Resource Management Plan
- Cottonwood Creek Watershed Group
- Cow Creek Watershed Management Group
- Lakehead Community Development Association
- McCloud River Coordinated Resource Management Plan
- Pit River Watershed Alliance
- Sacramento River Preservation Trust
- Sacramento River Watershed Program
- Sacramento Watersheds Action Group
- Shasta Lake Business Owners Association
- Shasta Land Trust
- Stillwater-Churn Creek Watershed Alliance
- Sulphur Creek Coordinated Resource Management Plan
- The Nature Conservancy (McCloud River Preserve and Lassen Foothills projects)
- The Trust for Public Land
- Winnemem Wintu

# Chapter 2
# Water Resources and Related Conditions

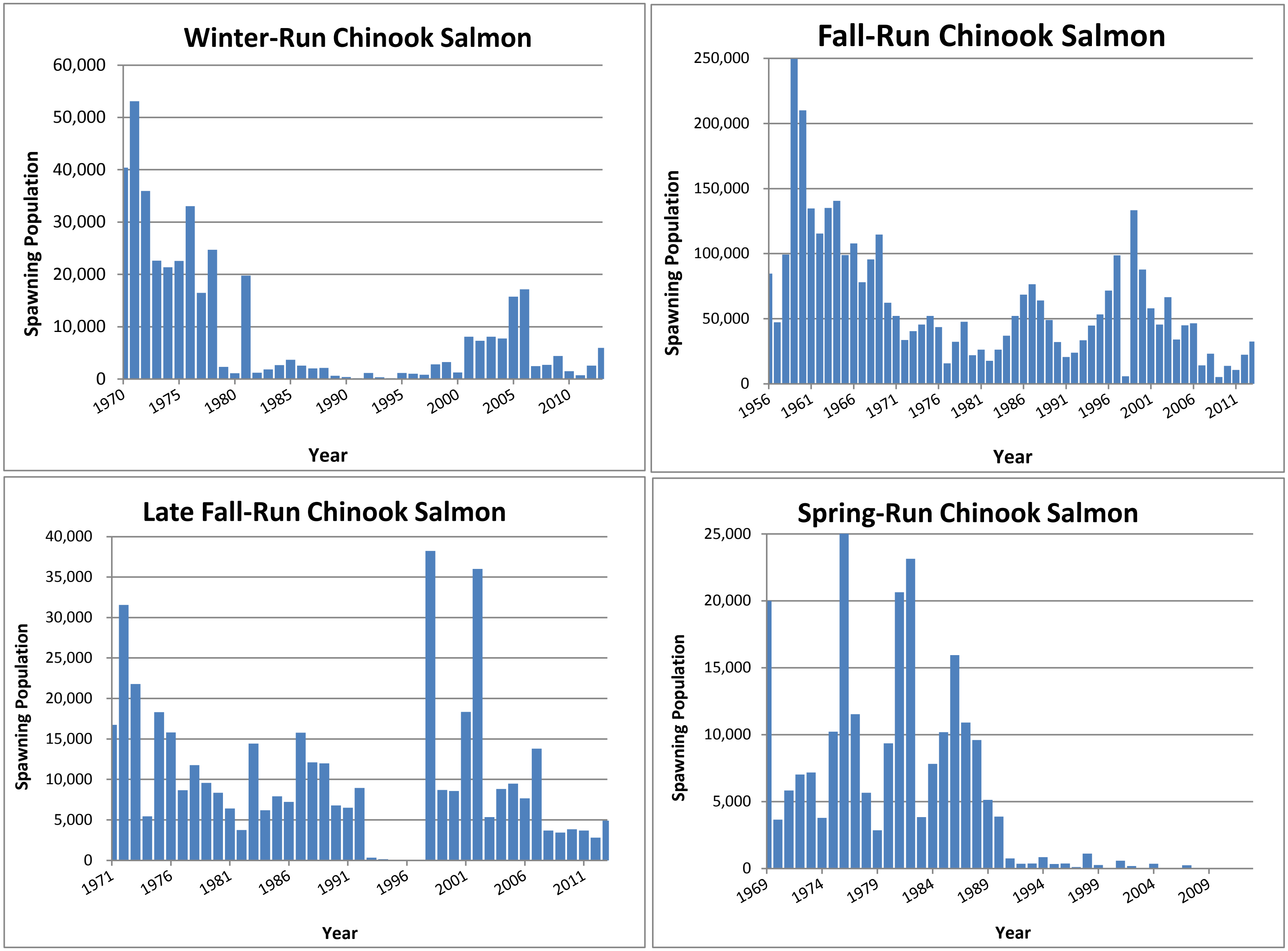
This chapter addresses an initial and essential step in the SLWRI planning process – identifying and assessing existing and likely future conditions – to establish an understanding and basis for comparing the potential effects of alternative plans. This step includes describing water resources problems, needs, and opportunities to be addressed, and inventorying, forecasting, and analyzing the specified existing and likely future conditions in the study area. Identified problems, needs, and opportunities serve as the basis for planning objectives, which guide the formulation of alternative plans. The plan formulation process for Federal water resources studies and projects is specified in the P&Gs (WRC 1983), and is further described in Chapter 3, "Plan Formulation."

## Water and Related Resources Problems, Needs, and Opportunities

Based on the overall feasibility study authority, Public Law 96-375, and concerns expressed about existing and likely future water and related resources issues, the following is a description of identified major water resources problems, needs, and opportunities in the primary SLWRI study area.

### 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 declined considerably over the last 40 years (Figure 2-1) (CDFW 2014a). Several fish species in the upper Sacramento River have been listed as endangered or threatened, as defined by the ESA: 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 also are listed as endangered or threatened, as defined by the CESA: Sacramento River winter-run Chinook salmon (endangered) and Central Valley spring-run Chinook salmon (threatened).




*Source: CDFW, 2014*

**Figure 2-1. Chinook Salmon Historic Spawning Populations in Sacramento River**

Numerous factors have contributed to these declines, including unstable water temperature, loss of historic spawning areas and suitable rearing habitat, water diversions from the Sacramento River, drought conditions, reduction in suitable spawning gravels, fluctuations in river flows, toxic acid mine drainage, high rates of predation, unsustainable fish harvests, and unsuitable ocean conditions. One of the most significant environmental factors affecting Chinook salmon is unsuitable water temperature in the Sacramento River (NMFS 2009b, 2014). 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 stored behind Shasta Dam can significantly improve seasonal water temperatures in the Sacramento River for anadromous fish during critical periods. The NMFS *2014 Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-run Chinook Salmon and Central Valley Spring-run Chinook Salmon and the Distinct Population Segment of Central Valley Steelhead* states that prolonged droughts depleting the cold-water stored in Shasta Reservoir, or some related failure to manage cold-water storage, could put populations of anadromous fish at risk of severe population decline or extirpation in the long-term (NMFS 2009b, 2014). The risk associated with a prolonged drought conditions is especially high in the Sacramento River, as Shasta Reservoir is intended to maintain only one year of carryover storage. The recovery plan emphasizes that, under current conditions, even two consecutive years of drought could reduce Shasta Reservoir storage to levels insufficient to support the Sacramento River winter-run Chinook salmon spawning and incubation season.

Conversely, water that is too cold is detrimental to the rapid growth of rearing juveniles. Following construction of Shasta Dam, water released in the spring was unusually cold and prevented the characteristic rapid growth of fall-run and late fall-run juvenile Chinook salmon. Reduced growth rates result in increased risk for predation and entrainment at unscreened and inadequately screened diversions.

Various Federal, State, and local projects are addressing each of the aforementioned factors contributing to anadromous fish population declines. Recovery actions range from changing the timing and magnitude of reservoir releases to changing the temperature of released water. In May 1990, the State Water Board issued Water Rights Order 90-5, which included temperature objectives for the Sacramento River to protect winter-run Chinook salmon. This order was reinforced by the 1993, 2004, and 2009 NMFS BO for winter-run Chinook salmon, which established certain operating parameters for Shasta Reservoir. The State Water Board action and the NMFS BOs set minimum flows in the river downstream from Keswick Dam and minimum Shasta Reservoir carryover storage targets primarily to affect water temperatures during key periods.

In addition to flow requirements, structural changes were made at Shasta Dam to change the temperature of released water, such as construction of a temperature control device (TCD), completed in 1997. The TCD can be used to selectively draw water from different depths within the lake, including the deepest, to help maintain river water temperatures beneficial to salmon. The TCD is effective in helping to reduce winter-run Chinook salmon mortality in some critical years,[1] and for fall- and spring-run Chinook salmon in below-normal water years.

However, implementing requirements in the Trinity River ROD (Reclamation 2000), as amended, may diminish the water temperature improvements provided by the TCD at Shasta Dam. One of the major elements of the Trinity River ROD is reducing the average annual export of Trinity River water from 74 percent to 52 percent of the flow (Reclamation 2000). This reduces flow from the Trinity River basin into Keswick Reservoir, and then into the Sacramento River. Because water diverted from the Trinity River is generally cooler than flows released from Shasta Dam, implementing the Trinity River ROD offsets some of the benefits derived from the TCD.

With the exception of spring-run Chinook salmon, the average Chinook salmon spawning population in the Sacramento River since 1999 has increased compared with the previous 20 years (1979 to 1998) (CDFW 2014a). This increase in salmon populations is likely due primarily to minimum release requirements at Shasta Dam and the TCD. Additionally, changes in operating the RBDD and the RBPP have benefited Chinook salmon populations in the Sacramento River. However, there is a continual need for cool water in the Sacramento River, especially in dry and critical years, to promote anadromous fish survival and reduce the risk of extinction.

In the future, effects of climate change on operations at Shasta Lake could potentially result in changes to water temperature, flow, and ultimately, fish survival. As described in the Climate Change Modeling Appendix, climate change could result in higher reservoir releases because of an increase in winter and early spring inflow into the lake from high intensity storm events. The change in reservoir releases could be necessary to manage flood events resulting from these potentially larger storms. Climate change could also cause reduced end-of-September carryover storage volumes, resulting in lower lake levels for a portion of the year and a smaller cold-water pool, which could lead to warmer water temperature and reduced water quality within Shasta Reservoir. Most importantly, it is expected that climate change may result in increased water

[1] Throughout this document, water year types are defined according to the Sacramento Valley Index Water Year Hydrologic Classification unless specified otherwise.

temperatures downstream from Shasta Dam, particularly in summer months, and more frequent wet and drought (particularly extended drought) years. Increased water temperatures and extended drought periods may compound the threats to anadromous fish in the Sacramento River.

## Water Supply Reliability

California's water supply system faces critical challenges, with demands exceeding supplies for urban, agricultural, and environmental water uses across the State. The *California Water Plan Update 2013* (DWR 2014b) 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. 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 (DWR 2014b). Compounding these issues, Reclamation's *Water Supply and Yield Study* (Reclamation 2008b) describes dramatic increases in population, land use changes, regulatory requirements, and limitations on storage and conveyance facilities, further straining available water supplies and infrastructure to meet water demands. The resulting unmet water demands have led to increases in competition for water supplies among urban, agricultural, and environmental uses.

The following subsections discuss identified key issues related to water supply reliability in California, including current and estimated water shortages, anticipated effects of population growth and climate change on water supply and demand, and limitations on system flexibility. The final subsection discusses strategies for meeting future statewide water supply needs.

### *Estimated Water Supply Shortages*

Projecting accurate and quantified water supply and shortages in California is complex; numerous variables exist and, just as important, numerous opinions have been expressed regarding these variables. Table 2-1 displays estimated water demands, available supplies, and shortages for the Central Valley and the State under existing conditions (Reclamation 2008b). Current water supply shortages for the State are estimated at 2.3 and 4.1 MAF for average and dry years, respectively. As shown in Table 2-2, without further investment in water management and infrastructure, future shortages are expected to increase to approximately 4.9 and 6.1 MAF in average and dry years, respectively, by 2030. Representative demands for dry and average years were based on water use data from the *California Water Plan Update 2005* (DWR 2005), adjusted for population growth, increasing urban water use, and reductions in irrigated acreage and environmental flow due to insufficient water supplies. Shortages were determined on a regional basis, considering that limitations on conveyance and storage would prevent surpluses from one region or use category from filling shortages in another.

**Table 2-1. Estimated Water Demands, Supplies, and Shortages Under Existing Conditions**

| Item | Hydrologic Basin | | | | | | State of California | |
|---|---|---|---|---|---|---|---|---|
| | Sacramento | | San Joaquin | | Two-Basin Total | | | |
| | Average Year[1,2] | Dry Year[1,2] | Average Year[1,2] | Dry Year[1,2] | Average Year[1,2] | Dry Year[1,2] | Average Year[1,2] | Dry Year[1,2] |
| Population (million)[3] | 2.9 | | 2.0 | | 4.9 | | 36.9 | |
| **Water Demand (MAF)** | | | | | | | | |
| Urban | 0.9 | 0.9 | 0.6 | 0.6 | 1.5 | 1.5 | 8.9 | 9.0 |
| Agricultural | 8.7 | 8.7 | 7.0 | 7.0 | 15.7 | 15.7 | 34.2 | 34.2 |
| Environmental | 11.9 | 9.4 | 3.1 | 2.3 | 15.0 | 11.7 | 17.5 | 13.9 |
| ***Total*** | ***21.5*** | ***19.0*** | ***10.7*** | ***9.9*** | ***32.2*** | ***28.9*** | ***60.6*** | ***57.1*** |
| **Water Supply (MAF)** | | | | | | | | |
| Urban | 0.9 | 0.9 | 0.6 | 0.6 | 1.5 | 1.5 | 8.8 | 8.4 |
| Agricultural | 8.7 | 8.6 | 6.9 | 7.0 | 15.6 | 15.6 | 33.2 | 32.0 |
| Environmental | 11.5 | 8.7 | 2.5 | 1.8 | 14.0 | 10.5 | 17.5 | 12.6 |
| ***Total*** | ***21.1*** | ***18.2*** | ***10.0*** | ***9.4*** | ***31.1*** | ***27.6*** | ***60.6*** | ***53.0*** |
| **Total Shortage (MAF)[4]** | **0.4** | **0.8** | **0.7** | **0.5** | **1.1** | **1.3** | **2.3** | **4.1** |

Notes:

1 Water demands, supplies, and shortages are from the 2008 Reclamation Water Supply and Yield Study (Reclamation 2008b).

2 Representative dry and average year supplies and demands were based on adjusted water use and supply data from the *California Water Plan Update 2005* (DWR 2005).

3 Year 2005 population estimates are from the California Department of Finance (2010a).

4 Total shortages are calculated as the sum of shortages for each water demand category by region (e.g., North Coast, Sacramento River) and, therefore, may not equal the difference between total demands and supplies. Shortages were determined on a regional basis, assuming that limitations on conveyance and storage would prevent surpluses from one region or use category from filling shortages in another. Detailed estimates of shortages for each region can be found in the 2008 Reclamation Water Supply and Yield Study in Table A-1 (dry year) and Table A-2 (average year). For categories where supply is greater than demand, the shortage is equal to zero.

Key:
MAF = million acre-feet

**Table 2-2. Estimated Water Demands, Supplies, and Shortages for 2030**

| Item | Sacramento and San Joaquin Hydrologic Basins (Two-Basin Total) | | State of California | |
|---|---|---|---|---|
| | Average Year[1,2] | Dry Year[1,2] | Average Year[1,2] | Dry Year[1,2] |
| Population (million)[3] | 10.5 | | 49.2 | |
| **Water Demand (MAF)** | | | | |
| Urban | 2.4 | 2.5 | 11.9 | 12.0 |
| Agricultural | 15.0 | 15.0 | 31.4 | 31.4 |
| Environmental | 14.9 | 11.7 | 17.5 | 14.0 |
| ***Total*** | ***32.3*** | ***29.2*** | ***60.8*** | ***57.4*** |
| **Water Supply (MAF)** | | | | |
| Urban | 1.5 | 1.5 | 8.4 | 8.0 |
| Agricultural | 15.6 | 15.6 | 32.8 | 31.5 |
| Environmental | 14.0 | 10.5 | 16.3 | 12.6 |
| ***Total*** | ***31.1*** | ***27.6*** | ***57.5*** | ***52.1*** |
| **Total Shortage (MAF)[4] (MAF)[4]** | **1.8** | **2.2** | **4.9** | **6.1** |

Notes:

1 Water demands, supplies, and shortages are from the 2008 Reclamation Water Supply and Yield Study (Reclamation 2008b).

2 Representative dry and average year supplies and demands were based on water use and supply data from the *California Water Plan Update 2005* (DWR 2005), adjusted for population growth, increasing urban water use, and reductions in irrigated acreage and environmental flow due to insufficient water supplies.

3 Year 2030 Population estimates are from the California Department of Finance (2007).

4 Total shortages are calculated as the sum of shortages for each water demand category by region (e.g., North Coast, Sacramento River) and, therefore, may not equal the difference between demands and supplies. Shortages were determined on a regional basis, assuming that limitations on conveyance and storage would prevent surpluses from one region or use category from filling shortages in another. Detailed estimates of shortages for each region can be found in the 2008 Reclamation Water Supply and Yield Study in Table A-4 (dry year) and Table A-5 (average year). For categories where supply is greater than demand, the shortage is equal to zero.

Key:
MAF = million acre-feet

### *Potential Effects of Population Growth on Water Demands*

A major factor in California's future water picture is population growth. California's population is expected to increase by just over 60 percent relative to 2005 levels by 2050 (California Department of Finance 2007), potentially redirecting some agricultural water supplies to urban uses. A portion of the increased population in the Central Valley would occur on lands currently used for irrigated agriculture. Water that would have been needed for these lands for irrigation would instead be used to serve replaced urban demands. However, this would only partially offset the agricultural-to-urban water conversion needed to meet projected urban water demands, since much of the growth would occur on nonirrigated agricultural lands.

The *California Water Plan Update 2013* (DWR 2014b) estimates changes in future water demands by 2050 considering three different population growth scenarios as well as climate change. Table 2-3 shows results of this study for an average water year (DWR 2014b). The first scenario (Current Trends) assumes that recent population growth trends will continue until 2050. The second scenario (Lower than Current Trends) assumes that population growth will be slower than currently projected. The third scenario (Higher than Current Trends) assumes that population growth will be faster than currently projected, with nearly 70 million people living in California in 2050. Estimated reductions in agricultural water demands in Table 2-3 represent decreases in future agricultural water demands due to conversion from agricultural to urban land uses. Under the Higher than Current Trends scenario, as much as 1.8 MAF of increased demand is projected. This would be in addition to the current water shortages estimated in Table 2-1.

**Table 2-3. Estimated Annual Change in Water Demand in California for 2050 Considering Different Population Growth Scenarios**

| Item | Current Trends | Lower than Current Trends | Higher than Current Trends |
|---|---|---|---|
| Population (million) | 51.0 | 43.9 | 69.4 |
| Irrigated Crop Acreage (million) | 8.9 | 9.0 | 8.6 |
| **Water Demand Change[1]** (MAF) | | | |
| Urban | 2.9 | 1.3 | 6.1 |
| Agricultural | -3.6 | -3.0 | -4.3 |
| **Total** | **-0.7** | **-1.7** | **1.8** |

*Source: DWR 2014b*

Note:

[1] Estimated water demand change is the difference between the average demands for 2043—2050 relative to 1998—2005. A positive value indicates an increase in water demand, while a negative value indicates a decrease in water demand.

Key:

MAF = million acre-feet

### *Potential Effects of Climate Change*

Another potentially significant factor affecting water supply reliability is climate change. Potential effects of climate change are many and complex (DWR 2006), varying through time and geographic location across the State (Reclamation 2011e). Changes in geographic distribution, timing, and intensity of precipitation are projected for the Central Valley (Reclamation 2011e), which could broadly impact rainfall runoff relationships important for flood management as well as water supply. Additionally, there is potential for climate change to increase annual water demand compared to a repeat of historical climate (DWR 2014b). Other possible impacts range from potential sea level rise, which could impact coastal areas and water quality, to impacts to overall system storage for water supply.

A reduction in total system storage is widely predicted to occur with climate change. Precipitation held in snowpacks makes up a significant quantity of total annual supplies needed for urban, agricultural, and many environmental uses. It is expected that in the future, climate change may significantly reduce water held in snowpacks in the Sierra Nevada (Reclamation 2011e, DWR 2014b). Further potential for reductions in water conservation space in existing reservoirs in the Central Valley is anticipated because of increasing needs for additional space for flood management purposes stemming from shifts in the timing of flood runoff and magnitude of extreme events. These potential reductions could significantly impact available water supplies, especially for reservoirs immediately upstream from large urban areas such as Folsom Lake on the American River, which is upstream from the greater Sacramento metropolitan area. During drought periods, supplies could be further reduced, and expected shortages would be substantially greater. For additional information on potential climate change implications for water supply reliability, please see the Climate Change Modeling Appendix to the accompanying EIS.

### *System Flexibility*

In addition to concerns about future water supply and demand, California's Federal and State water systems lack flexibility in timing, location, and capacity to meet the multiple objectives of the projects. CVP and SWP flexibility has diminished with population growth and increased environmental and ecosystem commitments and requirements (Reclamation 2008b). Complicating this issue is the variability associated with water resources in California. Precipitation in California is seasonably, temporally, and spatially variable, and urban, agricultural, and environmental water users have variable needs for quantity, quality, timing, and place of use.

California's water systems face the threat of too much water during floods, and too little water to meet demands during dry and critical water years. Chronic water shortages have led to increases in groundwater usage, which has led to groundwater overdraft in many regions across the State. Groundwater overdraft can cause permanent declines in groundwater levels, long-term reductions in groundwater supplies, land subsidence, decreases in water quality, a greater potential for salt water intrusion, and lasting environmental impacts. Challenges are greatest during dry years, when water supplies are less available (DWR 2014b).

Increasing CVP/SWP operational constraints have led to growing competition for limited system resources between various users and uses. Urban and required environmental water uses have each increased, resulting in increased competition and conflicting demands for limited water supplies. For example, the CVPIA, implemented in 1993, dedicated 800,000 acre-feet of CVP water supplies to the environment as well as additional water supplies for the Trinity River and wildlife refuges. Current BOs by NMFS and USFWS, resulting in increased Delta pumping constraints and other operational restrictions, coupled with drought conditions, have even further decreased CVP deliveries. As competition for limited resources between various uses grows, water management flexibility and adaptability will be even more necessary in the future.

#### *Strategies to Address Water Supply Needs*

As noted by Reclamation's *Water Supply and Yield Study* (Reclamation 2008b), the *California Water Plan Update 2013* (DWR 2014b), and CALFED Programmatic ROD (CALFED 2000a), an integrated portfolio of solutions, regional and statewide, is needed to meet future water supply needs. The *Water Supply and Yield Study* stated that a "variety of storage and conveyance projects and water management actions have the potential to help fill [the] gap" between water supply and demand in California. The *California Water Plan Update 2013* concluded that to improve public safety, foster environmental stewardship, and support economic stability, California must continue its commitment to integrated water management, promote better alignment of government agency efforts at all levels, and encourage greater investment in innovation and infrastructure, including increased surface storage. Accordingly, California must invest in reliable, high quality, and affordable water conservation; efficient water management; and development of water supplies. Major efforts by multiple agencies are needed to address the complex water resources issues in the State, as demands are expected to continue to exceed supplies in the future.

To avoid major impacts to the overall economy, environment, and standard of living in California, actions to conserve existing supplies and optimize the use of existing facilities will be needed. Additionally, development of additional water sources and increased storage and delivery capability are critical for providing reliable water supplies for expanding M&I uses and to maintain adequate supplies for agricultural and environmental purposes.

### Ecosystem Resources

The health of the Sacramento River ecosystem, as elsewhere in the Central Valley, has been impacted in the last century by conflicts over the use of limited natural resources, particularly water resources. Many of California's rivers and streams have been harnessed for beneficial uses such as hydropower, flood damage reduction, and water supply, contributing to a decline in habitat and native species populations, and a resulting increase in endangered or threatened species listings under the ESA and CESA. Climate change is expected to place additional stress on California's native species and habitats.

Construction of Shasta Dam has had both negative and positive effects on environmental resources in the region. While construction of the dam displaced valuable riverine and upland habitat and blocked access to upstream riverine habitat for some species, it also created shoreline and shallow water habitat for aquatic, terrestrial, and avian species in the reservoir area. For example, Shasta Lake is home to a substantial concentration of nesting bald eagles in California.

#### *Shasta Lake Area*

Various activities have impacted natural resources upstream from Shasta Dam, within the lake, on adjacent lands, and in and near tributary streams. Historical mining, ore processing practices and resulting acid mine drainage, and fire suppression are among the activities causing the greatest challenges to ecosystem resources in this area. Although mines in this area are no longer operational and are currently undergoing remediation, they continue to remain a documented source of metals, acidity, and sediments in the reservoir area. In addition, fire suppression activities have resulted in an accumulation of vegetation cover in the watershed and a decrease in the return intervals of natural fires, both of which potentially affect erosion processes and sediment delivery to tributaries and increase the likelihood of higher intensity fires (USFS 2011). To guide management of the Shasta-Trinity National Forest (STNF), the USFS has prepared the *Shasta-Trinity National Forest Land and Resource Management Plan* (USFS 1995). Primary goals of the *Shasta-Trinity National Forest Land and Resource Management Plan*, which was implemented in 1995, are to integrate a mix of management activities that allows use and protection of forest resources; meets the needs of guiding legislation; and addresses local, regional, and national issues. The *Shasta-Trinity National Forest Land and Resource Management Plan* is intended to guide implementation of the *Aquatic Conservation Strategy of the Northwest Forest Plan* (USFS 1994) for protection and management of riparian and aquatic habitats adjacent to Shasta Lake.

Opportunities exist to further support ongoing USFS programs. These opportunities include improving and restoring environmental conditions by developing self-sustaining natural habitat in the area of Shasta Lake and its tributaries to benefit fish and wildlife resources.

#### *Downstream from Shasta Dam*

Land and water resources development has caused major resource problems and challenges in the Sacramento River basin, including decreases in anadromous fish and wildlife populations and losses of riparian, wetland, floodplain, and shaded riverine habitat. These decreases and losses have resulted in reduced populations of many plant and animal species.

The quantity, quality, diversity, and connectivity of riparian, wetland, floodplain, and shaded riverine habitat along the Sacramento River have been severely limited through confinement of the river system by levees, reclamation of adjacent lands for farming, bank protection, channel stabilization, and land development. Modification of seasonal flow patterns by dams and water diversions also has inhibited the natural channel-forming processes that drive riparian habitat succession. It is estimated that less than 5 percent of the historical riparian vegetation within the Sacramento River basin remains today (USFWS 2014).

Decreases in the quality and quantity of habitat have resulted in reduced populations of various fish and wildlife species. The low populations and questionable sustainability of these species have led to an increase in listings under the ESA and CESA in recent years. Introduction of nonnative species has also contributed to the decline in native animal and plant species. In addition, lack of linear continuity of riparian habitat has impacted the movement of wildlife species among habitat areas, adversely affecting dispersal, migration, emigration, and immigration. For many species, this has resulted in reduced wildlife numbers and population viability.

Ecosystem restoration along the Sacramento River has been the focus of several ongoing programs, including the Senate Bill 1086 Program, CVPIA, CALFED, and Central Valley Habitat Joint Venture. These and numerous local programs have been established to address ongoing conflicts over the use of limited resources within the Central Valley. Much effort has been directed in the upper Sacramento River region above the RBPP toward restoring or improving anadromous fisheries, which provide recreational and commercial values in addition to their environmental value. Despite these efforts, a significant need remains to conserve and restore ecosystem resources along the Sacramento River.

Endangered and threatened fish and wildlife populations, critical habitat, and sensitive Delta ecosystems are also declining. The decline is especially pronounced in the case of pelagic fish species in the Delta, including delta smelt, striped bass, threadfin shad, and longfin smelt. Monitoring results indicate that the threatened delta smelt population continues to remain at or near all-time lows. In 2006, the USFWS was petitioned to upgrade the status of delta smelt to endangered (Center for Biological Diversity, et al. 2006). In 2010, the USFWS conducted their 5-year review and found delta smelt warranted the upgrade in status, however, the listing was precluded by other higher priority-listing actions (Volume 75, Federal Register (FR), page 17667 (75 FR 17667 (April 7, 2010))). Longfin smelt were petitioned for listing as endangered in 2007 (Center for Biological Diversity, et al. 2007). The USFWS found that the Bay-Delta distinct population segment of longfin smelt does warrant listing, however, as with the delta smelt, the listing is precluded by other higher priority actions. Therefore, longfin smelt have been added to the candidate list (77 FR 19756 (April 2, 2012)).

In recognition of the challenges facing water management in California, and the need to develop new strategies for a sustainable Delta ecosystem that would continue to support its economic functions, various planning efforts are underway. Current planning efforts, such as the BDCP and Delta Habitat Conservation and Conveyance Program are focused on developing ecological solutions to protect Delta fisheries while providing a sustainable and reliable water conveyance system for the CVP and SWP.

### Flood Management

Large and small communities and agricultural lands in the Central Valley are subject to flooding from the Sacramento River and its tributaries. USACE, in partnership with DWR, has worked to assess basin-wide flood management issues and identify options in the Sacramento River basin to address these issues. Measures to reduce high flows in the Sacramento River include spilling floodwater into bypass areas through historical overflow areas, streams, conveyance canals, and weirs. The comprehensive flood control system in the

Sacramento River basin includes river, canal, and stream channels, levees, flood relief bypasses, weirs, flood relief structures, a natural overflow area, outfall gates, and drainage pumping plants. USACE and DWR continue to develop improvements associated with the Sacramento River Bank Protection Project and to assist in local flood damage reduction projects along the Sacramento River. DWR is currently working on the implementation of the *Central Valley Flood Protection Plan* (DWR 2012), which was adopted in 2012 to address flood issues throughout the Sacramento and San Joaquin valleys and the Delta.

Flooding poses risks to human life, health, and safety. Threats to the public from flooding are caused by many factors, including overtopping or sudden failures of levees, which can cause deep and rapid flooding with little warning, threatening lives and public safety. In addition, urban development in flood-prone areas has exposed the public to the risk of flooding.

Physical impacts from flooding occur to residential, agricultural, commercial, industrial, institutional, and public property. Damages occur to buildings, contents, automobiles, and outside property, including agricultural crops, equipment, and landscaping. Physical damages include cleanup costs and costs to repair roads, bridges, sewers, power lines, and other infrastructure components. Nonphysical flood losses include income losses, losses of public and social services, and the cost of emergency services, such as flood fighting and disaster relief.

Even though a project to enlarge Shasta Dam and Reservoir has the potential to improve flood management along the upper Sacramento River, operational practices, forecasting uncertainties, and other influencing factors exist that can inhibit flood management operations. Explicit rules for the operation of Shasta Dam during the flood season are provided in the Shasta Dam and Lake Flood Control Diagram (USACE 1977); however, these operations can be difficult to achieve during a flood event. This is primarily due to the extreme inflow volumes to Shasta Reservoir that can occur over long periods, numerous points of inflow along the river downstream from Shasta Dam, and multiple points of operational interest downstream (such as Hamilton City and other rural communities). The primary downstream control point along the Sacramento River that determines reservoir releases under real-time operations is Bend Bridge.

Other unofficial factors enter into flood management decisions at Shasta Dam, such as peak flows at Hamilton City or other rural communities that are at risk of flooding. These factors, combined with the uncertainty of storm forecasting, could lead to a reduction in flood operation flexibility at Shasta Dam. Should this occur, it could cause a cascading impact on effective flood management downstream to the Delta. Accordingly, there is a need to review flood control operations at Shasta Dam.

### Hydropower

While California is the second largest consumer of electricity in the nation, it is also the most energy efficient. Although California has 12 percent of the nation's population, it uses only 7 percent of the nation's electricity (DOE 2014), making California the most energy-efficient State per capita in the nation. Even so, demands for electricity are growing at a rapid pace.

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 (California Energy Commission 2012). There are, and will continue to be, increasing demands for new electrical energy supplies, including clean energy sources, such as hydropower. 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 (California Public Utilities Commission 2011). Senate Bill X1-2, signed by Governor Edmund G. Brown, Jr., in April 2011, codified the requirement for power retailers to meet the 33 percent renewable target by 2020. To meet renewable energy goals, 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 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. For example, the San Onofre Nuclear Generating Station in San Diego County is in the process of decommissioning.

### Recreation

As the population of the State continues to grow, demands will increase significantly for water-oriented recreation at and near the lakes, reservoirs, streams, and rivers of the Central Valley. According to the *California Water Plan Update 2013* (DWR 2014b), the Central Valley is experiencing dramatic population growth, but currently has insufficient access to recreation opportunities. Further increases in demand, accompanied by relatively static recreation resources, will cause additional 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 capacity problems at existing marinas and USFS facilities. A significant 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. The Sacramento River downstream from Keswick Dam is critical habitat for the migration and reproduction of Chinook salmon (NMFS 2009b) and the Delta is one of the largest ecosystems for fish and wildlife habitat and production in the United States (Regional Water Boards, State Water Board, and CalEPA 2006). However, 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, that have resulted in significant declines in pelagic populations (Regional Water Boards, State Water Board, and CalEPA 2006). In the Sacramento River and its tributaries, water temperatures, which are vital for anadromous fish survival, are affected by variations in climate and rainfall as well as operating conditions of various Federal, State, and local water supply systems. Additionally, urban and agricultural runoff, and runoff and seepage from abandoned mining operations, have resulted in elevated levels of pesticides, phosphorous, mercury, and other metals in the Sacramento River.

Several environmental flow goals and objectives in the Central Valley, including the Delta, have been established through legal mandates to address the impacts of water operations and water quality deterioration on the Sacramento River basin and Delta ecosystems and on endangered and threatened fish populations. Planning efforts, such as the BDCP, are intended to allow implementation of projects that restore and protect water supply and reliability, water quality, and ecosystem health in the Delta to proceed within a stable regulatory framework. Additional operational flexibility is needed to provide further opportunities to improve Sacramento River and Delta water quality conditions. Increasing storage in Shasta Reservoir could provide increased CVP operational flexibility to meet water quality goals in the Delta, as well as provide more cold-water storage in critical years to improve Sacramento River water temperatures.

## Existing and Likely Future Resources Conditions in Study Area

One of the most important elements of any water resources evaluation is defining existing resource conditions in the study area, and how these conditions may change in the future. The magnitude of change not only influences the scope of the problems, needs, and opportunities, but the extent of related resources that could be influenced by possible actions taken to address them. Defining the existing and likely future conditions is critical in establishing the basis for comparing potential alternative plans consistent with the P&G, NEPA, California Environmental Quality Act (CEQA), and Reclamation policy guidance, including Reclamation Directives and Standards.

The following section briefly discusses existing conditions in the study area, including existing infrastructure, the physical environment, the biological environment, cultural resources, and socioeconomic resources. Because of the potential influence of the proposed modification of Shasta Dam, and subsequent water deliveries over a large geographic area, the SLWRI includes both a primary and extended study area, as described in Chapter 1. Figure 1-4 shows the geographic extent of the primary study area. The discussion of existing conditions focuses on the primary study area, but also provides information about water resources facilities and water deliveries in the extended study area. Additional information is provided in the "Affected Environment" sections of each resource chapter in the accompanying EIS.

## Existing Conditions Summary

The following sections summarize existing conditions for reservoir area infrastructure and physical, biological, cultural, and socioeconomic resources within the SLWRI study area. Additional information is included in the "Affected Environment" sections of each resource chapter in the accompanying EIS. Appendices to the accompanying EIS present further, detailed information, including the Engineering Summary Appendix, Physical Resources Appendix, Biological Resources Appendix, Cultural Resources Appendix, and Socioeconomics Appendix.

### *Reservoir Area Infrastructure*

**Figure 2-2. Shasta Dam and Reservoir Looking North Toward Mount Shasta**

Existing infrastructure in the primary study area includes Shasta Dam and Reservoir, associated water management facilities, numerous recreation amenities, and various other public and private infrastructure (Reclamation 2003c), as described below.

**Shasta Dam and Reservoir** Shasta Dam and Reservoir (Figure 2-2) are located on the upper Sacramento River in Northern California, about 9 miles northwest of the City of Redding; the dam and entire reservoir are within Shasta County. Shasta Dam is a curved, gravity-type, concrete structure that rises 533 feet above the streambed with a total height above the foundation of 602 feet. The dam has a crest width of about 41 feet and a length of 3,460 feet. The spillway has a discharge capacity of 186,000 cubic feet per second (cfs) at pool elevation of 1,065 feet above mean sea level (elevation 1,065). Table 2-4 summarizes the pertinent data and features of Shasta Dam and Reservoir.[2]

[2] Two elevation datum are referenced in text and figures herein and in the accompanying EIS. The National Geodetic Vertical Datum of 1929 (NGVD29) is used in reference to Shasta Dam and appurtenant facility designs. The North American Vertical Datum of 1988 (NAVD88) is used in reference to Shasta Reservoir inundation pool elevations, and the elevations of potential reservoir area infrastructure that may need to be modified or relocated to accommodate increased water levels, consistent with a 2001 aerial survey of the reservoir area that referenced the NAVD88 datum. The NGVD88 is 2.66 feet higher than NGVD29.

**Table 2-4. Pertinent Data[1] – Shasta Dam and Reservoir and Keswick Dam and Reservoir**

| | | | |
|---|---|---|---|
| **General** | | | |
| **Drainage Areas (excluding Goose Lake basin)** | | **Mean Annual Runoff (1908 – 2006)** | |
| Sacramento River at Shasta Dam | 6,421 sq-mi | Sacramento R. at Shasta Dam | 5,737,000 acre-feet |
| Sacramento River at Keswick Dam | 6,468 sq-mi | Sacramento R. near Red Bluff | 8,421,000 acre-feet |
| Sacramento River near Red Bluff | 8,900 sq-mi | Sacramento River maximum flows | |
| Sacramento River near Ord Ferry | 12,250 sq-mi | At Shasta Lake (January 16, 1974) | 216,000 cfs |
| Pit River at Big Bend | 4,710 sq-mi | Near Red Bluff (February 28, 1940) | 291,000 cfs |
| McCloud River above Shasta Lake | 604 sq-mi | At Ord Ferry (February 28,1940) | 370,000 cfs |
| Sacramento River at delta above Shasta Lake | 425 sq-mi | | |
| **Shasta Dam and Reservoir** | | | |
| **Shasta Dam (concrete gravity)** | | **Shasta Reservoir** | |
| Crest elevation | 1,077.5 feet | Full pool elevation | 1,067.0 feet |
| Freeboard above full pool | 10.5 feet | Minimum operating level elevation | 840.0 feet |
| Height above foundations | 602 feet | Take line elevation | Irregular |
| Height above streambed | 487 feet | Surface area | |
| Length of crest | 3,500 feet | Minimum operating level | 6,700 acres |
| Width of crest | 30 feet | Full pool | 29,500 acres |
| Slope, upstream | Vertical | Take line | 90,000 acres |
| Slope, downstream | 1 on 0.8 cu-yd | Storage capacity | |
| Structure volume | 8,430,000 cu-yd | Minimum operating level | 587,000 acre-feet |
| Normal tailwater elevation | 585 feet | Full pool | 4,552,000 acre-feet |
| **Spillway (gated ogee)** | | **Shasta Powerplant** | |
| Crest length | | Main units | |
| Full pool | 360 feet | 5 turbines, Francis type | 515,000 hp (total) |
| Net | 330 feet | 5 units @ 142 MW | 710 MW (total) |
| Crest gates (steel drum) | | Station units | |
| Number and size | 3@110 feet x 28 feet | 2 generators, 2,500 kW each | 5,000 kW (total) |
| Top elevation when lowered | 1,037.0 feet | Elevation centerline turbines | 586 feet |
| Top elevation when raised | 1,065.0 feet | Maximum tailwater elevation | 632.5 feet |
| Discharge capacity at pool (elevation 1,065 feet) | 186,000 cfs | Total discharge capacity at pool (elevation 1,065 feet) | 14,500 cfs |

**Table 2-4. Pertinent Data[1] – Shasta Dam and Reservoir and Keswick Dam and Reservoir (contd.)**

| | | | |
|---|---|---|---|
| **Shasta Dam and Reservoir (contd.)** | | | |
| **Spillway (gated ogee) (contd.)** | | **Shasta Powerplant (contd.)** | |
| Flashboard gates | 3@110 feet x 2 feet | Total discharge at pool (827.7 feet) | 16,000 cfs |
| Top elevation when lowered | 1,067.0 feet | Power outlets (15-foot steel penstocks) | |
| Bottom elevation when raised | 1,069.5 feet | 5 with invert elevation of intake | 807.5 feet |
| Outlets (102-inch-diameter conduit with 96-inch-diameter wheel-type gate) | | | |
| 4 with invert elevation | 737.75 feet | Capacity at elevation 1,065 | 81,800 cfs |
| 8 with invert elevation | 837.75 feet | Capacity at elevation 827.7 | 12,200 cfs |
| 6 with invert elevation | 937.75 feet | | |
| **Keswick Dam and Reservoir** | | | |
| **Keswick Dam (concrete gravity)** | | **Keswick Reservoir** | |
| Crest elevation | 595.5 feet | Elevation – maximum operating level | 587.0 feet |
| Freeboard above maximum operating level | 8.5 feet | Elevation – minimum operating level | 574.0 feet |
| Height of dam above foundation | 159 feet | Surface area at maximum operating level | 643 acres |
| Height of dam above streambed | 119 feet | Storage capacity | |
| Length of crest | 1,046 feet | At maximum operating level | 23,800 acre-feet |
| Width of crest | 20 feet | At minimum operating level | 16,300 acre-feet |
| Volume | 197,000 cu-yd | **Keswick Powerplant** | |
| Normal tailwater elevation | 487 feet | 3 generator units | 105,000 kW (total) |
| **Spillway (gated ogee)** | | | |
| Crest length | 200 feet | | |
| Crest gates (fixed wheel) | 4 gates, 50 feet x 50 feet each | | |
| Discharge capacity at pool (elevation 587 feet) | 248,000 cfs | | |

Note:
[1] Elevations for Shasta Dam and appurtenant facilities and Keswick Dam are based on the National Geodetic Vertical Datum of 1929 (NGVD29).
Key:
cfs = cubic feet per second
cu-yd = cubic yard
elevation = elevation in feet above mean sea level
hp = horsepower
kW = kilowatt
MW = megawatt
R = River
sq-mi = square mile

Figure 2-3 shows the relationship between Shasta Reservoir surface area and storage capacity at various water surface elevations. At full pool, Shasta Lake has a storage capacity and water surface area of 4.55 MAF and 29,500 acres, respectively. Seasonal flood control storage space in Shasta Reservoir is about 1.3 MAF. Shasta Dam operations are summarized later in this chapter in the section on "Physical Environment."

Shasta Powerplant consists of five main generating units and two station service units with a combined capacity of 715,000 kilowatts (kW). Several elevation and plan views of Shasta Dam and Powerplant are provided in the Engineering Summary Appendix to the accompanying EIS. These drawings were prepared before construction of the existing temperature control facilities on the upstream face of the dam.

Construction of the existing TCD at Shasta Dam was completed in 1997. It is a multilevel water intake structure located on the upstream face of the dam. The TCD allows operators to draw water from the top of the reservoir during the winter and spring when surface water temperatures are cool, and from deeper in the reservoir in the summer and fall when surface water is warm. It also improves oxygen and sediment levels in downstream river water. The TCD helps Reclamation fulfill contractual obligations for both water delivery and power generation while managing habitat conditions for fish, such as Chinook salmon, that require cooler water temperatures.

**Keswick Dam and Reservoir** Shasta Dam is operated in conjunction with Keswick Dam and Reservoir, located about 9 miles downstream from Shasta Dam. In addition to regulating outflow from Shasta Dam, Keswick Dam controls runoff from 45 square miles of drainage area. Keswick Dam is a concrete, gravity-type structure with a spillway over the center of the dam. The spillway has a discharge capacity of 248,000 cubic feet per second (cfs) at a full pool elevation of 587 feet above mean sea level (elevation 587). Storage capacity of Keswick Reservoir below the top of the spillway gates at full pool is 23,800 acre-feet. The powerplant has a nameplate generating capacity of 105,000 kW and can pass about 15,000 cfs at full pool. Table 2-4 summarizes the pertinent data and features of Keswick Dam and Reservoir.

#### *Physical Environment*

Elements of the existing physical environment described in this section include topography, geology, and soils; geomorphology, sedimentation, and erosion; climate and air quality; hydrology; water quality; noise and vibration; hazardous materials; and agricultural and important farmlands.

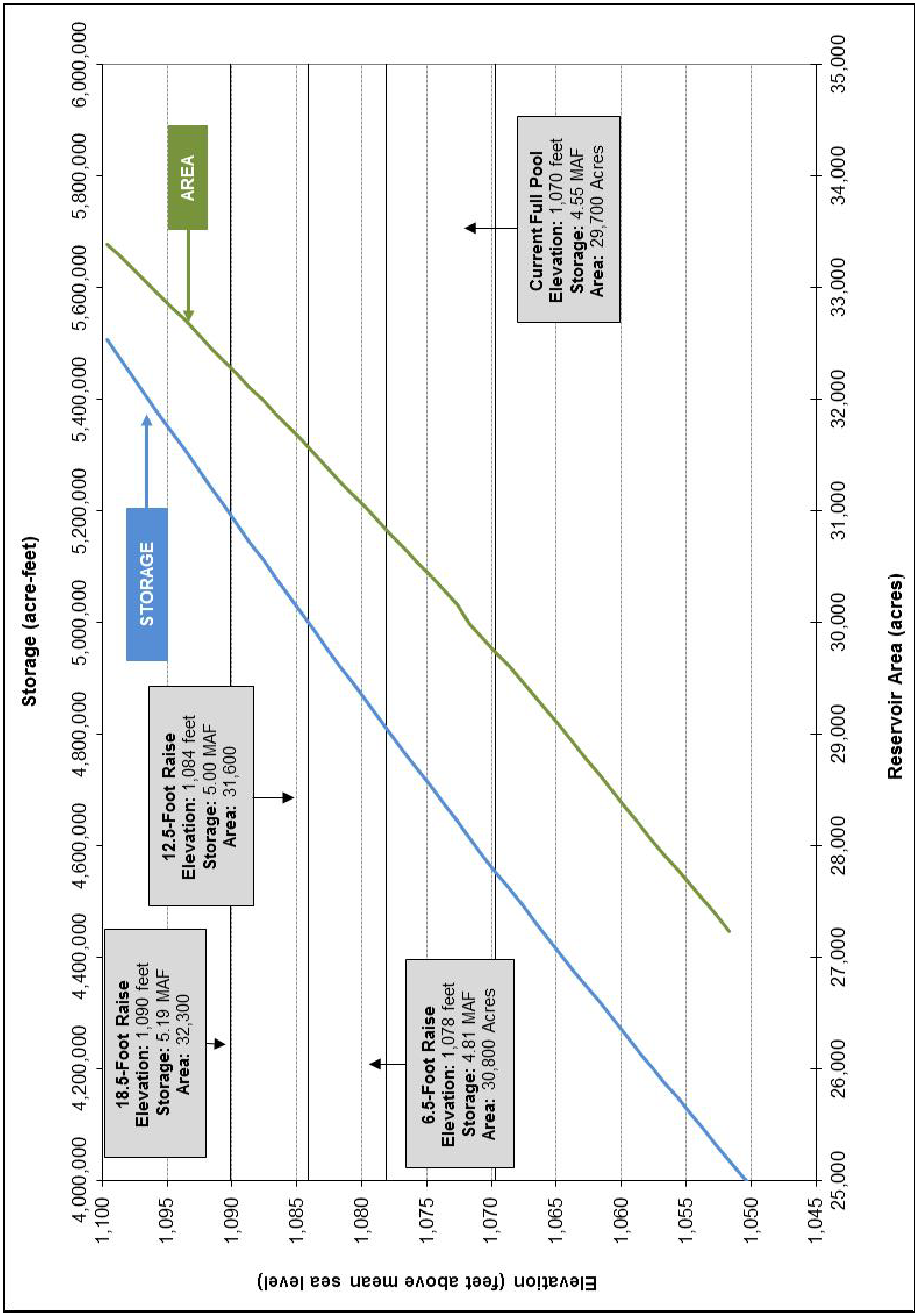



**Figure 2-3. Shasta Reservoir Area-Capacity Relationships (elevations based on NAVD88)**

**Topography, Geology, and Soils** Shasta Dam and Lake are located on the northern edge of the Central Valley. The topography of the area surrounding Shasta Lake is generally steep and mountainous. Ground surface elevations near Shasta Lake range from above elevation 14,000 at Mount Shasta to approximately elevation 1,070 at Shasta Lake. Other topographic features in the primary study area include major tributary drainages above Shasta Dam – the Sacramento, McCloud, and Pit rivers, and Squaw Creek, as well as several smaller drainages. Downstream from Shasta Dam are numerous major tributaries to the Sacramento River. Much of the extended study area is contained within the Central Valley, which is almost completely enclosed by mountains and has only one outlet, through San Francisco Bay, to the Pacific Ocean. Topography in the extended study area is dominated by the flat expanses of the Sacramento River basin, Delta, and San Joaquin River basin. Topography of the Delta includes a network of over 700 miles of interconnecting waterways with more than 600 islands and tracts, with land surfaces ranging from about elevation 20 to more than 20 feet below mean sea level.

The geology of the study area is highly complex, containing portions of five geomorphic provinces: the Klamath Mountain, Coast Range, Great Valley, Cascade Range, and Modoc Plateau. Shasta Lake is located within the Klamath Mountain Geomorphic Province at the north end of the Sacramento Valley. Geology of the Klamath Mountains to the north and west of the study area, including Shasta Lake and its tributaries, comprises older bedrock materials, sedimentary basin deposits, and volcanic deposits. Alluvial deposits overlay a large portion of this area, and soils are mainly derived from metamorphic rock and deep alluvium. Limestone caves provide habitat for several cave-dwelling species in the area. The segment of the study area along the Sacramento River downstream to the location of the RBPP encompasses portions of the Klamath Mountain, Great Valley, and Cascade Range geomorphic provinces. The Cascade Range to the east comprises primarily volcanic formations and volcanic sedimentary deposits. The Great Valley Geomorphic Province (also referred to as the Central Valley) is a large structural trough formed between the uplands of the California Coast Range to the west and the Sierra Nevada to the east. This trough is filled with a sequence of sediments ranging in age from Jurassic to Recent.

Principal formations downstream along the Sacramento River to Red Bluff include the Tehama, Riverbank, Chico, and Red Bluff formations, which contain marine and nonmarine sedimentary rocks eroded from the surrounding Cascade Range and Klamath Mountains. The deep alluvial and aeolian soils of the Central Valley floor comprise some of the best agricultural land in the State. Delta soils comprise primarily intertidal deposits of soft mud and peat, with organic peat soils up to 60 feet deep in some areas.

**Geomorphology, Sedimentation, and Erosion** Much of the area around Shasta Lake and adjacent to the lower reaches of its tributaries is characterized by active and historic mass wasting processes. The steep hillsides and coarse soils are subject to mud flows, debris flows, slides, and other forms of mass erosion. The Sacramento River between Shasta Lake and Red Bluff is characterized by steep, vertical banks, and the river is primarily confined to its channel with limited overbank floodplain areas, resulting in limited channel migration and meander. Downstream from Red Bluff, the Sacramento River is active and sinuous, meandering across alluvial deposits within a wide meander belt. Natural geomorphic processes in the Sacramento River and Delta have been highly modified by changes to upstream hydrology (reservoirs and stream flow regulation) and construction of levees, channels, and other physical features.

Watersheds for many of the tributaries of Shasta Lake have been significantly altered by a number of factors that cause sediment influxes and accelerated erosion, including logging and hydraulic mining; construction of dams, roads, reservoirs, and channel modifications; wildfires; and agricultural and urban activities. Slides and sheet wash typically supply debris and sediments to the tributary streams of Shasta Lake during the rainy season. Because much of the terrain is steep, landslides are common and vary in intensity. In addition to sediment carried into Shasta Lake via tributaries, shoreline erosion contributes to a portion of sediment deposition in the reservoir. Shoreline erosion is caused by seasonal changes in reservoir water levels and, to some extent, by recreational activities in and around the lake. The shoreline below full pool elevation is generally steep and devoid of vegetation that might otherwise help stabilize soils.

Shasta and Keswick dams have a significant influence on sediment transport in the upper Sacramento River because they block sediment that would normally have been transported downstream. The result has been a net loss of coarse sediment, including salmon spawning gravels, in the Sacramento River below Keswick Dam. In alluvial river sections, bank erosion and sediment deposition cause river channel migrations that are vital to maintaining instream and riparian habitats, but which can cause loss of agricultural lands and damage to roads and other structures. In the Sacramento River, these processes are most important in the major alluvial section of the river, which begins downstream from the RBPP. The river channel in the reach from Keswick Dam to RBPP is constrained by erosion-resistant formations and therefore is more stable.

**Climate and Air Quality** The northern half of the Central Valley is located in the Sacramento Valley Air Basin (SVAB). The Mediterranean climate of the SVAB is characterized by hot, dry summers and cool, rainy winters. Average temperatures range from about 60 degrees Fahrenheit (°F) in low valley regions to about 40°F in mountain areas. Characteristic of SVAB winters are periods of dense and persistent low-level fog, which are prevalent between storms. Precipitation on the valley floor occurs mostly during winter as rain. Average annual precipitation throughout the Sacramento River basin is 36 inches. Total annual precipitation at higher elevations is as much as 95 inches in the northern Sierra Nevada and the Cascade Range. In the primary study area, measurements recorded at the Shasta Dam station show that normal annual precipitation is approximately 61 inches. Summer air temperatures range from an average low of 62°F to an average high of 95°F. Winter air temperatures range from an average low of 39°F to an average high of 57°F.

In the SVAB, air pollutants can become concentrated during the summer because of inversion layers forming in the lower elevations, subsequently lowering air quality. Winter winds disperse pollutants, often resulting in clear weather and better air quality over most of the region. Much of the SVAB is designated as nonattainment with respect to the National and State ozone and particulate matter (PM) standards; the urban Sacramento and Marysville/Yuba City areas are designated as nonattainment for National and State carbon monoxide standards.

**Hydrology** Hydrologic features of the study area include perennial, intermittent, and ephemeral stream channels, and natural water bodies and wet meadowlands. The hydrology and climate of the primary study area make it favorable to water resources development; consequently, streamflow hydrology on the upper Sacramento River and major tributaries to Shasta Lake has been significantly modified by the development of water management and hydropower facilities. The following subsections discuss historical flows and storage at Shasta Reservoir, historical flows in the Sacramento River below Keswick Dam, and flood control operations for Shasta Dam and Reservoir.

*Historical Flows and Storage at Shasta Reservoir* Mean monthly inflow, outflow, and storage at Shasta Reservoir are shown in Table 2-5. The highest average monthly inflow period for Shasta is January through March. Winter and early spring inflows are stored for later release during the summer irrigation season.

**Table 2-5. Mean Monthly Inflow, Outflow, and Storage at Shasta Reservoir**

| Month | Inflow[1] (TAF) | Outflow[2] (TAF) | Storage[3] (TAF) |
|---|---|---|---|
| January | 799 | 587 | 3,143 |
| February | 836 | 628 | 3,366 |
| March | 889 | 511 | 3,732 |
| April | 693 | 421 | 3,981 |
| May | 537 | 524 | 3,965 |
| June | 339 | 536 | 3,730 |
| July | 247 | 615 | 3,326 |
| August | 223 | 571 | 2,967 |
| September | 220 | 377 | 2,808 |
| October | 263 | 301 | 2,770 |
| November | 365 | 331 | 2,793 |
| December | 585 | 465 | 2,911 |
| **Total** | **5,991** | **5,868** | NA |
| **Average** | **499** | **489** | **3,291** |

Notes:
[1] Computed data from 1944 through 2002.
[2] Recorded data from 1944 through 2002.
[3] Computed data from 1956 through 2005.
Key:
NA = not applicable
TAF = thousand acre-feet

*Historical Flows in the Sacramento River* Historical streamflow in the Sacramento River below Keswick Dam is shown in Figure 2-4. Since 1964, an annual average of 1.27 MAF of Trinity River flow has been exported to the Sacramento River through CVP facilities, or approximately 17 percent of the flows measured in the Sacramento River at Keswick Dam. Trinity River diversions to the Sacramento River were reduced as part of the 2000 Trinity River ROD (as amended) to retain more flows in the Trinity River for fish and associated habitat restoration purposes (Reclamation 2000).

*Flood Control* A storage space of up to 1.3 MAF is kept available for flood control purposes in Shasta Reservoir in accordance with the Shasta Dam and Lake Flood Control Diagram, as prescribed by USACE (1977). As prescribed by the diagram, seasonal flood storage space requirements increase from zero on October 1 to 1.3 MAF on December 1 and are maintained until December 23. From December 23 to June 15, the required flood storage space varies according to the accumulation of seasonal inflow. This variable space allows water to be stored for conservation purposes unless it is required for flood damage reduction purposes, based on basin wetness parameters and the level of seasonal inflow.

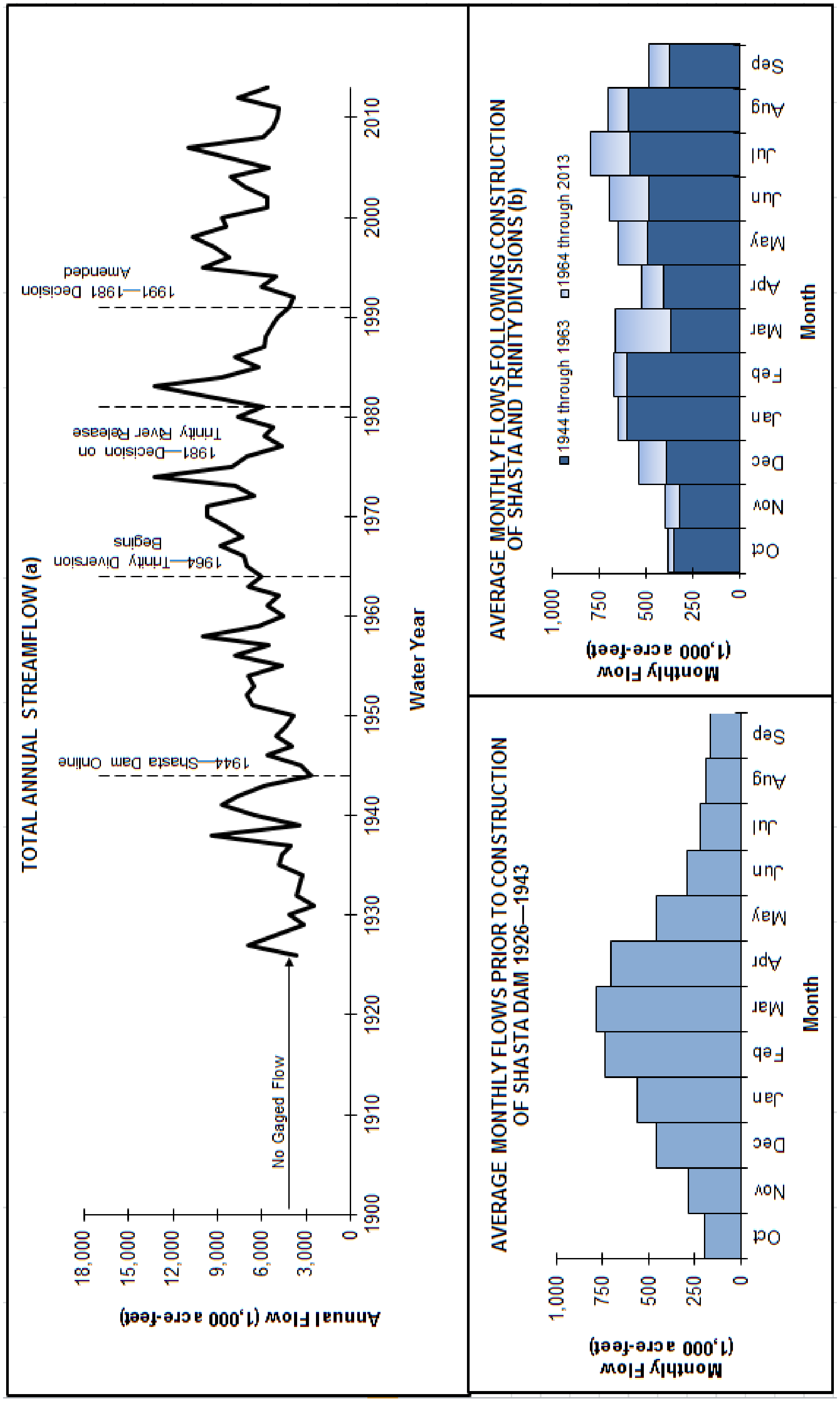
Daily flood management operations consist of determining the required flood storage space reservation, and scheduling releases in accordance with flood operating criteria. This requires forecasting flood runoff both above and below the dam. Rapidly changing inflows are continually monitored, and forecasts of the various inflows are adjusted, as required. The large size of the flood pool at

Shasta Reservoir can necessitate prolonged flood release operations over many weeks as operators vacate the pool before the next storm event.

A goal of existing operations is to maintain vacant flood storage space consistent with flood control requirements in the flood season, then then fill the pool to the maximum extent possible for water supply and other needs in the remainder of the year. Figure 2-5 is a plot showing historical monthly storage in Shasta Reservoir for 1953 through 2013.

Table 2-6 shows the historical annual inflow, storage, and outflow history for Shasta Reservoir from 1945 through 2013. Releases for flood damage reduction purposes typically occur in the fall, to reach the prescribed vacant flood space beginning in early October, and/or later in the winter and spring to evacuate space during or after a storm event to maintain the prescribed vacant flood space in the reservoir. Releases for flood management occur over the spillway during large events or through river outlets for smaller events. As shown in Table 2-6, from about 1950 through 2013, flows over the spillway occurred in 14 years, or in 20 percent of post-1950 years.

For large flood events rarer than about 1 chance in 100 in any given year, inflows to Shasta Lake can exceed the ability of the reservoir to store the inflow volume and maintain the estimated downstream safe channel-carrying capacity of 79,000 cfs. Under these circumstances, outflows would need to be increased to prevent uncontrolled conditions. Between Keswick Dam and the RBPP, intermittent levees help prevent flooding of low-lying lands along the Sacramento River.




*Source: California Data Exchange Center 2014*

Notes:

(a) Full year of streamflow data for USGS Station 11370500 was 1939. Data for 1926--1963 are from USGS Station 1136950.

(b) Upper portion of bar represents incremental increase in average monthly flows since Water Year 1964, due to releases from the Trinity River Division.

**Figure 2-4. Historical Streamflow in Sacramento River Below Keswick Dam**

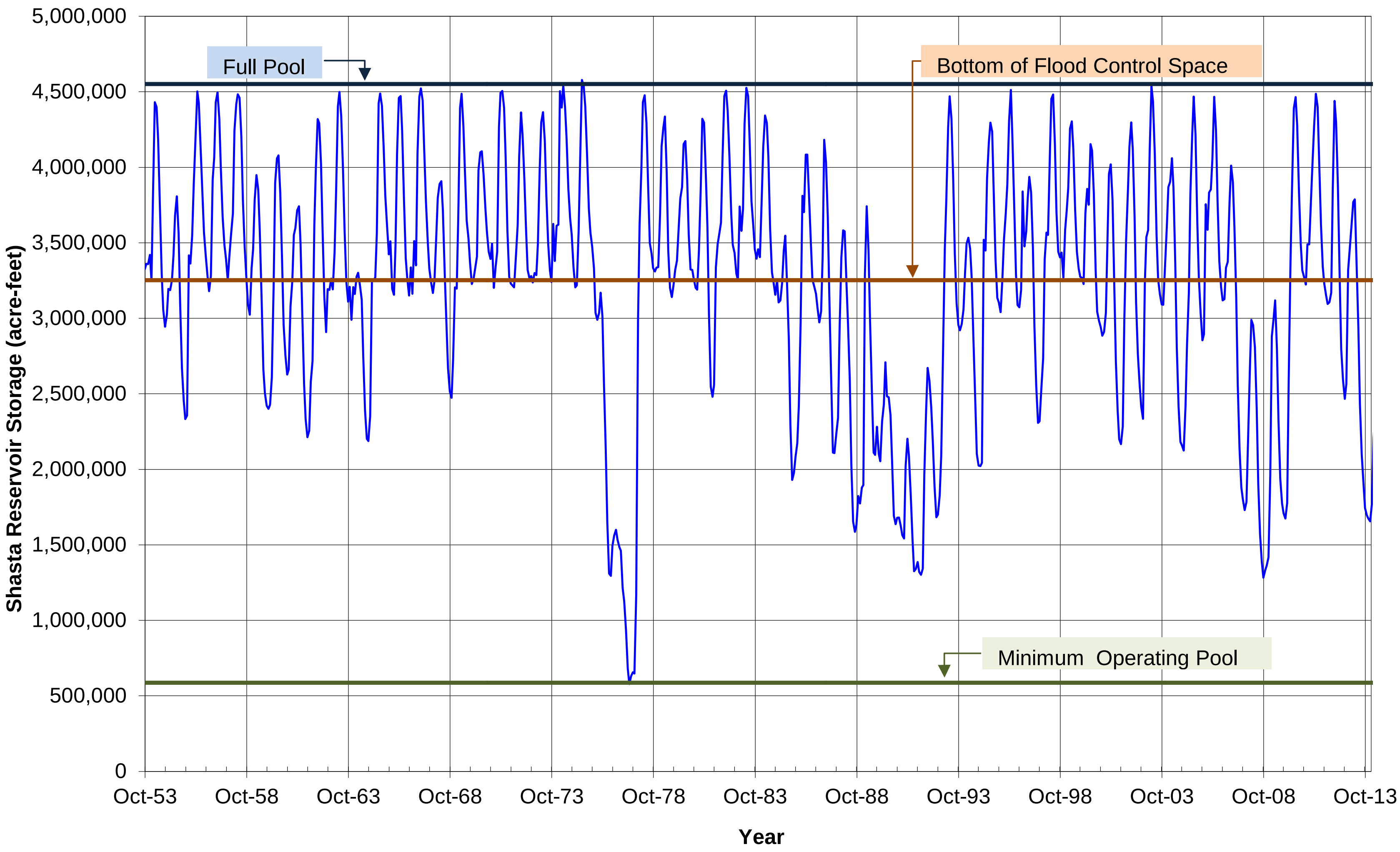



**Figure 2-5. Monthly Average Storage in Shasta Reservoir**

**Table 2-6. Historical Shasta Dam and Reservoir Flood Management Releases**

| Water Year | Total Inflow (TAF) | End of Sept. Storage (TAF) | Outflows (TAF) | | | | Water Year | Total Inflow (TAF) | End of Sept. Storage (TAF) | Outflows (TAF) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Total | Powerplant | Spillway | Outlets | | | | Total | Powerplant | Spillway | Outlets |
| 1945 | 4,858 | * | 3,462 | 2,624 | 0 | 839 | 1980 | 6,415 | 3321 | 6,139 | 4,773 | 0 | 1,366 |
| 1946 | 5,906 | * | 5,599 | 3,898 | 0 | 1700 | 1981 | 4,103 | 2480 | 4,845 | 4,845 | 0 | 0 |
| 1947 | 3,908 | * | 3,964 | 3,571 | 0 | 393 | 1982 | 9,013 | 3486 | 7,910 | 6,464 | 253 | 1,193 |
| 1948 | 5,416 | * | 4,958 | 4,244 | 0 | 714 | 1983 | 10,794 | 3617 | 10,576 | 7,123 | 1 | 3,452 |
| 1949 | 4,318 | * | 4,303 | 4,303 | 0 | 0 | 1984 | 6,667 | 3240 | 6,944 | 6,514 | 0 | 429 |
| 1950 | 4,133 | * | 3,784 | 3,781 | 1 | 2 | 1985 | 3,971 | 1978 | 5,154 | 5,152 | 2 | 0 |
| 1951 | 6,316 | * | 6,486 | 5,696 | 0 | 790 | 1986 | 7,546 | 3211 | 6,225 | 4,383 | 0 | 1,842 |
| 1952 | 7,785 | * | 6,800 | 5,625 | 9 | 1166 | 1987 | 3,944 | 2108 | 4,957 | 4,800 | 0 | 157 |
| 1953 | 6,540 | 3,300 | 6,408 | 5,067 | 0 | 1341 | 1988 | 3,931 | 1,586 | 4,368 | 3,973 | 0 | 395 |
| 1954 | 6,541 | 3,059 | 6,826 | 5,941 | 0 | 885 | 1989 | 4,745 | 2,096 | 4,154 | 3,951 | 0 | 203 |
| 1955 | 4,112 | 2,455 | 4,612 | 4,612 | 0 | 0 | 1990 | 3,616 | 1,637 | 3,999 | 3,707 | 0 | 292 |
| 1956 | 8,834 | 3,569 | 7,606 | 4,926 | 12 | 2668 | 1991 | 3,051 | 1,340 | 3,286 | 2,666 | 0 | 620 |
| 1957 | 5,368 | 3,485 | 5,341 | 4,841 | 17 | 483 | 1992 | 3,622 | 1,683 | 3,204 | 1,755 | 0 | 1,449 |
| 1958 | 9,698 | 3,473 | 9,610 | 6,672 | 13 | 2,924 | 1993 | 6,825 | 3,102 | 5,316 | 3,728 | 0 | 1,588 |
| 1959 | 5,086 | 2,504 | 5,952 | 5,631 | 0 | 321 | 1994 | 3,087 | 2,102 | 4,002 | 3,252 | 0 | 750 |
| 1960 | 4,733 | 2,756 | 4,380 | 4,380 | 0 | 0 | 1995 | 9,638 | 3,136 | 8,511 | 5,187 | 0 | 3,324 |
| 1961 | 5,071 | 2,333 | 5,402 | 5,402 | 0 | 0 | 1996 | 6,846 | 3,089 | 6,781 | 3,703 | 0 | 3,078 |
| 1962 | 5,262 | 2,908 | 4,582 | 4,582 | 0 | 0 | 1997 | 7,424 | 2,308 | 8,106 | 5,808 | 0 | 2,298 |
| 1963 | 7,003 | 3,242 | 6,575 | 6,077 | 13 | 485 | 1998 | 10,294 | 3,441 | 9,072 | 6,698 | 2 | 2,372 |
| 1964 | 3,905 | 2,202 | 4,849 | 4,849 | 0 | 0 | 1999 | 7,196 | 3,328 | 7,202 | 6,379 | 0 | 824 |
| 1965 | 6,983 | 3,612 | 5,475 | 4,581 | 0 | 894 | 2000 | 6,839 | 2,985 | 7,074 | 5,573 | 0 | 1,501 |
| 1966 | 5,299 | 3,263 | 5,544 | 5,544 | 0 | 0 | 2001 | 4,141 | 2,200 | 4,824 | 4,823 | 0 | 1 |
| 1967 | 7,404 | 3,506 | 7,066 | 6,131 | 0 | 935 | 2002 | 5,052 | 2,558 | 4,590 | 4,590 | 0 | 0 |
| 1968 | 4,772 | 2,670 | 5,515 | 5,138 | 0 | 377 | 2003 | 6,363 | 3,159 | 5,659 | 5,409 | 0 | 250 |
| 1969 | 7,668 | 3,528 | 6,714 | 5,421 | 0 | 1293 | 2004 | 5,738 | 2,183 | 6,615 | 5,617 | 0 | 998 |
| 1970 | 7,902 | 3,440 | 7,885 | 5,477 | 4 | 2404 | 2005 | 5,639 | 3,035 | 4,692 | 4,475 | 0 | 217 |
| 1971 | 7,328 | 3,275 | 7,402 | 6,824 | 1 | 578 | 2006 | 9,241 | 3,205 | 8,964 | 6,608 | 0 | 2,356 |
| 1972 | 5,078 | 3,267 | 5000 | 5000 | 0 | 0 | 2007 | 3,957 | 1,879 | 5189 | 5166 | 0 | 23 |
| 1973 | 6,167 | 3,317 | 6026 | 5583 | 0 | 443 | 2008 | 3,984 | 1,385 | 4220 | 4178 | 0 | 42 |
| 1974 | 10,796 | 3,658 | 10364 | 6796 | 0 | 3568 | 2009 | 4,533 | 1,774 | 4309 | 4105 | 186 | 18 |
| 1975 | 6,405 | 3,570 | 6384 | 6153 | 0 | 231 | 2010 | 5,646 | 3,319 | 4107 | 4004 | 0 | 103 |
| 1976 | 3,611 | 1,295 | 5813 | 5813 | 0 | 0 | 2011 | 6,468 | 3,341 | 6577 | 5703 | 0 | 874 |
| 1977 | 2,628 | 631 | 3247 | 3247 | 0 | 0 | 2012 | 3,971 | 2591.6 | 5211 | 5209 | 0 | 1 |
| 1978 | 7,837 | 3,428 | 4944 | 4538 | 0 | 407 | 2013 | 3,998 | 1,906 | 4588 | 4587 | 0 | 1 |
| 1979 | 4,022 | 3,141 | 4203 | 4203 | 0 | 0 | **Average** | **5,898** | **2,766** | **5804** | **4958** | **7** | **839** |

*Source: Reclamation 2007b, Reclamation 2014b*

Key:
* = reservoir filling
Sept. = September
TAF = thousand acre-feet

Shasta Lake collects flow in the upper Sacramento River watershed, but many uncontrolled tributaries, including Cow Creek, Battle Creek, Cottonwood Creek, and Thomes Creek, enter the Sacramento River downstream from the dam (USACE 1999). Stream gages located on various uncontrolled tributaries help the operators of Shasta Dam adjust releases to accommodate downstream peak flows. However, the influence of Shasta Dam's operation on reducing peak flood flows on the Sacramento River diminishes with distance downstream, largely because of these uncontrolled tributaries.

Downstream from the RBPP, flood management projects along the Sacramento River affect the flow and operation of facilities. Major reservoirs include Folsom Lake on the American River, Lake Oroville on the Feather River, and Black Butte Reservoir on Stony Creek. Levees associated with the Sacramento River Flood Control Project begin intermittently downstream from the RBPP and become continuous along both banks between Colusa and the Delta. Weirs located along the Sacramento River divert high flows to overflow basins and bypasses including Butte Basin, Sutter Bypass, and Yolo Bypass (Figure 2-6).

**Water Quality** Principal water quality issues in the primary study area include water temperatures in the Sacramento River between Keswick Dam and the RBPP, turbidity in Shasta Lake, and acid mine drainage and associated heavy metal contamination. The Central Valley Water Board determined that the 25-mile-long reach of the Sacramento River from Keswick Dam downstream to Cottonwood Creek is impaired because levels of dissolved metals periodically exceed levels identified to protect aquatic organisms (Central Valley Regional Water Board 2002a).

Water quality in the lower part of the Sacramento River and in the Delta may be affected by urban and agricultural runoff, acid mine drainage, stormwater discharges, and water project flows and diversions. The Sacramento River downstream from the RBPP was listed as an impaired water body under Section 303(d) of the CWA, and water quality was an identified objective of CALFED. Parameters of concern in this reach included diazinon, mercury, and unknown sources of toxicity (Central Valley Water Board 2002b). In the Delta, water quality can also be affected by saltwater intrusion. Water quality issues within the Delta, particularly those related to salinity, have resulted in significant declines in pelagic populations (Regional Water Boards, State Water Board, and Cal/EPA 2006). Potential changes in hydrology and sea levels due to climate change could further affect water quality within the Delta.


**Figure 2-6. Sacramento River Overflow Basins and Bypasses South of the Red Bluff Pumping Plant**

**Noise and Vibration** The area immediately surrounding Shasta Dam and Lake, where the majority of project construction would occur, is in an undeveloped canyon of the Sacramento River in Shasta County. Various recreational uses and sensitive receptors are present throughout the vicinity. Existing noise sources are associated with local roadway traffic, I-5 traffic, railway traffic, Redding Municipal Airport aircrafts, boats and personal watercraft on Shasta Lake, and stationary noise sources (e.g., mechanical equipment at the existing dam facility). Existing vibration sources in the SLWRI study area are primarily associated with local construction, roadway traffic, and trains.

**Hazardous Materials** Metals are present in inactive and abandoned mines around Shasta Lake and in the Sacramento River watershed. A records search for the primary study area identified one known contaminated site, which appears on the Federal National Priorities List/Superfund: the Iron Mountain Mine. The continuous release of metals from the Iron Mountain Mine since the 1940s is believed to have contributed to a steady decline in the fisheries population in the Sacramento River. In addition, several other former mining operations may currently impact environmental conditions in the primary study area. Of these, Bully Hill is the closest abandoned mine to the current shoreline; portions of mine tailings and a debris dam are periodically inundated by the reservoir.

**Agricultural and Important Farmlands** Within the primary study area, the valleys of the Sacramento River and its tributaries contain some of the most productive agricultural land in Shasta County. Many hundreds of acres of land in these valleys are classified as prime farmland, unique farmland, or farmland of statewide importance. Although there is little agricultural development immediately adjacent to Shasta Lake, agricultural lands are present in the upper watersheds of several tributaries, primarily to the east of the reservoir. In the extended study area, the Sacramento River basin downstream from the RBPP to the Delta, the Delta, the San Joaquin River basin to the Delta, portions of the American River basin, and the CVP and SWP water service areas are all rich in agricultural resources.

#### *Biological Resources Environment*

Biological resources in the region result from a wealth and diversity of climatic and vegetative associations within and adjacent to the study areas. Influences from the coastal mountains, southern Cascades, northern Sierra Nevada, Great Basin, and Central Valley provide for a unique mix of biota. The study area supports a variety of habitats, including riparian, grasslands, oak woodlands, chaparral, scrub, vernal pools, seasonal and permanent wetlands, estuaries, tidal sloughs, and marshes. Each of these habitats supports its own unique assemblage of vegetation and wildlife species.

Much of the area, especially within the Central Valley, has been modified by past and present land uses. Before human settlement, this region was dominated by riparian vegetation within the annual floodplains, with stands of valley oak and interior live oak on higher ground. The extensive oak forests and riparian/wetland habitats hosted a diverse and abundant wildlife community. Deforestation, water development, flood protection, and expansion of agriculture onto the floodplains in the early to mid-1800s substantially altered the historical floodplain and channel vegetation.

Agriculture is currently the primary land use in the Central Valley; much of the remaining habitat exists as a mosaic of fragmented upland communities or narrow strips of riparian habitat along the Sacramento River and its tributary creeks and sloughs. Although the remaining riparian habitat along the Sacramento River corridor is limited, it supports wildlife, and also supplies shade, cover, and transported nonnative material to the adjacent streamside environment, benefiting the floral and faunal species that are closely associated with the riparian environment.

**Fisheries and Aquatic Resources** Shasta Lake and Keswick Reservoir fish species include native and introduced warm-water and cold-water species. Shasta Lake tributary species comprise planted and wild trout and several native species. Major nonfish aquatic animal species assemblages of the study area include the lake floor macroinvertebrates of Shasta Lake, the Sacramento River, and tributaries to Shasta Lake, and zooplankton of the reservoirs.

The Sacramento River between Keswick Dam and the RBPP has a stable, largely confined channel with little meander. Riffle habitat with gravel substrates and deep pool habitats are abundant compared to reaches downstream from the RBPP. Immediately below Keswick Dam, the river is deeply incised in bedrock with very limited riparian vegetation and no functioning riparian ecosystems. Water temperatures are generally cool, even in late summer, because of regulated releases from Shasta Reservoir and Keswick Reservoir. Near Redding, the river enters the valley and the floodplain broadens. Historically, this area appears to have had wide expanses of riparian forests, but much of the river's riparian zone is currently subject to urban encroachment, particularly in the Anderson/Redding area.

The Sacramento River supports a variety of anadromous fishes, including four runs of Chinook salmon, steelhead, green sturgeon, white sturgeon, striped bass, American shad, and Pacific lamprey. Resident species include rainbow trout, hardhead, California roach, Sacramento sucker, Sacramento pikeminnow, and various species of nonnative catfish, sunfish, and black bass. The population of the four runs of salmon, and other important fish species (including steelhead) that also spawn upstream from Red Bluff, have significantly declined since the 1950s.

**Vegetation and Habitat Types** Shasta Lake is surrounded by mountainous terrain forested primarily by brushy, hardwood stands, chaparral, oak woodlands, mixed conifer forests, and ponderosa-pine-dominated conifer stands. Vegetation diversity tends to be high in the area, due largely to the favorable climate and varying geology. Elevation and sun exposure create variation in the forest stands around the lake. Shoreline vegetation around Shasta Lake provides important cover for aquatic species, and shade to maintain cooler water temperatures. The Shasta Lake area also supports nonnative plant species introduced to the region by early settlers. Some of the more invasive exotic species out-compete native vegetation.

Vegetation in the upper Sacramento River watershed upstream from Shasta Lake can be separated into seven basic vegetation types: Douglas fir-mixed conifer forest, mixed conifer, ponderosa pine, canyon oak woodland, black oak woodland, gray pine woodland, and chaparral. Lower elevation vegetation consists of a mix of chaparral and hardwoods; mid-elevation slopes are within a transitional zone that contains both the chaparral/hardwood mix and a mixed conifer component; and higher elevation sites are dominated by a mixed conifer overstory with brush species in the understory, primarily in open areas. An exception is in the riparian corridors, where conifers can span from lower to upper elevations.

Although the Central Valley historically contained an estimated 1,400,000 acres of wetlands, only about 123,000 acres remain today. Along most of the Sacramento River and its tributaries, the once productive and extensive riparian areas have been greatly reduced. Riparian and wetland habitats provide food and shelter to aquatic fauna and help attenuate high flows. Wetlands occupy many areas along Sacramento River waterways, and are extensive in the Delta. Grasslands and wooded upland communities are more abundant in this reach of the primary study area, which also includes some agricultural lands. Open-water areas occur mainly on the larger waterways, where waterways converge, and in reservoirs.

The Delta includes extensive areas of fresh and brackish tidal marsh, and submerged aquatic plant communities. Additional natural plant communities occur in the extended study area outside the Central Valley and adjacent foothills, but are not a focus of this study. Urban and agricultural and urban vegetation occupies nearly 70 percent of the Central Valley, and a larger portion of terrestrial habitats in the Delta. Urban area plant communities (landscaping) also occupy an increasingly greater portion of the extended study area.

**Wildlife** A variety of wildlife is present in the areas surrounding Shasta Lake and lower reaches of its tributaries, and includes black-tailed deer, elk, black bear, mountain lion, bobcat, gray squirrel, rabbit, and turkey. Avian species include quail, falcon, eagle, turkey, dove, pigeon, hawk, woodpecker, ash-throated flycatcher, Hutton’s and warbling vireos, and house sparrow. The area provides excellent habitat for deer and elk, and suitable habitat for numerous bat species, although few bat sightings have been confirmed. Several other wildlife species inhabited this area before European settlement but were extirpated by over-hunting or because they were seen as threats; these species included grizzly bear, wolf, and various species of elk. Shasta Lake is home to the largest concentration of nesting bald eagles in California.

The variety of habitats along the Sacramento River from Shasta Dam to the RBPP supports a wide range of wildlife species. Composition, abundance, and distribution of wildlife are directly related to the accessibility of these habitats. The range of wildlife species present includes a variety of waterfowl, raptors, and migratory and resident avian species, plus a variety of mammals, amphibians, and reptiles that inhabit both aquatic and upland habitats within the upper Sacramento River study area. Many of the wildlife species are unable to adapt to other habitat types or altered habitat conditions and are therefore most susceptible to habitat loss and degradation. Species that depend on riparian woodland, oak woodland, marsh, and grassland habitats have declined. The region also supports a variety of exotic species, some of which are detrimental to survival of native species.

**Special-Status Species** Special-status species primarily include plants and animals in the study area that are legally protected or are otherwise considered sensitive by Federal, State, or local resource conservation agencies and organizations. These include species that are Federally listed and/or State-listed as rare, threatened, or endangered; species considered as candidates or proposed for listing; species identified by CDFW as species of special concern; species identified as species of concern by USFWS; plants considered by the California Rare Plant Ranking System (formerly known as California Native Plant Society Lists) to be rare, threatened, or endangered; and species afforded protection under local planning documents. Within the primary study area, 32 special-status species were identified for which generally suitable habitat was determined to be present.

**Wild and Scenic Rivers** The National Wild and Scenic Rivers Act of 1968, as amended (Public Law 90-542; 16 USC 1271 – 1287), established the National Wild and Scenic Rivers System, which identifies rivers of the nation that possess outstandingly remarkable scenic, recreational, geologic, fish and wildlife, historic, cultural, or other similar values. This act preserves the free-flowing condition of rivers that are designated, and protects their local environments. The California Wild and Scenic Rivers Act of 1972, as amended (California Public Resources Code (PRC) Section 5093.50 – 5093.70), aims to preserve designated rivers possessing extraordinary scenic, recreation, fishery, or wildlife values.

Although the McCloud River is not formally designated as a Federal or State wild and scenic river, Section 5093.542 of the PRC specifies that the McCloud River should be maintained in its free-flowing condition, and its wild trout fishery protected from 0.25 miles below McCloud Dam downstream to the McCloud River Bridge.

Raising Shasta Dam would inundate portions of the lower McCloud River. Section 5093.542 (c) may limit assistance or cooperation from State departments or agencies in planning or constructing any water impoundment facility that could adversely affect the free-flowing condition of the McCloud River or on its wild trout fishery, with the exception of participation by DWR in studies involving the feasibility of enlarging Shasta Dam. Section 5093.542(d) states, “All state agencies exercising powers under any other provision of law with respect to the protection and restoration of fishery resources shall continue to exercise those powers in a manner to protect and enhance the fishery” of the protected segments of the McCloud River. Participation by various State agencies in planning and potential construction activities associated with modifying Shasta Dam and Reservoir, including related permitting and approval processes, varies by an agency’s mandate and PRC Section 5093.542. CDFW has taken the position that it must participate in preparing the EIS to comply with Section 5093.542(d). Other State agencies, including DWR and the State Water Resources Control Board, have participated to a limited extent or expressed their intent to participate in the SLWRI. The CALFED Program Plan (CALFED 2000c) concluded that although Section 5093.542 sought to protect the free-flowing condition of the McCloud River, it also provided for investigations of enlarging Shasta Dam. The CALFED Programmatic ROD also specified that legal issues to allow State agency cooperation in Shasta Lake expansion studies were to be resolved by 2000.

#### *Cultural Resources Environment*

Investigations have revealed repeated occupation of the Shasta Lake area as early as 8,000 years ago. From available information, it is believed that at least 210 archaeological sites are currently inundated by Shasta Reservoir at full pool elevation 1,070. The records search identified 261 cultural resources within the study area, including 190 prehistoric sites, 45 historic-era resources, and 26 resources with both prehistoric and historic-era components.

The study area was the focus of intensive Native American occupation during historic times, with a variety of religious, economic, historic, and other values identified by Native American groups. Ten groups, including those listed by the Native American Heritage Commission, represent Native American interests in the study area. They include the Grindstone Indian Rancheria, Paskenta Band of Nomlaki Indians, Pit River Environmental Council, Pit River Tribe of California, Redding Rancheria, Shasta Indian Nation, United Tribe of Northern California, Inc., Winnemem Wintu Tribe, Wintu Educational and Cultural Council, and the Wintu Tribe of Northern California Toyon-Wintu Center. Notably, the Pit River Tribe and Winnemem Wintu live within the Shasta Lake area, where they continue to actively practice many aspects of their traditional culture. Both groups have relayed that a complex cultural landscape of village sites, ceremonial areas, burial sites, and resource areas intersects the study area. Several sites of cultural and religious significance to the Winnemem Wintu, a Native American group, are located within the study area. Documented locations include some 155 ancestral villages within the Shasta Lake area. At least 81 village locations are known along the lower McCloud River and lower Pit River. An additional 73 villages are known to have existed on the eastern side of the Sacramento River. The California Native American Heritage Commission has identified several locations of particular concern in the study area.

Settlement in the study area by whites began when trappers recognized the grazing potential of the land in the northern Sacramento River valley in the 1830s and 1840s. Mineral exploration, which included gold, silver, and, most influential to the region, copper, began with the Gold Rush of 1849. The lumber industry began in the region in the 1850s. Ranching (cattle and sheep) and agriculture (grain and fruit) have been practiced from the mid-nineteenth century onward. Railroads and State highways cross the study area. National efforts to preserve forests and other natural resources began in the late nineteenth century and continue today. Historic-era structures in the study area include, among others, seven bridges, one dam, one railroad bridge and grade, and one aerial-tramway.

#### *Socioeconomic Resources Environment*

The sections below describe social and economic resources in the SLWRI study area, including population, land use, employment and labor force, business and industrial activity, local government and finance, public health and safety, recreation and public access, aesthetics and visual resources, traffic and transportation, utilities and public services, and water supply.

**Population** California's population totaled an estimated 37 million in 2005. Approximately 2.9 million and 2.0 million of this population resided in the Sacramento River and San Joaquin River basins, respectively (California Department of Finance 2010a). The growth rate in the Sacramento River and San Joaquin River basins was over 11 and 14 percent from 2000 to 2005, respectively, significantly greater than the statewide rate of 8 percent for the same period. About three-fourths of the population in the Sacramento River basin resides in or near the City of Sacramento. The estimated population in the Sacramento River valley region in 2005 was approximately 2.6 million people with about three-fourths of this total residing in the greater Sacramento metropolitan area. Similarly, most of the population of the CVP service area is concentrated within urban areas. The CVP water service area includes various M&I water contractors and water districts that serve portions of the Sacramento, Stockton, and Bay Area metropolitan areas. Outside these population centers, most of the CVP water service area is rural, with irrigated agriculture the predominant land use and economic driver.

In Shasta County, Redding serves as the primary center for development and economic activity, while Red Bluff, although much smaller than Redding, plays that role in Tehama County. Because of the area's limited urbanization, residents live a more rural lifestyle than in many other areas of California. In total, the populations of Shasta and Tehama counties make up less than 1 percent of the total population in California. Although Shasta and Tehama counties are still comparatively small, both counties have grown substantially over the past 15 years.

**Land Use** Primary land uses in the vicinity of Shasta Lake include public and private lands managed for habitat and wildlife, residential, and some commercial industry uses. Portions of the STNF are located within Shasta County. Primary land uses along the Sacramento River between Shasta Dam and the RBPP include urban, residential, and agricultural. Land use in the extended study area varies greatly because of the differences in demographics and environment. Major urban development is concentrated in the Sacramento River valley along the transportation corridor provided by I-5, State Route 99, and the UPRR. Within 5 to 8 miles to the east and west of this corridor, development is characterized by rural communities. Development in the upland areas consists of agriculture, grazing, and timber operations, with small rural community centers and individual homes dispersed throughout.

**Employment and Labor Force** Trends in employment and the labor force are key considerations for rural communities like those in the primary study area, and offer insight into the area economy. Trends in unemployment within Shasta and Tehama counties indicate the economy within the primary study area is in transition, with the economy shifting away from natural-resource-based industries and agriculture, and employment opportunities diminishing. At the same time, agriculture and its related support activities remain comparatively strong and provide employment opportunities in the remainder of the CVP water service area.

**Business and Industrial Activity** Established industries near the study area include the nonfarm industries of trade, transportation, and utilities, professional and business services, and government services. Tourism, recreation, and related hospitality industries are a major source of economic development in the primary study area. Shasta Lake and the Sacramento River play a central role in the tourism industry and the appeal of the region to prospective businesses and investors. The economy in the vicinity of Shasta Lake has historically depended on natural resources.

**Local Government and Finance** Rural jurisdictions generally dominate the primary study area. Local officials allocate financial resources for a diverse collection of activities, including providing police and public safety, reviewing development, and providing educational services within their jurisdictions. The two largest sources of revenue for most local jurisdictions are property taxes and funding received from the Federal and State governments. These two sources provide a relatively stable revenue base for funding local programs. Public health and safety, social services of various forms, and education represent the biggest expenditures at the local level. These activities serve as a safety net for the local population and are frequently the most visible local programs.

**Public Health and Safety** At Shasta Lake, water hazards are generally associated with recreational use; water management operations at a reservoir the size of Shasta Lake typically do not pose specific hazards to humans because water levels do not fluctuate rapidly. Downstream from Shasta Dam, water-related hazards may be associated with rapid increases in flow in the Sacramento River, as during flood events. Operations at Shasta and Keswick dams have historically helped to dampen rapid changes in flow in the Sacramento River, particularly in the reach between Shasta Dam and the RBPP. Downstream from the RBPP, Shasta Dam has a decreasing influence on flow conditions and associated water-related hazards.

**Recreation and Public Access** Much of the outdoor recreation and tourism in Shasta County is related to Shasta Lake. The Whiskeytown-Shasta-Trinity NRA was established by an Act of Congress in November 1965. The area comprises three separate units: Whiskeytown Lake, Shasta Lake, and Trinity Lake. The Shasta Lake and Trinity Lake units of the NRA are within the STNF, and recreation is managed by USFS; the Whiskeytown Lake Unit is administered by the National Park Service. Among the facilities that are administered by USFS within the Shasta Lake Unit of the NRA are 10 marinas with 1,075 houseboats; 625 are privately owned and 450 are owned by a marina and rented on a weekly or weekend basis. Also, 18 developed public campgrounds have a total of 246 sites. USFS maintains 11 group or boat-in campgrounds and also operates launching ramps and beach and picnic areas. A map with locations of the major recreation facilities in the Shasta Lake Unit of the Whiskeytown-Shasta-Trinity NRA is shown in Figure 2-7.

The area along the Sacramento River from Shasta Dam to the RBPP contains many recreation resources and public access sites. These include day use sites, boat launches, trail accesses, fishing accesses, recreational vehicle parks, wildlife areas, and undeveloped open space areas. Beyond Lake Red Bluff and the RBPP on the Sacramento River, it is not expected that recreation or public access would be affected by implementation of the project and, therefore, an in-depth review of recreation activities and facilities downstream is not presented in this analysis.

**Aesthetics and Visual Resources** Visual resources in the study area include views of and from Shasta Dam and Lake, and viewsheds or viewpoints along the Sacramento River downstream from Shasta Dam to the RBPP. Several highways located in the primary study area are designated, or are eligible for designation, as State or County Scenic Highways. California's Scenic Highway Program was created to preserve and protect scenic highway corridors from change that would diminish the aesthetic value of lands adjacent to the highways. Potential Class A visual features include Federal and State park and recreation areas, such as the Whiskeytown-Shasta-Trinity NRA and Lassen Volcanic National Park. Mount Shasta, Mount Lassen, and the Sutter Buttes are prominent mountains in the study area.

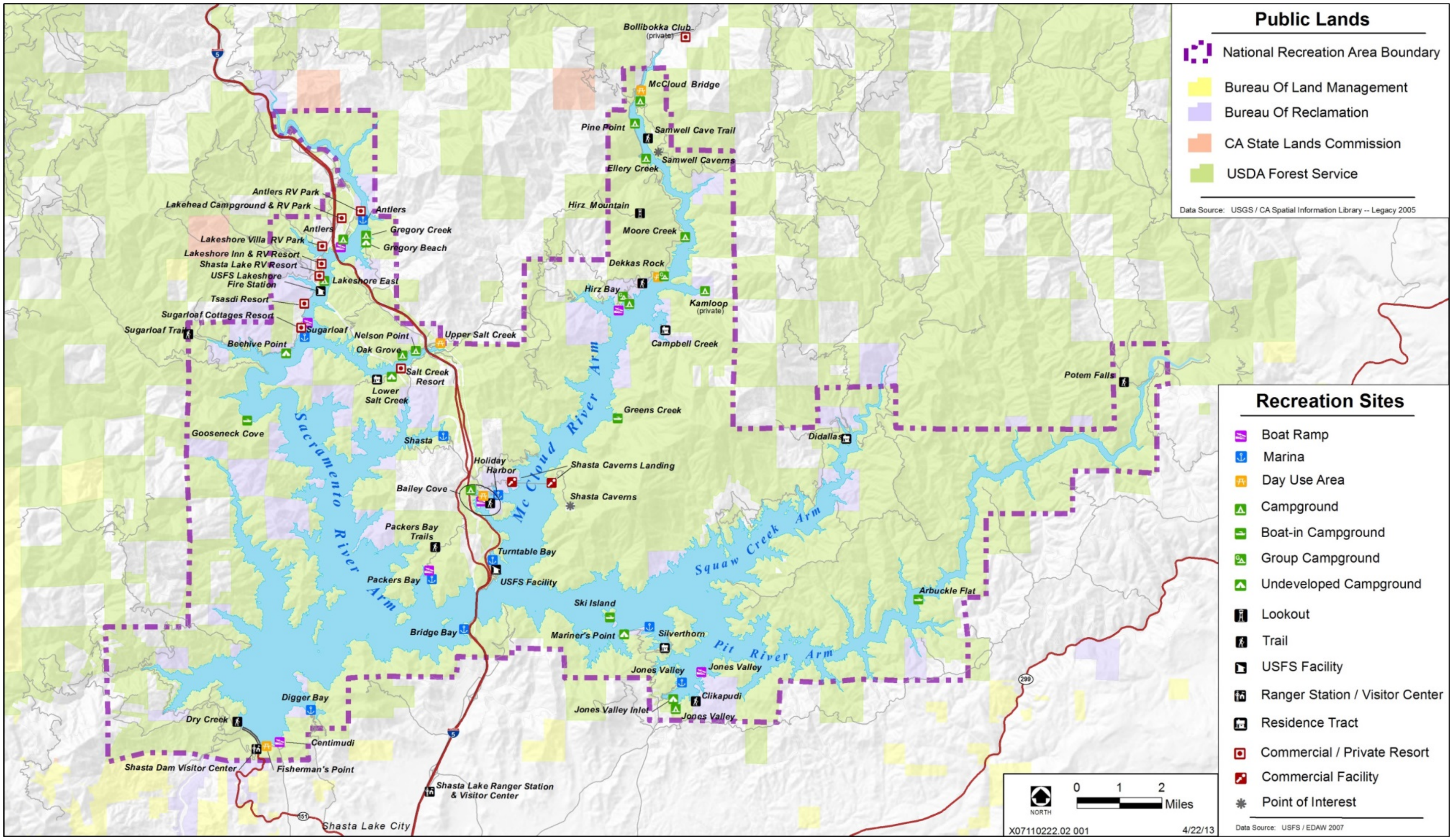



**Figure 2-7. Shasta Lake Recreation Facilities**

**Traffic and Transportation** Major transportation routes in the study area include I-5, and State Routes 20, 29, 36, 70, 99, 162, and 299. Excluding Chico, traffic within the central and northern portions of the Central Valley is usually moderate to light. Southern Pacific Railroad is the main rail line serving the Sacramento River basin area as a whole. The UPRR and Western Pacific Railroad both have rail lines serving the vicinity of Shasta Lake and the upper Sacramento River area. The UPRR main line follows the I-5 alignment and crosses Shasta Reservoir at the Pit River Bridge. Travel and navigation by water in the primary study area are primarily for recreational purposes. The extended study area includes numerous major and minor transportation features, including several rail lines, commercial and industrial ports, and a deep-water ship channel that runs from the Delta to the Port of Sacramento.

**Utilities and Public Services** Various county and local agencies provide the primary study area with solid waste and wastewater removal and management, emergency services, public safety, and law enforcement services. Pacific Gas and Electric Company (PG&E) is responsible for providing electrical and natural gas service to the primary study area. Gas is delivered to the study area through portions of PG&E's 40,000 miles of natural gas pipelines. Many areas scattered throughout Shasta and Tehama counties are served by individual septic systems.

**Water Supply** The CVP is the largest water storage and delivery system in California, covering 29 of 58 counties in the State. The CVP consists of 20 reservoirs capable of storing over 11 MAF of water, 11 powerplants, 500 miles of major canals and aqueducts, and many tunnels, conduits, and power transmission lines (Reclamation 2004b). CVP water is used to irrigate about 3 million acres of farmland and supplies water to more than 2.5 million people and businesses through more than 250 long-term water contracts (Reclamation 2008b, 2011c). Most of the CVP service area lies within the Central Valley. About 90 percent of south-of-Delta contractual delivery is for agricultural uses.

The SWP provides water to 25 million Californians and 750,000 acres of irrigated farmland (DWR 2014a), with water deliveries allocated 70 percent to M&I use and 30 percent to agricultural use (DWR 2008b). The SWP includes 34 storage facilities, reservoirs, and lakes; 20 pumping plants; four pumping-generating plants; five hydroelectric powerhouses; and about 700 miles of open canals and pipelines (DWR 2014a). SWP water is delivered under long-term contracts to 29 public water agencies throughout the State, including the San Joaquin Valley, Tulare basin, and Southern California service areas (DWR 2014a).

It is estimated that water demands (applied water) in the State in 2005 for urban, agricultural, and environmental purposes were about 83 MAF, including water dedicated to wild and scenic rivers (DWR 2009, 2014b). Approximately 54 MAF of water was available in 2005 from statewide water management projects, including the CVP and SWP, as well as local projects. Approximately

12 MAF was available from groundwater. The remaining water supply came from reused or recycled water sources.

**Environmental Justice** Environmental justice considerations include disproportionate adverse impacts to minority and low income populations, and Native American populations. In the primary study area**,** Shasta and Tehama counties are not considered environmental justice communities from minority population or low income population perspectives. The Sacramento River and its major tributaries, particularly the Pit and McCloud rivers, were the focus of intensive Native American occupation during historic times, with a variety of religious, economic, historic, and other values identified here for Native American groups. Ten groups, including those listed by the Native American Heritage Commission, represent Native American interests in the study area. The extended study area, including the CVP and SWP service areas, encompasses 36 of California's 58 counties, accounting for 91 percent of California's population in 2010 (Department of Finance 2010b). Minority groups have been steadily increasing and such ethnic diversification is expected to continue.

## Summary of Likely Future Conditions

Identification of the magnitude of potential water resources and related problems, needs, and opportunities in the study area is based not only on the existing conditions highlighted above but also on an estimate of how these conditions may change in the future. Predicting future conditions is complicated by a variety of factors, including uncertainty regarding future regulatory requirements, and ongoing programs and projects affecting the study area, as described in the following sections.

### *Likely Future Conditions Without Project Implementation*

Predicting future changes to the physical, biological, cultural, and socioeconomic environments in the primary and extended study areas is additionally complicated by ongoing programs and projects and potential changes in regulatory requirements. Several ecosystem restoration, water quality, water supply, and levee improvement projects are likely to be implemented in the future. Collectively, these efforts may improve ecosystem resources, Delta water quality, water supply, and levees. Much of this improvement would be based on separate opportunities that are not integrated in a single plan or part of an approved and funded program.

The baselines for analysis of future conditions without project implementation include reasonably foreseeable actions with current authorization, complete funding for design and construction, and complete environmental permitting and compliance. However, other programs currently in the planning phases could also potentially influence the SLWRI in the future. Prominent examples include the State's Delta Plan and the BDCP. These projects and programs have not been included in the evaluation of the alternative plans for the SLWRI because there has not been a specific decision to implement them at this time.

The following sections summarize likely future conditions without project implementation for physical, biological, cultural, and socioeconomic resources within the study area. Additional, detailed information is included in the accompanying EIS, including  the Physical Resources Appendix, Biological Resources Appendix, Cultural Resources Appendix, and Socioeconomics Appendix.

**Physical Resources Environment**   Basic physical conditions in the primary and extended study areas are expected to remain relatively unchanged in the future. Continued development in urban and suburban areas is expected. Ongoing restoration efforts along rivers are expected to marginally improve natural riverine processes. Without major physical changes to the river systems, hydrologic conditions may remain unchanged. However, the region’s hydrology could be altered should there be significant changes in global climatic conditions; scientific work in this field of study is continuing. Without major changes in hydrology, topography, or geology, sedimentation and erosion are also likely to remain unchanged.

Much effort has been expended to control the levels and types of herbicides, fungicides, and pesticides that can be used in the environment. Further, efforts are underway to better manage the quality of runoff from urban environments to the major stream systems. However, water quality conditions are expected to remain unchanged and similar to existing conditions.

It is unclear to what extent potential changes to the region’s climate could occur in association with global climate change. As the population continues to grow and agricultural lands are converted to urban and industrial uses, a general degradation of air quality conditions could occur. However, because of technological innovation and stringent regulations, air quality could improve over time. While similar types and sources of hazardous materials and waste are likely to be present in the future, increasing population will likely increase the potential for hazardous waste issues. Similarly, increasing population will likely affect increases in environmental noise and vibration.

**Biological Resources Environment**   Efforts are underway by numerous agencies and groups to restore various biological conditions throughout the primary and extended study areas. Accordingly, major areas of wildlife habitat, including wetlands and riparian vegetation areas, are expected to be protected and restored. However, as population and urban growth continues, and land uses are converted to urban centers, many wildlife and plant species especially dependent on woodland, oak woodland, and grassland habitats may be adversely affected.

Through the significant efforts of Federal and State wildlife agencies, populations of special-status species in the riverine and nearby areas are estimated to generally remain as under existing conditions. Although increases in anadromous and resident fish populations in the Sacramento River could continue through implementation of projects (including CVPIA actions and programs), such as the Battle Creek Salmon and Steelhead Restoration Project, some degradation will likely occur through actions that reduce Sacramento River flows or elevate water temperatures such as implementation of the Trinity River ROD. Accordingly, populations of anadromous fish are expected to remain generally similar to existing conditions.

No rivers or streams in the primary study area are expected to be added to the list of Federal and/or State wild and scenic rivers. The McCloud River is expected to be managed under existing federal and state statues and policies.

**Cultural Resources Environment** In the vicinity of Shasta Lake, any archaeological, historic, or ethnographic resources currently affected by erosion due to reservoir fluctuations would continue to be impacted. Artifacts located around the perimeter of the existing reservoir will continue to be subject to collection by recreationalists. Similarly, conditions related to the cultural environment downstream from Shasta Dam are unlikely to change significantly.

**Socioeconomic Resources Environment** The State’s population is estimated to increase from approximately 37 million in 2005 to approximately 44 million by 2020, and to about 60 million by 2050. Between now and 2050, Shasta and Tehama counties are expected to continue their historic growth trends. According to the California Department of Finance (2007, 2010a), Shasta County’s population is expected to increase by approximately 86 percent by 2050 to a total of approximately 332,000 residents (2005 population was 179,000). This represents an expected increase in population that is almost 20 percent greater than for the State as a whole. The population of Tehama County is expected to more than double by 2050, with population increasing from approximately 60,000 (in 2005) to 124,000 (California Department of Finance 2007, 2010a).

To support these expected increases in population, some conversion of agricultural and other rural land to urban uses is anticipated. More transportation routes are likely to be constructed to connect the anticipated population increase in the Central Valley to transportation infrastructure. Anticipated increases in population growth will also impact visual resources as areas of open space on the valley floor are converted to urban uses.

Increases in population will increase demands for electric, natural gas, and wastewater utilities; public services such as fire, police protection, and emergency services; and water-related and communication infrastructure. The increase in population and aging “baby boomer” generation will increase the need for health services. The region’s superior outdoor recreational opportunities and moderate housing cost opportunities are expected to attract increasing numbers of retirees from outside the region and State. An increasing population will produce employment gains, particularly in retail sales, personal services, finance, insurance, and real estate. Recreation is expected to remain an important element of the community and economy in the region.

Anticipated increases in population growth in the Central Valley will also significantly increase demands on water resources systems for additional and reliable Central Valley water supplies, energy supplies, water-related facilities, recreational facilities, and flood management facilities.

# Chapter 3
# Plan Formulation

The plan formulation process for Federal water resources studies is identified in the P&G (WRC 1983) and consists of the following deliberate and iterative steps:

- Identifying water resources problems, needs, and opportunities to be addressed, and developing planning objectives, constraints, and criteria.
- Inventorying and forecasting conditions likely to occur in the study area.
- Formulating alternative plans based on potential management measures identified to meet planning objectives within planning constraints, and refining alternative plans.
- Evaluation of potential effects of alternative plans (e.g., economic, environmental, social).

Comparing alternative plans to determine the differences among alternative plans (including no action).

- Selecting a plan for recommendation to decision makers for implementation or no action.

For the SLWRI, consistent with P&G and NEPA, this iterative process was separated into multiple phases, all of which have been completed and are documented in this Final Feasibility Report, related Final EIS, and supporting documents. All phases were completed in coordination and collaboration with stakeholders, cooperating agencies, affected communities, and decision makers. Further, all phases were completed in consideration of study authorizations and guidance, and other pertinent Federal planning procedures, requirements, directives, standards, policy, laws, and executive orders. These planning phases are illustrated in Figure 3-1 and described below:

- **Mission Statement Phase** – This study phase consisted of projecting without-project future conditions; defining resulting resource problems, and needs; defining a specific set of planning objectives; and identifying constraints and criteria for addressing the planning objectives.

- **Initial Alternatives 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.

- **Comprehensive Plans 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.

- **Plan Refinement Phase –** This phase focused on further refinement and iterative evaluation of the potential effects of the comprehensive plans. This phase included preparing and circulating a Draft Feasibility Report, which was completed in November 2011 and released to the public in February 2012, and DEIS, which was released to the public in June 2013 for public review and comment.

- **Recommended Plan Phase –** This phase of the SLWRI planning process focuses on identifying a plan for recommendation, and preparing and processing this Final Feasibility Report and the Final EIS to support a Federal decision.

Public and stakeholder outreach was performed concurrently with the above phases, as shown in Figure 3-1. Major reports documenting public and stakeholder outreach include the *Strategic Agency Public Involvement Plan*, published in 2003 (Reclamation), and the *Environmental Scoping Report*, published in 2006 (Reclamation). For additional information on public and stakeholder outreach see Chapter 7 of this Final Feasibility Report.

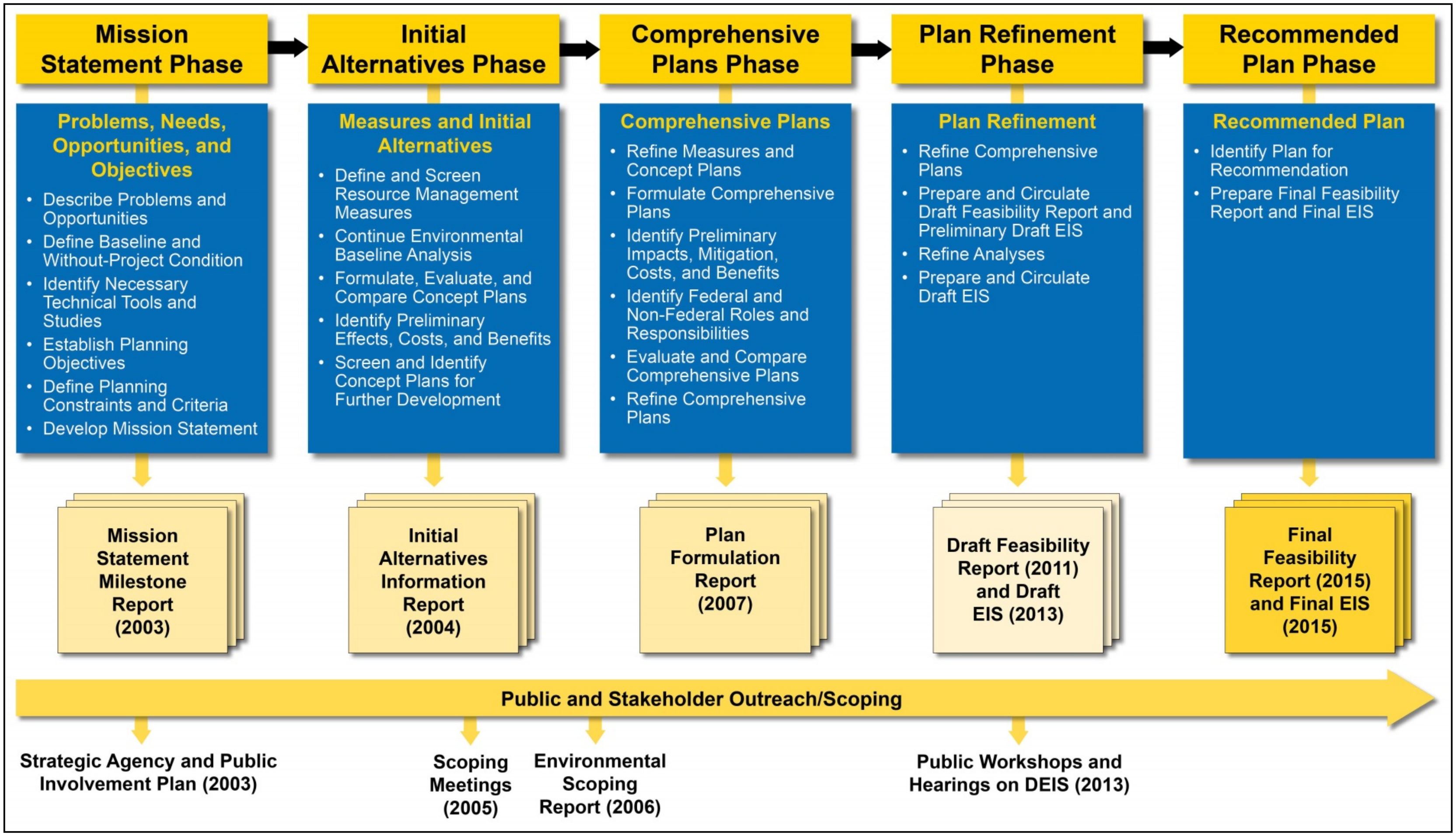



**Figure 3-1. Plan Formulation Phases**

## Planning Objectives

This section discusses national planning objectives and objectives, constraints, and considerations specific to the SLWRI.

### National Planning Objectives

The Federal objective is defined in the P&G (WRC 1983):

> *The Federal objective of water and related resources project planning is to contribute to national economic development consistent with protecting the Nation's environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements.*

Contributions to national economic development (NED) are further defined as "increases in the net value of the national output of goods and services, expressed in monetary units. Contributions to NED are direct net benefits that accrue in the planning area and the rest of the Nation" (WRC 1983).

The National Water Resources Planning Policy, specified in the Water Resources Development Act of 2007 (Public Law 110-114, Section 2031), declares that Federal water resources investments should reflect national priorities, encourage economic development, and protect the environment by doing the following:

- Seek to maximize sustainable economic development
- Seek to avoid the unwise use of floodplains and flood-prone areas and minimize adverse impacts and vulnerabilities in any case in which a floodplain or flood-prone area must be used
- Protect and restore the functions of natural systems and mitigate any unavoidable damage to natural systems

In consideration of many complex water management challenges and competing demands for limited Federal resources, Federal agencies investing in water resources should strive to maximize public benefits, particularly compared to costs. Public benefits encompass environmental, economic, and social goals; include monetary and nonmonetary benefits; and allow for the inclusion of quantified and unquantified benefits. Stakeholders and decision makers expect the formulation and evaluation of a diverse range of alternative solutions. Such solutions may produce varying degrees of benefits and/or impacts relative to the three goals specified above. As a result, trade-offs among potential solutions will need to be assessed and properly communicated during the decision-making process.

## SLWRI-Specific Planning Objectives

On the basis of the problems, needs, and opportunities identified and defined in Chapter 2, study authorities, and other pertinent direction, including information contained in the CALFED PEIS/R and Programmatic ROD, primary and secondary planning objectives were developed. Primary planning objectives are those which specific alternatives are formulated to address. The primary objectives are considered to have coequal priority, with each pursued to the maximum practicable extent without adversely affecting the other. Secondary planning objectives are actions, operations, and/or features that should be considered in the plan formulation process, but only to the extent possible through pursuit of the primary planning objectives.

- **Primary Planning Objectives**
  - Increase the survival of anadromous fish populations in the Sacramento River, primarily upstream from the RBPP
  - Increase water supply and water supply reliability for agricultural, M&I, and environmental purposes to help meet current and future water demands, with a focus on enlarging Shasta Dam and Reservoir
- **Secondary Planning Objectives**
  - Conserve, restore, and enhance ecosystem resources in the Shasta Lake area and along the upper Sacramento River
  - Reduce flood damage along the Sacramento River
  - Develop additional hydropower generation capabilities at Shasta Dam
  - Maintain and increase recreation opportunities at Shasta Lake.
  - Maintain or improve water quality conditions in the Sacramento River downstream from Shasta Dam and in the Delta

## Planning Constraints and Other Considerations

The P&G provides fundamental guidance for the formulation of Federal water resources projects. In addition, basic constraints and other considerations specific to an investigation must be developed and identified. Following is a summary of the constraints and considerations relevant to the SLWRI.

### *Planning Constraints*

Planning constraints help guide the direction and scope of the feasibility study and the formulation and evaluation of alternatives plans. Some planning constraints can also assist in defining existing and likely future resource conditions. Some planning constraints are more rigid than others. Examples of more rigid constraints include congressional direction in study authorizations; other current applicable laws, regulations, and policies; and physical conditions (e.g., topography, hydrology). Other planning constraints are less restrictive but are still influential in guiding the process. Several key constraints identified for the SLWRI are as follows:

- **Study Authorizations –** On August 30, 1935, in the Rivers and Harbors Bill, an initial amount of Federal funds was authorized for constructing Kennett (now Shasta) Dam. As described in Chapter 1, initial authorization for the SLWRI derives from Public Law 96-375, and additional guidance is contained in Public Law 108-361. These legislative actions authorized an investigation of the potential benefits and costs of enlarging or replacing Shasta Dam and Reservoir.

- **CALFED PEIS/R and Programmatic ROD –** CALFED was established to "develop and implement a long-term comprehensive plan that would restore ecological health and improve water management for beneficial uses of the Bay-Delta system." The 2000 CALFED PEIS/R and Programmatic ROD include program goals, objectives, and projects primarily to benefit the Bay-Delta system. The objectives of the SLWRI are consistent with the CALFED Programmatic ROD (CALFED 2000a) for Shasta Dam enlargement, as follows:

  > *Expand CVP storage in Shasta Lake by approximately 300 TAF. Such an expansion will 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.*

  The CALFED Programmatic ROD has been adopted by various Federal and State agencies as a framework for further consideration. In addition to objectives for potential enlargement of Shasta Dam and Reservoir, the Preferred Program Alternative in the CALFED PEIS/R and Programmatic ROD includes four other potential surface water and various groundwater storage projects to help reduce the gap between water supplies and projected demands. Expanding water storage capacity is critical to the successful implementation of all aspects of the program. Water supply reliability rests on capturing peak flows, especially during wet years. New storage must be strategically located to provide the needed flexibility in the current water system to improve water quality, support fish restoration goals, and meet the needs of a growing population. The CALFED Programmatic ROD also includes numerous other projects to help improve the ecosystem functions of the Bay-Delta system. Developed plans should address the goals, objectives, and programs and projects of the CALFED PEIS/R and Programmatic ROD (CALFED 2000a, 2000c).

CALFED conducted an initial screening of a list of 52 potential surface water storage sites to reduce the number of sites to a more manageable number for more detailed evaluation during project-specific studies (2000b). CALFED eliminated sites providing less than 200,000 acre-feet storage and those that conflicted with CALFED solution principles, objectives, or policies. Further, based on existing information, CALFED identified some potential surface water storage sites that were more promising in contributing to CALFED goals and objectives and more implementable due to relative costs and stakeholder support. Surface water storage sites recommended by CALFED for subsequent evaluation focused on those with the most potential for helping meet CALFED goals and objectives: Shasta Lake Enlargement, Los Vaqueros Reservoir Enlargement, Sites Reservoir, In-Delta Storage, and development of storage in the upper San Joaquin River Basin (CALFED 2000b) (Figure 3-2).

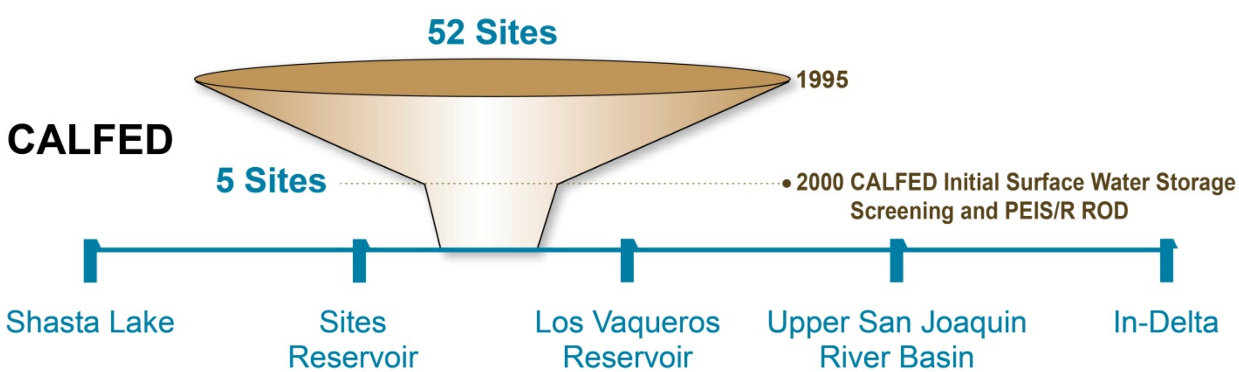



**Figure 3-2. CALFED Surface Water Storage Investigations Screening**

- **Laws, Regulations, and Policies –** Numerous laws, regulations, executive orders, and policies need to be considered, among them the P&G, NEPA, FWCA, Federal Clean Air Act, Federal CWA, National Historic Preservation Act, California PRC, ESA and CESA, CEQA, and CVPIA. The CVPIA, including the associated AFRP, is pertinent because it identified specific actions for fish and wildlife mitigation, protection, restoration, and enhancement which influence water supply deliveries, river flows, and related environmental conditions in the primary and extended study areas. Other important laws and regulations are discussed in the Plan Formulation Appendix.

***Statewide Water Operation Considerations***

Reclamation and DWR use CalSim-II, a specific application of the Water Resources Integrated Modeling System (WRIMS) to Central Valley water operations, to study operations, benefits, and effects of new facilities and operational parameters for the CVP and SWP. Operational assumptions for refinement, modeling, and evaluation of potential effects of the No-Action Alternative and comprehensive plans included in this Final Feasibility Report were derived from the following:

- The Reclamation 2008 *Biological Assessment on the Continued Long-Term Operations of the CVP and SWP* (2008 Long-Term Operation BA) (Reclamation 2008a)
- The USFWS 2008 *Formal ESA Consultation on the Proposed Coordinated Operations of the CVP and SWP* (2008 USFWS BO) (USFWS 2008)
- The NMFS 2009 *BO and Conference Opinion on the Long-Term Operations of the CVP and SWP* (2009a NMFS BO) (NMFS 2009a)
- *Coordinated Operations Agreement* between Reclamation and DWR for the CVP and SWP, as ratified by Congress (Reclamation and DWR 1986)

Despite the uncertainty resulting from ongoing consultation processes, the 2008 Long-Term Operation BA and the 2008 USFWS and 2009 NMFS BOs contain the most recent estimate of potential changes in water operations that could occur in the near future. If the revised USFWS and NMFS BOs contain new or amended RPAs, these legal challenges may result in changes to CVP and SWP operational constraints.

#### *Other Planning Considerations*

Other planning considerations were specifically identified to help formulate, evaluate, and compare initial plans and, later, detailed alternatives:

- Alternatives should incorporate results of coordination with other Federal and State agencies such as the USFWS; NMFS; USFS; BIA; BLM; DWR; and CDFW.
- A direct and significant geographical, operational, and/or physical dependency must exist between major components of alternatives.
- Alternatives should address, at a minimum, each of the identified primary planning objectives and, to the extent possible, the secondary planning objectives.
- Measures to address secondary planning objectives should be either directly or indirectly related to the primary planning objectives (i.e., plan features should not be independent increments).

- Alternatives should strive to first avoid potential adverse effects to environmental resources, or then should include features to mitigate for unavoidable adverse effects through enhanced designs, construction methods, and/or facilities operations.
- Alternatives should avoid any increases in flood damage or other significant, adverse hydraulic effects to areas downstream along the Sacramento River.
- Alternatives should strive to first avoid potential adverse effects to present or historical cultural resources, or then include features to mitigate unavoidable adverse effects.
- Alternatives should not result in significant adverse effects to existing and future water supplies, hydropower generation, or related water resources conditions.
- Alternatives should strive to balance increased water supply reliability between agricultural and M&I uses.
- Alternatives should not result in a reduction in existing recreation capacity at Shasta Lake.
- Alternatives are to consider the purposes, operations, and limitations of existing projects and programs and be formulated to not adversely impact those projects and programs.
- Alternatives are to be formulated and evaluated based on a 100-year period of analysis.
- Construction costs for alternatives are to reflect current prices and price levels, and annual costs are to include the current Federal discount rate and an allowance for interest during construction.
- Alternatives are to be formulated to neither preclude nor enhance development and implementation of other elements included in the CALFED Programmatic ROD or other water resources programs and projects in the Central Valley.
- Alternatives should have a high certainty for achieving intended benefits and not significantly depend on long-term actions (past the initial construction period) for success. Alternatives that require future and ongoing action specific for success have a higher uncertainty than other plans.

### Criteria

The Federal planning process in the P&G also includes four specific criteria for consideration in formulating and evaluating alternatives: (1) completeness, (2) effectiveness, (3) efficiency, and (4) acceptability (WRC 1983). Completeness is a determination of whether a plan includes all elements necessary to realize planned effects, and the degree that intended benefits of the plan depend on the actions of others. Effectiveness is the extent to which an alternative alleviates problems and achieves objectives. Efficiency is the measure of how efficiently an alternative alleviates identified problems while realizing specified objectives consistent with protecting the nation's environment. Acceptability is the workability and viability of a plan with respect to its potential acceptance by other Federal agencies, State and local governments, and public interest groups and individuals. These criteria, and how they apply in helping to compare comprehensive alternative plans, are described in Chapter 5.

## Management Measures

A management measure is a project action or feature that could address a specific planning objective. Concept plans are formulated by combining retained measures that address the primary planning objectives. These concept plans are then refined, as appropriate, considering measures to address the secondary planning objectives.

### Measures Considered

More than 60 potential management measures were identified based on information from previous studies, programs, and projects to address the primary and secondary planning objectives and satisfy the other planning constraints, considerations, and criteria. These measures were reviewed and others developed during study team meetings, field inspections, scoping, and public outreach for the SLWRI. Many of these management measures were also considered under CALFED. Since the accompanying EIS tiers to the CALFED PEIS/R, consistent with guidance in the CALFED Programmatic ROD, this Feasibility Report and the accompanying EIS rely on evaluations and alternatives development and screening included in 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 during the SLWRI plan formulation process.

These measures were initially analyzed in the *Mission Statement Milestone Report* (Reclamation 2003b), *Ecosystem Restoration Opportunities in the Upper Sacramento River Region* (Reclamation 2003d), and *Initial Alternatives Information Report* (Reclamation 2004a) to determine whether they would be retained for further consideration. At each step of the plan formulation process, measures were reviewed, and in some cases reconsidered and incorporated into alternatives, or screened and eliminated from alternatives. The rationale for retaining or deleting each measure is described in greater detail in the Plan Formulation Appendix. Tables 3-1 through 3-4 list the management measures that address the planning objectives and other planning considerations, status of the measures (retained or deleted from further consideration), and rationale for the status determination.

In the discussion of SLWRI management measures and alternative plans, the term “enhancement” specifically refers to restoration actions that would improve environmental conditions above the baseline (without-project condition). Correspondingly, the term “mitigation” refers to restoration actions that improve environmental conditions toward the baseline to compensate for alternative plan impacts. The relationship between restoration, enhancement, and mitigation is illustrated in Figure 3-3.

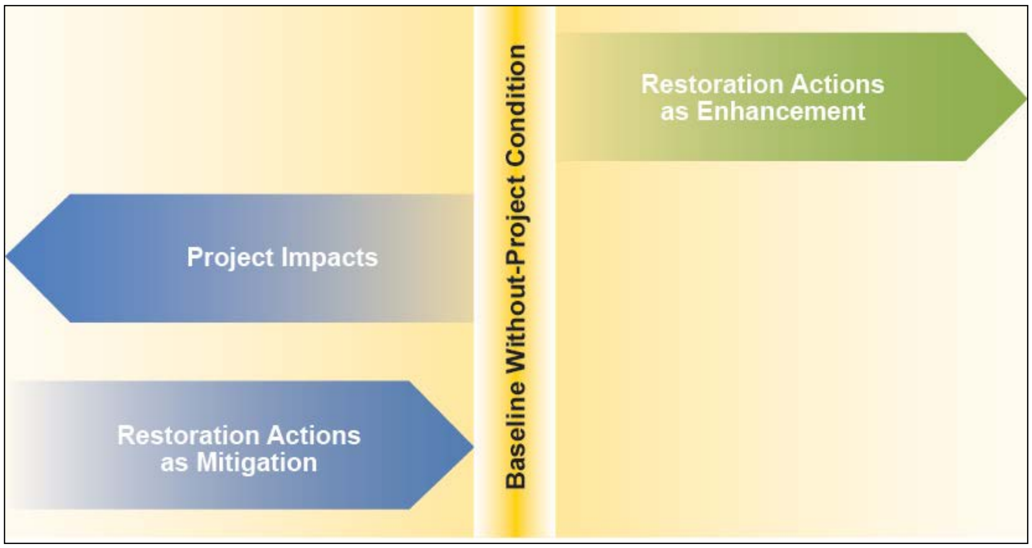



**Figure 3-3. Conceptual Schematic of Restoration Actions as Enhancement Versus Restoration Actions as Mitigation**

Although management measures were not specifically identified, developed, or retained/deleted based on the potential to address the effects of climate change, many of the measures retained to address the primary and secondary planning objectives would provide additional system flexibility, helping to offset the potential effects of future climate change.

It should be noted that measures that did not directly address the planning objectives, or were otherwise eliminated from consideration and further development as alternative plan components under certain circumstances, were considered for incorporation into alternative plans as mitigation measures. Development and refinement of mitigation measures is described in the Preliminary Environmental Commitments and Mitigation Plan Appendix to the accompanying EIS.

Table 3-1. Management Measures Addressing Primary Planning Objective of Increasing Anadromous Fish Survival

| Measure Description | Study Status | Status Rationale |
|---|---|---|
| **Improve Fish Habitat** | | |
| Restore abandoned gravel mines along the Sacramento River | **Deleted** | Moderate potential to effectively address the primary planning objective and for likelihood of success. Although this measure was initially retained during preliminary analyses, it has been deleted from further consideration because of likely marginal benefits to anadromous fish and a general lack of interest from the public and stakeholders. Encompassed within actions evaluated and prioritized under the CALFED ERP. |
| Construct instream aquatic habitat downstream from Keswick Dam | **Retained** | High potential for combining with other measures. This measure was retained for potential further development because of its potential to successfully address the first primary planning objective, and its potential to combine favorably with other potential measures. In addition, this measure received strong interest from fisheries and resource agencies. Encompassed within actions evaluated and prioritized under CALFED ERP. |
| Replenish spawning gravel in the Sacramento River | **Retained** | High potential for combining with other measures. Demonstrated benefits that continue as gravel moves downstream. Low initial cost. Concerns over induced downstream impacts to agricultural facilities. Consistent with Federal planning objectives and principles. Encompassed within actions evaluated and prioritized under CALFED ERP. |
| Construct instream fish habitat on tributaries to the Sacramento River | **Deleted** | Significant benefit to tributaries. Independent of hydraulic/hydrologic conditions in upper Sacramento River and would not directly contribute to improved ecological conditions along mainstem Sacramento River. Encompassed within actions evaluated and prioritized under CALFED ERP. |
| Remove instream sediment along Middle Creek | **Deleted** | Significant benefit to spawning conditions in tributaries. Independent of hydraulic/hydrologic conditions in upper Sacramento River and would not directly contribute to improved ecological conditions along mainstem Sacramento River. High uncertainty due to increased need for long-term remediation. Encompassed within actions evaluated and prioritized under CALFED ERP. |
| Rehabilitate inactive instream gravel mines along Stillwater and Cottonwood creeks | **Deleted** | Significant benefit to spawning conditions in tributaries. Independent of hydraulic/hydrologic conditions in upper Sacramento River, and would not directly contribute to improved ecological conditions along mainstem Sacramento River. Encompassed within actions evaluated and prioritized under CALFED ERP. |
| **Improve Water Flows and Quality** | | |
| Make additional modifications to Shasta Dam for temperature control | **Retained** | High likelihood of combining with measures involving increasing Shasta Reservoir storage. Although existing TCD at Shasta effectively meets objectives, potential may exist to further modify the device to benefit anadromous fish with increased storage at Shasta Reservoir. |
| Enlarge Shasta Lake cold-water pool | **Retained** | High potential for combining with other measures. Consistent with other primary planning objective and secondary planning objectives. Consistent with goals of CALFED. |
| Modify storage and release operations at Shasta Dam | **Retained** | Moderate potential to meet the primary planning objective of increasing anadromous fish survival. This measure was initially deleted from consideration because of analyses indicating a decreased fisheries benefit with increasing Sacramento River flows compared to increasing the cold-water pool. However, this measure has been retained as part of an adaptive management strategy. |
| Modify ACID diversions to reduce flow fluctuations | **Deleted** | Potential modified operations include not installing diversion dam flash boards in spring, or not removing flash boards in the late summer/fall. Non-installation would conflicts with the other primary planning objective of water supply reliability. Non-removal would potentially conflict with the secondary objective of flood damage reduction. Encompassed within actions evaluated and prioritized under CALFED ERP. |
| Increase instream flows on Clear, Cow, and Bear creeks | **Deleted** | Independent of hydraulic/hydrologic conditions in upper Sacramento River. Would not contribute directly to increasing anadromous fish survival within the primary Sacramento River study area. Encompassed within actions evaluated and prioritized under CALFED ERP. |

**Table 3-1. Management Measures Addressing Primary Planning Objective of Increasing Anadromous Fish Survival (contd.)**

| Measure Description | Study Status | Status Rationale |
|---|---|---|
| **Improve Water Flows and Quality (contd.)** | | |
| Construct a storage facility on Cottonwood Creek to augment spring instream flows | **Deleted** | Independent of hydraulic/hydrologic conditions in upper Sacramento River. Adverse environmental impacts expected to exceed benefits. Evaluated during the CALFED alternative development process. |
| Transfer existing Shasta Reservoir storage from water supply to cold-water releases | **Deleted** | Violates basic plan formulation considerations – causes significant reduction in water supply reliability without development of a replacement supply. |
| Remove Shasta Dam and Reservoir | **Deleted** | Violates basic plan formulation considerations – causes considerable reduction in water supply reliability. No known project or projects could replace the lost benefits provided by Shasta and Keswick dams, reservoirs, and appurtenant facilities, at any price. |
| **Improve Fish Migration** | | |
| Improve fish trap below Keswick Dam | **Deleted** | Although helps fish populations, would not contribute to favorable conditions for sustained spawning and rearing of anadromous fish along mainstem Sacramento River. |
| Screen diversions on Old Cow and South Cow creeks | **Deleted** | Significant benefit to spawning conditions in tributaries. Independent of hydraulic/hydrologic conditions in upper Sacramento River and would not contribute to improved ecological conditions along mainstem Sacramento River. Encompassed within actions evaluated and prioritized under CALFED ERP. |
| Remove or screen diversions on Battle Creek | **Deleted** | Significant benefit to spawning conditions in tributaries. Independent of hydraulic/hydrologic conditions in upper Sacramento River, and would not contribute to improved ecological conditions along mainstem Sacramento River. Encompassed within actions evaluated and prioritized under CALFED ERP. |
| Construct a migration corridor from the Sacramento River to the Pit River | **Deleted** | Volitional fish passage above Shasta Dam is being studied under a separate Federal program as the result of the 2009 NMFS Biological Opinion. |
| Cease operating or remove the Red Bluff Diversion Dam | **Deleted** | As the result of another Federal investigation – Red Bluff Diversion Dam Fish Passage Improvement Project – Reclamation subsequently ceased operation of Red Bluff Diversion Dam. |
| Reoperate the CVP to improve overall fish management | **Deleted** | See above measure regarding the Red Bluff Diversion Dam. Issues regarding reoperating facilities on the Trinity River were addressed in the Trinity River Record of Decision in 2000 (DOI). Any further modification within that system would violate planning criteria for the SLWRI through reducing water supply reliability without development of a replacement supply. |
| Construct a fish ladder on Shasta Dam | **Deleted** | Volitional fish passage above Shasta Dam is being studied under a separate Federal program as the result of the 2009 NMFS Biological Opinion. |
| Reintroduce anadromous fish to areas upstream from Shasta Dam | **Deleted** | Non-volitional fish passage above Shasta Dam is being studied under a separate Federal program as the result of the 2009 NMFS Biological Opinion. |

Key:
ACID = Anderson-Cottonwood Irrigation District
CALFED = CALFED Bay-Delta Program
CVP = Central Valley Project
DOI = U.S. Department of the Interior
ERP = Ecosystem Restoration Program
Reclamation = U.S. Department of the Interior, Bureau of Reclamation
SLWRI = Shasta Lake Water Resources Investigation
TCD = temperature control device

**Table 3-2. Management Measures Addressing Primary Planning Objective of Increasing Water Supply Reliability**

| Measure Description | Study Status | Status Rationale |
|---|---|---|
| **Increase Surface Water Storage** | | |
| Increase conservation storage space in Shasta Reservoir by raising Shasta Dam | **Retained** | Consistent with primary planning objective and directly contributes to secondary planning objectives. |
| Construct new conservation storage reservoir(s) upstream from Shasta Reservoir | **Deleted** | Upstream storage sites capable of CVP system-wide benefits would be very costly, result in environmental impacts difficult to mitigate, and would be inconsistent with the 2000 CALFED Programmatic ROD. |
| Construct new conservation storage on tributaries to the Sacramento River downstream from Shasta Dam | **Deleted** | Although potentially feasible sites/projects exist that could increase water supply reliability, significant overriding environmental and socioeconomic issues restrict implementation at this time. Evaluated during the CALFED alternative development process. |
| Construct new conservation offstream surface storage near the Sacramento River downstream from Shasta Dam | **Deleted** | Not as efficient as developing additional storage in Shasta Dam. NODOS being pursued as added increment to system through a separate feasibility-scope study initiated under Public Law 108-361. Evaluated during the CALFED alternative development process. |
| Construct new conservation surface water storage south of the Sacramento-San Joaquin Delta | **Deleted** | Not an effective alternative to additional storage at Shasta. Does not contribute to other planning objectives. Upper San Joaquin River storage being pursued as added increment to system through a separate feasibility-scope study initiated under Public Law 108-361. Evaluated during the CALFED alternative development process. |
| Increase total or seasonal conservation storage at other CVP facilities | **Deleted** | Not an efficient alternative to increasing storage in Shasta Reservoir; significantly higher unit cost for increased water supply. Known efforts to increase space in other Northern California CVP (or SWP) reservoirs rejected by CALFED. |
| Dredge bottom of Shasta Reservoir | **Deleted** | Extremely high cost for a very small potential benefit, and severe environmental impacts associated with disposal of dredged materials. |
| **Reoperate Reservoir** | | |
| Increase effective conservation storage space in Shasta Reservoir by increasing efficiency of reservoir operation for water supply reliability | **Retained** | Moderate to high potential for increment of increased water supply reliability at Shasta Reservoir. Although potential for increased water supply reliability is limited, added opportunities exist for increased flood control and other management elements. |
| Increase the conservation pool in Shasta Reservoir by encroaching on dam freeboard | **Deleted** | Very limited potential to encroach on existing freeboard above full pool, which is only 9.5 feet. Major modifications would be required to the dam and appurtenances to allow operational encroachments on the design freeboard of the dam, only to gain a small potential increase in reservoir storage. |
| Increase conservation storage space in Shasta Reservoir by reallocating space from flood control | **Deleted** | Very low potential for implementation due to significant adverse impacts on system flood management. |

**Table 3-2. Management Measures Addressing Primary Planning Objective of Increasing Water Supply Reliability (contd.)**

| Measure Description | Study Status | Status Rationale |
|---|---|---|
| **Improve Conjunctive Water Management** | | |
| Develop conservation offstream surface storage near the Sacramento River downstream from Shasta Dam | **Deleted** | Implementing additional surface water storage project increment for Shasta would not be as efficient as new storage in Shasta Reservoir. Potential for shared storage in NODOS project is being considered in separate feasibility study initiated under Public Law 108-7. Evaluated during the CALFED alternative development process. |
| Develop conservation groundwater storage near the Sacramento River downstream from Shasta Dam | **Deleted** | Moderate to high potential to enhance water supplies for system deliveries when combined with new storage and reoperation of Shasta Dam and Reservoir. Although this measure was initially retained during preliminary analyses, it has been eliminated because of operations analyses indicating tradeoffs between conjunctive use water supply benefits and critical gains in fisheries accomplishments. |
| Develop additional conservation groundwater storage south of the Sacramento-San Joaquin Delta | **Deleted** | Not as effective as storage north of the Delta and would not contribute to other study objectives. Evaluated during the CALFED alternative development process. |
| **Coordinate Operation and Precipitation Enhancement** | | |
| Improve Delta export and conveyance capability through coordinated CVP and SWP operations | **Deleted** | JPOD is being actively pursued in other programs. A likely without-project condition. |
| Implement additional precipitation enhancement | **Deleted** | Not an effective alternative to new storage. Very limited potential to benefit drought period water supply reliability. Being actively pursued under without-project conditions. |
| **Reduce Demand** | | |
| Implement water use efficiency methods | **Retained** | Although water use efficiency does not increase supplies, conservation is being actively pursued through other programs. Conservation needs to be considered as an element of any plan for addressing California's water future. |
| Retire agricultural lands | **Deleted** | Limited potential to help meet future water demands in the Central Valley. Agricultural lands of marginal value are often already fallowed drought periods. High degree of uncertainty regarding the ability to acquire and retire sufficient higher productivity lands. Land retirement test programs being performed by Reclamation under other programs. On a large scale, could have significant negative impacts on agricultural industry. |
| **Improve Water Transfers and Purchases** | | |
| Transfer water between users | **Deleted** | Not an alternative to new storage at Shasta Dam. Does not address planning objectives or considerations/criteria. Will likely be accomplished with or without additional efforts to develop new sources. Evaluated during the CALFED alternative development process. |

**Table 3-2. Management Measures Addressing Primary Planning Objective of Increasing Water Supply Reliability (contd.)**

| Measure Description | Study Status | Status Rationale |
|---|---|---|
| **Expand Delta Export and Conveyance Facilities** | | |
| Expand Banks Pumping Plant | **Deleted** | Not an alternative to new storage north of the Delta. Does not address planning objectives or considerations/criteria. Will likely be accomplished with or without additional efforts to develop new sources. |
| Construct DMC/CA intertie | **Deleted** | Not an alternative to new storage north of the Delta. Does not address planning objectives or considerations/criteria. Will likely be accomplished with or without additional efforts to develop new sources. |
| **Improve Surface Water Treatment** | | |
| Implement treatment/supply of agricultural drainage water | **Deleted** | Not a viable alternative to new water storage. High unit water cost. Evaluated as part of the CALFED Water Quality Program. |
| Construct desalination facility | **Deleted** | Low potential to address the primary planning objective of agricultural water supply reliability. Most efficient when used as a base water supply; highly inefficient in providing drought period water supplies. Very high unit water cost. Evaluated as part of the CALFED Water Use Efficiency Program. |

Key:
Banks Pumping Plant = Harvey O. Banks Pumping Plant
CALFED = CALFED Bay-Delta Program
CVP = Central Valley Project
Delta = Sacramento-San Joaquin Delta
DMC/CA = Delta-Mendota Canal/California Aqueduct
JPOD = Joint Point of Diversion
NODOS = North-of-the-Delta Offstream Storage
Reclamation = U.S. Department of the Interior, Bureau of Reclamation
ROD = Record of Decision
SWP = State Water Project

**Table 3-3. Management Measures Addressing Secondary Planning Objective of Conserving, Restoring, and Enhancing Ecosystem Resources**

| Measure Description | Study Status | Status Rationale |
|---|---|---|
| **Improve Cold-Water and Warm-Water Fishery Habitat** | | |
| Construct shoreline fish habitat around Shasta Lake | **Retained** | Would complement measures to increase storage in Shasta Lake. |
| Construct instream fish habitat on tributaries to Shasta Lake | **Retained** | Would complement measures to increase storage in Shasta Lake. High local interest. |
| Increase instream flows on the lower McCloud River | **Deleted** | Significant impacts to hydropower. |
| Reduce acid mine drainage entering Shasta Lake | **Deleted** | Significant implementation, O&M, and liability issues. Encompassed within actions evaluated and prioritized under CALFED ERP. |
| Reduce motorcraft access to upper reservoir arms | **Deleted** | Motorcraft management is under the purview of USFS. |
| Increase instream flows on the Pit River | **Deleted** | Significant impacts to hydropower. |
| **Restore and Conserve Riparian and Wetland Habitat** | | |
| Restore riparian and floodplain habitat along the Sacramento River | **Retained** | Would be compatible with other primary planning objectives. Consistent with other restoration programs and projects in the primary study area. Encompassed within actions evaluated and prioritized under CALFED ERP. |
| Restore wetlands along the Fall River and Hat Creek | **Deleted** | Significantly removed from primary study area. Independent action with low potential to contribute to other primary or secondary planning objectives. |
| Conserve upper Pit River riparian areas | **Deleted** | Significantly removed from primary study area. Independent action with low potential to contribute to other primary or secondary planning objectives. |
| Restore riparian and floodplain habitat on lower Clear Creek | **Deleted** | Significant benefit to tributaries. Independent action and would not directly contribute to improved ecological conditions along mainstem Sacramento River. Encompassed within actions evaluated and prioritized under CALFED ERP. |
| Promote Great Valley cottonwood regeneration along the Sacramento River | **Deleted** | High uncertainty for Federal participation and potential to conflict with flood control requirements related to levee protection. Encompassed within actions evaluated and prioritized under CALFED ERP. |
| Conserve riparian corridor along Cow Creek | **Deleted** | Significant benefit to tributaries. Independent action and would not directly contribute to improved ecological conditions along mainstem Sacramento River. Encompassed within actions evaluated and prioritized under CALFED ERP. |
| Remove and control nonnative vegetation in the Cow Creek and Cottonwood Creek watersheds | **Deleted** | Limited ability to provide consistent and reliable benefits, compared with the other measures proposed. Independent action and would not directly contribute to improved ecological conditions along mainstem Sacramento River. Encompassed within actions evaluated and prioritized under CALFED ERP. |

**Table 3-3. Management Measures Addressing Secondary Planning Objective of Conserving, Restoring, and Enhancing Ecosystem Resources (contd.)**

| Measure Description | Study Status | Status Rationale |
|---|---|---|
| **Improve Other Fish and Wildlife Habitat** | | |
| Create a parkway along the Sacramento River | **Deleted** | Primarily focuses on land acquisition and conversion to public uses. As a project element, it would be a non-Federal responsibility with little direct Federal interest. Elements are a likely without-project condition. |
| Enhance forest management practices to conserve bald eagle nesting habitat | **Deleted** | Likely a without-project condition; is an element of USFS forest recovery plans. |
| Remove and control nonnative plants around Shasta Lake | **Deleted** | Likely a without-project condition; is an element of USFS forest recovery plans. |
| Control erosion and restore affected habitat in the Shasta Lake area | **Deleted** | Likely a without-project condition; is an element of USFS forest recovery plans. |
| Develop geographic information system for Shasta to Red Bluff reach | **Deleted** | Would not directly contribute to other primary or secondary planning objectives. GIS mapping likely a without-project condition as part of other ongoing studies and projects. |
| Implement erosion control in tributary watersheds | **Deleted** | Significant benefit to tributaries. Independent action and would not directly contribute to improved ecological conditions near Shasta Lake or along mainstem Sacramento River. |

Key:
CALFED = CALFED Bay-Delta Program
GIS = geographic information system
O&M = operations and maintenance

**Table 3-4. Management Measures Addressing Secondary Planning Objectives of Reducing Flood Damage, Developing Additional Hydropower Generation, Maintaining and Increasing Recreation, and Maintaining or Improving Water Quality**

| Planning Objectives/ Measure Description | Study Status | Status Rationale |
|---|---|---|
| **Reduce Flood Damage** | | |
| Update Shasta Dam and Reservoir flood management operations | **Retained** | Compatible with any potential modification of Shasta Dam and Reservoir. Potential to realize an increase in flood damage reduction with increasing size of Shasta Reservoir for primary planning objectives. Would not conflict with other secondary planning objectives or planning considerations/criteria. |
| Increase flood management storage space in Shasta Reservoir | **Deleted** | Would conflict with the primary planning objectives. Estimated low potential for economic justification (costs are expected to exceed benefits). For increased space via raising Shasta Dam, it is expected that dam raise construction costs would significantly exceed flood damage reduction benefits. For space increase through reoperation, expected costs to replace reduction in water reliability would also significantly exceed flood damage reduction benefits. |
| Implement nonstructural flood damage reduction measures | **Deleted** | Independent action and not directly related to accomplishing the primary or other secondary planning objectives. |
| Implement traditional flood damage reduction measures | **Deleted** | Independent action and not directly related to accomplishing the primary or other secondary planning objectives. |
| Route probable maximum flood from top of conservation pool | **Deleted** | This measure is already consistent with existing reservoir conditions and operations, making further changes unnecessary. |
| **Develop Additional Hydropower Generation** | | |
| Modify existing/construct new generation facilities at Shasta Dam to take advantage of increased hydraulic head | **Retained** | Potential to realize an increase in hydropower output from Shasta with increasing size of Shasta Reservoir for primary planning objectives. Would not conflict with other secondary planning objectives or planning considerations/criteria. |
| Construct new hydropower generation facilities | **Deleted** | This measure would directly contribute to the secondary planning objective but it is an independent action and not directly related to accomplishing the primary planning objectives. Although this measure has potential to realize additional hydropower benefits with increased/replaced hydropower facilities, it could be pursued regardless of primary planning objectives. |

**Table 3-4. Management Measures Addressing Secondary Planning Objectives of Reducing Flood Damage, Developing Additional Hydropower Generation, Maintaining and Increasing Recreation, and Maintaining or Improving Water Quality (contd.)**

| Planning Objectives/ Measure Description | Study Status | Status Rationale |
|---|---|---|
| **Maintain and Increase Recreation Opportunities** | | |
| Maintain and enhance recreation capacity, facilities, and opportunities | **Retained** | Compatible with any potential modification of Shasta Dam and Reservoir. Would be consistent with established planning guidelines for Federal water storage projects and with existing recreation uses at Shasta Reservoir. |
| Develop new National Recreation Area recreation plan | **Deleted** | Developing, coordinating, and implementing a new National Recreation Area as a stand-alone measure is believed to be a separate Federal action outside the scope of this investigation. It is understood, however, that other measures, such as enlarging Shasta Dam and Reservoir would likely require, at minimum, modification of existing recreation plan. |
| Reoperate reservoir for recreation | **Retained** | Compatible with any potential modification of Shasta Dam and Reservoir. Potential to realize an increase in recreation experiences with increasing size of Shasta Reservoir for primary planning objectives. Limited potential for reservoir reoperation to benefit recreation by allowing more reliable filling of the reservoir during the spring. |
| **Maintain or Improve Water Quality** | | |
| Improve operational flexibility for Sacramento-San Joaquin Delta water quality by increasing storage in Shasta Reservoir | **Retained** | Compatible with any potential modification of Shasta Dam and Reservoir. Increased storage would contribute to meeting downstream water quality requirements and would provide for increased operational flexibility and Sacramento-San Joaquin Delta emergency response. |

### Measures to Address Primary Planning Objectives

As shown in Tables 3-1 and 3-2, numerous measures were identified to address the primary planning objectives of increasing anadromous fish survival and increasing water supply reliability.

**Increase Anadromous Fish Survival** A number of potential management measures were identified to address increasing anadromous fish survival and other ecosystem restoration opportunities, above and beyond implementation of actions and programs identified in the CVPIA and AFRP. Most are listed in the 2003 *Ecosystem Restoration Office Report* (Reclamation). These measures were separated into three broad categories: (1) improved fish habitat, (2) improved water flows and quality, and (3) improved fish migration. Of more than 20 measures identified specifically to address the primary planning objective of increasing anadromous fish survival in the Sacramento River, 6 measures were initially retained for possible inclusion in concept plans. Through the alternatives formulation and screening process, these measures were further refined and screened. Five measures were incorporated into the comprehensive plans evaluated in this Feasibility Report (see Table 3-1).

As indicated in Table 3-1, many of the management measures considered to address increasing anadromous fish survival are encompassed under the Ecosystem Restoration Program (ERP) included as part of the CALFED Preferred Program Alternative. The CALFED ERP includes multiple actions to address the goal of improving and increasing aquatic and terrestrial habitats and improving ecological functions in the Bay-Delta system to support sustainable populations of diverse and valuable plant and animal species. The ERP has prioritized restoration actions and funded approximately $630 million of ecosystem restoration activities (DFG et al. 2010).

**Increase Water Supply Reliability** Various potential management measures were identified to address the primary planning objective of increasing water supply reliability for M&I, agricultural, and environmental purposes to help meet current and future water demands. These measures were separated into eight categories: (1) increased surface water storage, (2) reservoir reoperation, (3) improved conjunctive water management, (4) coordinated operation and precipitation enhancement, (5) demand reduction, (6) improved water transfers and purchases, (7) improved Delta export and conveyance, and (8) improved surface water treatment. Of 22 measures considered to help increase water supply reliability, 4 were retained for possible inclusion in concept plans. Through the alternatives formulation and screening process, these measures were further refined and screened. Three measures were incorporated into the comprehensive plans evaluated in this Feasibility Report (see Table 3-2).

### Measures to Address Secondary Planning Objectives

The following is a discussion of measures identified to address secondary planning objectives.

**Conserving, Restoring, or Enhancing Ecosystem Resources** Identifying potential ecosystem restoration opportunities included management measures to address the secondary objective of ecosystem restoration in the Shasta Lake vicinity and along the Sacramento River downstream from Shasta Dam. The measures were separated into three categories: (1) improving cold-water and warm-water fisheries, (2) restoring and conserving riparian and wetland habitat, and (3) improving other fish and wildlife habitat. Of the 19 management measures identified to address this secondary planning objective, 3 were retained for further development (see Table 3-3). As indicated in Table 3-3, many of the management measures considered to address increasing anadromous fish survival are encompassed under the ERP, which was included as part of the CALFED Preferred Program Alternative.

**Reduce Flood Damage** Five management measures were identified to help reduce flood damage along the Sacramento River. Of the five, two were initially retained for further development and possible inclusion in concept plans. These included (1) updating Shasta Dam and Reservoir flood management operations and (2) routing the probably maximum flood from the top of the conservation pool. Through additional analyses, the second measure was found to be consistent with existing reservoir operations and was subsequently eliminated from further consideration; the first measure was incorporated into the comprehensive plans evaluated in this Feasibility Report (see Table 3-4).

**Develop Additional Hydropower Generation** Two management measures were considered to increase hydropower potential in the study area. They included (1) modifying the existing/constructing new generation facilities at Shasta Dam to take advantage of increased hydraulic head and (2) constructing new hydropower generation facilities in the area. As shown in Table 3-4, the first measure was retained for further development in concept and comprehensive plans.

**Maintain and Increase Recreation Opportunities** Three management measures were identified to help maintain and increase recreation opportunities at Shasta Lake. Of these three measures, two (see Table 3-4) were retained for further development in concept and comprehensive plans. They include (1) maintaining and enhancing recreation capacity, facilities, and opportunities, and, (2) reoperating the reservoir to stabilize early season filling in Shasta Lake.

**Maintain or Improve Water Quality** One management measure was identified to improve water quality in the Sacramento River and Delta (see Table 3-4). It was retained for further development in concept and comprehensive plans. This measure involves improving operational flexibility to improve Delta water quality by increasing storage in Shasta Reservoir.

### *Measures Retained for Further Development*

Following is a brief description of the management measures retained for further consideration and incorporated into the comprehensive plans.

**Increase Anadromous Fish Survival** The following five measures were retained to address the primary objective of increasing the survival of anadromous fish populations in the Sacramento River.

- **Construct Instream Aquatic Habitat Downstream from Keswick Dam –** Keswick Dam is the uppermost barrier to anadromous fish migration on the Sacramento River. Releases from the dam have scoured the channel, and the dam blocks passage of gravels, bed sediments, and woody debris that were replenished historically by upstream tributaries. As a result, aquatic habitat is poor for spawning and rearing of anadromous fish, and predation can be high because of the lack of instream cover. Despite these unfavorable channel conditions, cold-water releases from Keswick Dam attract large numbers of spawners to this reach. This measure consists of constructing aquatic habitat in and adjacent to the Sacramento River downstream from Keswick Dam to encourage use of this reach by anadromous fish for reproduction. Habitat restoration would involve acquiring lands adjacent to the Sacramento River; earthwork along the riverbank to construct side channels for spawning; and strategic placement of instream cover structures within the river channel, including large boulders, anchored root wads, and other natural materials. Side channels and other features could be created to encourage spawning and rearing. Restored floodplain lands could be revegetated with native riparian plants.

  This measure was retained for potential further development as part of the SLWRI because it may have potential to successfully address the first primary planning objective, and because of high interest from fisheries agencies. Furthermore, it may combine favorably with other potential measures related to Shasta Dam and Reservoir and their operation. This measure would not be expected to conflict with other known programs or projects on the upper Sacramento River.

- **Replenish Spawning Gravel in the Sacramento River –** The restoration of aquatic habitat between Keswick Dam and Red Bluff is of high priority because this reach is one of the few remaining spawning corridors available to anadromous fish along the Sacramento River. This measure would support the primary planning objective of increasing the survival of anadromous fish populations in the Sacramento River by contributing to the replenishment of spawning gravels used by anadromous fish. Gravel recruitment is of particular importance to anadromous fish, which require clean gravels for their spawning beds. Dams, river diversions, gravel mining, and other obstructions have blocked or reduced natural gravel sources. Suitable spawning gravel has been identified as a potential limiting factor in the recovery of anadromous fish populations on the Sacramento River. Several other programs, including CALFED and the AFRP, have provided gravel replenishment in selected locations. This measure would involve transporting and placing gravel into the Sacramento River downstream from Keswick Dam. Structural treatments may be required below Keswick Dam to prevent the gravel from being washed downstream. Temporary construction easements could be required. Suitable spawning gravel would consist of uncrushed, natural river rock, washed and placed in the river at strategic locations. Hydraulic and geomorphic evaluations are needed to determine the most effective gravel size distribution and the most appropriate locations for gravel placement.

- **Make Additional Modifications to Shasta Dam for Temperature Control –** For relatively small raises of Shasta Dam, the existing TCD structure would be retrofitted to account for additional dam height, and to reduce leakage of warm water into the structure, but no new structure would be needed. However, modifications to, or replacement of, the existing structure are more likely to be necessary for increasingly higher dam raises. This measure would support the primary planning objective of increasing the survival of anadromous fish populations by (1) increasing the ability of operators at Shasta Dam to meet downstream temperature requirements for anadromous fish, (2) providing more flexibility in achieving desirable water temperatures during critical spawning, rearing, and out-migration, and (3) extending the area of suitable spawning habitat farther downstream in the Sacramento River.

- **Enlarge Shasta Lake Cold-Water Pool –** Cold water released from Shasta Dam significantly influences water temperature conditions on the Sacramento River between Keswick and the RBPP. This measure includes increasing the volume of the cold-water pool in Shasta Lake by raising Shasta Dam and enlarging Shasta Reservoir primarily to help maintain colder releases for anadromous fish during certain periods. Increased storage volume could also help increase seasonal flows during dry and critical years in the upper Sacramento River that are important to fish populations.

  Possible operational changes to the timing and magnitude of releases from Shasta Dam, primarily to improve the quality of aquatic habitat, could be applied under an adaptive management plan. Changes in operating the cold-water pool could include increasing minimum flows, timing releases out of Shasta Dam to mimic more natural seasonal flows, meeting flow targets for side channels, or retaining the additional water in storage to meet temperature requirements. Reclamation would manage the cold-water pool each year based on recommendations from the Sacramento River Temperature Task Group (SRTTG).

This measure would support the primary planning objective of increasing survival of anadromous fish populations by (1) improving water temperature control, (2) extending suitable spawning habitat, and (3) improving overall physical aquatic habitat conditions in the Sacramento River.

- **Modify Storage and Release Operations at Shasta Dam –** In addition to water temperature, flow conditions in the upper Sacramento River are important in addressing anadromous fish needs. This measure consists of enlarging Shasta Dam and modifying seasonal storage and releases to benefit anadromous fisheries. Although this measure could help provide greater flexibility in meeting water temperature targets, it would be aimed primarily at improving flows and influencing physical channel conditions for anadromous fish. Changes would be made to the timing and magnitude of releases performed to maintain target flows in spawning areas, and improve the quality of aquatic habitat. The quality of aquatic habitat could be further improved by cleaning spawning gravels. This measure could also include release changes during the flood season to permit "pulse flows" and other releases that could improve aquatic habitat conditions. Further, the measure could help provide additional control and dilution of acid mine drainage from Spring Creek. This measure was retained as part of an adaptive management strategy.

**Increase Water Supply Reliability** The following three measures were retained to address the primary objective of increasing water supply and water supply reliability for agricultural, M&I, and environmental purposes.

- **Increase Conservation Storage Space in Shasta Reservoir by Raising Shasta Dam –** This measure consists of structural raises of Shasta Dam ranging from about 6.5 feet to approximately 200 feet. A range of potential dam raises has been considered in previous studies, including raises of more than 200 feet. A raise of 6.5 feet is included in the Preferred Program Alternative for the CALFED Programmatic ROD (2000a). Raising Shasta Dam would contribute directly to the primary planning objectives, and previous studies have indicated that raising the dam would be technically feasible. Raising Shasta Dam also could contribute to the secondary planning objectives.

- **Increase Effective Conservation Storage Space in Shasta Reservoir by Increasing Efficiency of Reservoir Operation for Water Supply Reliability –** This measure consists of modifying the operation of Shasta Dam to improve water supply reliability. It could also assist in improving efforts to reduce flood damages. Potential methods to improve water supply reliability include modifying rainflood parameters – those which address space for flows from winter rainfall – in the operation rules for Shasta Reservoir and modifying the Shasta

Dam release schedule. The goal of the operation changes would be to minimize required evacuation of the reservoir from about late November through March, and to possibly allow the reservoir to be filled more rapidly in the spring. A primary criterion would be to prevent adversely affecting existing flood protection provided by Shasta Dam.

- **Implement Water Use Efficiency Methods –** Water use efficiency methods can help reduce future water shortages by allowing a more effective use of existing supplies. As population and resulting water demands continue to grow, and available supplies remain relatively static, more effective use of supplies can reduce potential critical impacts to urban and agricultural resources resulting from water shortages. Many water use efficiency actions will be accomplished with or without implementation of other projects to address water supply reliability. This includes continued implementation of current best management practices for urban and agricultural conservation. It is estimated that additional water conservation measures, although costly to implement, will play a major role in California's water future. Accordingly, water use efficiency was retained for consideration as a potential project element for any plan to be considered for the SLWRI.

**Conserve, Restore, and Enhance Ecosystem Resources** The following measures were retained to address the secondary objective of conserving, restoring, and enhancing ecosystem resources in the Shasta Lake area and along the upper Sacramento River.

- **Construct Shoreline Fish Habitat Around Shasta Lake –** The mostly barren shoreline of Shasta Lake does not contribute to supporting juvenile fish. In addition, lack of shoreline cover structures, such as vegetation and woody debris, and suitable shallow-water fish habitat around the lake limit preferred habitat for juvenile fish. This measure would improve shallow, warm-water fish habitat at specific locations around the shoreline of Shasta Lake using resilient vegetation and aquatic "cover" structures within the upper drawdown area of the lake. The measure would involve (1) installing artificial fish cover, including complex woody structures, (2) planting water-tolerant and/or erosion-resistant vegetation at prescribed locations within the reservoir drawdown area, and (3) performing selective reservoir rim clearing of specific trees and vegetation. This measure would support the secondary planning objective of preserving and restoring ecosystem resources in the Shasta Lake area by (1) increasing the survival of juvenile fish through improving the quantity of available cover and overall quality of shallow-water habitat, and (2) benefiting land-based species that inhabit the shoreline of Shasta Lake through establishing resilient vegetation.

- **Construct Instream Fish Habitat on Tributaries to Shasta Lake –** This measure would conserve and/or restore instream aquatic habitat on lower reaches of key tributaries to Shasta Lake. Two categories of potential aquatic habitat restoration in tributaries include (1) identifying and correcting barriers to fish passage that are critical to various life stages for native fish species, particularly at culverts and other human-made barriers, and (2) identifying and implementing feasible aquatic habitat improvements intended to conserve or restore degraded aquatic and riparian habitat in tributaries to Shasta Lake. Fish passage improvements include restoring and/or enhancing a minimum of five perennial stream crossings to help enable upstream and downstream passage for all life stages of native fish in Shasta Lake. Aquatic habitat restoration includes efforts to reestablish or enhance aquatic connectivity, and reestablish or conserve riparian vegetation needed to provide shade, cover, and organic material. Additionally, aquatic habitat restoration includes reducing sediment and other pollutants associated with roads and other human-made disturbances from discharging into streams flowing into Shasta Lake. The lower reaches of intermittent and perennial streams tributary to Shasta Lake that support aquatic organisms native to the upper Sacramento River would be targeted for aquatic restoration under this measure, because they provide year-round fish habitat. This measure would support the secondary planning objective of conserving and restoring ecosystem resources in Shasta Lake.

- **Restore Riparian and Floodplain Habitat Along the Sacramento River –** This measure consists of restoring riparian and floodplain habitat at specific locations along the Sacramento River to promote the health and vitality of the river ecosystem. It would involve acquiring and revegetating floodplain terraces and adjacent riparian areas with native plants. Suitable locations for restoration would be in areas with a 20 percent to 50 percent chance of flooding in any year (commonly referred to as 5-year to 2-year floodplains). Locations near the confluences of perennial creeks and streams tributary to the Sacramento River would have potential to provide maximum benefits. Continuity is also important to the health and vitality of riparian areas; small, isolated portions of riparian habitat tend to be less productive than larger, continuous stretches of habitat. A limited amount of land contouring and imported fill material would be required at several locations where the historic floodplain has been disconnected from the river or disturbed by human activity.

**Reduce Flood Damage** The following measure was retained to address the secondary objective of reducing flood damages along the Sacramento River.

- **Update Shasta Dam and Reservoir Flood Management Operations** – This measure would include reassessing existing seasonal flood management storage space needs at Shasta using updated information on regional hydrologic and meteorological conditions and rainfall/runoff characteristics in the drainage basin. Potential methods to improve flood management would include improved long-range weather forecasting, implementing additional forecast-based reservoir drawdown to provide additional space for anticipated high flow events, changing the criteria regarding the rate of outflows from Shasta Dam, and modifying target peak flows at Bend Bridge. Several possible reoperation opportunities are described in the document *Assessment of Potential Shasta Dam Reoperation for Flood Control and Water Supply Improvement* (Reclamation 2004c). This measure would not conflict with other secondary planning objectives, planning considerations, or criteria.

**Develop Additional Hydropower Generation** The following measure was retained to address the secondary objective of developing additional hydropower generation capabilities at Shasta Dam.

- **Modify Existing/Construct New Generation Facilities at Shasta Dam to Take Advantage of Increased Hydraulic Head –** This measure consists of modifying the hydropower generation facilities at Shasta Dam to take advantage of any increases in water surface elevations resulting from enlarging the dam, if applicable. Nearly all releases from Shasta and Keswick dams are made through their generating facilities. On occasion, however, outflows during flood operations are made through the flood control outlets and over the spillway. During these instances, the existing powerplant is bypassed for much of the flood (space evacuation) release. Power generated during these brief and infrequent periods generally has a lower value because of usually abundant supplies during winter periods. Raising Shasta Dam would create the potential to reduce these flood releases in winter and allow water to pass through the generators later in the year when the water and power are usually more valuable. Further, with higher water surface elevation, greater energy levels (head) would be available for operating the turbines.

**Maintain and Increase Recreation Opportunities** The following measures were retained to address the secondary objective of maintaining and increasing recreation opportunities at Shasta Lake.

- **Maintain and Enhance Recreation Capacity, Facilities, and Opportunities –** Recreation is not a specific purpose of the Shasta Division of the CVP, and no formal recreation facilities were developed as part of the original project. However, in 1965, Congress established the Whiskeytown-Shasta-Trinity NRA. As a result of that act and subsequent direction, USFS manages recreation within the NRA, which includes managing numerous water resources and related recreation activities at Shasta Lake. Increasing the storage in Shasta Lake would provide a larger water surface for recreation and reduce drawdown during the recreation season. This measure focuses on maintaining existing recreation capacity at Shasta Dam and Lake through relocating and modernizing recreation facilities adversely affected by a higher lake level. It also includes enhancing opportunities related to the larger lake surface and modernized recreation facilities.

- **Reoperate Reservoir for Recreation –** This measure consists of changing the established rules for operating Shasta Dam and Reservoir for flood management to benefit recreation resources at Shasta Lake. A claim by many of the recreation interests around Shasta Lake is that often the lake has to be drawn down in early spring for flood management purposes and then, because of limited inflows in the remainder of the season, the lake cannot recover, which adversely impacts recreation (as well as water supply). Local residents identify 2004 as an example and also claim that the existing reservoir operation rules for flood management are outdated (based on a USACE report dated 1977, over 35 years ago) and that by using more recent data and current technologies, the drawdown would not be required in some years, or would not be as significant. There is limited potential for changes in flood management rules to allow for more operational flexibility in reservoir drawdown requirements in response to storms with improved advanced forecasting. Additionally, with an increase in reservoir depth due to raising Shasta Dam, reservoir reoperation would likely include raising the bottom of flood control pool elevation, allowing for higher winter and spring water levels.

**Maintain or Improve Water Quality** The following measure was retained to address the secondary objective of maintaining or improving water quality conditions downstream from Shasta Dam and in the Delta.

- **Improve Operational Flexibility for Sacramento-San Joaquin Delta Water Quality by Increasing Storage in Shasta Reservoir –** This measure consists of enlarging Shasta Dam to improve operational flexibility, which could contribute to Delta water quality conditions and Delta emergency response. Shasta Dam has the ability to provide increased releases and high flow releases to reestablish 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.

#### *Measures Summary*

Table 3-5 summarizes the final management measures carried forward to address the primary and secondary planning objectives. Of the management measures considered, eight measures addressing primary planning objectives were identified for further consideration and potential inclusion in alternative plans. Additionally, eight measures addressing the secondary planning objectives were identified for further consideration and inclusion, to the extent possible, in alternative plans. Measures that have been carried forward are believed to best address the objectives of the SLWRI, with consideration of planning constraints and criteria.

## Concept Plans

Concept plans are plans that are conceptual in scope, formulated from retained management measures to investigate strategies to address project objectives. For the SLWRI, concept plans were first formulated from the retained management measures, as shown in Table 3-6. As noted in Table 3-6, some management measures initially carried forward and included in concept plans were later eliminated from further consideration during the planning process and are not included in the final management measures in Table 3-5. Each concept plan was reviewed for impacts, costs, and benefits and compared to planning objectives to determine whether the plan should be eliminated or carried forward into the comprehensive plans phase. The purpose of this phase of the formulation process was to (1) explore an array of different strategies to address the primary planning objectives, constraints, considerations, and criteria, and (2) identify concepts that warranted further development in the comprehensive plans phase.

**Table 3-5. Final Measures to Address Planning Objectives**

| Planning Objective | Management Measure | |
|---|---|---|
| **Primary Planning Objectives** | | |
| Increase Anadromous Fish Survival | Construct Instream Aquatic Habitat | Construct instream aquatic habitat downstream from Keswick Dam through side channel restoration |
| | Replenish Spawning Gravel | Replenish spawning gravel in the Sacramento River |
| | Modify Temperature Control Device | Make additional modifications to Shasta Dam for temperature control |
| | Enlarge Shasta Lake Cold-Water Pool | Raise Shasta Dam to increase the cold-water pool in the lake to increase anadromous fish survival |
| | Modify Storage and Release Operations at Shasta Dam | Modify storage and release operations at Shasta Dam to benefit anadromous fish (included as part of adaptive management strategy) |
| Increase Water Supply and Supply Reliability | Increase Conservation Storage | Increase conservation storage space in Shasta Reservoir by raising Shasta Dam |
| | Reoperate Shasta Dam | Increase the effective conservation storage space in Shasta Reservoir by increasing the efficiency of reservoir operation for water supply reliability |
| | Reduce Demand | Identify and implement, to the extent possible, water use efficiency methods |
| **Secondary Planning Objectives** | | |
| Conserve, Restore, and Enhance Ecosystem Resources | Restore Shoreline Aquatic Habitat | Construct shoreline fish habitat around Shasta Lake |
| | Restore Tributary Aquatic Habitat | Construct instream fish habitat on tributaries to Shasta Lake |
| | Restore Riparian Habitat | Restore riparian and floodplain habitat along the upper Sacramento River |
| Reduce Flood Damage | Modify Flood Operations Guidelines | Update Shasta Dam and Reservoir flood management operations to improve system-wide reliability and public health and safety |
| Develop Additional Hydropower Generation | Modify Hydropower Facilities | Modify existing/construct new generation facilities at Shasta Dam to take advantage of increased head |
| Maintain and Increase Recreation | Maintain and Enhance Recreation Facilities | Maintain and enhance recreation capacity, facilities, and opportunities |
| | Reoperate Reservoir | Increase recreation use by stabilizing early season filling in Shasta Lake |
| Maintain or Improve Water Quality | Increase Operational Flexibility | Improve operational flexibility for Delta water quality by increasing storage in Shasta Reservoir |

Key:
Delta = Sacramento-San Joaquin Delta

**Table 3-6. Summary of Concept Plan Features**

| Concept Plan[1] | Features: Dam Raise | Primary Planning Objective Focus: Water Supply Reliability[2] | | | Primary Planning Objective Focus: Anadromous Fish Survival | | | | Secondary Planning Objectives Addressed[4]: Environmental Restoration | | | Secondary Planning Objectives Addressed[4]: Flood Control and Hydropower | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Raise Shasta Dam (feet) | Increase Conservation Storage | Perform Conjunctive Water Management[3] | Reoperate Shasta Dam | Modify TCD | Replenish Spawning Gravel | Enlarge Shasta Lake Cold-Water Pool | Increase Minimum Flows[3] | Restore Shoreline Aquatic Habitat | Restore Tributary Aquatic Habitat | Restore Riparian Habitat | Modify Flood Control Operations and Implement Shasta Public Safety[3] Features | Modify Hydropower Facilities |
| AFS-1 | 6.5 | * | | Changes to water supply operations and modification of the TCD would likely be included, to some extent, in any alternative that includes raising Shasta Dam. | | | X | | | | | Changes to flood control operations at Shasta Dam, Public Safety,[3] and hydropower facilities would likely be part of any alternative that includes physically modifying Shasta Dam; the degree and details of these changes will be included in feasibility level alternative plans. | |
| AFS-2 | 6.5 | * | | | | | * | X | | | | | |
| AFS-3 | 6.5 | * | | | | X | * | X | | | | | |
| WSR-1 | 6.5 | X | | | | | * | | | | | | |
| WSR-2 | 18.5 | X | | | | | * | | | | | | |
| WSR-3 | 202.5 | X | | | | | * | | | | | | |
| WSR-4 | 18.5 | X | X | | | | * | | | | | | |
| CO-1 | 6.5 | X | | | | X | X | | | | | | |
| CO-2 | 18.5 | X | | | | X | X | | | | | | |
| CO-3 | 18.5 | X | | | | X | X | X | | | | | |
| CO-4 | 6.5 | X | X | | | X | X | | X | X | X | | |
| CO-5 | 18.5 | X | X | | | X | X | | X | X | X | | |

Notes:

[1] Raising Shasta Dam provides both water supply and temperature benefits, regardless of how the additional storage is exercised. While the AFS measures focus on use of the additional space for anadromous fish survival, they also provide water supply benefits. Similarly, the WSR measures focus on water supply reliability but the reservoir enlargements also provide benefits to anadromous fish.

[2] All concept plans include water demand reduction.

[3] These measures were used for evaluation because they were retained at the time of plan formulation. However, they have since been removed from consideration.

[4] Water quality and recreation were added as secondary objectives after development of concept plans, and are not considered in this table.

Key:

* Coincidental benefit, although not a primary focus of the concept plan.

AFS = anadromous fish survival

CO = combined objectives

TCD = temperature control device

WSR = water supply reliability

X = Primary focus of concept plan

First, two sets of plans were developed that focused on either anadromous fish survival (AFS) or water supply reliability (WSR) as the single primary planning objective. Three AFS plans and four WSR plans were developed. Although the AFS and WSR plans focused on single planning objectives, each generally contributed to both primary planning objectives. In the three AFS plans, for example, emphasis was placed on combinations of measures that could best address the fish survival goals while considering incidental benefits to water supply reliability, if possible. Second, five plans were developed that included measures to address both primary and, to a lesser degree, secondary planning objectives. These are termed combined objective (CO) plans.

Each of the concept plans (and later comprehensive plans) included various common features:  (1) modifications to the TCD, (2) reoperation of Shasta Dam for flood management, and (3) facilities to take advantage of the increased head for hydropower. Concept plans are described in detail in the Plan Formulation Appendix and summarized briefly below.

## Plans Focused on Anadromous Fish Survival

Three concept plans were formulated from the management measures retained to address the primary planning objective of AFS. Each plan includes raising Shasta Dam 6.5 feet and enlarging the reservoir by 256,000 acre-feet, but the plans differ in how the additional storage would be used to benefit anadromous fish. Progressively higher raises produce proportionally greater benefits to anadromous fish. Although larger dam raises could produce greater benefits to fisheries, the goal at this stage in plan formulation was to provide a common baseline from which the relative performance of the three AFS plans could be compared.

### *AFS-1 – Increase Cold-Water Assets with Shasta Operating Pool Raise*

The primary focus of AFS-1 is to maintain 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 this plan 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 was not retained for further development as a stand-alone plan because it did not meet the primary planning objective of increasing water supply reliability. However, major features of this plan were retained for further development into comprehensive plans.

### *AFS-2 – Increase Minimum Anadromous Fish Flow with Shasta Enlargement*

AFS-2 focuses 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. No changes would be made to the carryover target volume or minimum operating pool. Subsequent evaluation indicated that although at various stages of development the concept of increasing minimum flows would be beneficial for fish, at other life stages increasing minimum flows would be detrimental. Accordingly, this plan was deleted from further development.

#### *AFS-3 – Increase Minimum Anadromous Fish Flow and Restore Aquatic Habitat with Shasta Enlargement*

AFS-3 is similar to AFS-2, except that it also includes acquiring, restoring, and reclaiming one or more inactive gravel mine along the upper Sacramento River to restore about 150 acres of aquatic and floodplain habitat. However, 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 RBPP. Accordingly, this plan element was deleted from further consideration.

### Plans Focused on Water Supply Reliability

Four concept plans were formulated from the management measures retained to address the primary planning objective of increasing WSR. The magnitude of enlarging Shasta Dam was important when developing the WSR plans because storage capacity is the most influential factor in determining benefits to water supply reliability for this study. Hence, three dam raises were considered in the WSR plans: 6.5 feet, 18.5 feet, and 200 feet. Water supply reliability estimates presented in this section are from the 2004 *SLWRI Initial Alternatives Information Report* (Reclamation 2004a). Increases in south-of-Delta agricultural water deliveries comprise the majority of water supply reliability benefits for all WSR plans. The remaining benefits are seen in increased water deliveries for south-of-Delta M&I and north-of-Delta agricultural and M&I uses.

#### *WSR-1 – Increase Water Supply Reliability with 6.5-foot Dam Raise*

WSR-1 would increase water supply reliability by increasing critical and dry year water supplies for CVP and SWP deliveries by at least 72,000 acre-feet per year. In addition to water supply reliability, there would be benefits to anadromous fish in the upper Sacramento River, increases in power generation, and the potential for increases in reservoir area recreation. This plan was retained for further development.

#### *WSR-2 – Increase Water Supply Reliability with 18.5-foot Dam Raise*

The 18.5-foot raise is the largest practical dam raise that does not require relocating the Pit River Bridge, and would increase the capacity of the reservoir by 634,000 acre-feet to a total of 5.19 MAF. WSR-2 would increase water supply reliability by increasing critical and dry year water supplies for CVP and SWP deliveries by at least 125,000 acre-feet per year. Additionally, there would be benefits to anadromous fish in the upper Sacramento River, increases in power generation, and the potential for increases in reservoir area recreation. This plan was retained for further development.

#### *WSR-3 – Increase Water Supply Reliability with 200-foot Dam Raise*

The 200-foot raise is the maximum amount considered to be technically feasible and would increase the capacity of the reservoir by 9.3 MAF to a total of 13.9 MAF. The magnitude of this raise would require significant modifications or replacement of most facilities associated with the dam, including hydropower facilities, 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 at this time because the construction cost is estimated at over $6 billion (at October 2008 price levels). Accordingly, this plan was deleted from further consideration in this Feasibility Report.

#### *WSR-4 – Increase Water Supply Reliability with 18.5-foot Dam Raise and Conjunctive Water Management*

This plan is similar to WSR-2, but includes implementing a conjunctive water management component consisting largely of contracts between Reclamation and certain Sacramento River basin water users. The conjunctive water management component includes downstream facilities, such as additional river diversions and transmission and groundwater pumping facilities, to facilitate exchanges. Reclamation would provide additional surface supplies in wet and normal water years to participating CVP users, 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 this alternative indicated that water supplies for CVP and SWP deliveries could be increased between 10 to 20 percent. This plan was initially retained for further development. However, subsequent analysis of WSR-4 indicated tradeoffs between conjunctive use water supply benefits and critical gains in fisheries benefits. The resulting reduction in benefits to fisheries operations in dry and critical years[1] was deemed unacceptable in terms of meeting primary project objectives. Thus, WSR-4 was eliminated from further consideration.

### Plans Focused on Combined Objectives

Five combination plans are summarized below that were developed to represent a reasonable balance between the two primary planning objectives. The CO concept plans also include measures to actively address the secondary planning objectives, as appropriate. The CO plans identified below are believed to be reasonably representative, although not exhaustively, of the range of potential and applicable actions.

[1] Throughout this document, water year types are defined according to the Sacramento Valley Index Water Year Hydrologic Classification unless specified otherwise.

#### *CO-1 and CO-2 – Increase Anadromous Fish Habitat and Water Supply Reliability with 6.5-foot and 18.5-foot Dam Raises, Respectively*

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. Similar to AFS-3, both CO plans include restoring one or more inactive gravel mine along the upper Sacramento River, providing additional aquatic and floodplain resources to the Sacramento River between Keswick and Battle Creek, a critical spawning reach. Both plans could increase water supply reliability by increasing water supplies for CVP and SWP critical and dry year deliveries by 72,000 acre-feet and 125,000 acre-feet, for CO-1 and CO-2, respectively. A higher water surface elevation in the reservoir would result in a net increase in power generation, and increase the maximum surface area, which would benefit recreation. 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 18.5-foot Dam Raise*

CO-3 includes features similar to those of CO-2, except a portion of the additional storage created by the 18.5-foot dam raise 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. However, as described for ASF-2, while it was concluded that although at various stages of development the concept of increasing minimum flows would be beneficial for fish, at other life stages, increasing minimum flows would be detrimental. Accordingly, this plan was deleted from further development.

#### *CO-4 and CO-5 – Multipurpose with 6.5-foot and 18.5-foot Dam Raise, Respectively*

CO-4 and CO-5 address both the primary and secondary planning objectives of the SLWRI through a combination of measures, including 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. The secondary planning objective of environmental restoration also would be addressed through shoreline and tributary habitat improvements, including restoring (1) resident fish habitat in Shasta Lake and (2) riparian habitat at locations along the lower arms of the Sacramento River, McCloud River, and Squaw Creek. This plan, at the 18.5-foot dam raise (CO-5), was retained for further development.

# Comprehensive Plan Development and Influencing Factors

Consistent with the P&G, the iterative plan formulation process includes assessing and refining concept plans and management measures carried forward to formulate comprehensive plans. Following is a summary of the rationale used to formulate SLWRI comprehensive plans in the Draft Feasibility Report and DEIS and the final comprehensive plans in the Final Feasibility Report and Final EIS.

## Formulation of Comprehensive Plans

As described above, numerous management measures were identified, evaluated, and screened. Through continued refinement of management measures and concept plans carried forward, the following plan types were identified for further development into comprehensive plans:

- Plan(s) to raise Shasta Dam between 6.5 feet and 18.5 feet, focusing on both water supply reliability and anadromous fish survival but with benefits to various secondary planning objectives
- Plan(s) to raise Shasta Dam by about 18.5 feet, focusing on anadromous fish survival, but also including water supply reliability and other various secondary planning objectives
- Plan(s) to raise Shasta Dam by about 18.5 feet, focusing on all planning objectives

Considering results of initial plan formulation efforts, the approach was to first formulate plans focusing on different dam raise heights within the range of 6.5 to 18.5 feet to address the first plan type listed above. A dam raise of 12.5 feet in CP2 was chosen because it represented a midpoint between the smallest and largest practical dam raises. Next, the approach was to identify the most efficient and effective dam raise height and formulate comprehensive plans to focus on anadromous fish survival and other objectives at this height.

### *Comprehensive Plans in the Draft Feasibility Report and Supporting Documents*

Using the general rationale described above, and incorporating input from the public scoping process and continued coordination with resource agencies and other interested parties, five comprehensive plans were developed for the Draft Feasibility Report and Preliminary DEIS:

- **Preliminary Comprehensive Plan 1 (PCP1)** – 6.5-foot-dam raise, enlarging the reservoir by 256,000 acre-feet, focusing on both anadromous fish survival and water supply reliability

- **Preliminary Comprehensive Plan 2 (PCP2) –** 12.5-foot-dam raise, enlarging the reservoir by 443,000 acre-feet, focusing on both anadromous fish survival and water supply reliability

- **Preliminary Comprehensive Plan 3 (PCP3) –** 18.5-foot-dam raise, enlarging the reservoir by 634,000 acre-feet, focusing on both anadromous fish survival and water supply reliability

- **Preliminary Comprehensive Plan 4 (PCP4) –** 18.5-foot-dam raise, enlarging the reservoir by 634,000 acre-feet, focusing on anadromous fish survival while increasing water supply reliability

- **Preliminary Comprehensive Plan 5 (PCP5) –** 18.5-foot-dam raise, enlarging the reservoir by 634,000 acre-feet; a combination plan focusing on all planning objectives

As described further in Section “Related Studies, Projects, and Programs,” of Chapter 1, due to uncertainty related to CVP and SWP operational constraints, water operations modeling and related evaluations in the 2011 Draft Feasibility Report and Preliminary DEIS were based on available modeling analyses at the time. This modeling reflected CVP and SWP operations and constraints described in the 2004 Long-Term Operation BA, 2004 NMFS BO, and 2005 USFWS BO.

- The Reclamation 2004 *Long-Term CVP and SWP Operations Criteria and Plan Biological Assessment* (2004 Long-Term Operations BA) (Reclamation 2004)

- The NMFS 2004 *Biological Opinion on the Long-Term Central Valley Project and State Water Project Operations Criteria and Plan* (2004 NMFS BO) (NMFS 2004)

- The USFWS 2005 *Reinitiation of Formal and Early Section 7 Endangered Species Consultation on the Coordinated Operations of the Central Valley Project and State Water Project and the Operational Criteria and Plan to Address Potential Critical Habitat Issues* (2005 USFWS BO) (USFWS 2005)

These analyses were suitable for comparison purposes, and reflected expected variation among the alternatives, including the type and relative magnitude of anticipated impacts and benefits.

Because of the large number of possibilities for increasing anadromous fish survival, additional analyses were conducted to determine the combination of actions that would provide the greatest overall benefits within PCP4. These analyses are described below.

**Refinement of Plan for Anadromous Fish Survival Focus with Water Supply Reliability** Primarily using the SALMOD model, and based on output from the water operations (CalSim-II), reservoir temperature, and river temperature models, a suite of flow- and temperature-focused actions (scenarios) were investigated to assess which combination of actions would likely result in the maximum increase in fish populations.

To formulate PCP4, three dam height raises were considered (6.5 feet, 12.5 feet, and 18.5 feet), resulting in 256,000 acre-feet, 443,000 acre-feet, and 634,000 acre-feet of increased storage, respectively. For each of these proposed dam raises, several combinations for allocating the increased storage were analyzed. For instance, assuming a dam raise of 12.5 feet, three options were considered: (1) no increase in the minimum pool, (2) an increase in the minimum pool similar to a 6.5-foot dam raise, and (3) all of the increased space dedicated to increased fisheries. The combinations considered represent scenarios developed to focus on increasing the cold-water pool, and are listed in Table 3-7.

Additional scenarios focusing on increasing Sacramento River flows with an 18.5-foot raise were also analyzed. The flow combinations were based primarily on flows identified as part of the Anadromous Fish Restoration Program (USFWS 2001). These scenarios are listed in Table 3-8.

Quantitative analysis indicated that increasing the minimum pool in Shasta Reservoir would have the greatest net fishery benefit. By increasing the minimum pool, the allowable carryover pool storage would increase in the reservoir. This carryover would act to conserve cold water that could be managed to better benefit anadromous fish. Scenarios 1, 2, 3, and 4 (flow augmentation scenarios) showed limited benefits to anadromous fish compared with other scenarios, and were eliminated from further analysis. Scenarios B, E, and I would not contribute to increased water supply reliability. Although PCP4 focuses on anadromous fish survival, because these three scenarios would not contribute to a primary planning objective, they were deleted from further consideration. Of the remaining scenarios, Scenarios D and H were deemed to be the most cost-effective. Based on further analysis, Scenario H was chosen to represent reservoir operations in PCP4 because this scenario would provide the greatest benefit to anadromous fish and still meet the primary planning objective of water supply reliability. Scenario comparison and selection are further discussed in the Plan Formulation Appendix.

**Table 3-7. Scenarios Considered for Cold-Water Storage – Anadromous Fish Survival Focus Plan**

| Cold-Water Pool Scenarios | Dam Raise (feet) | Enlarged Reservoir | Description |
|---|---|---|---|
| **A (PCP1)** | 6.5 | 256,000 acre-feet | No increase in minimum pool. |
| **B** | 6.5 | 256,000 acre-feet | Dedicating 256,000 acre-feet of water from increased storage to increase the size of the cold-water pool for fishery benefit. |
| **C (PCP2)** | 12.5 | 443,000 acre-feet | No increase in minimum pool. |
| **D** | 12.5 | 443,000 acre-feet | Dedicating 187,000 acre-feet of the additional water from increased storage to increase the size of the cold-water pool for fishery benefit. |
| **E** | 12.5 | 443,000 acre-feet | Dedicating 443,000 acre-feet of water from increased storage to increase the size of the cold-water pool for fishery benefit. |
| **F (PCP3/PCP5)** | 18.5 | 634,000 acre-feet | No increase in minimum pool. |
| **G** | 18.5 | 634,000 acre-feet | Dedicating 191,000 acre-feet of the additional water from increased storage to increase the size of the cold-water pool for fishery benefit. |
| **H (PCP4)** | 18.5 | 634,000 acre-feet | Dedicating 378,000 acre-feet of the additional water from increased storage to increase the size of the cold-water pool for fishery benefit. |
| **I** | 18.5 | 634,000 acre-feet | Dedicating 634,000 acre-feet of water from increased storage to increase the size of the cold-water pool for fishery benefit. |

Key:
PCP = preliminary comprehensive plan

**Table 3-8. Scenarios Considered to Augment Flows – Anadromous Fish Survival Focus Plan**

| Flow Augmentation Scenario | Dam Raise (feet) | Enlarged Reservoir | Description |
|---|---|---|---|
| **1** | 18.5 | 634,000 acre-feet | October – March AFRP flows or 500 cfs increase, whichever is less |
| **2** | 18.5 | 634,000 acre-feet | October – March AFRP flows or 750 cfs increase, whichever is less |
| **3** | 18.5 | 634,000 acre-feet | October – March AFRP flows or 1,000 cfs increase, whichever is less |
| **4** | 18.5 | 634,000 acre-feet | Increase August flows to 10,000 cfs and September flows to 6,000 cfs for temperature control |

Key:
AFRP = Anadromous Fish Restoration Program (USFWS 2001)
cfs = cubic foot per second

### *Refinement of Comprehensive Plans for the Final Feasibility Report, DEIS, and Final EIS*

Following the release of the Draft Feasibility Report and Preliminary DEIS, Comprehensive Plans were further refined for the DEIS based on several factors, including updates to CVP and SWP water operations and stakeholder input. Water operations modeling in CalSim-II and related analyses were updated to include the following:

- 2008 USFWS BO (USFWS 2008)
- 2009 NMFS BO (NMFS 2009a)
- Additional changes in CVP and SWP facilities and operations, such as the enlarged Los Vaqueros Reservoir and implementation of the San Joaquin River Restoration Program
- Additional changes in non-CVP/SWP facilities and operations, such as the addition of the Freeport Regional Water Project

Preliminary analyses based on these updated operations indicated shifts in the distribution of water supply benefits from M&I to agricultural uses, resulting in decreased M&I water supply benefits for the Draft Feasibility Report comprehensive plans.

To improve the balance between agricultural and M&I water supply benefits, a portion of the increased storage capacity in Shasta Reservoir was reserved to specifically focus on increasing M&I deliveries during dry and critical years under Comprehensive Plan 1 (CP1), Comprehensive Plan 2 (CP2), Comprehensive Plan 4 (CP4), and Comprehensive Plan 5 (CP5). Operations targeting increased M&I deliveries were based on existing and anticipated future demands, operational priorities, and facilities of the SWP, which provides M&I water to a majority of the State’s population.

In addition, to provide a greater range of focus and operations within the set of comprehensive plans, water supply operations for Comprehensive Plan 3 (CP3) were focused on agricultural water supply reliability and anadromous fish survival. Accordingly, for CP3, none of the increased storage capacity in Shasta Reservoir was reserved for increasing M&I deliveries.

**Refinement of Operational Scenario for Plan Focused on Anadromous Fish Survival with Water Supply Reliability** Based on public comments on the Draft Feasibility Report and DEIS, a refined operational scenario (Comprehensive Plan 4A (CP4A)) was developed for the anadromous fish focused plan. This new operational scenario is a refinement of the operations for CP4, based on several factors, including the updated CVP and SWP operations, described above, which are based on the 2008 USFWS BO and 2009 NMFS BO. A suite of temperature and flow-focused actions (scenarios) were investigated to assess which combination of actions would likely maximize increases in anadromous fish populations. These investigations primarily used the SALMOD model, and were based on output from the water operations (CalSim-II), reservoir temperature, and river temperature models. Similar scenario refinements were considered for the Draft Feasibility Report, as summarized in Table 3-7 and Table 3-8. However, Draft Feasibility Report scenarios were based on CVP and SWP operational scenarios including the 2004 NMFS BO and 2005 USFWS BO, which have been since updated.

A range of scenarios were considered during the development of CP4A. For these scenarios, several combinations for allocating the increased storage were analyzed, focusing on either increasing the volume of the cold-water pool in Shasta Reservoir or augmenting flows downstream from Shasta Dam. Flow augmentation scenarios were based primarily on flows identified as part of the Anadromous Fish Restoration Plan (USFWS 2001). Table 3-9 highlights the range of scenarios considered and estimated benefits to water supply reliability and anadromous fisheries under each scenario.

CP4A was selected as the refined operational scenario for CP4, as it allows for improved balance between water supply benefits and fisheries benefits compared to other scenarios.

Based on the refinements described above, this Final Feasibility Report and the accompanying Final EIS includes the following final array of comprehensive plans:

- **CP1 –** 6.5-foot dam raise, enlarging the reservoir by 256,000 acre-feet, focusing on both anadromous fish survival and water supply reliability

- **CP2 –** 12.5-foot dam raise, enlarging the reservoir by 443,000 acre-feet, focusing on both anadromous fish survival and water supply reliability

- **CP3 –** 18.5-foot dam raise, enlarging the reservoir by 634,000 acre-feet, focusing on both agricultural water supply reliability and anadromous fish survival

- **CP4 and CP4A –** 18.5-foot dam raise, enlarging the reservoir by 634,000 acre-feet, focusing on anadromous fish survival while increasing water supply reliability

- **CP5 –** 18.5-foot dam raise, enlarging the reservoir by 634,000 acre-feet, a combination plan focusing on all objectives

The No-Action Alternative and comprehensive plans for this Feasibility Report are described in detail in Chapter 4.

**Table 3-9. Scenarios Considered for Refinement of Final EIS Comprehensive Plans**

| Scenario | Dam Raise (feet) | Enlarged Reservoir (acre-feet) | Description | Production Increase (number of fish)[1] | Total Increase in Water Supply Reliability[2] Average (acre-feet/year) | Total Increase in Water Supply Reliability[2] Dry/Critical (acre-feet/year) |
|---|---|---|---|---|---|---|
| **Scenarios Considered for Cold-Water Storage as Part of Fish Focus Plan** | | | | | | |
| A (CP1) | 6.5 | 256,000 | No increase in minimum cold-water pool for fishery benefit. 70,000 acre-feet and 35,000 acre-feet of the increased storage capacity in Shasta Reservoir was reserved for increasing M&I deliveries in dry and critical years, respectively. | 61,300 | 31,000 | 47,300 |
| B | 6.5 | 256,000 | Dedicate 256,000 acre-feet of water from increased storage to increase the size of the cold-water pool for fishery benefit. No increased storage capacity in Shasta Reservoir reserved for water supply. | 673,000 | 0 | 0 |
| C (CP2) | 12.5 | 443,000 | No increase in minimum cold-water pool for fishery benefit. 100,000 acre-feet and 50,000 acre-feet of the increased storage capacity in Shasta Reservoir was reserved for increasing M&I deliveries in dry and critical years, respectively. | 379,200 | 51,300 | 77,800 |
| D | 12.5 | 443,000 | Dedicate 187,000 acre-feet of the additional water from increased storage to increase the size of the cold-water pool for fishery benefit. 70,000 acre-feet and 35,000 acre-feet of the increased storage capacity in Shasta Reservoir was reserved for increasing M&I deliveries in dry and critical years, respectively. | 428,700 | 31,000 | 47,300 |
| E | 12.5 | 443,000 | Dedicate 443,000 acre-feet of water from increased storage to increase the size of the cold-water pool for fishery benefit. No increased storage capacity in Shasta Reservoir reserved for water supply. | 999,900 | 0 | 0 |
| F (CP3) | 18.5 | 634,000 | No increase in minimum cold-water pool for fishery benefit. Increased storage capacity in Shasta Reservoir dedicated to agricultural deliveries. | 207,400 | 61,700 | 63,100 |
| F (CP5) | 18.5 | 634,000 | No increase in minimum cold-water pool for fishery benefit. 150,000 acre-feet and 75,000 acre-feet of the increased storage capacity in Shasta Reservoir was reserved for increasing M&I deliveries in dry and critical years, respectively. | 377,800 | 75,900 | 113,500 |
| G (CP4A) | 18.5 | 634,000 | Dedicate 191,000 acre-feet of the additional water from increased storage to increase the size of the cold-water pool for fishery benefit. 100,000 acre-feet and 50,000 acre-feet of the increased storage capacity in Shasta Reservoir was reserved for increasing M&I deliveries in dry and critical years, respectively. | 710,000 | 51,300 | 77,800 |

**Table 3-9. Scenarios Considered for Refinement of Final EIS Comprehensive Plans (contd.)**

| Scenario | Dam Raise (feet) | Enlarged Reservoir (acre-feet) | Description | Production Increase (number of fish)[1] | Total Increase in Water Supply Reliability[2] Average (acre-feet/year) | Total Increase in Water Supply Reliability[2] Dry/Critical (acre-feet/year) |
|---|---|---|---|---|---|---|
| **Scenarios Considered for Cold-Water Storage as Part of Fish Focus Plan (contd.)** | | | | | | |
| H (CP4) | 18.5 | 634,000 | Dedicate 378,000 acre-feet of the additional water from increased storage to increase the size of the cold-water pool for fishery benefit. 70,000 acre-feet and 35,000 acre-feet of the increased storage capacity in Shasta Reservoir was reserved for increasing M&I deliveries in dry and critical years, respectively. | 812,600 | 31,000 | 47,300 |
| I | 18.5 | 634,000 | Dedicate 634,000 acre-feet of water from increased storage to increase the size of the cold-water pool for fishery benefit. No increased storage capacity in Shasta Reservoir reserved for water supply. | 971,400 | 0 | 0 |
| **Scenarios Considered to Augment Flows as Part of Fish Focus Plan** | | | | | | |
| 1[3] | 18.5 | 634,000 | October – March AFRP flows or 500 cfs increase, whichever is lower. Increased storage capacity in Shasta Reservoir dedicated to agricultural deliveries. | 348,700 | 54,600 | 57,200 |
| 1[4] | 18.5 | 634,000 | October – March AFRP flows or 500 cfs increase, whichever is lower. 150,000 acre-feet and 75,000 acre-feet of the increased storage capacity in Shasta Reservoir was reserved for increasing M&I deliveries in dry and critical years, respectively. | 319,300 | 65,000 | 91,300 |
| 3[3] | 18.5 | 634,000 | October – March AFRP flows or 1,000 cfs increase, whichever is lower. Increased storage capacity in Shasta Reservoir dedicated to agricultural deliveries. | 222,800 | 42,200 | 35,700 |
| 3[4] | 18.5 | 634,000 | October – March AFRP flows or 1,000 cfs increase, whichever is lower. 150,000 acre-feet and 75,000 acre-feet of the increased storage capacity in Shasta Reservoir was reserved for increasing M&I deliveries in dry and critical years, respectively. | 309,500 | 54,600 | 69,300 |
| 4[3] | 18.5 | 634,000 | Increase August flows to 10,000 cfs and September flows to 6,000 cfs for temperature control. Increased storage capacity in Shasta Reservoir dedicated to agricultural deliveries. | 88,400 | 62,600 | 76,400 |
| 4[4] | 18.5 | 634,000 | Increase August flows to 10,000 cfs and September flows to 6,000 cfs for temperature control. 150,000 acre-feet and 75,000 acre-feet of the increased storage capacity in Shasta Reservoir was reserved for increasing M&I deliveries in dry and critical years, respectively. | 63,900 | 73,000 | 122,800 |

**Table 3-9. Scenarios Considered for Refinement of Final EIS Comprehensive Plans (contd.)**

Notes:

[1] Estimates of increased anadromous fish survival were based on simulations using the SALMOD model. These estimates represent an index of production increase, based on the simulated average annual increase in juvenile Chinook salmon surviving to migrate downstream from the RBPP.

[2] Increased water supply reliability was simulated with CalSim-II based on October to September water years. Water Year Types Based on the Sacramento Valley Water Year Hydrologic Classification. Water operations based on the USFWS 2008 *USFWS 2008 Formal Endangered Species Act Consultation on the Proposed Coordinated Operations of the CVP and SWP (*USFWS 2008) and NMFS 2009 *Biological Opinion and Conference Opinion on the Long-Term Operations of the CVP and SWP* (NMFS 2009a).

[3] Refined operational scenario based on CP3 and corresponding distribution of water supply benefits.

[4] Refined operational scenario based on CP5 and corresponding distribution of water supply benefits.

Key:

AFRP = Anadromous Fish Restoration Program

cfs = cubic feet per second

CP = Comprehensive Plan

CVP = Central Valley Project

M&I = municipal and industrial

NMFS = National Marine Fisheries Service

RBPP = Red Bluff Diversion Dam

SWP = State Water Project

USFWS = U.S. Department of the Interior, Fish and Wildlife Service

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# Chapter 4 No-Action Alternative and Comprehensive Plans

This chapter describes the No-Action Alternative, representing a scenario in which a project is not implemented, and comprehensive plans developed as action alternatives for this Feasibility Report. This chapter concludes with an evaluation of the consistency of comprehensive plans with other programs, including the CVPIA and CALFED Bay-Delta Program, and consistency with Department of Interior climate change policy.

## No-Action Alternative (No Additional Federal Action)

For all Federal feasibility studies of potential water resources projects, the No-Action Alternative is intended to account for existing facilities, conditions, land uses, and reasonably foreseeable actions expected to occur in the study area. Reasonably foreseeable actions include actions with current authorization, secured funding for design and construction, and environmental permitting and compliance activities that are substantially complete. The No-Action Alternative is considered to be the basis for comparison with potential action alternatives, consistent with the *Federal Water Resources Council Principles and Guidelines for Water and Related Land Resources Implementation Studies* (WRC 1983) and NEPA guidelines.

For the SLWRI, the No-Action Alternative is based on CVP and SWP operational conditions described in the 2008 Long-Term Operation BA issued by Reclamation, and the Biological Opinions (BO) issued by USFWS and NMFS in 2008 and 2009, respectively. The No-Action Alternative also includes continued implementation of actions and programs identified under the CVPIA. In addition, the No-Action Alternative includes key projects assumed to be in place and operating in the future, including the Freeport Regional Water Project, Delta Water Supply Project, South Bay Aqueduct Improvement and Enlargement Project, a functional equivalent of the Vernalis Adaptive Management Plan, full restoration flows under the San Joaquin River Restoration Program, and full implementation of the Grassland Bypass Project. Table 2-1 of the EIS Modeling Appendix shows which actions were assumed to be part of the future condition (or No-Action Alternative) in the SLWRI 2012 Version CalSim-II model.

Under the No-Action Alternative, the Federal Government would continue to implement reasonably foreseeable actions, as defined above, but 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. The following discussions highlight the consequences of implementing the No-Action Alternative, as they relate to the planning objectives of the SLWRI.

### Anadromous Fish Survival

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, to increase anadromous fish survival and reduce the risk of extinction, further water temperature improvements are needed in the Sacramento River, especially in dry and critical years. Increased demand for water for urban, agricultural, and environmental uses is also expected to reduce the reliability of cold water for anadromous fish. Prolonged drought, that depletes the cold-water pool in Shasta Reservoir, could put populations of anadromous fish at risk of severe population decline or extirpation in the long-term (NMFS 2009b). The risk associated with a prolonged drought is especially high in the Sacramento River because Shasta Reservoir is operated to maintain only 1 year of carryover storage. 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.

### Water Supply Reliability

Demands for water in the Central Valley and throughout California exceed available supplies, and the need for additional supplies is expected to grow. There is growing competition for limited system resources between various users and uses, including urban, agricultural, and environmental. Urban water demand and environmental water requirements have each increased, resulting in greater competition for limited water supplies. The population of California is expected to increase by more than 60 percent above 2005 levels by 2050. Significant increases in population also are expected to occur in the Central Valley, nearly 130 percent above 2005 levels by 2050 (California Department of Finance 2007). As these population increases occur, and are coupled with the need to maintain a healthy and vibrant industrial and agricultural economy, the demand for water would continue to significantly exceed available supplies. Competition for available water supplies would intensify as water demands increase to support this population growth.

Water conservation and reuse efforts are expected to significantly increase, and forced conservation resulting from increasing water shortages would continue. In the past, during drought years, many water conservation measures have been implemented to reduce the effects of the drought. In the future, as more water use efficiency actions become necessary to help meet even average year demands, the impacts of droughts will be much more severe. Besides forced conservation, without developing cost-effective new sources, the growing urban population would increasingly rely on shifting water supplies from such areas as agricultural production to satisfy M&I demands. In the urban sector, reduced supplies or increased supply uncertainty could cause water rates to increase as agencies seek to remedy supply shortfalls by implementing measures to reduce demand and/or augment supplies.

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. One example could include higher water costs, resulting in a further shift in agricultural production to areas outside California and/or outside the United States. Another example could include water supply shortages resulting in changes in land use patterns, loss and destruction of permanent crops, and/or decreased production of existing crops. In response to reduced water supplies, farmers may fallow fields, reducing agricultural productivity directly resulting in layoffs, reduced hours for agricultural employees, and increased unemployment in agricultural communities. Reduced water supplies and the resulting employment losses could also cause socioeconomic impacts in affected communities.

Under the No-Action Alternative, Shasta Dam would not be modified and the CVP would continue operating similarly to existing conditions. The No-Action Alternative would continue to meet water supply demands at levels similar to existing conditions, but would not be able to meet the expected increased demand in California.

### Ecosystem Resources, Flood Management, Hydropower Generation, Recreation, and Water Quality

As opportunities arise, some locally sponsored 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 quantity, quality, diversity, and connectivity of riparian, wetland, and riverine habitats along the Sacramento River have been limited by confinement of the river system by levees, reclamation of adjacent lands for farming, bank protection, channel stabilization, and land development.

Shasta Dam and Reservoir have greatly reduced flood damage along the Sacramento River. Shasta Dam and Reservoir were constructed at a total cost of about $36 million (in 1936 dollars). Shasta Dam, in combination with the Sacramento River Flood Control Project, protects about 1 million people and over $60 billion in assets.  However, residual risks to human life, health, and safety along the Sacramento River remain. Development in flood-prone areas has exposed the public to the risk of flooding. Storms producing peak flows, and volumes greater than the existing flood management system was designed for, can occur, and result in extensive flooding along the upper Sacramento River. Under the No-Action Alternative, the threat of flooding would continue, and may increase as population growth increases.

California's demand for electricity is expected to significantly increase in the future. Under the No-Action Alternative, no actions would be taken to help meet this growing demand.

As California's population continues to grow, demands would grow significantly for water-oriented recreation at and near the lakes, reservoirs, streams, and rivers of the Central Valley. This increase in demand will 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 and objectives in the Central Valley (including the Delta) have been established through legal mandates aimed at maintaining and recovering endangered and threatened fish and wildlife, and protecting designated critical habitat. Despite these efforts, under the No-Action Alternative, these resources would continue to decline and ecosystems would continue to be impacted. In addition, Delta water quality may continue to decline.

## Comprehensive Plans

The following sections describe the comprehensive plans developed as action alternatives for the SLWRI. Throughout this Feasibility Report, "comprehensive plan" is used synonymously with the NEPA terminology "action alternative." Management measures and environmental commitments common to all comprehensive plans are described first, followed by descriptions of major components, potential benefits, potential primary effects, mitigation measures, and estimated costs and economic benefits for each comprehensive plan. Quantification of potential benefits for each alternative plan is described in detail in the Modeling Appendix to the accompanying EIS. The Engineering Summary Appendix to the accompanying EIS provides additional information on the engineering designs and costs of each comprehensive plan. A detailed discussion of potential effects of all comprehensive plans is included in Chapters 4 through 25 of the EIS. A detailed discussion of the mitigation plan, including its development and proposed mitigation measures for all comprehensive plans, is included in the Preliminary Environmental Commitments and Mitigation Plan Appendix to the accompanying EIS. The Economic Valuation Appendix provides additional information on the economic valuation methods and analyses for the comprehensive plans.

## Management Measures Common to All Comprehensive Plans

Eight of the management measures retained are included, to some degree, in all of the comprehensive plans. 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.

### *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 comprehensive plans, 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 comprehensive plans 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 capacity of the reservoir available to store water for subsequent release to increase water supply reliability for M&I, agricultural, and environmental purposes. The comprehensive plans include a range of dam enlargements and various increases in conservation space.

### *Reduce Demand*

All comprehensive plans would include an additional water conservation program for increased water deliveries created by the project, to augment current water use efficiency practices. The proposed program would consist of a 10-year initial program in which Reclamation would allocate approximately $2.3 million to $3.8 million, proportional to additional water supplies delivered, to fund water conservation efforts. Funding 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 SLWRI 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 comprehensive plans. 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 comprehensive plan, 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 comprehensive plans would address, to some extent, the secondary planning objective of maintaining and 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 leases, 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 comprehensive plans would include features to, at a minimum, maintain the overall recreation capacity of the existing facilities. All comprehensive plans would also provide for modernization of relocated recreation facilities, including, at a minimum, modifications to comply with current standards for health and safety.

#### *Maintain or Improve Water Quality*

All 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 reestablish 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.

## Environmental Commitments Common to All Comprehensive Plans

Reclamation and/or its contractors would incorporate certain environmental commitments and best management practices (BMP) into all comprehensive plans, including any plan authorized 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 following environmental commitments would be incorporated into any comprehensive plan/action alternative for any project-related construction activities. This section does not include mitigation measures. Mitigation measures for each comprehensive plan are summarized later in this chapter. A mitigation plan to mitigate potential effects of comprehensive plans is included in the Preliminary Environmental Commitments and Mitigation Plan Appendix to the accompanying 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 required 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 departments in the areas where construction would occur. In addition, the construction management plan would include similar procedures for Federal and State agencies with similar jurisdictions, including USFS. 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. Compliance with applicable laws, policies, and plans for this project is discussed in Section 26.6 of the accompanying EIS.

#### ***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, Code of Federal Regulations (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 facilities 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, affected facilities capacity will be replaced 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 will be filed with 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 will stop immediately and Reclamation will be notified (as applicable). A qualified paleontologist will be retained to evaluate the find and recommend appropriate conservation measures, such as data recovery or protection in place. The conservation measures will be implemented before re-initiation 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, and 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 that can provide containment) of bulk storage tanks.

Haulers delivering materials to the project site would be required to comply with regulations for 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 are managed outside the flood season (e.g., June to September). In-river work between Keswick Dam and the RBPP would be conducted mid-August through September to minimize impacts to Sacramento River winter-run Chinook salmon.

**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 would be incorporated into the project design, and would be 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; and 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. Post-construction 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.

## Major Components of Comprehensive Plans

Each of the comprehensive plans involves raising Shasta Dam by 6.5 feet to 18.5 feet, increasing the storage capacity in Shasta Reservoir by 256,000 acre-feet to 634,000 acre-feet, and constructing a common set of features, as shown in Table 4-1. Features and related construction activities under all comprehensive plans would include the following:

- Clearing vegetation from portions of the inundated reservoir area
- Constructing the dam raise, appurtenant structures, reservoir area dikes, and railroad embankments
- Relocating roadways, bridges, recreation facilities, utilities, and miscellaneous minor infrastructure

Figure 4-1 illustrates major features in the Shasta Lake area common to all comprehensive plans.

In addition, as described in the Preliminary Environmental Commitments and Mitigation Measures Appendix to the accompanying EIS, environmental commitments and mitigation measures have been identified for and included in all comprehensive plans.

CP4, CP4A, and CP5 would also include features and related construction activities associated with gravel augmentation and restoring riparian, floodplain, and side channel habitat along the upper Sacramento River. Additional features and related construction activities associated with Shasta Lake and tributary shoreline enhancements and features to increase Shasta Lake recreation opportunities are included under CP5.

**Table 4-1. Summary of Physical Features of Comprehensive Plans**

| Main Features | | Comprehensive Plans | | | | |
|---|---|---|---|---|---|---|
| | CP1 | CP2 | CP3 | CP4 | CP4A | CP5 |
| **Dam and Appurtenant Structures** | | | | | | |
| Shasta Dam | | | | | | |
| *Crest Raise (feet)* | 6.5 | 12.5 | 18.5 | 18.5 | 18.5 | 18.5 |
| *Full Pool Height Increase (feet)* | 8.5 | 14.5 | 20.5 | 20.5 | 20.5 | 20.5 |
| *Elevation of Dam Crest (feet)*[1] | 1084.0 | 1090.0 | 1096.0 | 1096.0 | 1096.0 | 1096.0 |
| *Elevation of Full Pool (feet)*[2] | 1,078.2 | 1,084.2 | 1,090.2 | 1,090.2 | 1,090.2 | 1,090.2 |
| *Capacity Increase (acre-feet)* | 256,000 | 443,000 | 634,000 | 634,000 | 634,000 | 634,000 |
| *Main Dam* | Raise dam crest. Construct new parapets and utility gallery. Raise existing elevator tower and hoist tower. | Raise dam crest. Construct new parapets and utility gallery. Raise existing elevator tower and hoist tower. | Raise dam crest. Construct new parapets and utility gallery. Raise existing elevator tower and hoist tower. | Raise dam crest. Construct new parapets and utility gallery. Raise existing elevator tower and hoist tower. | Raise dam crest. Construct new parapets and utility gallery. Raise existing elevator tower and hoist tower. | Raise dam crest. Construct new parapets and utility gallery. Raise existing elevator tower and hoist tower. |
| *Wing Dams* | Raise to meet dam crest. Build new visitor center along left wing dam. Relocate gantry crane on right wing dam. | Raise to meet dam crest. Build new visitor center along left wing dam. Relocate gantry crane on right wing dam. | Raise to meet dam crest. Build new visitor center along left wing dam. Relocate gantry crane on right wing dam. | Raise to meet dam crest. Build new visitor center along left wing dam. Relocate gantry crane on right wing dam. | Raise to meet dam crest. Build new visitor center along left wing dam. Relocate gantry crane on right wing dam. | Raise to meet dam crest. Build new visitor center along left wing dam. Relocate gantry crane on right wing dam. |
| *Spillway* | Raise crest and extend piers. Replace 3 drum gates with 6 sloping fixed-wheel gates. | Raise crest and extend piers. Replace 3 drum gates with 6 sloping fixed-wheel gates. | Raise crest and extend piers. Replace 3 drum gates with 6 sloping fixed-wheel gates. | Raise crest and extend piers. Replace 3 drum gates with 6 sloping fixed-wheel gates. | Raise crest and extend piers. Replace 3 drum gates with 6 sloping fixed-wheel gates. | Raise crest and extend piers. Replace 3 drum gates with 6 sloping fixed-wheel gates. |
| *River Outlets* | Replace 4 lower-tier tube valves with jet flow gates. | Replace 4 lower-tier tube valves with jet flow gates. | Replace 4 lower-tier tube valves with jet flow gates. | Replace 4 lower-tier tube valves with jet flow gates. | Replace 4 lower-tier tube valves with jet flow gates. | Replace 4 lower-tier tube valves with jet flow gates. |
| *Temperature Control Device* | Raise/modify controls. | Raise/modify controls. | Raise/modify controls. | Raise/modify controls. | Raise/modify controls. | Raise/modify controls. |
| **Shasta Powerplant/Penstocks** | Raise penstock hoists. | Raise penstock hoists. | Raise penstock hoists. | Raise penstock hoists. | Raise penstock hoists. | Raise penstock hoists. |

**Table 4-1. Summary of Physical Features of Comprehensive Plans (contd.)**

| **Main Features** | | **Comprehensive Plans** | | | | |
|---|---|---|---|---|---|---|
| | **CP1** | **CP2** | **CP3** | **CP4** | **CP4A** | **CP5** |
| **Pit 7 Dam/Powerhouse** | Increase height of training walls on dam spillway. Install a tailwater depression system. Modify other Pit 7ancillary facilities. | Increase height of training walls on dam spillway. Install a tailwater depression system. Modify other Pit 7ancillary facilities. | Increase height of training walls on dam spillway. Install a tailwater depression system. Modify other Pit 7ancillary facilities. | Increase height of training walls on dam spillway. Install a tailwater depression system. Modify other Pit 7ancillary facilities. | Increase height of training walls on dam spillway. Install a tailwater depression system. Modify other Pit 7ancillary facilities. | Increase height of training walls on dam spillway. Install a tailwater depression system. Modify other Pit 7ancillary facilities. |
| **Reservoir Area Clearing** | Clear 150 acres completely and 220 acres with overstory removal. | Clear 240 acres completely and 350 acres with overstory removal. | Clear 340 acres completely and 500 acres with overstory removal. | Clear 340 acres completely and 500 acres with overstory removal. | Clear 340 acres completely and 500 acres with overstory removal. | Clear 340 acres completely and 500 acres with overstory removal. |
| **Reservoir Area Dikes and Railroad Embankments** | Construct 3 railroad embankments and 2 new dikes. | Construct 3 railroad embankments and 3 new dikes. | Construct 3 railroad embankments and 4 new dikes. | Construct 3 railroad embankments and 4 new dikes. | Construct 3 railroad embankments and 4 new dikes. | Construct 3 railroad embankments and 4 new dikes. |
| **Relocations** | | | | | | |
| Roadways | Match replacement widths to existing paved roads to be replaced. | Match replacement widths to existing paved roads to be replaced. | Match replacement widths to existing paved roads to be replaced. | Match replacement widths to existing paved roads to be replaced. | Match replacement widths to existing paved roads to be replaced. | Match replacement widths to existing paved roads to be replaced. |
| *Length of Relocated Roadway (linear feet)* | 16,700 | 28,400 | 33,100 | 33,100 | 33,100 | 33,100 |
| *Number of Road Segments Affected* | 10 | 21 | 30 | 30 | 30 | 30 |
| Vehicle Bridges | Relocate 4 bridges, modify 1 bridge. | Relocate 4 bridges, modify 1 bridge. | Relocate 4 bridges, modify 1 bridge. | Relocate 4 bridges, modify 1 bridge. | Relocate 4 bridges, modify 1 bridge. | Relocate 4 bridges, modify 1 bridge. |
| Railroad | Relocate 2 bridges and realign track in-between, modify 1 bridge | Relocate 2 bridges and realign track in-between, modify 1 bridge | Relocate 2 bridges and realign track in-between, modify 1 bridge | Relocate 2 bridges and realign track in-between, modify 1 bridge | Relocate 2 bridges and realign track in-between, modify 1 bridge | Relocate 2 bridges and realign track in-between, modify 1 bridge |
| Recreation Facilities | Modify or replace 9 marinas, 6 public boat ramps, 6 resorts, 202 campsites/day-use sites/RV sites, 2 USFS facilities, 8.1 miles of trail, and 2 trailheads. | Modify or replace 9 marinas, 6 public boat ramps, 6 resorts, 261 campsites/ day-use sites/RV sites, 2 USFS facilities, 9.9 miles of trail, and 2 trailheads. | Modify or replace 9 marinas, 6 public boat ramps, 6 resorts, 328 campgrounds/day-use areas/RV sites, 2 USFS facilities, 11.6 miles of trail, and 2 trailheads. | Modify or replace 9 marinas, 6 public boat ramps, 6 resorts, 328 campgrounds/day-use areas/RV sites, 2 USFS facilities, 11.6 miles of trail, and 2 trailheads. | Modify or replace 9 marinas, 6 public boat ramps, 6 resorts, 328 campgrounds/day-use areas/RV sites, 2 USFS facilities, 11.6 miles of trail, and 2 trailheads. | Modify or replace 9 marinas, 6 public boat ramps, 6 resorts, 328 campgrounds/day-use areas/RV sites, 2 USFS facilities, 11.6 miles of trail, and 2 trailheads. Add 6 trailheads and18 miles of new hiking trails. |

**Table 4-1. Summary of Physical Features of Comprehensive Plans (contd.)**

| Main Features | Comprehensive Plans | | | | | |
|---|---|---|---|---|---|---|
| | CP1 | CP2 | CP3 | CP4 | CP4A | CP5 |
| Utilities | Relocate inundated utilities. Construct wastewater treatment facilities. | Relocate inundated utilities. Construct wastewater treatment facilities. | Relocate inundated utilities. Construct wastewater treatment facilities. | Relocate inundated utilities. Construct wastewater treatment facilities. | Relocate inundated utilities. Construct wastewater treatment facilities. | Relocate inundated utilities. Construct wastewater treatment facilities. |
| Ecosystem Enhancements | None | None | None | Reserve 378 TAF of the additional storage for cold-water supply for anadromous fish. Implement adaptive management plan to benefit anadromous fish. Augment spawning gravel in the upper Sacramento River at the rate of up to 10,000 tons per year. Restore riparian, floodplain, and side channel habitat along the upper Sacramento River. | Reserve 191 TAF of the additional storage for cold-water supply for anadromous fish. Implement adaptive management plan to benefit anadromous fish. Augment spawning gravel in the upper Sacramento River at the rate of up to 10,000 tons per year. Restore riparian, floodplain, and side channel habitat along the upper Sacramento River. | Construct shoreline fish habitat around Shasta Lake. Enhance aquatic habitat in tributaries to Shasta Lake to improve fish passage. Augment spawning gravel in the upper Sacramento River at the rate of up to 10,000 tons per year. Restore riparian, floodplain, and side channel habitat along the upper Sacramento River. |

Notes:
[1] Dam crest elevations are based on the National Geodetic Vertical Datum of 1929 (NGVD29). All 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 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
RV = recreational vehicle
TAF = thousand acre-feet
USFS = U.S. Department of Agriculture, Forest Service

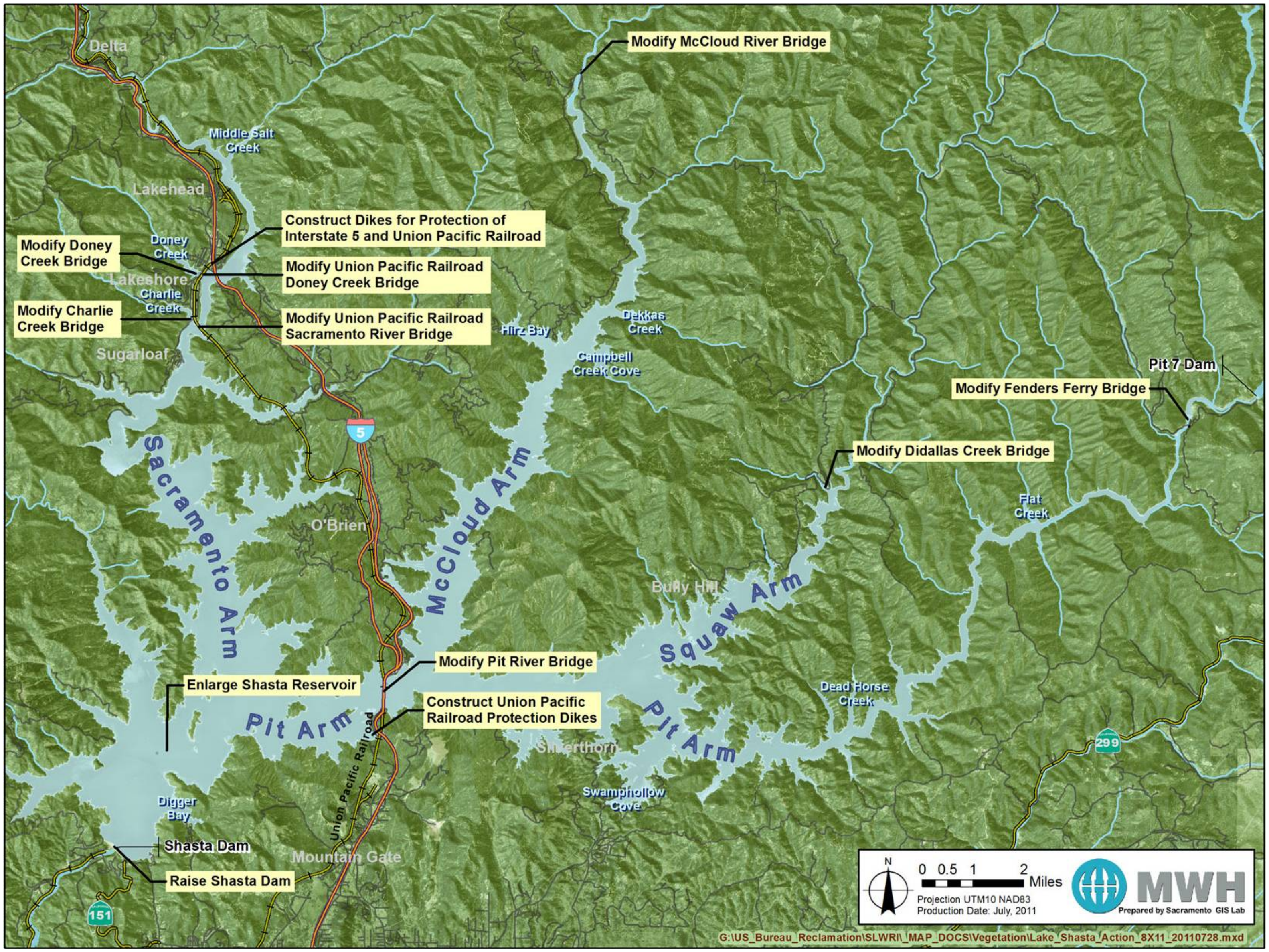



**Figure 4-1. Major Features Common to All Comprehensive Plans in Shasta Lake Area**

## CP1 – 6.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

CP1 consists primarily of enlarging Shasta Dam by raising the crest 6.5 feet and enlarging the reservoir by 256,000 acre-feet. Major features of CP1 in the Shasta Lake area are shown in Figure 4-1 and summarized in Table 4-1.

### *Major Components of CP1*

CP1 includes the following major components:

- Raising Shasta Dam and appurtenant facilities by 6.5 feet.
- Implementing the set of eight common management measures described above.
- Implementing the common environmental commitments described above.

As shown in Table 4-1, by raising Shasta Dam 6.5 feet, from a crest elevation of 1,077.5 feet to 1,084.0 feet (based on NGVD29),[1] CP1 would increase the height of the reservoir full pool by 8.5 feet. The additional 2-foot increase in the height of the full pool above the dam raise height would result from spillway modifications, including replacing the three drum gates with six sloping, fixed-wheel gates. 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. Figure 2-3 shows the increase in surface area and storage capacity for each dam raise.

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. This alternative (and all comprehensive plans) involves extending the existing TCD for efficient use of the expanded cold-water pool. 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 capacity 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 also include the potential to revise the operational rules for flood control at Shasta Dam and Reservoir, which could reduce the potential for flood damage, and benefit recreation. Although the volume of the flood control pool would remain the same as under existing operations (1.3 MAF), the bottom of the flood control pool elevation would likely be increased based on increased

[1] Dam crest elevations are based on NGVD29. All designs and figures for Shasta Dam and appurtenant structures are based on NGVD29.

dam height and reservoir capacity. Because of reservoir geometry, this would decrease the depth of the flood control pool, allowing higher winter and spring water levels. Increased reservoir capacity could have further flood damage reduction benefits in years when water levels are below the new flood control pool elevation.

A limited potential also exists for changes in flood control rules to allow more operational flexibility in reservoir drawdown requirements in response to storms, resulting in a net increase in the rate of spring reservoir filling during some years. The ability to revise the operational rules might result from using advanced weather forecasting tools and enhanced basin monitoring, which may be included during refinement of operational parameters after authorization. Higher spring water levels and associated increases in reservoir surface area would benefit recreation.

#### *Potential Benefits of CP1*

Major potential benefits of CP1, related to the SLWRI planning objectives and broad public services, are summarized in Tables 4-2 and 4-3 and described below.  In addition, Table 4-4 qualitatively compares the benefits and effects of each of the comprehensive plans relative to the beneficial water uses recognized by the State Water Board.

**Table 4-2. Summary of Potential Features and Benefits of Comprehensive Plans (Compared to No-Action Alternative)**

| Item | CP1 | CP2 | CP3 | CP4 | CP4A | CP5 |
|---|---|---|---|---|---|---|
| **Shasta Dam Raise (feet)** | 6.5 | 12.5 | 18.5 | 18.5 | 18.5 | 18.5 |
| Total Increased Storage (TAF) | 256 | 443 | 634 | 634 | 634 | 634 |
| **Benefits** | | | | | | |
| Increase Anadromous Fish Survival | | | | | | |
| Dedicated Storage (TAF) | - | - | - | 378 | 191 | - |
| Production Increase (thousand fish)[1] | 61 | 379 | 207 | 813 | 710 | 378 |
| Spawning Gravel Augmentation (tons)[2] | | | | 10,000 | 10,000 | 10,000 |
| Side Channel Rearing Habitat Restoration | | | | Yes | Yes | Yes |
| Increase Water Supply Reliability | | | | | | |
| Total Increased Dry and Critical Year Water Supplies (TAF/year)[3] | 47.3 | 77.8 | 63.1 | 47.3 | 77.8 | 113.5 |
| Increased NOD Dry and Critical Year Water Supplies (TAF/year)[3] | 4.5 | 10.7 | 35.2 | 4.5 | 10.7 | 25.2 |
| Increased SOD Dry and Critical Year Water Supplies (TAF/year)[3] | 42.7 | 67.1 | 28.0 | 42.7 | 67.1 | 88.3 |
| Increased Water Use Efficiency Funding | Yes | Yes | Yes | Yes | Yes | Yes |
| Increased Emergency Water Supply Response Capability | Yes | Yes | Yes | Yes | Yes | Yes |
| Reduce Flood Damage | | | | | | |
| Increased Reservoir Storage Capacity | Yes | Yes | Yes | Yes | Yes | Yes |
| Additional Hydropower Generation[4] | | | | | | |
| Increased Hydropower Generation (GWh/year)[5] | 52 - 54 | 87 - 90 | 86 - 90 | 127 - 133 | 125 - 130 | 112 - 117 |

**Table 4-2. Summary of Potential Features and Benefits of Comprehensive Plans (Compared to No-Action Alternative) (contd.)**

| Item | CP1 | CP2 | CP3 | CP4 | CP4A | CP5 |
|---|---|---|---|---|---|---|
| Conserve, Restore, and Enhance Ecosystem Resources | | | | | | |
| Shoreline Enhancement (acres) | - | - | - | - | - | 130 |
| Tributary Aquatic Habitat Enhancement (miles)[6] | - | - | - | - | - | 6 |
| Riparian, Floodplain, and Side Channel Restoration Habitat | - | - | - | Yes | Yes | Yes |
| Increased Ability to Meet Flow and Temperature Requirements Along Upper Sacramento River | Yes | Yes | Yes | Yes | Yes | Yes |
| Improve Water Quality | | | | | | |
| Improved Delta Water Quality | Yes | Yes | Yes | Yes | Yes | Yes |
| Increased Delta Emergency Response Capability | Yes | Yes | Yes | Yes | Yes | Yes |
| Increase Recreation | | | | | | |
| Recreation (user days, thousands)[7] | 85 - 89 | 116 - 134 | 201 - 205 | 307 - 370 | 246 - 259 | 142 - 175 |
| Modernization of Recreation Facilities | Yes | Yes | Yes | Yes | Yes | Yes |

Notes:

[1] 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 the RBPP.

[2] Average amount per year for 10-year period.

[3] Total increased dry and critical year reliability for Central Valley Project and State Water Project deliveries estimated using the SLWRI 2012 Version CalSim-II model. Does not reflect benefits related to water use efficiency actions included in all comprehensive plans.

[4] In addition to increased hydropower generation, all comprehensive plans provide increased capacity benefits (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.

[5] Annual increases in hydropower generation were estimated using two methodologies – at load center (accounting for transmission losses) and at-plant (no transmission losses). To provide a more conservative estimate of potential hydropower benefits, load center generation values were used to estimate potential benefits of increased hydropower generation under comprehensive plans. However, increased generation values reported in Chapter 23 of the EIS are based on at-plant generation values to capture the largest potential effects from changes in hydropower generation and pumping.

[6] Tributary aquatic enhancement provides for the connectivity of native fish species and other aquatic organisms between Shasta Lake and its tributaries. Estimates of benefits reflect only connectivity with perennial streams and do not reflect additional miles of connectivity with intermittent streams.

[7] Annual recreation visitor user days were estimated using two methodologies. The minimum user day value was used to estimate potential recreation benefits to provide a more conservative estimate of the potential benefits of increased recreation under comprehensive plans. However, the maximum user value was used for direct and indirect effects evaluations in each resource area chapter to capture the largest potential effects from increased visitation. These values do not account for increased visitation due to modernization of recreation facilities associated with all comprehensive plans. For more detailed information related to estimated recreation user days, please see Chapter 10 of the Modeling Appendix.

Key:
- = not applicable
CP = comprehensive plan
Delta = Sacramento-San Joaquin Delta
GWh/year = gigawatt-hours per year
NOD = north of Delta
SOD = south of Delta
SLWRI = Shasta Lake Water Resources Investigation
RBPP = Red Bluff Pumping Plant
TAF = thousand acre feet

**Table 4-3. Summary of Additional Broad Public Benefits**

| Category | Benefit Description |
|---|---|
| System-Wide Water Management Flexibility | All CPs improve system-wide water management flexibility for storage and operations to meet multiple competing public needs |
| Air Quality | All CPs provide for increased clean energy generation, potentially reducing GHG emissions |
| Groundwater | All CPs allow for decreased groundwater pumping and related groundwater overdraft conditions in CVP/SWP water service areas |
| Reservoir Water Quality | All CPs replace reservoir area septic systems with centralized wastewater treatment plants |
| Shasta Lake Cold-Water Fisheries | All CPs improve Shasta Lake cold-water fisheries conditions through increasing the cold-water pool |
| Traffic and Transportation | All CPs modernize relocated roadways and bridges with facilities designed to meet current public safety standards |
| Public Services | All CPs relocate USFS emergency response facilities to a more centralized location adjacent to major transportation corridors |

Note:
[1] Broad public benefits above are additional to benefits associated with project planning objectives.

Key:
CP = Comprehensive Plan
CVP = Central Valley Project
GHG = greenhouse gas
SWP = State Water Project
USFS = U.S. Forest Service

**Table 4-4. Comparison of Comprehensive Plans Relative to Beneficial Uses of Water in California**

| State Water Board Recognized Beneficial Use[1] | CP1 | CP2 | CP3 | CP4 | CP4A | CP5 |
|---|---|---|---|---|---|---|
| Agricultural Supply | +++ | ++++ | ++++++ | +++ | ++++ | +++++ |
| Municipal and Industrial Supply[2] | + | ++ | 0 | + | ++ | +++ |
| Groundwater Recharge[3] | + | ++ | +++ | + | | ++++ |
| Freshwater Replenishment | + | ++ | +++ | +++ | +++ | +++ |
| Navigation | 0 | 0 | 0 | 0 | | 0 |
| Hydropower Generation | + | ++ | ++ | ++++ | ++++ | +++ |
| Water Contact Recreation | + | ++ | +++ | +++++ | ++++ | ++ |
| Noncontact Water Recreation | + | ++ | +++ | +++++ | ++++ | ++ |
| Ocean, Commercial, and Sport Fishing | + | +++ | ++ | ++++++ | ++++++ | +++ |
| Aquaculture | 0 | 0 | 0 | 0 | 0 | 0 |
| Warm Freshwater Habitat | + | + | + | + | + | +++ |
| Cold Freshwater Habitat | + | +++ | ++ | ++++++ | ++++++ | +++ |
| Inland Saline Water Habitat | 0 | 0 | 0 | 0 | | 0 |
| Estuarine Habitat | + | ++ | +++ | +++ | +++ | +++ |

**Table 4-4. Comparison of Comprehensive Plans Relative to Beneficial Uses of Water in California (contd.)**

| State Water Board Recognized Beneficial Use[1] | CP1 | CP2 | CP3 | CP4 | CP4A | CP5 |
|---|---|---|---|---|---|---|
| Marine Habitat | + | ++ | ++ | ++++ | ++++ | ++ |
| Preservation of Biological Habitats of Special Significance | + | +++ | ++ | ++++++ | ++++++ | ++++ |
| Rare, Threatened, or Endangered Species – Aquatic | + | +++ | ++ | ++++++ | ++++++ | +++ |
| Rare, Threatened, or Endangered Species – Terrestrial | – | – | – | – | – | – |
| Migration of Aquatic Organisms | + | +++ | ++ | ++++++ | ++++++ | ++++ |
| Spawning, Reproduction, and/or Early Development | + | +++ | ++ | ++++++ | ++++++ | ++++ |
| Shellfish Harvesting | 0 | 0 | 0 | 0 | 0 | 0 |

Notes:

[1] Listed beneficial use categories are those officially recognized by the State Water Resources Control Board, as described in the *2002 California 305(b) Report on Water Quality* State Water Board 2003).

[2] "Municipal and Industrial Supply" combines the State Water Board "Municipal and Domestic Supply," "Industrial Process Supply," and "Industrial Service Supply" beneficial use categories.

[3] Although the SLWRI comprehensive plans do not include specific features to fund or assist groundwater storage, enlarging Shasta Reservoir could allow for additional system flexibility for surface water deliveries, decreasing reliance on groundwater pumping and reducing groundwater overdraft conditions in Central Valley Project and State Water Project service areas.

Key:
– = net negative effect (net impact)
\+ = net positive effect (net benefit)
0 = minimal anticipated effect
CP = comprehensive plan
SLWRI = Shasta Lake Water Resources Investigation

**Increase Anadromous Fish Survival** Water temperature is one of the most important factors affecting anadromous fish survival in the Sacramento River (NMFS 2009a, 2009b, 2014). CP1 would increase the ability of Shasta Dam to make cold-water releases and regulate water temperatures for fish in the upper Sacramento River, primarily in dry and critical water years. This would be accomplished by raising Shasta Dam 6.5 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 RBPP. Hence, the most significant benefits to anadromous fish would occur upstream from the RBPP. It is estimated that under CP1, improved water temperature and flow conditions could result in an average annual increase in the salmon population of about 61,300 outmigrating juvenile Chinook salmon.

Figure 4-2 shows an exceedence probability relationship of maximum annual storage in Shasta Lake for CP1 and other comprehensive plans compared to the No-Action Alternative, illustrating expected increases in storage volumes under each comprehensive plan. Storage volumes for Figure 4-2 were simulated with the CalSim-II model as discussed in detail in the EIS Modeling Appendix. Figure 4-3 shows simulated reservoir storage fluctuations for the No-Action Alternative and CP1 for a representative period of 1972 through 2003.

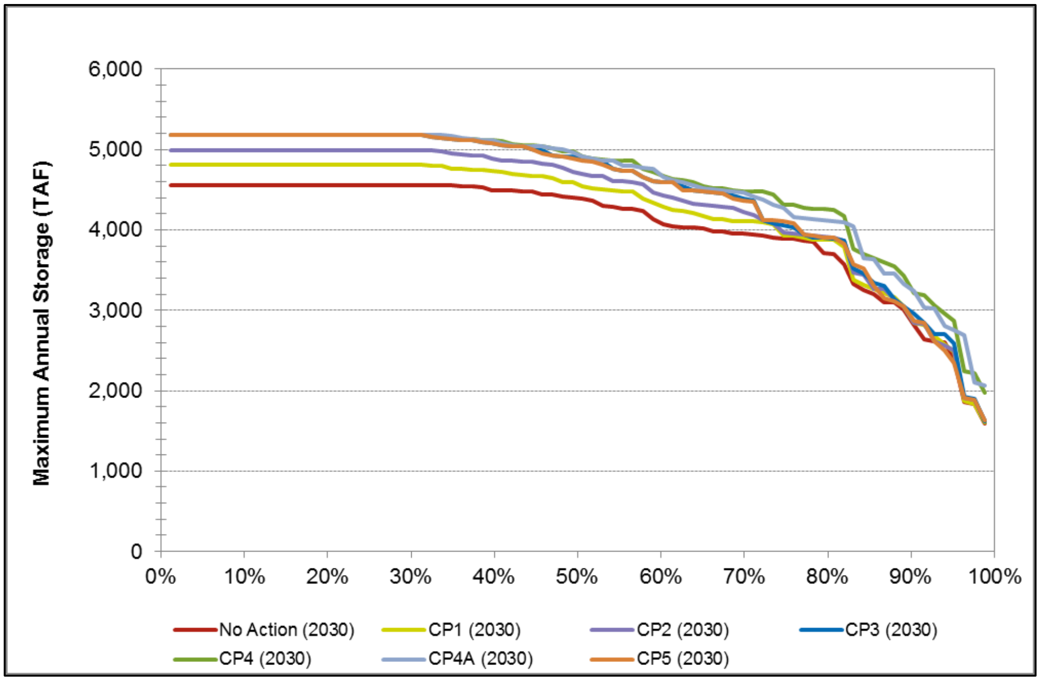



**Figure 4-2. Simulated Exceedence Probability Relationship of Maximum Annual Storage in Shasta Lake for Future Level of Development (2030)**

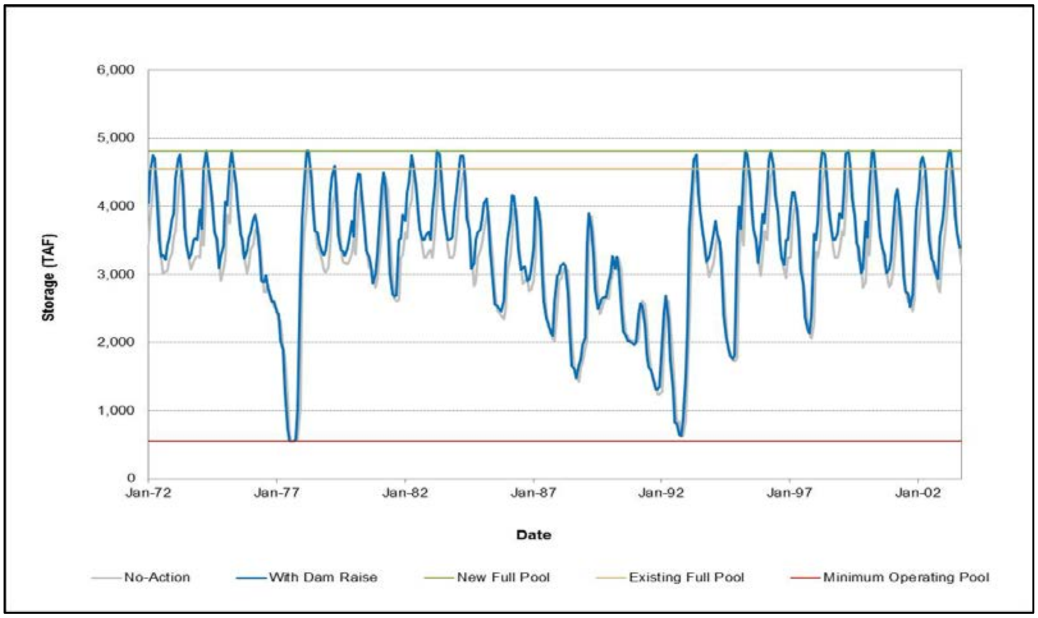
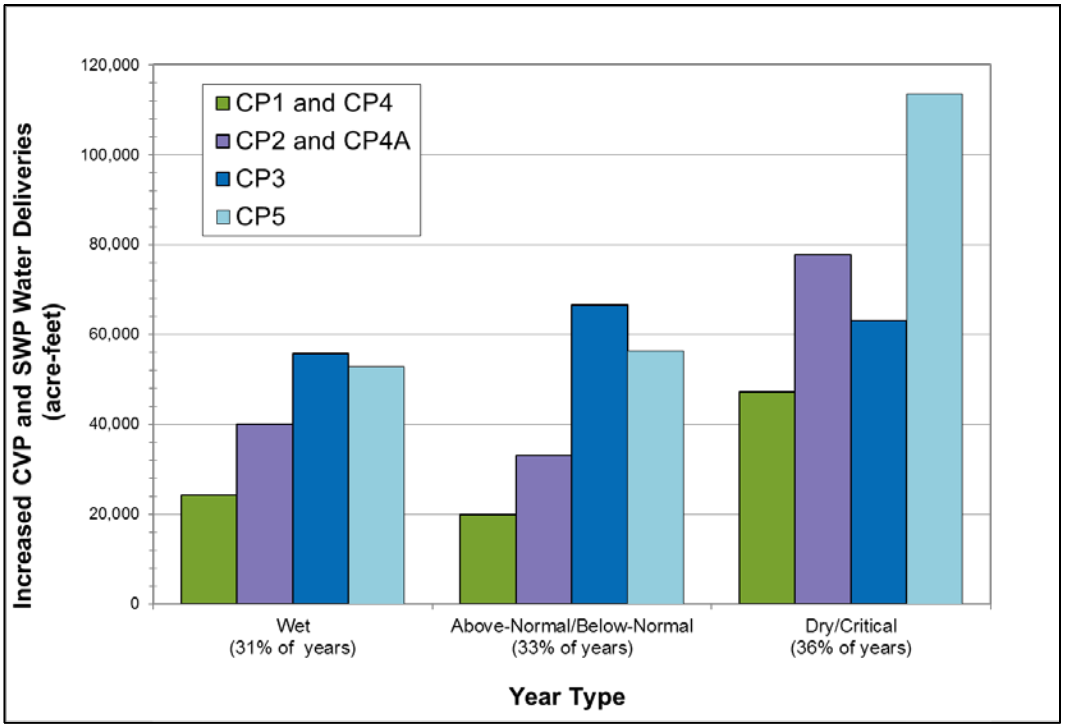



**Figure 4-3. Simulated Shasta Reservoir Storage from 1972 to 2003 for the No-Action Alternative and CP1**

**Increase Water Supply Reliability** CP1 would increase water supply reliability by increasing water supplies for CVP and SWP irrigation and M&I deliveries primarily during drought periods. Resulting increases in deliveries, based on CalSim-II modeling results, are shown in Figure 4-4 and Tables 4-2 and 4-5. This action would contribute to replacement of supplies redirected to other purposes in the CVPIA. As shown in Table 4-5, CP1 would help reduce estimated future water shortages by increasing dry and critical year water supplies for agricultural and M&I deliveries by at least 47,300 acre-feet per year and average annual deliveries by about 31,000 acre-feet per year. The majority of increased dry and critical year water supplies, 42,700 acre-feet, would be for south-of-Delta agricultural and M&I deliveries. In addition, water use efficiency could help reduce current and future water shortages by allowing a more effective use of existing supplies. As population and resulting water demands continue to grow and available supplies continue to remain relatively static, more effectively using these supplies could reduce potential critical impacts to agricultural and urban areas resulting from water shortages. Under CP1, approximately $1.6 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.




Note: Deliveries were simulated Using CalSim-II and water year types based on the Sacramento Valley Water Year Hydrologic Classification.

**Figure 4-4. Comparison of Increased CVP and SWP Water Deliveries by Year Type for Comprehensive Plans**

**Table 4-5. Increases in CVP and SWP Water Deliveries for Comprehensive Plans**

| CVP and SWP Deliveries | Average All Years | | | | | | Dry and Critical Years[2] | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CP1 (acre-feet) | CP2 (acre-feet) | CP3 (acre-feet) | CP4 (acre-feet) | CP4A (acre-feet) | CP5 (acre-feet) | CP1 (acre-feet) | CP2 (acre-feet) | CP3 (acre-feet) | CP4 (acre-feet) | CP4A (acre-feet) | CP5 (acre-feet) |
| **Agriculture** | | | | | | | | | | | | |
| CVP Agriculture | 16,300 | 25,600 | 64,400 | 16,300 | 25,600 | 44,300 | 13,500 | 23,500 | 77,300 | 13,500 | 23,500 | 51,200 |
| SWP Agriculture | 4,000 | 5,900 | (2,200) | 4,000 | 5,900 | 6,500 | 9,000 | 14,100 | (6,700) | 9,000 | 14,100 | 14,900 |
| **M&I** | | | | | | | | | | | | |
| CVP M&I | 30 | 1,300 | 5,500 | 30 | 1,300 | 3,300 | 100 | 1,200 | 8,000 | 100 | 1,200 | 4,000 |
| SWP M&I | 10,700 | 18,600 | (6,000) | 10,700 | 18,600 | 21,700 | 24,500 | 39,000 | (15,500) | 24,500 | 39,000 | 43,400 |
| **Combined CVP and SWP** | | | | | | | | | | | | |
| Agriculture[1] | 20,300 | 31,400 | 62,200 | 20,300 | 31,400 | 50,900 | 22,500 | 37,600 | 70,600 | 22,500 | 37,600 | 66,100 |
| M&I[1] | 10,700 | 19,900 | (500) | 10,700 | 19,900 | 25,000 | 24,700 | 40,200 | (7,500) | 24,700 | 40,200 | 47,400 |
| ***Total[1]*** | ***31,000*** | ***51,300*** | ***61,700*** | ***31,000*** | ***51,300*** | ***75,900*** | ***47,300*** | ***77,800*** | ***63,100*** | ***47,300*** | ***77,800*** | ***113,500*** |

Notes:

[1] Totals may not sum due to rounding.

[2] Based on the Sacramento Valley Water Year Hydrologic Classification

Key:

CP = Comprehensive Plan
CVP = Central Valley Project
M&I = Municipal and Industrial
SWP = State Water Project

**Develop Additional Hydropower Generation** Higher water surface elevations in the reservoir would result in an increase in power generation of about 52 gigawatt-hours (GWh) per year. 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.

**Maintain and Increase Recreation Opportunities** CP1 includes features to at least maintain the existing recreation capacity at Shasta Lake. Although CP1 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. The maximum surface area of the lake would increase by about 1,110 acres (4 percent), from 29,700 to about 30,800 acres. The average surface area of the lake during the recreation season from May through September would increase by about 800 acres (3 percent), from 23,900 acres to 24,700 acres. There is also limited potential to provide additional benefits to recreation by allowing more reliable filling of the reservoir during the spring.

**Benefits Related to Other SLWRI Planning Objectives** CP1 could also provide benefits related to flood damage reduction, ecosystem restoration, 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. Improved fisheries conditions as a result of CP1, as described above, and increased flexibility to meet flow and temperature requirements, could also enhance overall ecosystem resources in the Sacramento River. Furthermore, CP1 could potentially benefit ecosystem restoration through improved Delta water quality conditions by increasing Delta outflow during drought years and reducing salinity during critical periods. CP1 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.

**Additional Broad Public Benefits** Additional broad public benefits of CP1 obtained through pursuing project objectives are summarized in Table 4-3. These include benefits to reservoir water quality, traffic and transportation, and public services from modernization and upgrades of relocated facilities. Long-term benefits to air quality, groundwater, Shasta Lake fisheries, and system-wide operations are due to increased overall system capacity, allowing for increases in clean energy production, surface water deliveries, and storage capacity in Shasta Reservoir.

### *Potential Primary Effects of CP1*

Following is a summary of potential environmental consequences and proposed mitigation measures for this comprehensive plan. A detailed discussion of potential effects of all comprehensive plans is included in Chapters 4 through 25 of the EIS. A detailed discussion of the mitigation plan, including its development and proposed mitigation measures for all comprehensive plans, is included in the Preliminary Environmental Commitments and Mitigation Plan Appendix to the accompanying EIS. Proposed mitigation measures to address potential adverse impacts of CP1 are summarized below in Table 4-6.

**Shasta Lake Area** Within the reservoir area, the primary long-term impacts of this and other comprehensive plans would be due to the increased water surface elevations and inundation area and/or indirect effects related to facility modifications and relocations. Raising the full pool of the lake would cause direct impacts due to higher water surface elevations and inundation area. General types of impacts would include potential inundation of terrestrial and aquatic habitat, inundation of cultural resources, and inundation and resulting relocation of buildings, sections of paved and nonpaved roads, campground facilities (such as parking areas and restrooms), and low-lying bridges. Use of, and access to, recreation facilities also would be impacted, including trails, day-use picnic areas, boat ramps, marinas, campgrounds, resorts, and beaches. Several of the main buildings associated with Bridge Bay Resort and Marina, the largest resort and marina complex on Shasta Lake, are located within a few feet of the existing full pool elevation. Any potential real estate acquisition, or necessary relocations of displaced parties, would be accomplished under Public Law 91-646.

The future without-project and future with-project relationship of water stored in Shasta Reservoir is shown in Figure 4-3. Figure 4-2 shows the exceedence probability of maximum annual storages in Shasta Reservoir. From these graphics, it can be seen that Shasta Reservoir fills to (or near) full pool levels in the without-project condition about once every 3 years (about 35 percent of the years). In addition, on the basis of water operations modeling (CalSim-II), Shasta Reservoir fills to 80 percent capacity in about 81 percent of the years over the 82-year period of analysis of the CalSim-II model. With this plan, Shasta would fill to the new full pool storage of 4.81 MAF at about the same frequency as under without-project conditions – about once every 3 years. Further, Shasta Lake would also fill to 80 percent of the new capacity in about 81 percent of the years. Accordingly, annual operations in the reservoir generally would mirror existing operations except the water surface in the lake would be about 8.5 feet higher. The primary difference in additional reservoir area exposed under without-project versus with-project conditions would be that during extended drought periods, the reservoir would be drawn down to without-project minimum levels.

**Table 4-6. Summary of Proposed Mitigation Measures for Comprehensive Plans**

| Resource Topic/Impact | Alternative | Mitigation Measure |
|---|---|---|
| **Geology, Geomorphology, Minerals, and Soils** | | |
| Impact Geo-2: Alteration of Fluvial Geomorphology and Hydrology of Aquatic Habitats | CP1 – CP5 | Mitigation Measure Geo-2: Replace Lost Ecological Functions of Aquatic Habitats by Restoring Existing Degraded Aquatic Habitats in the Vicinity of the Impact. |
| Impact Geo-9: Substantial Increase in Channel Erosion and Meander Migration | CP1 – CP5 | Mitigation Measure Geo-9: Modification of Flow Releases in Response to River Management and Habitat Restoration Efforts between Keswick Dam and Red Bluff. |
| **Air Quality and Climate** | | |
| Impact AQ-1: Short-Term Emissions of Criteria Air Pollutants and Precursors at Shasta Lake and Vicinity During Project Construction | CP1 – CP5 | Mitigation Measure AQ-1: Implement Standard Measures and Best Available Mitigation Measures to Reduce Emissions Levels. |
| **Hydrology, Hydraulics, and Water Management** | | |
| No mitigation measures proposed. | | |
| **Water Quality** | | |
| Impact WQ-1: Temporary Construction-Related Sediment Effects on Shasta Lake and Its Tributaries that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses | CP1 – CP5 | Mitigation Measure WQ-1: Develop and Implement a Comprehensive Multi-scale Sediment Reduction and Water Quality Improvement Program Within Watersheds Tributary to the Primary Study Area. |
| Impact WQ-4: Long-Term Sediment Effects that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses in Shasta Lake or Its Tributaries | CP1 – CP5 | Mitigation Measure WQ-4: Implement Mitigation Measure WQ-1 (CP1): Develop and Implement a Comprehensive Multi-scale Sediment Reduction and Water Quality Improvement Program Within Watersheds Tributary to the Primary Study Area. |
| WQ-6: Long-Term Metals Effects that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses in Shasta Lake or Its Tributaries | CP1 – CP5 | Mitigation Measure WQ-6: Prepare and Implement a Site-Specific Remediation Plan for Historic Mine Features Subject to Inundation in the Vicinity of the Bully Hill and Rising Star Mines. |
| Impact WQ-7: Temporary Construction-Related Sediment Effects on the Upper Sacramento River that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses | CP1 – CP5 | Mitigation Measure WQ-7: Implement Mitigation Measure WQ-1 (CP1): Develop and Implement a Comprehensive Multi-scale Sediment Reduction and Water Quality Improvement Program Within Watersheds Tributary to the Primary Study Area. |
| Impact WQ-12: Long-Term Metals Effects that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses in the Upper Sacramento River | CP1 – CP5 | Mitigation Measure WQ-12: Implement Mitigation Measure WQ-6 (CP1): Prepare and Implement a Site-Specific Remediation Plan for Historic Mine Features Subject to Inundation in the Vicinity of the Bully Hill and Rising Star Mines |

**Table 4-6. Summary of Proposed Mitigation Measures for Comprehensive Plans (contd.)**

| Resource Topic/Impact | Alternative | Mitigation Measure |
|---|---|---|
| Impact WQ-18: Long-Term Metals Effects that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses in the Extended Study Area | CP1 – CP5 | Mitigation Measure WQ-18: Implement Mitigation Measure WQ-6 (CP1): Prepare and Implement a Site-Specific Remediation Plan for Historic Mine Features Subject to Inundation in the Vicinity of the Bully Hill and Rising Star Mines. |
| **Noise and Vibration** | | |
| Impact Noise-1: Exposure of Sensitive Receptors in the Primary Study Area to Project-Generated Construction Noise | CP1 – CP5 | Mitigation Measure Noise-1: Implement Measures to Prevent Exposure of Sensitive Receptors to Temporary Construction Noise at Project Construction Sites. |
| **Hazards and Hazardous Materials and Waste** | | |
| Impact Haz-1: Wildland Fire Risk (Shasta Lake and Vicinity and Upper Sacramento River) | CP1 – CP5 | Mitigation Measure Haz-1: Coordinate and Assist Public Services Agencies to Reduce Fire Hazards. |
| Impact Haz-2: Release of Potentially Hazardous Materials or Hazardous Waste (Shasta Lake and Vicinity and Upper Sacramento River) | CP1 – CP5 | Mitigation Measure Haz-2: Reduce Potential for Release of Hazardous Materials and Waste. |
| Impact Haz-4: Exposure of Sensitive Receptors to Hazardous Materials (Shasta Lake and Vicinity and Upper Sacramento River) | CP1 – CP5 | Mitigation Measure Haz-4: Reduce Potential for Exposure of Sensitive Receptors to Hazardous Materials or Waste. |
| **Agriculture and Important Farmlands** | | |
| No mitigation measures proposed. | | |
| **Fisheries and Aquatic Ecosystems** | | |
| Impact Aqua-4: Effects on Special-Status Aquatic Mollusks | CP1 – CP5 | Mitigation Measure Aqua-4: Implement Mitigation Measure Geo-2: Replace Lost Ecological Functions of Aquatic Habitats by Restoring Existing Degraded Aquatic Habitats in the Vicinity of the Impact. |
| Impact Aqua-7: Effects on Spawning and Rearing Habitat of Adfluvial Salmonids in Low-Gradient Tributaries to Shasta Lake | CP1 – CP5 | Mitigation Measure Aqua-7: Implement Mitigation Measure Aqua-4: Replace Lost Ecological Functions of Aquatic Habitats by Restoring Existing Degraded Aquatic Habitats in the Vicinity of the Impact. |
| Impact Aqua-14: Reduction in Ecologically Important Geomorphic Processes in the Upper Sacramento River Resulting from Reduced Frequency and Magnitude of Intermediate to High Flows | CP1 – CP5 | Mitigation Measure Aqua-14: Implement Mitigation Measure Bot-7: Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Avoid and Compensate for the Impact of Altered Flow Regimes on Riparian and Wetland Communities. |
| Impact Aqua-15: Changes in Flow and Water Temperatures in the Lower Sacramento River and Tributaries and Trinity River Resulting from Project Operation – Fish Species of Primary Management Concern | CP1 – CP5 | Mitigation Measure Aqua-15: Maintain Flows in the Feather River, American River, and Trinity River Consistent with Existing Regulatory and Operational Requirements and Agreements. |

**Table 4-6. Summary of Proposed Mitigation Measures for Comprehensive Plans (contd.)**

| Resource Topic/Impact | Alternative | Mitigation Measure |
|---|---|---|
| Impact Aqua-16: Reduction in Ecologically Important Geomorphic Processes in the Lower Sacramento River Resulting from Reduced Frequency and Magnitude of Intermediate to High Flows | CP1 – CP5 | Mitigation Measure Aqua-16: Implement Mitigation Measure Bot-7: Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Avoid and Compensate for the Impact of Altered Flow Regimes on Riparian and Wetland Communities. |
| **Botanical Resources and Wetlands** | | |
| Impact Bot-2: Loss of MSCS Covered Species | CP1 – CP5 | Mitigation Measure Bot-2: Acquire and Preserve Mitigation Lands; Avoid Populations; Relocate MSCS Plants; and Revegetate Affected Areas. |
| Impact Bot-3: Loss of USFS Sensitive, BLM Sensitive, or CRPR Species | CP1 – CP5 | Mitigation Measure Bot-3: Acquire and Preserve Mitigation Lands; Avoid Populations; Relocate USFS Sensitive, BLM Sensitive, and CRPR Plants and Revegetate Affected Areas. |
| Impact Bot-4: Loss of Jurisdictional Waters | CP1 – CP5 | Mitigation Measure Bot-4: Mitigate Loss of Jurisdictional Waters. |
| Impact Bot-5: Loss of General Vegetation Habitats | CP1 – CP5 | Mitigation Measure Bot-5: Acquire and Preserve Mitigation Lands for Loss of General Vegetation Habitats. |
| Impact Bot-6: Spread of Noxious and Invasive Weeds | CP1 – CP5 | Mitigation Measure Bot-6: Develop and Implement a Weed Management Plan In Conjunction with Stakeholders. |
| Impact Bot-7: Altered Structure and Species Composition and Loss of Sensitive Plant Communities and Special-Status Plant Species Resulting from Altered Flow Regimes | CP1 – CP5 | Mitigation Measure Bot-7: Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Avoid and Compensate for the Impact of Altered Flow Regimes on Riparian and Wetland Communities. |
| Impact Bot-8: Conflict with Approved Local or Regional Plans with Objectives of Riparian Habitat Protection or Watershed Management | CP1 – CP5 | Mitigation Measure Bot-8: Implement Mitigation Measure Bot-7: Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Avoid and Compensate for the Impact of Altered Flow Regimes on Riparian and Wetland Communities. |
| Impact Bot-11: Loss of Sensitive Natural Communities or Habitats Resulting from Implementing the Gravel Augmentation Program or Restoring Riparian, Floodplain, and Side Channel Habitats | CP4 – CP5 | Mitigation Measure Bot-11: Revegetate Disturbed Areas, Consult with CDFW, and Mitigate Loss of Jurisdictional Waters. |
| Impact Bot-12: Loss of Special-Status Plants Resulting from Implementing the Gravel Augmentation Program, or Restoring Riparian, Floodplain, and Side Channel Habitats | CP4 – CP5 | Mitigation Measure Bot-12: Conduct Preconstruction Surveys for Special-Status Plants and Avoid Special-Status Plant Populations During Construction. |

**Table 4-6. Summary of Proposed Mitigation Measures for Comprehensive Plans (contd.)**

| Resource Topic/Impact | Alternative | Mitigation Measure |
|---|---|---|
| Impact Bot-13: Spread of Noxious and Invasive Weeds Resulting from Implementing the Gravel Augmentation Program, Restoring Riparian, Floodplain, and Side Channel Habitats | CP4 – CP5 | Mitigation Measure Bot-13: Implement Weed Management Measures and Revegetation. |
| Impact Bot-14: Altered Structure and Species Composition and Loss of Sensitive Plant Communities and Special-Status Plant Species Resulting from Altered Flow Regimes on the Lower Sacramento River | CP1 – CP5 | Mitigation Measure Bot-14: Implement Mitigation Measure Bot-7: Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Avoid and Compensate for the Impact of Altered Flow Regimes on Riparian and Wetland Communities. |
| Impact Bot-15: Conflict with Approved Local or Regional Plans with Objectives of Riparian Habitat Protection or Watershed Management Along the Lower Sacramento River | CP1 – CP5 | Mitigation Measure Bot-15: Implement Mitigation Measure Bot-7: Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Avoid and Compensate for the Impact of Altered Flow Regimes on Riparian and Wetland Communities. |
| **Wildlife Resources** | | |
| Impact Wild-1: Take and Loss of Habitat for the Shasta Salamander | CP1 – CP5 | Mitigation Measure Wild-1: Avoid, Relocate, and Acquire Mitigation Lands for Shasta Salamander. |
| Impact Wild-2: Impact on the Foothill Yellow-Legged Frog and Tailed Frog and Their Habitat | CP1 – CP5 | Mitigation Measure Wild-2: Avoid, Relocate, and Acquire Mitigation Lands for Foothill Yellow-Legged Frog and Tailed Frog. |
| Impact Wild-3: Impact on the Northwestern Pond Turtle and Its Habitat | CP1 – CP5 | Mitigation Measure Wild-3: Avoid, Relocate, and Acquire Mitigation Lands for Northwestern Pond Turtle. |
| Impact Wild-4: Impact on the American Peregrine Falcon | CP1 – CP5 | Mitigation Measure Wild-4: Conduct Preconstruction Surveys for the American Peregrine Falcon and Establish Buffers. |
| Impact Wild-5: Take and Loss of Habitat for the Bald Eagle | CP1 – CP5 | Mitigation Measure Wild-5: Acquire and Preserve Mitigation Lands; Conduct Protocol-Level Surveys for the Bald Eagle and Establish Buffers. |
| Impact Wild-6: Loss of Dispersal Habitat for the Northern Spotted Owl | CP1 – CP5 | Mitigation Measure Wild-6: Acquire and Preserve Mitigation Lands, Habitat Enhancement. |
| Impact Wild-7: Impact on the Purple Martin and Its Habitat | CP1 – CP5 | Mitigation Measure Wild-7: Conduct a Preconstruction Survey for Purple Martin and Establish Buffers. |
| Impact Wild-8: Impacts on the Willow Flycatcher, Vaux's Swift, Yellow Warbler, and Yellow-Breasted Chat and Their Foraging and Nesting Habitat | CP1 – CP5 | Mitigation Measure Wild-8: Acquire and Preserve Mitigation Lands; Conduct a Preconstruction Survey for the Willow Flycatcher, Vaux's Swift, Yellow Warbler, and Yellow-Breasted Chat and Establish Buffers. |

**Table 4-6. Summary of Proposed Mitigation Measures for Comprehensive Plans (contd.)**

| Resource Topic/Impact | Alternative | Mitigation Measure |
|---|---|---|
| Impact Wild-9: Impacts on the Long-Eared Owl, Northern Goshawk, Cooper's Hawk, Great Blue Heron, and Osprey and Their Foraging and Nesting Habitat | CP1 – CP5 | Mitigation Measure Wild-9: Acquire and Preserve Mitigation Lands; Conduct a Preconstruction Survey for the Long-Eared Owl, Northern Goshawk, Cooper's Hawk, Great Blue Heron, and Osprey and Establish Buffers. |
| Impact Wild-10: Take and Loss of Habitat for the Pacific Fisher | CP1 – CP5 | Mitigation Measure Wild-10: Acquire and Preserve Mitigation Lands; Conduct Preconstruction Surveys for the Pacific Fisher and Establish Buffers. |
| Impact Wild-11: Impacts on Special-Status Bats (Pallid Bat, Spotted Bat, Western Red Bat, Western Mastiff Bat, Townsend's Big-Eared Bat, Long-Eared Myotis, and Yuma Myotis), the American Marten, and Ringtails and Their Habitat | CP1 – CP5 | Mitigation Measure Wild-11: Acquire and Preserve Mitigation Lands; Conduct a Preconstruction Survey for Special-Status Bats, American Marten, and Ringtails and Establish Buffers. |
| Impact Wild-12: Impacts on Special-Status Terrestrial Mollusks (Shasta Sideband, Wintu Sideband, Shasta Chaparral, and Shasta Hesperian) and Their Habitat | CP1 – CP5 | Mitigation Measure Wild-12: Avoid Suitable Habitat; Acquire and Preserve Mitigation Lands for Special-Status Terrestrial Mollusks. |
| Impact Wild-13: Permanent Loss of General Wildlife Habitat | CP1 – CP5 | Mitigation Measure Wild-13: Acquire and Preserve Mitigation Lands for Permanent Loss of General Wildlife Habitat. |
| Impact Wild-14: Impacts on Other Birds of Prey (Red-Tailed Hawk and Red-Shouldered Hawk) and Migratory Bird Species (American Robin, Anna's Hummingbird) and Their Foraging and Nesting Habitat | CP1 – CP5 | Mitigation Measure Wild-14: Acquire and Preserve Mitigation Lands and Conduct Preconstruction Surveys for Other Nesting Raptors and Migratory Birds and Establish Buffers. |
| Impact Wild-15: Loss of Critical Deer Winter and Fawning Range | CP1 – CP5 | Mitigation Measure Wild-15: Acquire and Preserve Mitigation Lands for Permanent Loss of Critical Deer Wintering and Fawning Range. |
| Impact Wild-16: Take and Loss of California Red-Legged Frog | CP1 – CP5 | TBD |
| Impact Wild-17: Impacts on Riparian-Associated Special-Status Wildlife Resulting from Modifications to the Existing Flow Regime in the Primary Study Area | CP1 – CP5 | Mitigation Measure Wild-17: Implement Mitigation Measure Bot-7: Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Avoid and Compensate for the Impact of Altered Flow Regimes on Riparian and Wetland Communities. |
| Impact Wild-20: Consistency with Local and Regional Plans with Goals of Promoting Riparian Habitat in the Primary Study Area | CP1 – CP5 | Mitigation Measure Wild-20: Implement Mitigation Measure Bot-7: Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Avoid and Compensate for the Impact of Altered Flow Regimes on Riparian and Wetland Communities. |

**Table 4-6. Summary of Proposed Mitigation Measures for Comprehensive Plans (contd.)**

| Resource Topic/Impact | Alternative | Mitigation Measure |
|---|---|---|
| Impact Wild-21: Impacts on Riparian-Associated Special-Status Wildlife Resulting from the Gravel Augmentation Program | CP4 – CP5 | Mitigation Measure Wild-21: Conduct Preconstruction Surveys for Elderberry Shrubs, Northwestern Pond Turtle, and Nesting Riparian Raptors and Other Nesting Birds. Avoid Removal or Degradation of Elderberry Shrubs and Avoid Vegetation Removal near Active Nest Sites. |
| Impact Wild-22: Impacts on Riparian-Associated Special-Status Wildlife Species Resulting from Restoration Projects | CP4 – CP5 | Mitigation Measure Wild-22: Implement Mitigation Measure Wild-21: Conduct Preconstruction Surveys for Elderberry Shrubs, Northwestern Pond Turtle, and Nesting Riparian Raptors and Other Nesting Birds. Avoid Removal or Degradation of Elderberry Shrubs and Avoid Vegetation Removal near Active Nest Sites. |
| Impact Wild-23: Impacts on Riparian-Associated and Aquatic Special-Status Wildlife Resulting from Modifications to Existing Flow Regimes in the Lower Sacramento River and Delta | CP1 – CP5 | Mitigation Measure Wild-23: Implement Mitigation Measure Bot-7: Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Avoid and Compensate for the Impact of Altered Flow Regimes on Riparian and Wetland Communities. |
| Impact Wild-26: Consistency with Local and Regional Plans with Goals of Promoting Riparian Habitat along the Lower Sacramento River and in the Delta | CP1 – CP5 | Mitigation Measure Wild-26: Implement Mitigation Measure Bot-7: Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Avoid and Compensate for the Impact of Altered Flow Regimes on Riparian and Wetland Communities. |
| **Cultural Resources** | | |
| Impact Culture-1: Disturbance or Destruction of Archaeological and Historical Resources Due to Construction or Inundation | CP1 – CP5 | Mitigation Measure Culture-1: Develop and Implement measures identified in an NHPA Section 106 MOA or PA. |
| Impact Culture-2: Inundation of Traditional Cultural Properties | CP4 – CP5 | Mitigation Measure Culture-2: Adverse effects will be avoided, minimized, or mitigated through project redesign, when warranted, or through the development and implementation of an MOA or PA. |
| Impact Culture-3: Disturbance or Destruction of Archaeological and Historical Resources near the Upper Sacramento River Due to Construction | CP4 – CP5 | Mitigation Measure Culture-3: Implement Mitigation Measure Culture-1: Develop and Implement measures identified in an NHPA Section 106 MOA or PA. |
| **Indian Trust Assets** | | |
| No mitigation measures proposed. | | |

**Table 4-6. Summary of Proposed Mitigation Measures for Comprehensive Plans (contd.)**

| Resource Topic/Impact | Alternative | Mitigation Measure |
|---|---|---|
| **Socioeconomics, Population, and Housing** | | |
| Impact Socio-14: Potential Temporary Reduction in Shasta Project Water or Hydropower Supplied to the CVP and SWP Service Areas During Construction | CP1 – CP5 | Mitigation Measure Socio-14: Secure Replacement Water or Hydropower During Project Construction. |
| **Land Use Planning** | | |
| Impact LU-1: Disruption of Existing Land Uses (Shasta Lake and Vicinity and Upper Sacramento River) | CP1 – CP5 | Mitigation Measure LU-1: Minimize and/or Avoid Temporary Disruptions to Local Communities. |
| Impact LU-2: Conflict with Existing Land Use Goals and Policies of Affected Jurisdictions (Shasta Lake and Vicinity and Upper Sacramento River) | CP1 – CP5 | Mitigation Measure LU-2: Minimize and/or Avoid Conflicts with Land Use Goals and Policies. |
| **Recreation and Public Access** | | |
| Impact Rec-2: Temporary Construction-Related Disruption of Recreation Access and Activities at and near Shasta Dam | CP1 – CP5 | Mitigation Measure Rec-2: Provide Information About and Improve Alternate Recreation Access and Opportunities to Mitigate the Temporary Loss of Recreation Access and Opportunities During Construction at Shasta Dam. |
| Impact Rec-4: Increased Hazards to Boaters and Other Recreationists at Shasta Lake from Standing Timber and Stumps Remaining in Untreated Areas of the Inundation Zone | CP1 – CP5 | Mitigation Measure Rec-4: Provide Information to Shasta Lake Visitors About Potential Safety Hazards in Newly Inundated Areas from Standing Timber and Stumps. |
| Impact Rec-15: Increased Difficulty for Boaters and Anglers in Using the Sacramento River and Rivers Below CVP and SWP Reservoirs as a Result of Decreased River Flows | CP1 – CP5 | Mitigation Measure Rec-15: Implement Mitigation Measure Aqua-15: Maintain Flows in the Feather River, American River, and Trinity River Consistent with Existing Regulatory and Operational Requirements and Agreements. |
| **Aesthetics and Visual Resources** | | |
| Impact Vis-1: Consistency with Guidelines for Visual Resources in the STNF LRMP (Shasta Lake and Vicinity and Upper Sacramento River) | CP1 – CP5 | Mitigation Measure Vis-1: Amend the STNF LRMP to Include Revised VQOs for developments at Turntable Bay area. |
| Impact Vis-2: Degradation and/or Obstruction of a Scenic View from Key Observation Points (Shasta Lake and Vicinity and Upper Sacramento River) | CP1 – CP5 | Mitigation Measure Vis-2: Minimize Construction-Related Visual Impacts on Scenic Views From Key Observation Points. |
| Impact Vis-3: Generation of Increased Daytime Glare and/or Nighttime Lighting (Shasta Lake and Vicinity and Upper Sacramento River) | CP1 – CP5 | Mitigation Measure Vis-3: Minimize or Avoid Visual Impacts of Daytime Glare and Nighttime Lighting. |

**Table 4-6. Summary of Proposed Mitigation Measures for Comprehensive Plans (contd.)**

| Resource Topic/Impact | Alternative | Mitigation Measure |
|---|---|---|
| **Transportation and Traffic** | | |
| Impact Trans-1: Short-Term and Long-Term Increases in Traffic in the Primary Study Area in Relation to the Existing Traffic Load and Capacity of the Street System | CP1 – CP5 | Mitigation Measure Trans-1: Prepare and Implement a Traffic Control and Safety Assurance Plan. |
| Impact Trans-2: Adverse Effects on Access to Local Streets or Adjacent Uses in the Primary Study Area | CP1 – CP5 | Mitigation Measure Trans-2: To Reduce Effects on Local Access, Implement Mitigation Measure Trans-1: Prepare and Implement a Traffic Control and Safety Assurance Plan. |
| Impact Trans-4: Adverse Effects on Emergency Access in the Primary Study Area | CP1 – CP5 | Mitigation Measure Trans-4: To Reduce Effects on Emergency Access, Implement Mitigation Measure Trans-1: Prepare and Implement a Traffic Control and Safety Assurance Plan. |
| Impact Trans-5: Accelerated Degradation of Surface Transportation Facilities in the Primary Study Area | CP1 – CP5 | Mitigation Measure Trans-5: Identify and Repair Roadway Segments Damaged by the Project. |
| **Utilities and Service Systems** | | |
| Impact Util-1: Damage to or Disruption of Public Utility and Service Systems Infrastructure (Shasta Lake and Vicinity and Upper Sacramento River) | CP1 – CP5 | Mitigation Measure Util-1: Implement Procedures to Avoid Damage to or Temporary Disruption of Service. |
| Impact Util-2: Utility Infrastructure Relocation or Modification (Shasta Lake and Vicinity and Upper Sacramento River) | CP1 – CP5 | Mitigation Measure Util-2: Adopt Measures to Minimize Infrastructure Relocation Impacts. |
| **Public Services** | | |
| Impact PS-1: Disruption of Public Services (Shasta Lake and Vicinity and Upper Sacramento River) | CP1 – CP5 | Mitigation Measure PS-1: Coordinate and Assist Public Services Agencies. |
| Impact PS-2: Degraded Level of Public Services (Shasta Lake and Vicinity and Upper Sacramento River) | CP1 – CP5 | Mitigation Measure PS-2: Provide Support to Public Services Agencies. |
| **Power and Energy** | | |
| No mitigation measures proposed. | | |
| **Environmental Justice** | | |
| No mitigation measures proposed. | | |

**Table 4-6. Summary of Proposed Mitigation Measures for Comprehensive Plans (contd.)**

| Resource Topic/Impact | Alternative | Mitigation Measure |
|---|---|---|
| **Wild and Scenic Rivers Considerations for McCloud River** | | |
| Impact WASR-3: Effects to McCloud River Wild Trout Fishery, as Identified in the California Public Resources Code, Section 5093.542 | CP1 – CP5 | Mitigation Measure WASR-3: Develop and Implement a Comprehensive Multi-scale Fishery Protection, Restoration and Improvement Program for the Lower McCloud River Watershed. |
| Impact WASR-4: Effects to McCloud River Free-Flowing Conditions, as Identified in the California Public Resources Code, Section 5093.542 | CP1 – CP5 | Mitigation Measure WASR-4: Implement Protection, Restoration, and Improvement Measures to Benefit Hydrologic Functions Within the Lower McCloud River Watershed. |

Key:
Ag = Agriculture and Important Farmlands
AQ = Air Quality and Climate
Aqua = Fisheries and Aquatic Ecosystems
BLM = U.S. Bureau of Land Management
BMP = best management practice
Bot = Botanical Resources and Wetlands
CDFW = California Department of Fish and Wildlife
CP – Comprehensive Plan
CRPR = California Rare Plant Rank
Culture = Cultural Resources
CVP = Central Valley Project
Delta = Sacramento-San Joaquin Delta
Geo = Geology, Geomorphology, Minerals, and Soils
Haz = Hazards and Hazardous Materials and Waste
LU = Land Use Planning
MSCS = Multi-Species Conservation Strategy
MOA = Memorandum of Understanding
NHPA = National Historic Preservation Act
Noise = Noise and Vibration
PA = Programmatic Agreement
PS = Public Services
Rec = Recreation and Public Access
Socio = Socioeconomics, Population, and Housing
SWP = State Water Project
TBD = to be determined
Trans = Transportation and Traffic
USFS = U.S. Forest Service
Util = Utilities and Service Systems
Vis = Aesthetics and Visual Resources
Wild = Wildlife Resources
WQ = Water Quality

The increased area of inundation for CP1 is about 1,110 acres. This equates to an average increase in the lateral zone of about 21 feet. An example of the extent of inundation for the 6.5-foot dam raise (as well as 12.5-foot and 18.5-foot dam raises) is shown in Figure 4-5. The figure shows increased inundation of the Sacramento River arm at the community of Lakeshore, considering proposed protective dikes and embankments. Lakeshore is the most populated area around the lake. Because of the gently sloping shoreline adjacent to Lakeshore, this area is representative of the maximum lateral increase in inundation that could be expected with dam raises up to 18.5 feet. The community of Sugarloaf would also be impacted.

The duration of inundation at given drawdown levels (e.g., 10 feet from top of full pool) would be similar to existing conditions. Water would inundate the highest levels of the reservoir for periods ranging from several days to about 1 month. Much of the vegetation in the enlarged drawdown zone on steeper lands would be removed during construction. In addition, much of the remaining vegetation in the expanded drawdown zone would eventually be lost over time. However, it is expected that significant amounts of vegetation could remain on the flatter slopes because of the infrequent inundation.

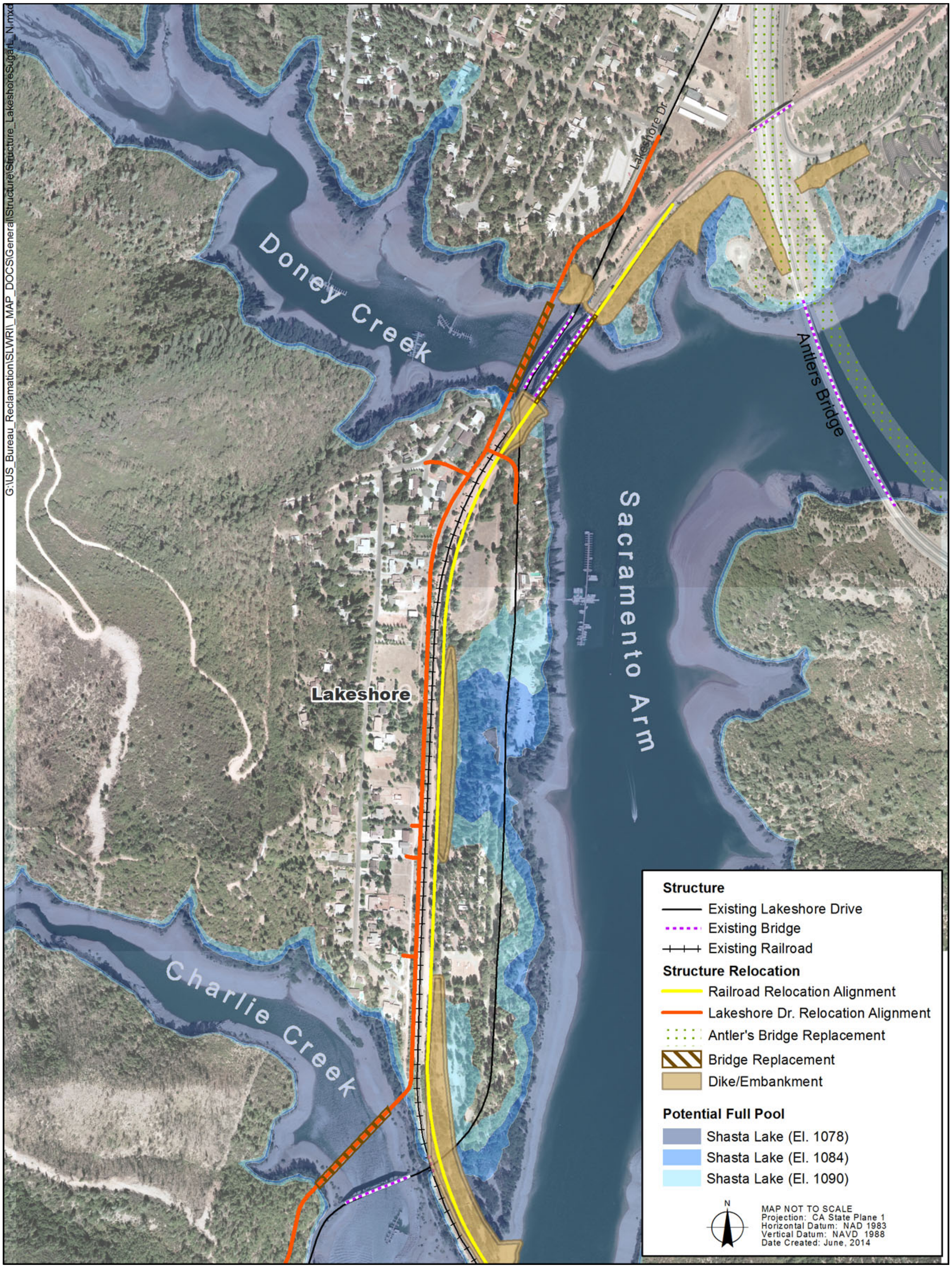



**Figure 4-5. Estimated Maximum Inundation in the Lakeshore Area for 6.5-foot, 12.5-foot, and 18.5-foot Dam Raises**

The McCloud River is of specific interest. PRC 5093.542 (c) and (d) may limit State involvement in studies to enlarge Shasta Dam and Reservoir if that action could have an adverse effect on the free-flowing conditions of the McCloud River or its wild trout fishery. Figure 4-6 illustrates the estimated increase in area of inundation on the McCloud River upstream from the McCloud Bridge for the 6.5-foot (and 18.5-foot) dam raise. As shown in Figure 4-6, raising Shasta Dam 6.5 feet would result in inundating an additional 1,470 lineal feet (about 9 acres) of the lower McCloud River, compared to existing conditions. Raising Shasta Dam 18.5 feet would result in inundating an additional 3,550 lineal feet (about 27 acres) of the lower McCloud River, compared to existing conditions. This represents a maximum of about 3 percent of the 24-mile-reach of river between the McCloud Bridge and McCloud Dam, which controls flows on the river.

Additional long-term effects on biological resources associated with the relocation of reservoir area infrastructure are anticipated. Short-term, construction-related impacts are also anticipated in the primary study area.

**Upper Sacramento River** Potential effects on flow and stages of the upper Sacramento River from this plan and other comprehensive plans would be minimal. Figure 4-7 shows Sacramento River flows above RBPP, simulated using CalSim-II, under wet, above- and below-normal, and dry and critical year conditions for the No-Action Alternative, and CP1 and CP4. Additional figures are included in the EIS Plan Formulation Appendix that show simulated Sacramento River flows below Keswick Dam and Stony Creek, under wet, above- and below-normal, and dry and critical year conditions for all of the alternatives. As shown in Figure 4-7, during most years, annual operations of Shasta Reservoir, and subsequent flows and stages in the Sacramento River, would be relatively unchanged. Also, flows and stages would increase slightly from June through November. Although small, this increase would be most pronounced during dry periods as more water is released from Shasta Dam for water supply reliability purposes. During dry periods, however, there are few to no changes in water flows or changes during the winter and spring periods. Potential noticeable changes in flows and stages would diminish rapidly downstream from the RBPP. This is primarily because of the significant amount of tributary inflows, especially from the Feather River system.

Changes in river flows and stages may impact geomorphic conditions along the river, existing riparian vegetation, and other wildlife resources. As described above, the changes in temperatures and flows are expected to have a beneficial impact on anadromous fish resources. A possibility exists, however, that by benefiting anadromous fish, a slightly altered temperature and flow regime may adversely impact warm-water species in the Sacramento River. This impact is not expected to be significant.

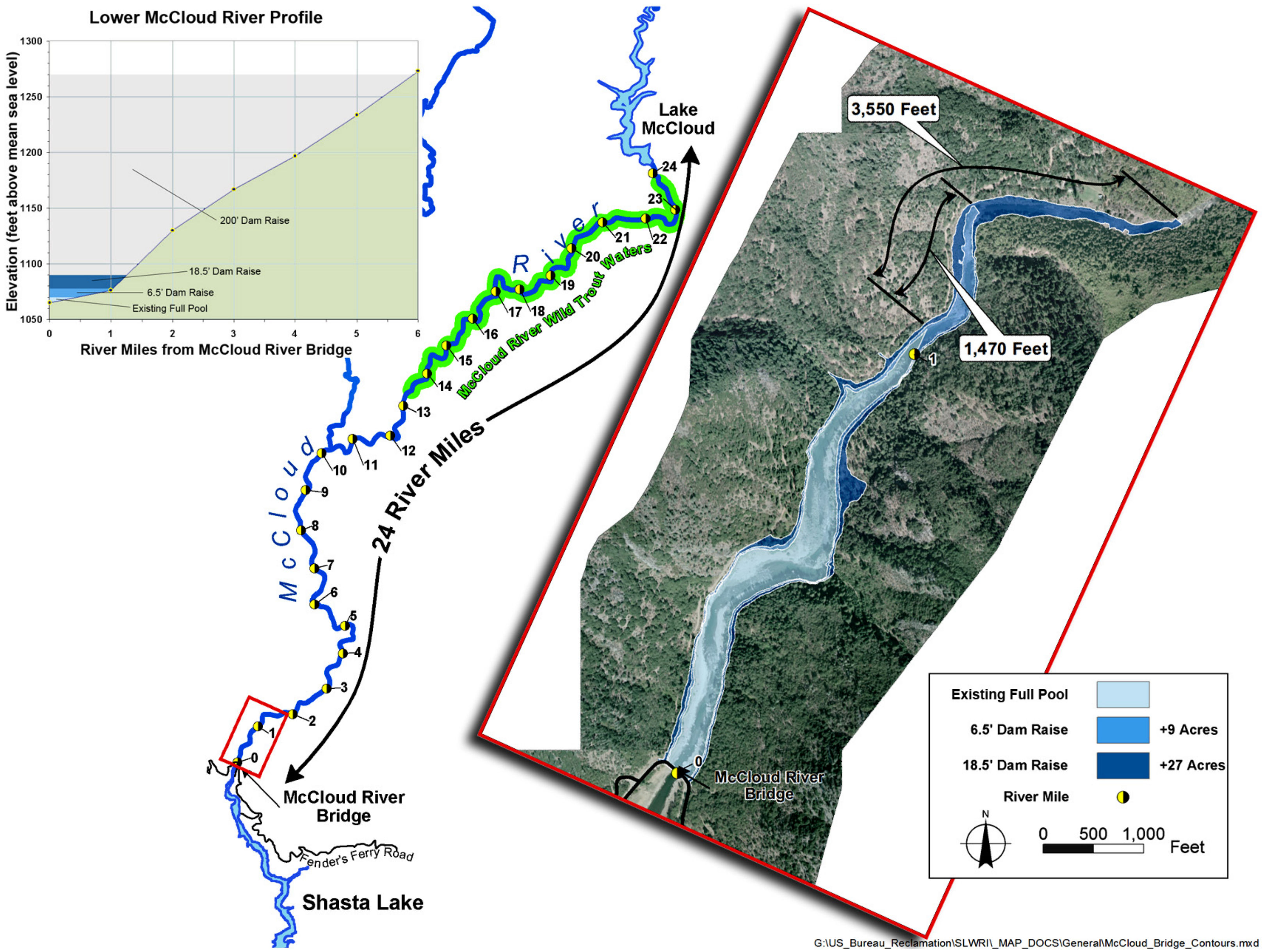
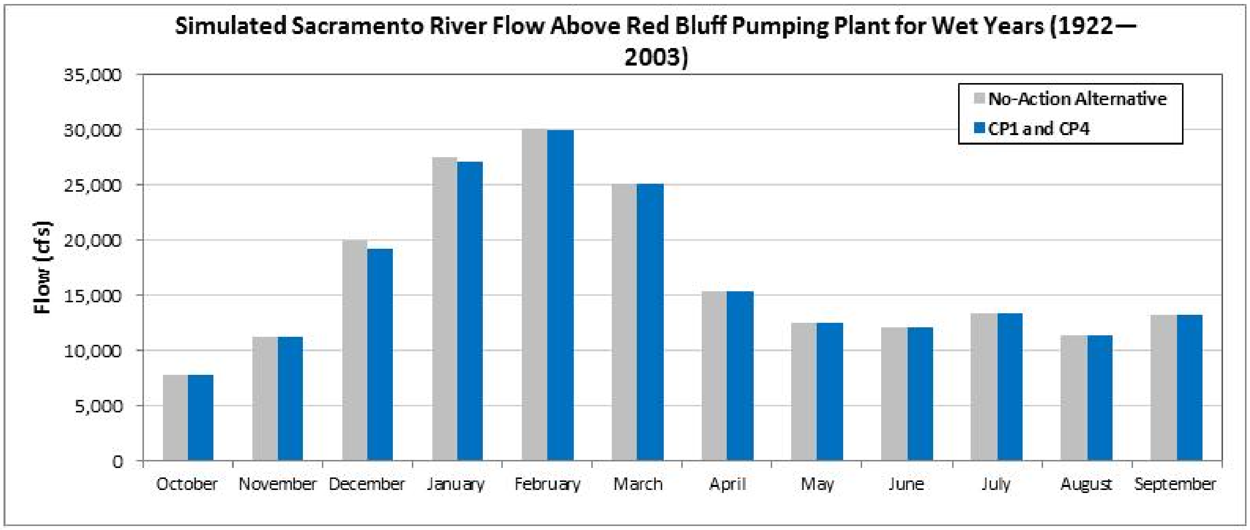
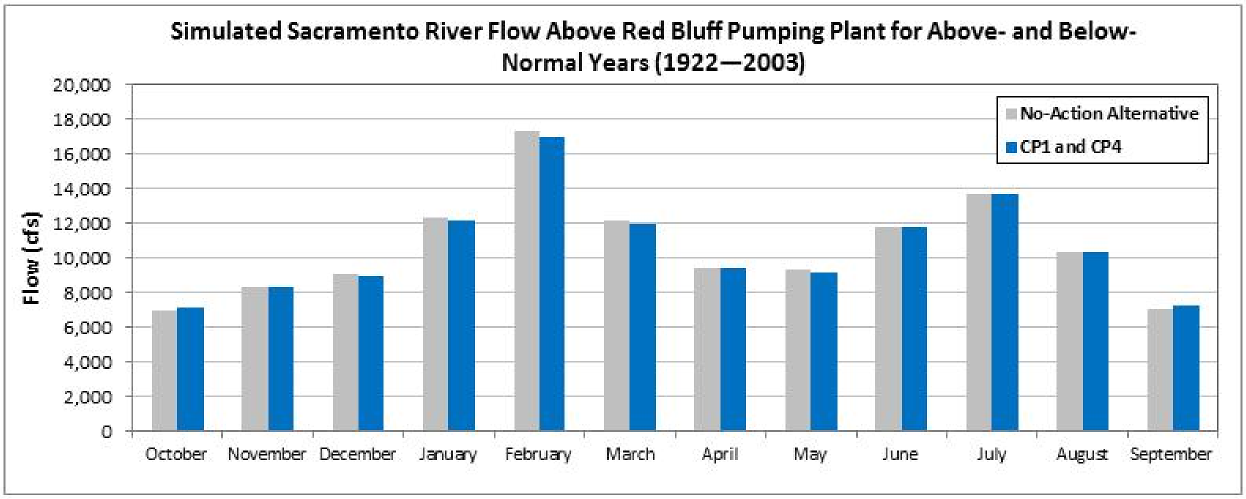
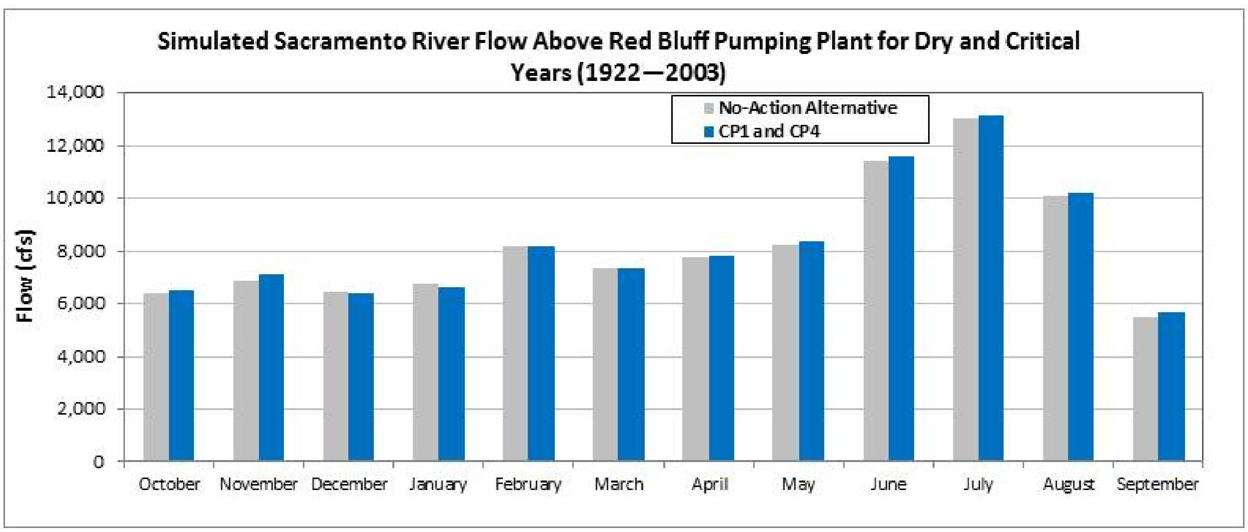



Figure 4-6. McCloud River Extent of Maximum Inundation for 6.5-foot Raise and 18.5-foot Raise




Note: Water year types based on the Sacramento Valley Water Year Hydrologic Classification.

**Figure 4-7. Simulated Sacramento River Flow Above Red Bluff Pumping Plant in Wet, Above- and Below-Normal, and Dry and Critical Years for No-Action and CP1 and CP4**

***Preliminary Economics Assessment of CP1***

**Estimated Costs** Estimated construction cost and annual cost of CP1 are included in Table 4-7. As shown, the estimated construction cost for CP1 is about $990 million. The estimated total annual cost of CP1 is $45.1 million.

**Table 4-7. Estimated Construction and Annual Costs of the Comprehensive Plans**

| Item | CP1 6.5 ft ($ millions) | CP2 12.5 ft ($ millions) | CP3 18.5 ft ($ millions) | CP4 18.5 ft ($ millions) | CP4A 18.5 ft ($ millions) | CP5 18.5 ft ($ millions) |
|---|---|---|---|---|---|---|
| **Construction Costs[1,2]** | | | | | | |
| **Field Costs** | | | | | | |
| Relocations | | | | | | |
| Vehicular Bridges | $34 | $34 | $54 | $54 | $54 | $54 |
| Doney Creek Railroad Bridge | $56 | $56 | $56 | $56 | $56 | $56 |
| Sacramento River Railroad Bridge, Second Crossing | $116 | $116 | $116 | $116 | $116 | $116 |
| Pit River Bridge Modifications | $17 | $23 | $31 | $31 | $31 | $31 |
| Railroad Realignment | $8.2 | $8.2 | $8.2 | $8.2 | $8.2 | $8.2 |
| Roads | $17 | $26 | $37 | $37 | $37 | $37 |
| Local Utilities | $24 | $24 | $30 | $30 | $30 | $30 |
| Transmission Lines | $19 | $19 | $19 | $19 | $19 | $19 |
| Buildings/Facilities – Recreation | $133 | $150 | $166 | $166 | $166 | $166 |
| Dams and Reservoirs | | | | | | |
| Main Dam | $54 | $64 | $76 | $76 | $76 | $76 |
| Outlet Works | $27 | $27 | $27 | $27 | $27 | $27 |
| Spillway | $126 | $131 | $131 | $131 | $131 | $131 |
| Temperature Control Device | $28 | $30 | $31 | $31 | $31 | $31 |
| Powerhouse and Penstocks | $1.3 | $1.3 | $1.3 | $1.3 | $1.3 | $1.3 |
| Right Wing Dam | $4.6 | $5.7 | $6.9 | $6.9 | $6.9 | $6.9 |
| Left Wing Dam | $13 | $18 | $26 | $26 | $26 | $26 |
| Visitor Center | $8.4 | $8.8 | $9.1 | $9.1 | $9.1 | $9.1 |
| Dikes | $14 | $16 | $27 | $27 | $27 | $27 |
| Reservoir Clearing | $4.5 | $7.2 | $21 | $21 | $21 | $21 |
| Pit 7 Dam and Powerhouse Modifications | $8.2 | $8.2 | $8.2 | $8.2 | $8.2 | $8.2 |
| Environmental Restoration | - | - | - | $6.2 | $6.2 | $18.2 |
| Recreation Enhancement | - | - | - | - | - | $1.3 |
| **Total Field Costs** | **$713** | **$773** | **$881** | **$887** | **$887** | **$901** |
| Planning, Engineering, Design, and Construction Management | $160 | $174 | $198 | $200 | $200 | $203 |
| Lands | $30 | $47 | $69 | $70 | $70 | $70 |
| Environmental Mitigation | $71 | $77 | $88 | $88 | $88 | $88 |
| Cultural Resource Mitigation | $14 | $15 | $18 | $18 | $18 | $18 |
| Water Use Efficiency Actions | $1.6 | $2.6 | $3.1 | $1.6 | $2.6 | $3.8 |
| **Total Construction Cost** | **$990** | **$1,089** | **$1,257** | **$1,264** | **$1,265** | **$1,283** |
| Interest During Construction | $83 | $91 | $105 | $105 | $105 | $108 |
| **Total Capital Cost** | **$1,073** | **$1,180** | **$1,362** | **$1,370** | **$1,371** | **$1,391** |

**Table 4-7. Estimated Construction and Annual Costs of the Comprehensive Plans (contd.)**

| Item | CP1 6.5 ft ($ millions) | CP2 12.5 ft ($ millions) | CP3 18.5 ft ($ millions) | CP4 18.5 ft ($ millions) | CP4A 18.5 ft ($ millions) | CP5 18.5 ft ($ millions) |
|---|---|---|---|---|---|---|
| **Annual Cost[1,2]** | | | | | | |
| Interest and Amortization | $39 | $43 | $49 | $50 | $50 | $50 |
| Operations and Maintenance | $6.3 | $8.5 | $4.6 | $7.5 | $9.4 | $10.7 |
| **Total Annual Cost** | **$45.1** | **$51.2** | **$53.8** | **$57.1** | **$59.0** | **$61.0** |

Notes:
1 Based on January 2014 price levels, 100-year period of analysis, and 3-1/2 percent interest rate.
2 Totals may not sum due to rounding.
Key:
- = not applicable
CP = Comprehensive Plan
ft = feet

**Estimated Economic Benefits** As shown in Table 4-8, the estimated average annual monetary benefit of CP1, assuming the cost of water and energy supplies increases at the same rate as inflation, is about $29.7 million. Assuming the cost of water supplies and hydropower increases at 2 percent above inflation, to account for future diminishment of water and energy supplies and increasing demands, the average annual benefit could exceed about $48.4 million per year.

**Table 4-8. Average Annual Economic Benefit Summary[1]**

| Economic Benefit Category[2,3] | CP1 ($ millions) | CP2 ($ millions) | CP3 ($ millions) | CP4 ($ millions) | CP4A ($ millions) | CP5 ($ millions) |
|---|---|---|---|---|---|---|
| Anadromous Fish | 2.9 | 17.8 | 9.7 | 38.1 | 33.3 | 17.7 |
| Water Supply Reliability[4] | 15.2 | 26.9 | 10.2 | 15.2 | 26.9 | 34.8 |
| Hydropower[5] | 6.8 | 10.3 | 11.1 | 14.9 | 14.4 | 13.4 |
| Recreation[6] | 4.9 | 6.7 | 11.6 | 17.8 | 14.3 | 8.2 |
| **Total Benefits** | | | | | | |
| Estimated Value (At Inflation)[7,8] | 29.7 | 61.6 | 42.6 | 86.0 | 88.9 | 74.2 |
| Estimated Value (2% Above Inflation)[9] | 48.4 | 93.3 | 60.7 | 111.6 | 124.1 | 115.2 |

Notes:
1 Based on Central Valley Project and State Water Project operational conditions described in the 2008 and 2009 Biological Opinions released by the National Marine Fisheries Service and the U.S. Fish and Wildlife Service, respectively.
2 Economic benefits have not been monetized for ecosystem restoration, including (1) restoring resident fish habitat in Shasta Lake, (2) restoring fisheries and riparian habitat at several locations along the lower reaches of the upper Sacramento River and tributaries to Shasta Lake, (3) augmenting spawning gravel in the upper Sacramento River, and (4) restoring riparian, floodplain, and side channel habitat along the upper Sacramento River.
3 Benefits for flood control and water quality have not been monetized.
4 Includes irrigation and municipal and industrial water supply. Does not reflect benefits related to water use efficiency actions included in all comprehensive plans.
5 Economic benefits for hydropower include ancillary services and capacity benefits in addition to increased hydropower generation.
6 These values do not account for increased visitation due to modernization of recreation facilities associated with all comprehensive plans.
7 Assumes the costs of water supplies and hydropower increase at the same rate as inflation.
8 All numbers are rounded for display purposes; therefore, line items may not sum to totals.
9 Includes increase of water supply and hydropower costs at 2 percent above inflation to account for growing scarcity in the future.
Key:
CP = comprehensive plan

## CP2 – 12.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

CP2 consists primarily of enlarging Shasta Dam by raising the crest 12.5 feet and enlarging the reservoir by 443,000 acre-feet. Major features of CP2 in the Shasta Lake area are shown in Figure 4-1 and summarized in Table 4-1.

### *Major Components of CP2*

- Raising Shasta Dam and appurtenant facilities by 12.5 feet.
- Implementing the set of eight common management measures previously described.
- Implementing the common environmental commitments described above.

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 elevation of 1,077.5 feet to 1,090.0 feet (based on NGVD29), CP2 would increase the height of the reservoir's full pool by 14.5 feet. The additional 2-foot increase in the height of the full pool above the dam raise height would result from spillway modifications similar to the modifications proposed under CP1. 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. Figure 2-3 shows the increase in surface area and storage capacity for CP2.

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. The existing TCD would also be extended for efficient use of the expanded cold-water pool. 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.

As described for CP1, this plan would include the potential to revise flood control operational rules, which could potentially reduce flood damage and benefit recreation.

### *Potential Benefits of CP2*

Major potential benefits of CP2, related to the SLWRI planning objectives and broad public services, are summarized in Tables 4-2 and 4-3 and described below.

**Increase Anadromous Fish Survival** Similar to CP1, raising Shasta Dam by 12.5 feet would increase the cold-water pool and increase the ability of Shasta Dam to make cold-water releases and regulate water temperatures for fish in the upper Sacramento River, primarily in dry and critical water years. It is estimated that improved water temperature and flow conditions under CP2 could result in an average annual increase in the Chinook salmon population of about 379,200 outmigrating juvenile Chinook salmon.

**Increase Water Supply Reliability** CP2 would increase water supply reliability by increasing water supplies for CVP and SWP irrigation and M&I deliveries primarily during drought periods. This action would contribute to replacement of supplies redirected to other purposes in the CVPIA. As shown in Table 4-5, CP2 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, water use efficiency could help reduce current and future water shortages by allowing a more effective use of existing supplies. Under CP2, 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.

**Develop Additional Hydropower Generation** Higher water surface elevations in the reservoir would result in a net increase in power generation of about 87 GWh per year. 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.

**Maintain and Increase Recreation Opportunities** CP2 includes features to, at minimum, maintain the existing recreation capacity at Shasta Lake. Although CP2 does not have specific features to further benefit recreation resources, 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. The maximum surface area of the lake would increase by about 1,900 acres (6 percent), from 29,700 acres to about 31,600 acres. The average surface area of the lake during the recreation season from May through September would increase by about 1,300 acres (5 percent), from 23,900 acres to 25,200 acres. There is also limited potential to provide additional benefits to recreation by allowing more reliable filling of the reservoir during the spring.

**Benefits Related to Other SLWRI Planning Objectives** CP2 could also provide benefits related to flood damage reduction, ecosystem restoration, and water quality, as described for CP1, but to a greater extent because of increased capacity and associated overall system flexibility.

**Additional Broad Public Benefits** Additional broad public benefits of CP2 obtained through pursuing project objectives are summarized in Table 4-3. Broad public benefits for CP2 are similar to those for CP1 but amplified because of increased system capacity and the facility upgrades associated with additional relocations.

#### *Potential Primary Effects of CP2*

Following is a summary of potential environmental effects of CP2. Potential environmental effects are generally comparable between comprehensive plans; some adverse impacts would be exacerbated by larger dam raises and the associated scale of those effects, such as expanded construction areas and increased area of inundation around Shasta Lake. Proposed mitigation measures to address potential adverse impacts of CP2 are summarized in Table 4-6. A detailed discussion of potential effects and proposed mitigation measures are included in Chapters 4 through 25 of the EIS. A detailed discussion of the mitigation plan, including its development and proposed mitigation measures for all comprehensive plans, is included in the Preliminary Environmental Commitments and Mitigation Plan.

**Shasta Lake Area** As with CP1, the primary long-term effects of this comprehensive plan would be due to the direct effects from increased water surface elevations and inundation area and/or indirect effects related to facility modifications and relocations. The dam raise scenario under CP2 is greater than under CP1; therefore, anticipated effects under CP2 are expected to be slightly greater.

CP2 includes modifying two bridges and replacing six other bridges, inundating a number of small segments of existing paved and nonpaved roads, and relocating a number of potable water facilities, wastewater facilities, gas and petroleum facilities, and power distribution and telecommunications facilities. A number of recreation facilities would also be impacted, including campgrounds, marinas, resorts, boat ramps, day-use areas, and trails. Approximately 21 segments of roadway would be relocated, including portions of Lakeshore Drive, Fenders Ferry Road, Gilman Road, and Silverthorn Road. Embankments would be constructed to protect I-5 at Lakeshore and the UPRR at Bridge Bay. Any potential real estate acquisitions or necessary relocations of displaced parties would be accomplished under Public Law 91-646.

With CP2, Shasta Reservoir would fill to the new full pool storage of 5.0 MAF at a frequency similar to existing and future conditions. On the basis of water operations modeling (CalSim-II), Shasta Reservoir fills to 80 percent or its current capacity in about 81 percent of the years over the 82-year period of analysis of the CalSim-II model. Figure 4-2 shows an exceedence probability relationship of maximum annual storage in Shasta Reservoir for this and other dam raises. Under CP2, Shasta Reservoir would fill to 80 percent of the new capacity in about 74 percent of the years. Accordingly, annual operations in the reservoir would generally mirror existing operations, but the water surface in the reservoir would be about 12.5 feet higher. The primary difference in the reservoir area would be that during extended drought periods, the reservoir would be drawn down to without-project minimum levels. Figure 4-8 shows the changes from without-project conditions for CP2 for a representative period of 1972 through 2003.

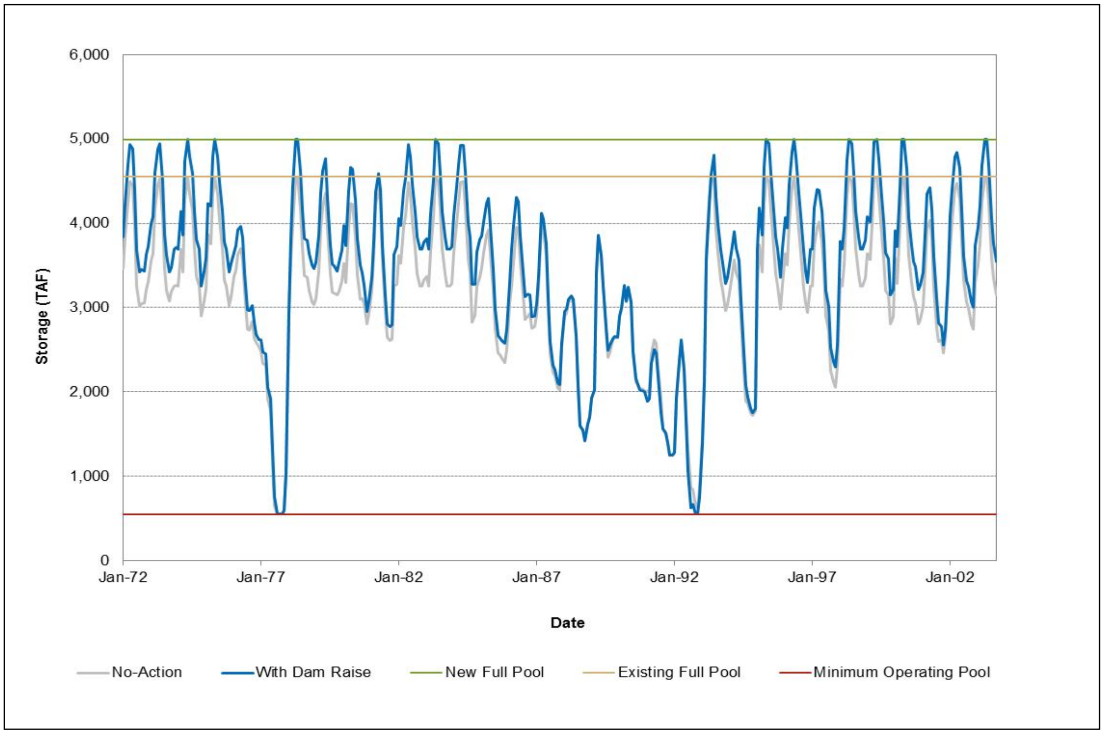



**Figure 4-8. Simulated Shasta Reservoir Storage from 1972 to 2003 for the No-Action Alternative and CP2**

The increased area of inundation for CP2 is about 1,900 acres. As with CP1, much of the vegetation in the enlarged drawdown zone on steeper lands would be removed during construction. In addition, some vegetation in the expanded drawdown zone would eventually be lost over time. However, it is expected that significant amounts of vegetation could remain on the flatter slopes because of infrequent inundation. The lower reaches of tributaries to Shasta Lake also would experience increased inundation.

Raising Shasta Dam 12.5 feet would result in inundating an additional 2,740 lineal feet (about 18 acres) of the lower McCloud River. This represents about 2 percent of the 24-mile-reach of river between the McCloud Bridge and McCloud Dam, which controls flows on the river.

Although recreation would generally improve under this plan, water in the reservoir would be drawn down to without-project conditions during the late fall and winter periods of some dry years, representing a drawdown 14.5 feet greater than under without-project conditions. In addition, clearances for boat traffic under the Pit River Bridge would be restricted to the north end of the bridge during periods of high reservoir levels (at or near full pool). This condition would typically occur in the late spring (May to June) in about 1 out of 3 years, and could last several days to a week. The estimated minimum clearance at the new full pool would be about 20 feet between Piers 6 and 7. This would not be expected to significantly impact boating on the lake.

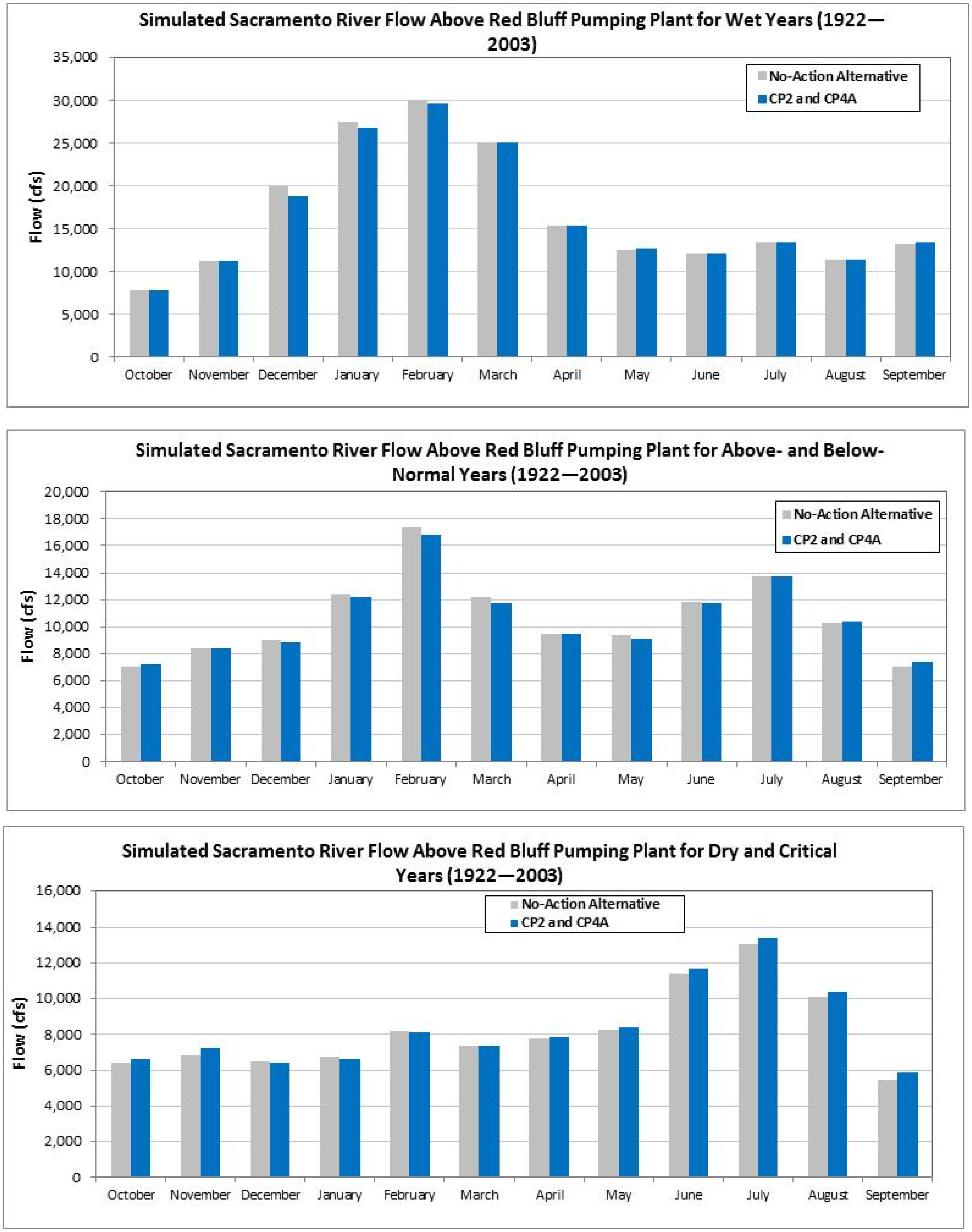
Additional long-term effects on biological resources associated with the relocation of reservoir area infrastructure are anticipated. Short-term, construction-related impacts are also anticipated in the primary study area.

**Upper Sacramento River** As with the previous plan, potential effects on flow and stages of the upper Sacramento River from this plan and other comprehensive plans would be minimal. Figure 4-9 shows Sacramento River flows above RBPP, simulated using CalSim-II, under above- and below-normal, and dry and critical year conditions for the No-Action Alternative, and CP2. Additional figures are included in the EIS Plan Formulation Appendix that show simulated Sacramento River flows below Keswick Dam and Stony Creek under wet, above- and below-normal, and dry and critical year conditions for all of the alternatives. As shown in Figure 4-9, during most years, annual operations of Shasta Reservoir, and subsequent flows and stages in the Sacramento River, would be relatively unchanged. Also, flows and stages would increase slightly from June through November. Although small, this increase would be most pronounced during dry periods as more water is released from Shasta Dam for water supply reliability purposes. During dry periods, however, there are few to no changes in water flows or changes during the winter and spring periods. All potential noticeable changes in flows and stages would diminish rapidly downstream from the RBPP.

Similar to CP1, changes in river flows and stages may impact geomorphic conditions, existing riparian vegetation, and other wildlife resources of the upper Sacramento River. As described above, the changes in temperatures and flows are expected to have a beneficial impact on anadromous fish resources. A possibility exists, however, that by benefiting anadromous fish, a slightly altered temperature and flow regime may adversely impact warm-water species in the Sacramento River. This effect is not expected to be significant.

#### *Preliminary Economics Assessment of CP2*

**Estimated Costs** Estimated construction cost and annual cost of CP2 are included in Table 4-7. As shown, the estimated construction cost is about $1,089 million. The estimated total annual cost of this plan is $51.2 million.




Note: Water year types based on the Sacramento Valley Water Year Hydrologic Classification.

**Figure 4-9. Simulated Sacramento River Flow Above Red Bluff Pumping Plant in Wet, Above- and Below-Normal, and Dry and Critical Years for No-Action, CP2, and CP4A**

**Estimated Economic Benefits** As shown in Table 4-8, the estimated average annual monetary benefit of this plan, assuming the cost of water and energy supplies increases at the same rate as inflation, is about $61.6 million. The largest monetary benefit is increased dry year water supply reliability. Assuming the cost of water supplies and hydropower increases at 2 percent above inflation, to account for future diminishment of water and energy supplies and increasing demands, the average annual benefit could exceed about $93.3 million per year.

## CP3 – 18.5-Foot Dam Raise, Agricultural Water Supply Reliability and Anadromous Fish Survival

CP3 consists primarily of enlarging Shasta Dam and Reservoir by raising the dam crest 18.5 feet and enlarging the reservoir by 634,000 acre-feet. Major features of CP3 in the Shasta Lake area are shown in Figure 4-1 and summarized in Table 4-1.

### *Major Components of CP3*

- Raising Shasta Dam and appurtenant facilities by 18.5 feet.
- Implementing the set of eight common management measures previously described.
- Implementing the common environmental commitments described above

As shown in Table 4-1, by raising Shasta Dam 18.5 feet, from a crest elevation of 1,077.5 feet to 1,096.0 feet (based on NGVD29), CP3 would increase the height of the reservoir's full pool by 20.5 feet. The additional 2-foot increase in the height of the full pool above the dam raise height would result from spillway modifications similar to modification proposed under CP1. 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 increase 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, I-5, and the UPRR tunnels, as shown in Figure 4-10. Raising the dam 18.5 feet would provide the minimum clearance required (4 feet) at the south end of the Pit River Bridge, while still providing more than 14 feet of clearance at the north end of the bridge. Figure 2-3 shows the increase in surface area and storage capacity for CP3.

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. The existing TCD would also be extended for efficient use of the expanded cold-water pool.

As described for the above plans, this plan would include the potential to revise flood control operational rules, which could reduce the potential for flood damage and benefit recreation.

### *Potential Benefits of CP3*

Major potential benefits of CP3, related to the SLWRI planning objectives and broad public services, are summarized in Tables 4-2 and 4-3 and described below.

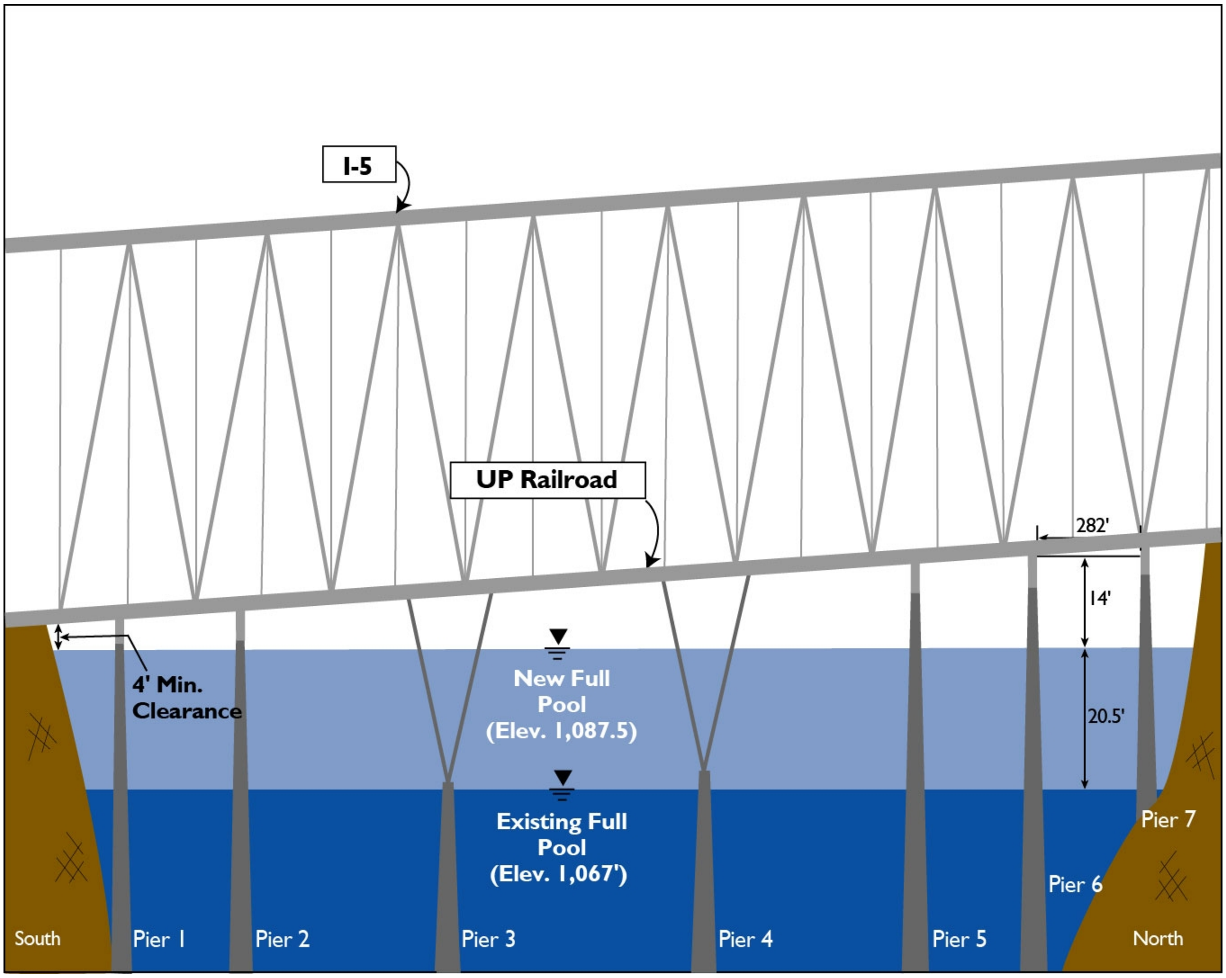



**Figure 4-10. Minimum Clearance for Boat Traffic at Pit River Bridge, Full Pool with 18.5-foot Dam Raise**

**Increase Anadromous Fish Survival** Similar to the above comprehensive plans, raising Shasta Dam by 18.5 feet would increase the ability of Shasta Dam to make cold-water releases and regulate water temperatures for fish in the upper Sacramento River, primarily in dry and critical water years. It is estimated that improved water temperature and flow conditions under CP3 could result in an average annual increase in the Chinook salmon population of about 207,400 outmigrating juvenile Chinook salmon.

**Increase Water Supply Reliability** CP3 would increase water supply reliability by increasing water supplies for CVP irrigation deliveries primarily during drought periods. This action would contribute to replacement of supplies redirected to other purposes in the CVPIA. As shown in Table 4-5, CP3 would help reduce estimated future water shortages by increasing the reliability of dry and critical year water supplies for agricultural deliveries by at least 63,100 acre-feet per year, and average annual deliveries by about 61,700 acre-feet per year**.** Almost half of the increased dry and critical year water supplies, 28,000 acre-feet, would be for south-of-Delta agricultural deliveries, with the remainder for north-of-Delta agricultural deliveries. In addition, water use efficiency could help reduce current and future water shortages by allowing a more effective use of existing supplies. Under CP3, approximately $3.1 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.

**Develop Additional Hydropower Generation** Higher water surface elevations in the reservoir would result in a net increase in power generation of about 86 GWh per year. 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.

**Maintain and Increase Recreation Opportunities** CP3 includes features to, at a minimum, maintain the existing recreation capacity at Shasta Lake. Although CP3 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. The maximum surface area of the lake would increase by about 2,600 acres (9 percent), from 29,700 acres to about 32,300 acres. The average surface area of the lake during the recreation season from May through September would increase by about 2,000 acres (8 percent), from 23,900 acres to 25,900 acres. There is also limited potential for reservoir reoperation to provide additional benefits to recreation by allowing more reliable filling of the reservoir during the spring.

**Benefits Related to Other SLWRI Planning Objectives** CP3 could also provide benefits related to flood damage reduction, ecosystem restoration, and water quality, as described for CP1, but to a greater extent because of increased capacity and associated overall system flexibility.

**Additional Broad Public Benefits** Additional broad public benefits of CP3 obtained through pursuing project objectives are summarized in Table 4-3. Broad public benefits for CP3 are similar to CP1 and CP2, but amplified because of increased system capacity and facility upgrades associated with additional relocations.

#### *Potential Primary Effects of CP3*

Following is a summary of potential environmental effects of CP3. Environmental effects are generally comparable between comprehensive plans; some adverse effects would be exacerbated by larger dam raises and the associated scale of those effects, such as expanded construction areas and increased area of inundation around Shasta Lake. Proposed mitigation measures to address potential adverse impacts of CP3 are summarized in Table 4-6. A detailed discussion of potential effects and proposed mitigation measures are included in Chapters 4 through 25 of the EIS. A detailed discussion of the mitigation plan, including its development and proposed mitigation measures for all comprehensive plans, is included in the Preliminary Environmental Commitments and Mitigation Plan Appendix to the accompanying EIS.

**Shasta Lake Area** As with the other comprehensive plans, the primary long-term effects of CP3 would be due to the increased water surface elevations and inundation area. The dam raise scenario under CP3 is greater than under CP1 or CP2; therefore, anticipated effects under CP3 are expected to be slightly greater. As with the above plan, raising the full pool of the lake would cause direct effects due to higher water levels, and/or indirect impacts related to facility modifications and relocations.

CP3 includes modifying two bridges and replacing six other bridges, inundating a number of small segments of existing paved and nonpaved roads, and relocating a number of potable water facilities, wastewater facilities, gas and petroleum facilities, and power distribution and telecommunications facilities. A number of recreation facilities would also be impacted, including campgrounds, marinas, resorts, boat ramps, day-use areas, and trails. Approximately 30 segments of roadway would be relocated, including portions of Lakeshore Drive, Fenders Ferry Road, Gilman Road, and Silverthorn Road. Embankments would be constructed to protect I-5 at Lakeshore and the UPRR at Bridge Bay. Any potential real estate acquisitions or necessary relocations of displaced parties would be accomplished under Public Law 91-646.

With CP3, Shasta Reservoir would fill to the new full pool storage of 5.19 MAF at a frequency similar to without-project conditions (see Figure 4-1). On the basis of water operations modeling (CalSim-II), Shasta Reservoir fills to 80 percent or its current capacity in about 81 percent of the years over the 82-year period of analysis of the CalSim-II model. Under CP3, Shasta Reservoir would fill to 80 percent of the new capacity in about 76 percent of the years (see Figure 4-2). Figure 4-2 shows an exceedence probability relationship of maximum annual storage in Shasta Reservoir for this and other dam raises.

Under CP3, Shasta Reservoir would also fill to 80 percent of the new capacity in about 72 percent of the years. Accordingly, annual operations in the reservoir would generally mirror existing operations, but the water surface in the reservoir would be about 18.5 feet higher. The primary difference in the reservoir area would be that during extended drought periods, the reservoir would be drawn down to without-project minimum levels. Figure 4-11 shows the changes from without-project conditions for CP3 feet for a representative period of 1972 through 2003.

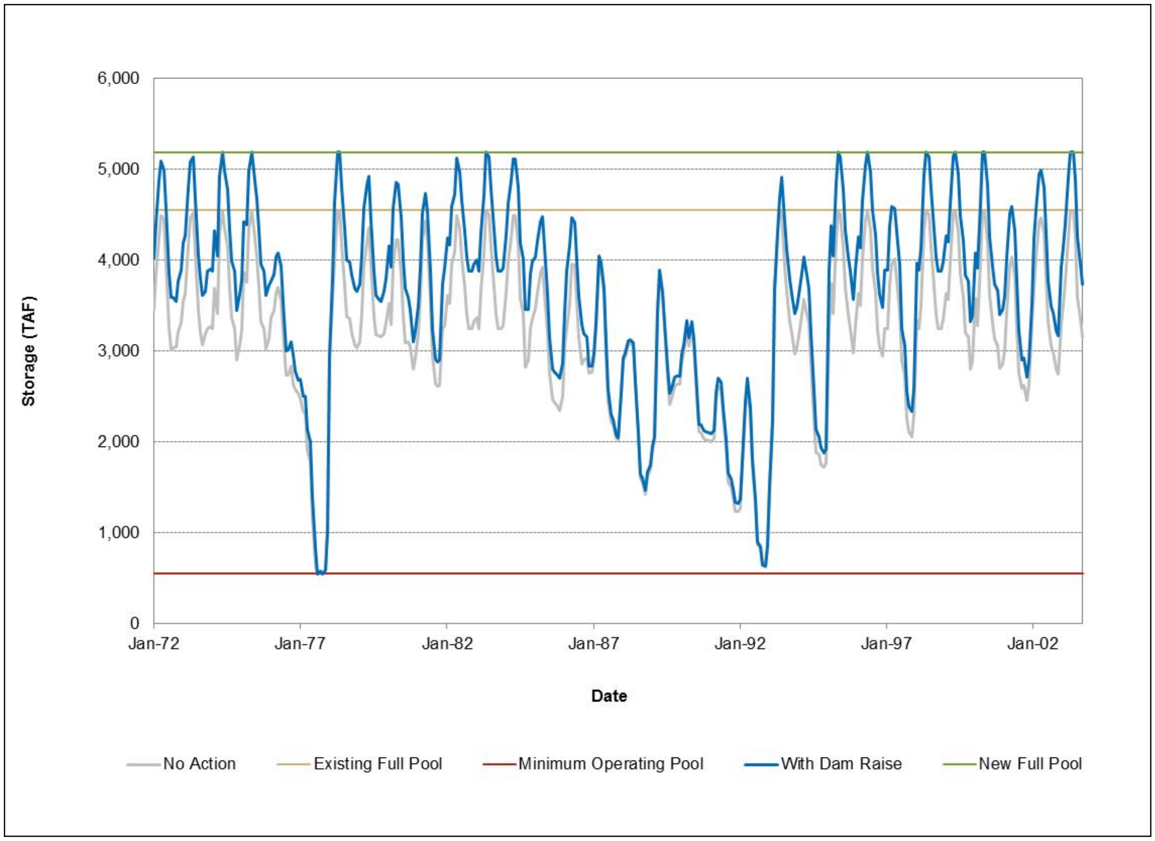



**Figure 4-11. Simulated Shasta Reservoir Storage from 1972 to 2003 for the No-Action Alternative and CP3**

The increased area of inundation for this plan is about 2,600 acres. As with the previous plans, much of the vegetation in the enlarged drawdown zone on steeper lands would be removed during construction. In addition, some vegetation in the expanded drawdown zone would eventually be lost over time. However, it is expected that significant amounts of vegetation could remain on the flatter slopes because of infrequent inundation. The lower reaches of tributaries to Shasta Lake would also experience increased inundation.

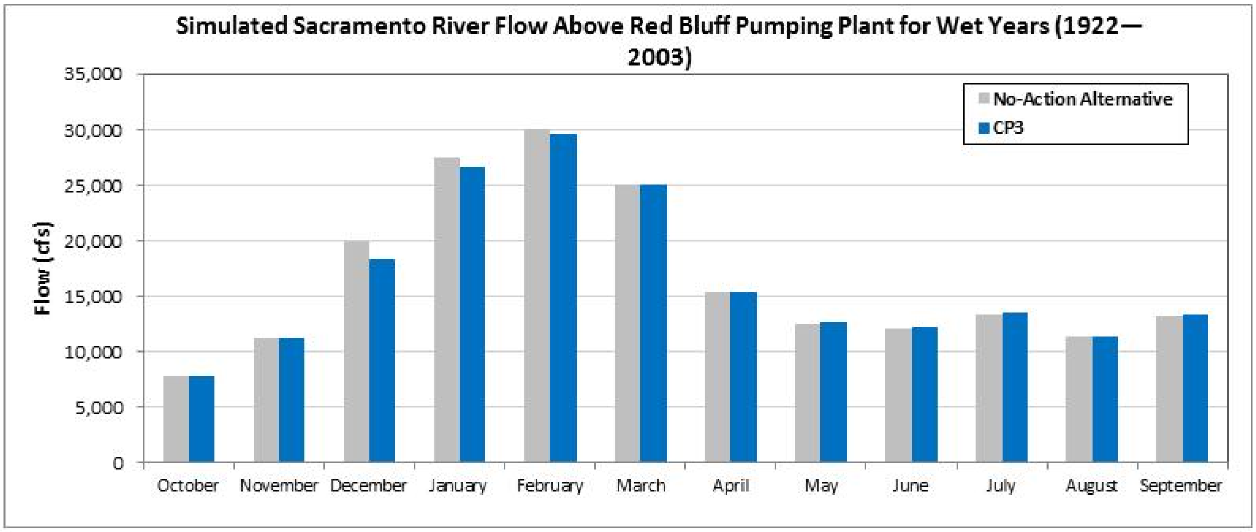
Raising Shasta Dam 18.5 feet would result in inundating an additional 3,550 lineal feet (about 27 acres) of the lower McCloud River (see Figure 4-4). This represents about 3 percent of the 24-mile-reach of river between the McCloud

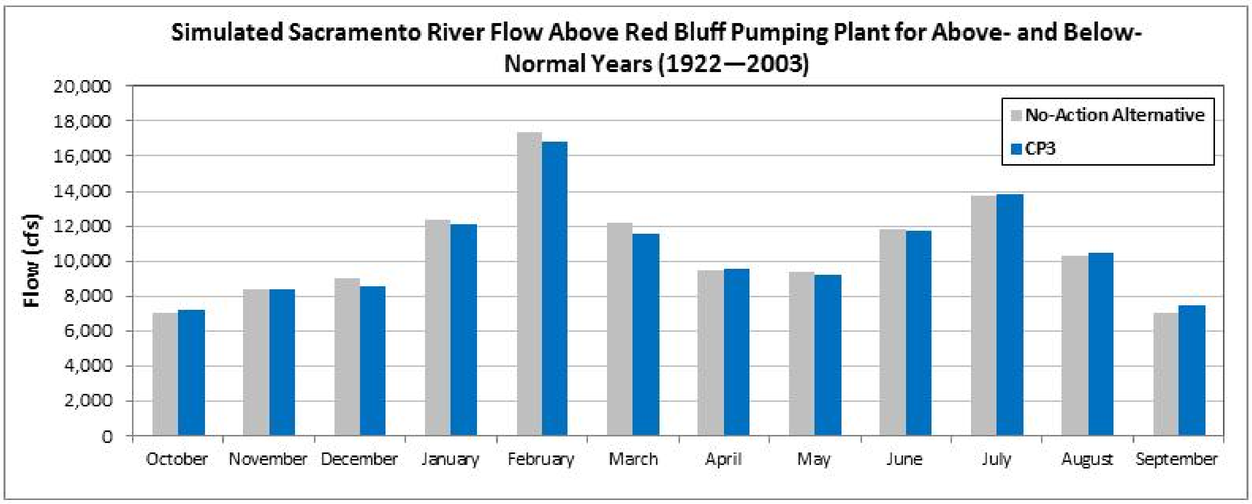
Bridge and McCloud Dam, which controls flows on the river. Although it is believed that recreation use would generally improve under this plan, water in the lake would be drawn down to without-project conditions during the late fall and winter periods of some dry years, representing a drawdown 20.5 feet greater than under without-project conditions. During these periods, the drawdown zone could increase by about 50 lineal feet. In addition, clearances for boat traffic under the Pit River Bridge would be restricted to the north end of the bridge during periods of high reservoir levels (at or near full pool). This condition would typically occur in the late spring (May to June) in about 1 out of 3 years, and could last several days to 1 or 2 weeks. Figure 4-10 illustrates that the minimum clearance at the new full pool would be about 14 feet between Piers 6 and 7. This could impact boating on the lake, as some houseboats exceed 16 feet in height. Since houseboating is a major recreational experience on Shasta Lake, especially around Memorial Day, restrictions on large boat traffic under the Pit River Bridge during maximum pool levels could adversely impact lake area boat rentals, marinas, and other recreation-dependent businesses.

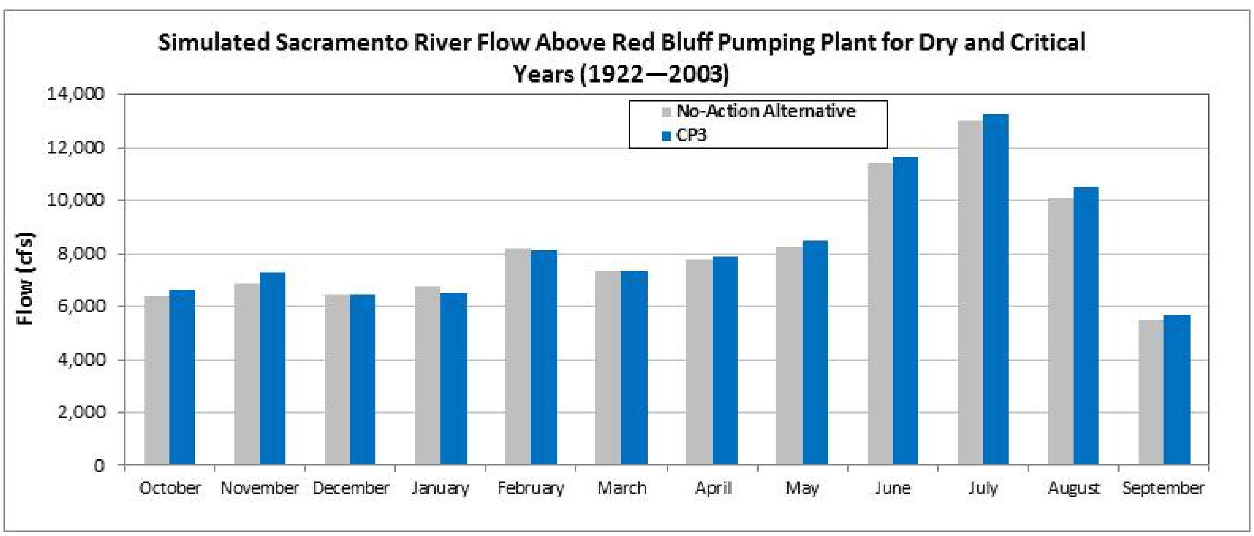
Additional long-term effects on biological resources associated with the relocation of reservoir area infrastructure are anticipated. Short-term, construction-related impacts are also anticipated in the primary study area.

**Upper Sacramento River** Potential effects on flow and stages of the upper Sacramento River from this plan and other comprehensive plans would be minimal. Figure 4-12 shows Sacramento River flows above RBPP, simulated using CalSim-II, under wet, above- and below-normal, and dry and critical year conditions for the No-Action Alternative and CP3. Additional figures are included in the EIS Plan Formulation Appendix that show simulated Sacramento River flows below Keswick Dam and Stony Creek, under wet, above- and below-normal, and dry and critical year conditions for all of the alternatives. As shown in Figure 4-12, during most years, annual operations of Shasta Reservoir, and subsequent flows and stages in the Sacramento River, would be relatively unchanged. Also, flows and stages would increase slightly from June through November. Although small, this increase would be most pronounced during dry periods as more water is released from Shasta Dam for water supply reliability purposes. During dry periods, however, there are few to no changes in water flows or changes during the winter and spring periods. All potential noticeable changes in flows and stages would diminish rapidly downstream from the RBPP.

Similar to other comprehensive plans, changes in river flow and stages may impact geomorphic conditions, existing riparian vegetation, and wildlife resources of the upper Sacramento River. As described above, the changes in temperature and flows are expected to have a beneficial effect on anadromous fish resources. A possibility exists, however, that by benefiting anadromous fish, a slightly altered temperature and flow regime may adversely impact warm-water species in the Sacramento River. This effect is not expected to be significant.




Note: Water year types based on the Sacramento Valley Water Year Hydrologic Classification.

**Figure 4-12. Simulated Sacramento River Flow Above Red Bluff Pumping Plant in Wet, Above- and Below- Normal, and Dry and Critical Years for No-Action and CP3**

#### *Preliminary Economics Assessment of CP3*

**Estimated Costs** Estimated construction cost and annual costs of CP3 are included in Table 4-7. As shown, the estimated construction cost is about $1,257 million. The estimated total annual cost of this plan is $53.8 million.

**Estimated Economic Benefits** As shown in Table 4-8, the estimated average annual monetary benefit of CP3, assuming the cost of water and energy supplies increases at the same rate as inflation, is about $42.6 million. Assuming the cost of water supplies and hydropower increases at 2 percent above inflation, to account for future diminishment of water and energy supplies and increasing demands, the average annual benefit could exceed about $60.7 million per year.

### CP4 and CP4A– 18.5-Foot Dam Raise, Anadromous Fish Focus with Water Supply Reliability

CP4 and CP4A focus on increasing anadromous fish survival by raising Shasta Dam 18.5 feet 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. Major features of CP4 and CP4A in the Shasta Lake area are shown in Figure 4-1 and summarized in Table 4-1.

#### *Major Components of CP4 and CP4A*

Major components CP4 and CP4A include the following:

- Raising Shasta Dam and appurtenant facilities by 18.5 feet.
- Reserving a portion of the increased storage in Shasta Lake for maintaining cold-water volume or augmenting flows as part of an adaptive management plan for anadromous fish survival (378,000 acre-feet for CP4, 191,000 acre-feet for CP4A)
- Augmenting spawning gravel in the upper Sacramento River.
- Restoring riparian, floodplain, and side channel habitat in the upper Sacramento River.
- Implementing the set of eight common management measures previously described.
- Implementing the common environmental commitments described above.

As shown in Table 4-1, by raising Shasta Dam 18.5 feet, from a crest at 1,077.5 feet to 1,096.0 feet (based on NGVD29), CP4 would increase the height of the reservoir full pool by 20.5 feet. The additional 2-foot increase in the height of the full pool above the dam raise height would result from spillway modifications similar to the modifications proposed under CP1. 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.

The additional storage created by the 18.5-foot dam raise would be used to improve the ability to meet temperature objectives and habitat requirements for anadromous fish during drought years, while also increasing water supply reliability. Of the increased reservoir storage space of CP4, about 378,000 acre-feet would be dedicated to increasing the cold-water supply for anadromous fish survival purposes. Of the increased storage space of CP4A, about 191,000 acre-feet would be dedicated to increasing the supply of cold water for anadromous fish survival purposes. Figure 2-3 shows the increase in surface area and storage capacity for CP4.

For CP4, operations for the remaining portion of increased storage (approximately 256,000 acre-feet) would be the same as in 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. For CP4A, operations for the remaining portion of increased storage (approximately 443,000 acre-feet) would be the same as in CP2, with 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. The existing TCD would also be extended to achieve efficient use of the expanded cold-water pool for CP4 or CP4A.

As described for the above comprehensive plans, both CP4 and CP4A would include the potential to revise operational rules for flood control for Shasta Dam and Reservoir, which could reduce the potential for flood damage and benefit recreation.

Both CP4 and CP4A also include an adaptive management plan for the cold-water pool, augmenting spawning gravel, and restoring riparian, floodplain, and side channel habitat in the upper Sacramento River.

**Adaptive Management of Cold-Water Pool** Both CP4 and CP4A may also include development of an adaptive management plan for the storage capacity dedicated to increasing the supply of cold water for anadromous fish survival (378,000 acre-feet for CP4, 191,000 acre-feet for CP4A). 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 are no conflicts with current operational guidelines or adverse impacts to water supply reliability. 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 water in storage to meet temperature requirements. Reclamation would manage the cold-water pool each year in cooperation with the SRTTG. Because adaptive management is 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 would conduct monitoring, develop monitoring protocols, and set performance standards to determine the success of adaptive management actions.

**Augment Spawning Gravel in 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 2009b). Under CP4 and CP4A, spawning-sized gravel would be injected 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 addition to the ongoing CVPIA gravel augmentation program, would help address the gravel debt in the upper Sacramento River, but this reach may continue to be gravel-limited in the future. Therefore, the gravel augmentation program proposed herein 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.

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 washed and sorted to meet specific size criteria, and would be applied to active river channels 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, USFWS, CDFW, and 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 impact 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** Under CP4 and CP4A, 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 4-13.

*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 I-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.

#### Potential Benefits of CP4 and CP4A

Major potential benefits of CP4 and CP4A, related to the SLWRI planning objectives and broad public services, are summarized in Tables 4-2 and 4-3 and described below.

**Increase Anadromous Fish Survival** CP4 or CP4A 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. It is estimated that improved temperature conditions under CP4 could result in an average annual increase in Chinook salmon population of nearly 812,600 outmigrating juvenile fish. It is estimated that improved water temperature and flow conditions under CP4A could result in an average annual increase in Chinook salmon population of nearly 710,000 outmigrating juvenile Chinook salmon.

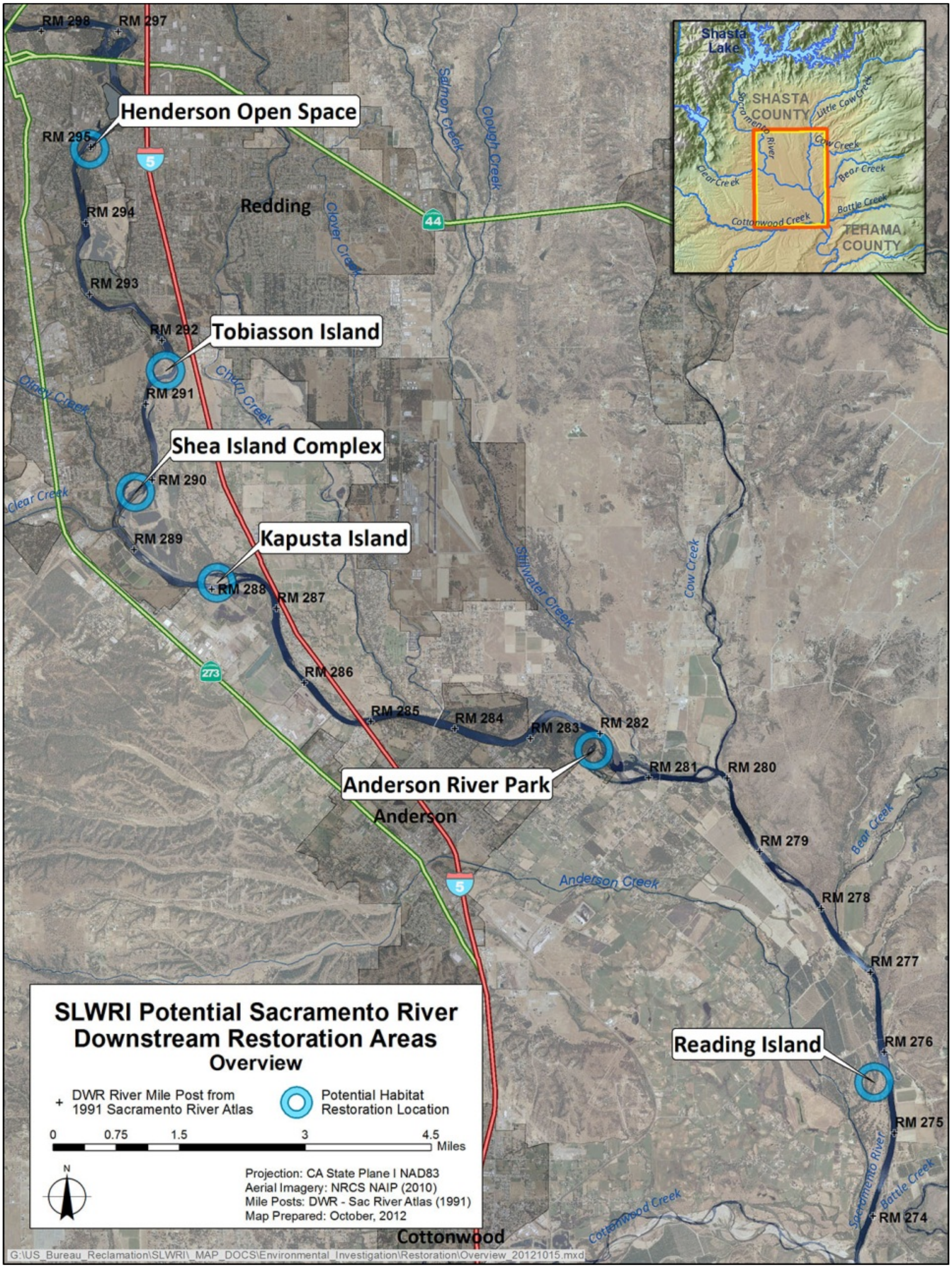
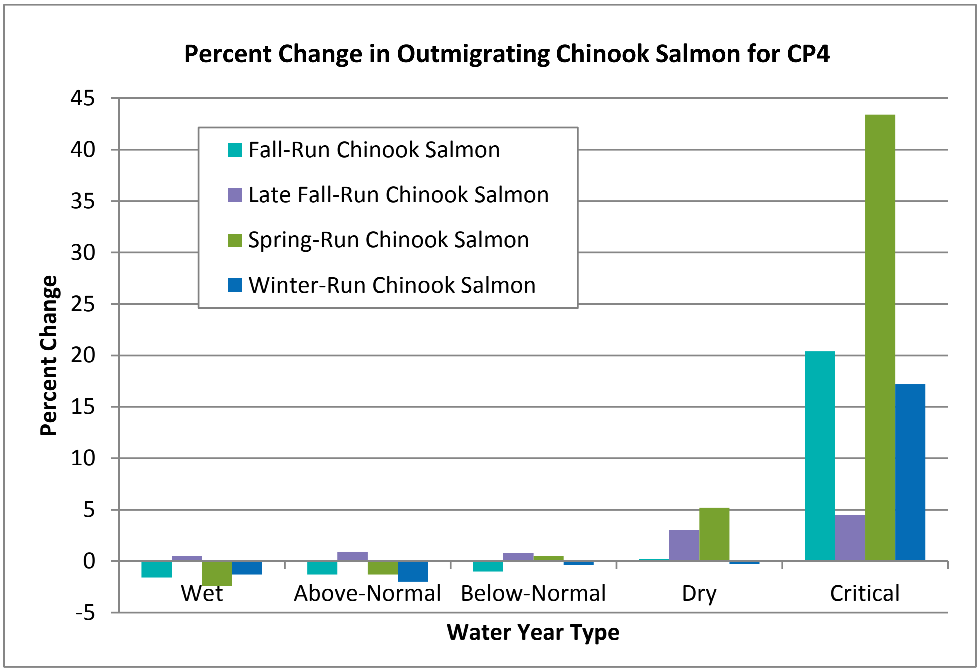


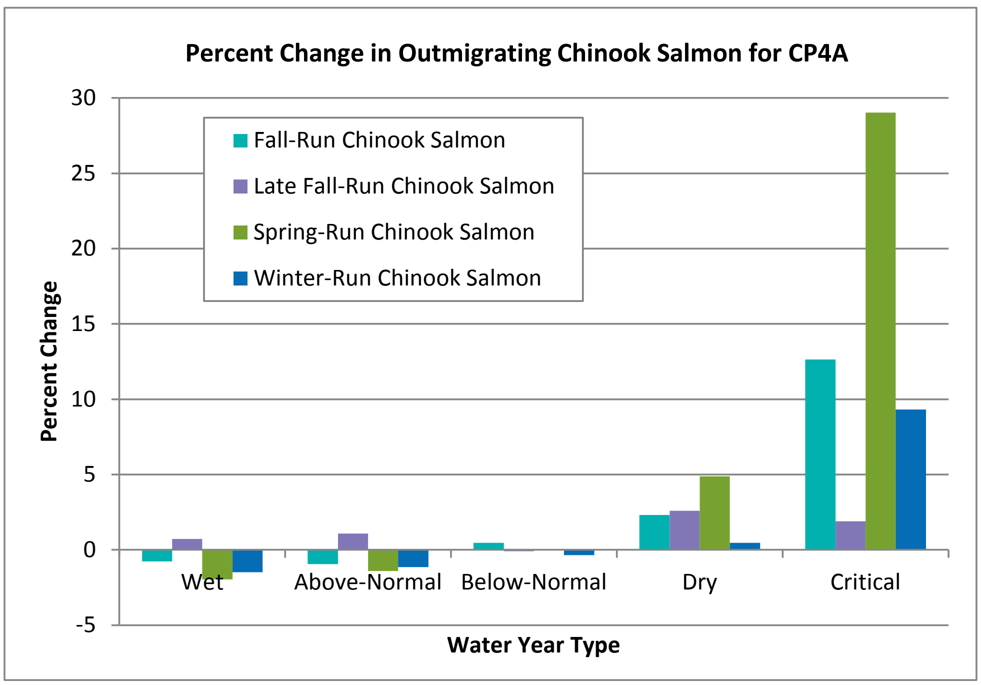

**Figure 4-13. Potential Sacramento River Restoration Areas**

Under CP4 and CP4A, 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 CP4, about 378,000 acre-feet (60 percent) would be dedicated to increasing the cold-water supply for anadromous fish survival purposes. Of the increased storage space for CP4A, about 191,000 acre-feet (30 percent) would be dedicated to increasing the cold-water supply for anadromous fish survival purposes. Reclamation would manage the cold-water pool each year based on recommendations from SRTTG. To assess the effects of operations on Chinook salmon in the upper Sacramento River, the computer model SALMOD was upgraded to evaluate changes in Chinook salmon population between Keswick Dam and the RBPP. In response to changes in Shasta Reservoir operations under CP4 and CP4A during dry and critical water years – the years targeted for improving water reliability for both users and fish – modeling with SALMOD showed increases in production of Chinook salmon populations, especially winter-run and spring-run Chinook (Figure 4-14).

In addition, CP4 and CP4A include 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 and, 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.

**Increase Water Supply Reliability** CP4 or CP4A would increase water supply reliability by increasing water supplies for CVP and SWP irrigation and M&I deliveries primarily during drought periods. This action would contribute to replacement of supplies redirected to other purposes in the CVPIA. As shown in Table 4-5, CP4 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 47,300 acre-feet per year and average annual deliveries by about 31,000 acre-feet per year. As shown in Table 4-5, CP4A 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, 42,700 acre-feet for CP4 and 67,100 acre-feet for CP4A, would be for south-of-Delta agricultural and M&I deliveries. In addition, water use efficiency could help reduce current and future water shortages by allowing a more effective use of existing supplies. Under CP4 and CP4A, approximately $1.6 million and $2.6 million, respectively, 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.




Note: Simulated Using SALMOD; Water Year Types Based on the Sacramento Valley Water Year Hydrologic Classification

**Figure 4-14. Percent Change in Outmigrating Chinook Salmon for CP4 and CP4A**

**Develop Additional Hydropower Generation** Higher water surface elevations in the reservoir would result in a net increase in power generation of about 127 GWh per year for CP4 and 125 GWh per year for CP4A. This generation value is the expected increased generation from Shasta Dam and other CVP/SWP facilities. Other power benefits for both CP4 and CP4A 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 are expected to improve the complexity of aquatic habitat and its suitability for anadromous salmonid spawning and rearing. Riparian areas provide habitat for a diverse array of plant and animal communities along the Sacramento River, including several threatened or endangered species. Riparian areas 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 play an important role in the health and succession of riparian habitat. Restoration would support the goals of the Sacramento River Conservation Area Forum and other programs associated with riparian restoration along the Sacramento River. Side channels can support important habitat for anadromous salmonids, including rearing and spawning habitat. Side channel habitats also provide refuge from predators and productive foraging habitat for juvenile anadromous salmonids. In addition, improved fisheries conditions as a result of cold-water carryover storage in CP4 or CP4A, as described above, and increased flexibility to meet flow and temperature requirements, could also enhance overall ecosystem resources in the Sacramento River.

**Maintain and Increase Recreation Opportunities** CP4 and CP4A include features to, at a minimum, maintain the existing recreation capacity at Shasta Lake. Although neither CP4 nor CP4A 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. For CP4 and CP4A, the maximum surface area of the lake would increase by about 2,600 acres (9 percent), from 29,700 acres to about 32,300 acres. For CP4, the average surface area of the lake during the recreation season from May through September would increase by about 2,600 acres (11 percent), from 23,900 acres to 26,500 acres. For CP4A, 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. There is also limited potential to provide additional benefits to recreation by allowing more reliable filling of the reservoir during the spring.

**Benefits Related to Other SLWRI Planning Objectives** CP4 and CP4A could also provide benefits related to flood damage reduction, and water quality, similar to CP1 and CP2, respectively.

**Additional Broad Public Benefits** Additional broad public benefits of CP4 and CP4A obtained through pursuing project objectives are summarized in

Table 4-3. Broad public benefits for CP4 and CP4A are similar to those for CP3.

### *Potential Primary Effects of CP4 and CP4A*

Following is a summary of potential environmental consequences of CP4 and CP4A. Potential environmental effects are generally comparable between comprehensive plans; some adverse effects would be exacerbated by larger dam raises and the associated scale of those effects, such as expanded construction areas and increased area of inundation around Shasta Lake. Anticipated effects of construction and increased water surface elevations under CP4 and CP4A are similar to CP3. Potential effects on flow and stages of the upper Sacramento River from CP4 and CP4A are identical to those for CP1 and CP2, respectively. Proposed mitigation measures to address potential adverse impacts of CP4 and CP4A are summarized in Table 4-6. A detailed discussion of potential effects and proposed mitigation measures are included in Chapters 4 through 25 of the EIS. A detailed discussion of the mitigation plan, including its development and proposed mitigation measures for all comprehensive plans, is included in the Preliminary Environmental Commitments and Mitigation Plan Appendix to the accompanying EIS.

**Shasta Lake Area** As with the other comprehensive plans, the primary long-term effects of CP4 and CP4A would be due to the increased water surface elevations and inundation area. As with the above plan, raising the full pool of the lake would cause direct effects due to higher water levels, and/or indirect impacts related to facility modifications and relocations. Anticipated construction and relocation effects associated with CP4 and CP4A would be the same as for CP3, as described above. Any potential real estate acquisitions or necessary relocations of displaced parties would be accomplished under Public Law 91-646.

With CP4 and CP4A, Shasta Reservoir would fill to the new full pool storage capacity of 5.19 MAF at a frequency similar to without-project conditions. On the basis of water operations modeling (CalSim-II), Shasta Reservoir fills to 80 percent of its current capacity in about 81 percent of the years over the 82-year period of analysis of the CalSim-II model. Included in Figure 4-2 is an exceedence probability relationship of maximum annual storage in Shasta Lake for this and other dam raises. Under CP4, Shasta Reservoir would fill to 80 percent of the new capacity in about 82 percent of the years. Under CP4A, Shasta Reservoir would fill to 80 percent of the new capacity in about 77 percent of the years. Accordingly, the annual operations in the reservoir under CP4 or CP4A would generally mirror existing operations, except the water surface in the lake would be about 18.5 feet higher. The primary difference in the reservoir area would be that during extended drought periods, the reservoir would be drawn down to approximately 378,000 acre-feet above without-project minimum levels under CP4 and 191,000 acre-feet above without-project minimum levels under CP4A. This is because of the dedicated storage capacity for increasing the cold-water pool for anadromous fish purposes. Figure 4-15 shows the changes from without-project conditions for CP4 and CP4A for a representative period of 1972 through 2003.

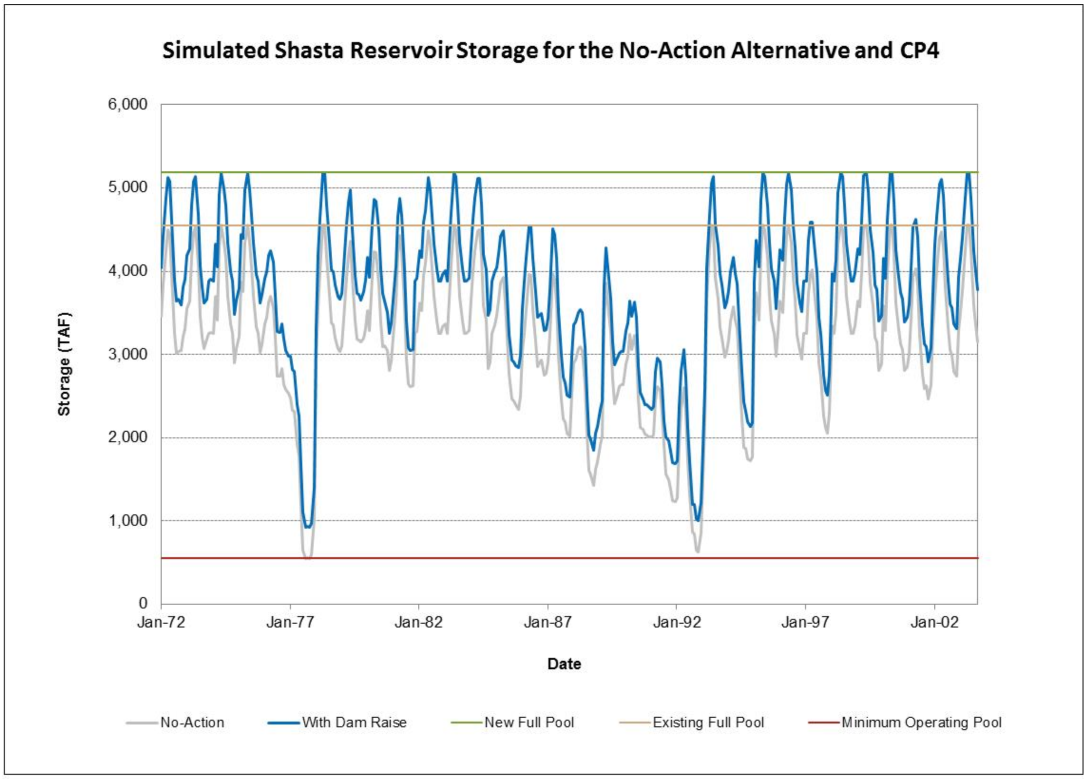
The increased area of inundation for CP4 and CP4A is about 2,600 acres, which is the same as for CP3. Accordingly, the effects of inundation on vegetation in the enlarged drawdown zone and on the lower McCloud River for CP4 and CP4A would be similar to CP3.

As shown in Figure 4-15, since a portion of the increased storage capacity would be dedicated to increasing the cold-water pool, water levels in the lake under CP4 and CP4A would generally be higher than under without-project conditions. It is anticipated that recreation use would generally improve under CP4 and CP4A because of a larger lake surface area, reduced drawdown during the recreation season, and modernization of recreation facilities. Although water levels would generally be higher than under existing conditions and drawdown during the recreation season would generally be reduced, during some dry years, the total drawdown zone could increase under CP4 and CP4A. Effects to clearances for boat traffic under the Pit River Bridge under CP4 and CP4A would be similar to CP3.

Additional long-term effects on biological resources associated with the relocation of reservoir area infrastructure are anticipated. Short-term, construction-related impacts are also anticipated in the primary study area.

**Upper Sacramento River** Potential effects on flow and stages of the upper Sacramento River from CP4 are identical to those for CP1 (Figure 4-7). Potential effects on flow and stages of the upper Sacramento River from CP4A are identical to those for CP2 (Figure 4-9).

Some potential exists for impacting existing habitat at upper Sacramento River restoration sites, but these impacts would likely result from converting present land use back to a more typical riverine environment.



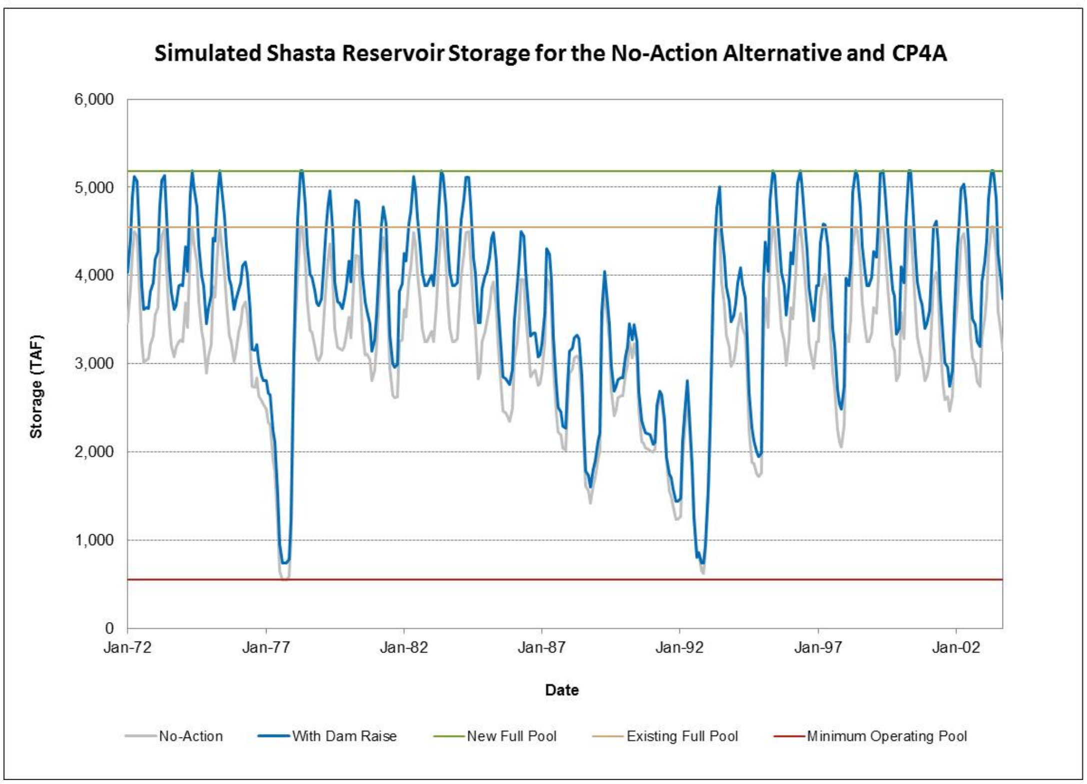




**Figure 4-15. Simulated Shasta Reservoir Storage from 1972 to 2003 for CP4 and CP4A Compared to the No-Action Alternative**

### *Preliminary Economics Assessment of CP4*

**Estimated Costs** The estimated construction cost and annual cost of CP4 and CP4A are included in Table 4-7. As shown, for CP4, the estimated construction cost is $1,264 million and the estimated total annual cost is $57.1 million. For CP4A, the estimated construction cost is $1,265 million and the estimated total annual cost is $59.0 million.

**Estimated Economic Benefits** The estimated average annual monetary benefits of CP4 and CP4A are included in Table 4-8. As shown, for CP4, the estimated average annual monetary benefit, assuming the cost of water and energy supplies increases at the same rate as inflation, is about $86.0 million. For CP4A, the estimated average annual monetary benefit, assuming the cost of water and energy supplies increases at the same rate as inflation, is about $88.9 million. Assuming the cost of water supplies and hydropower increases at 2 percent above inflation, to account for future diminishment of water and energy supplies and increasing demands, the average annual benefit could exceed about $111.6 million per year and $124.1 million per year for CP4 and CP4A, respectively.

## CP5 – 18.5-Foot Dam Raise, Combination Plan

CP5 primarily focuses on increased water supply reliability, anadromous fish survival, Shasta Lake area environmental resources, and increased recreation opportunities. Major features of CP5 in the Shasta Lake area are shown in Figure 4-1 and summarized in Table 4-1.

### *Major Components of CP5*

Major components of this plan include the following:

- Raising Shasta Dam and appurtenant facilities by 18.5 feet.
- Constructing additional resident fish habitat in Shasta Lake and along the lower reaches of its tributaries (Sacramento River, 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.
- Increasing recreation opportunities at Shasta Lake.
- Implementing the set of eight common management measures previously described.
- Implementing the common environmental commitments described above.

As shown in Table 4-1, by raising Shasta Dam 18.5 feet, from a crest elevation of 1,077.5 feet to 1,096.0 feet (based on NGVD29), CP5 would increase the height of the reservoir full pool by 20.5 feet. The additional 2-foot increase in the height of the full pool above the dam raise height would result from spillway modifications similar to those described for CP1. 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. Figure 2-3 shows the increase in surface area and storage capacity for CP5.

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. The existing TCD would be extended to achieve efficient use of the expanded cold-water pool. 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.

As described for the above plans, this plan also would include the potential to revise the flood control operational rules for Shasta Dam and Reservoir, which could reduce the potential for flood damage reduction and benefit recreation.

**Construct Reservoir Shoreline Enhancement** The ecosystem enhancement goal for the shoreline environment of Shasta Lake is to improve the warm-water fish habitat associated with the transition between the reservoir's aquatic and terrestrial habitats. Shoreline enhancement entails the range of enhancement opportunities along the Shasta Lake shoreline below the full pool elevation of 1,090 feet (based on NAVD88)[2] that would occur with an 18.5-foot dam raise. This area is typically between 0.1 mile and 1.5 miles upslope from the current full pool elevation of 1,070 feet (based on NAVD88). The shoreline is defined as the area encompassing nearshore aquatic habitat within the reservoir itself, and vegetation and other habitat components adjacent to the reservoir.

Two categories of potential nearshore warm-water fish habitat enhancement activities would be (1) structural enhancements, which entail placing artificial structures in Shasta Lake's littoral zone, and (2) vegetative enhancements, which entail planting and seeding to provide submerged and partly submerged vegetative cover when the reservoir is at full pool capacity during the winter/spring months.

[2] Shasta Lake water surface elevations are based on NAVD88. All 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 which was completed using NAVD88.

Vegetative enhancements associated with CP5 include planting willows (Salix) to enhance nearshore fish habitat, and single treatment aerial and hand seeding of annual native grasses to treat shoreline areas at Shasta Lake. Treatment with native grasses would provide only short-term cover, but would be cost-effective across large areas and can be implemented quickly and efficiently. The annual native grasses would provide cover for young fish and also nutrients for plankton as the grasses decompose. The plankton, in turn, are a valuable food source for juvenile fish.

**Construct Reservoir Tributary Aquatic Habitat Enhancement** The primary goal for the enhancement of aquatic habitat in the watershed is to enhance the connectivity for native fish species and other aquatic organisms between Shasta Lake and its tributaries. Two categories of potential aquatic habitat enhancement in tributaries would be (1) fish passage enhancements, which entail identifying and correcting barriers to fish passage, particularly at culverts and other human-made barriers, and (2) aquatic habitat enhancements, which entail identifying and implementing feasible habitat improvements intended to conserve or restore degraded aquatic and riparian habitat in tributaries to Shasta Lake.

Fish passage enhancements associated with CP5 would include opportunities to restore and/or enhance five perennial stream crossings. Barriers to fish passage in the watersheds above Shasta Lake would be associated primarily with culverts or other types of stream crossings.

Aquatic habitat enhancements associated with CP5 would involve enhancing aquatic connectivity and reducing sediment related to roads constructed across intermittent streams. The preliminary site survey identified opportunities to enhance 14 intermittent stream crossings. Based on the information obtained in the survey, these crossings would provide opportunities for meeting the objectives of enhancing aquatic connectivity and/or reducing the potential for road-related sediment. Two sites have been identified in the Salt Creek watershed, two sites have been identified in the Sugarloaf Creek watershed, and ten sites have been identified in the McCloud River Arm watershed.

**Augment Spawning Gravel in Upper Sacramento River** As described in CP4 and CP4A, spawning-sized gravel would be placed at multiple locations along the Sacramento River between Keswick Dam and the RBPP. Gravel augmentation under CP5 would be identical to the gravel augmentation measure of CP4 and CP4A.

**Restore Riparian, Floodplain, and Side Channel Habitat** As described in CP4 and CP4A, riparian, floodplain, and side channel habitat restoration would occur at suitable locations along the Sacramento River. Under CP5, this measure would be identical to that proposed under CP4 and CP4A.

**Recreation Enhancements** A total of 18 miles of new hiking trails and 6 trailheads would be constructed to enhance recreation under CP5.

### *Potential Benefits of CP5*

Major potential benefits of CP5, related to the SLWRI planning objectives and broad public services, are summarized in Tables 4-2 and 4-3 and described below.

**Increase Anadromous Fish Survival** CP5 would 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. It is estimated that improved water temperature and flow conditions under CP5 could result in an annual average increase in the Chinook salmon population of about 377,800 outmigrating juvenile Chinook salmon.

**Increase Water Supply Reliability** CP5 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. As shown in Table 4-5, CP5 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 113,500 acre-feet per year and average annual deliveries by about 75,900 acre-feet per year. The majority of increased dry and critical year water supplies, 88,300 acre-feet, would be for south-of-Delta agricultural and M&I deliveries. In addition, increased water use efficiency could help reduce current and future water shortages by allowing a more effective use of existing supplies. Under CP5, approximately $3.8 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.

**Develop Additional Hydropower Generation** Higher water surface elevations in the reservoir would result in a net increase in power generation of about 112 GWh per year. 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** CP5 would provide for habitat improvements both in the reservoir area and downstream from Shasta Dam on the upper Sacramento River.

Along the Shasta Lake shoreline, shallow warm-water fish habitat would be improved by using manzanita cleared from above the inundation zone to create structural enhancements, planting willows (*Salix*) to enhance nearshore fish habitat, and seeding of native grasses to treat shoreline areas. Once established, the willows and native grasses would provide submerged and partly submerged vegetative cover when the reservoir is at full pool capacity during the winter/spring months. These improvements would help provide favorable spawning conditions, and juvenile fish leaving the tributaries would benefit from improved adjacent shoreline habitat. Placing manzanita brush structures near the shoreline would enhance the diversity of structural habitat available for the warm-water fish species that occupy Shasta Lake. Establishing vegetation also could benefit terrestrial species that inhabit the shoreline of Shasta Lake.

The lower reaches of perennial tributaries to Shasta Lake would be the focus for aquatic restoration because they provide year-round fish habitat. Native fish species require connectivity to the full range of habitats offered by Shasta Lake and its tributaries. Improved fish passage would address the requirement to provide access and/or modify barriers necessary to improve ecological conditions that support these native fish assemblages. Aquatic habitat improvements would include enhancing aquatic connectivity and reducing sediment related to roads constructed across intermittent streams.

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 spawning and rearing. Riparian areas would provide habitat for a diverse array of plant and animal communities along the Sacramento River, including numerous 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. Restoration would support the goals of the Sacramento River Conservation Area Forum and other programs associated with riparian restoration along 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** CP5 includes features to, at a minimum, maintain the existing recreation capacity at Shasta Lake. In addition, this alternative involves construction of 18 miles of new trails and 6 trailheads to enhance recreation opportunities at Shasta Lake. As with the other alternatives, 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. The maximum surface area of the lake would increase by about 2,600 acres (9 percent), from 29,700 acres to about 32,300 acres. The average surface area of the lake during the recreation season from May through September would increase by about 1,900 acres (8 percent), from 23,900 acres to 25,800 acres. There would also be limited potential for reservoir reoperation to provide additional benefits to recreation by allowing more reliable filling of the reservoir during the spring.

**Benefits Related to Other SLWRI Planning Objectives** CP5 could also provide benefits related to flood damage reduction and water quality, similar to CP3.

**Additional Broad Public Benefits** Additional broad public benefits of CP5 obtained through pursuing project objectives are summarized in Table 4-3. Broad public benefits for CP5 are similar to those for CP3.

#### *Potential Primary Effects of CP5*

Following is a summary of potential environmental consequences of CP5. Potential environmental effects are generally comparable between comprehensive plans; some adverse effects would be exacerbated by larger dam raises and the associated scale of those effects, such as expanded construction areas and increased area of inundation around Shasta Lake. Anticipated effects of construction and increased water surface elevations under CP5 are similar to CP3, CP4, and CP4A as summarized above. Proposed mitigation measures to address potential adverse impacts of CP5 are summarized in Table 4-6. A detailed discussion of potential effects and proposed mitigation measures are included in Chapters 4 through 25 of the accompanying EIS. A detailed discussion of the mitigation plan, including its development and proposed mitigation measures for all comprehensive plans, is included in the Preliminary Environmental Commitments and Mitigation Plan Appendix to the accompanying EIS.

**Shasta Lake Area** As with the other comprehensive plans, the primary long-term effects of CP5 would be due to the increased water surface elevations and inundation area. As with the above plan, raising the full pool of the lake would cause direct effects due to higher water levels, and/or indirect impacts related to facility modifications and relocations. Anticipated construction and relocation effects associated with CP4 would be the same as CP3, CP4, and CP4A, as described above. Any potential real estate acquisitions or necessary relocations of displaced parties would be accomplished under Public Law 91-646.

With CP5, Shasta Reservoir would fill to the new full pool storage capacity of 5.19 MAF at a frequency similar to without-project conditions. On the basis of water operations modeling (CalSim-II), Shasta Reservoir fills to 80 percent of its current capacity in about 81 percent of the years over the 82-year period of analysis of the CalSim-II model. Included in Figure 4-2 is an exceedence probability relationship of maximum annual storage in Shasta Lake for this and other dam raises. Under CP5, Shasta Reservoir would also fill to 80 percent of the new capacity in about 72 percent of the years. Accordingly, the annual operations in the reservoir would generally mirror existing operations, except the water surface in the lake would be about 18.5 feet higher. The primary difference in the reservoir area would be that during extended drought periods, the reservoir would be drawn down to without-project minimum levels. Figure 4-16 shows the changes from without-project conditions for CP5 for a representative period of 1972 through 2003.

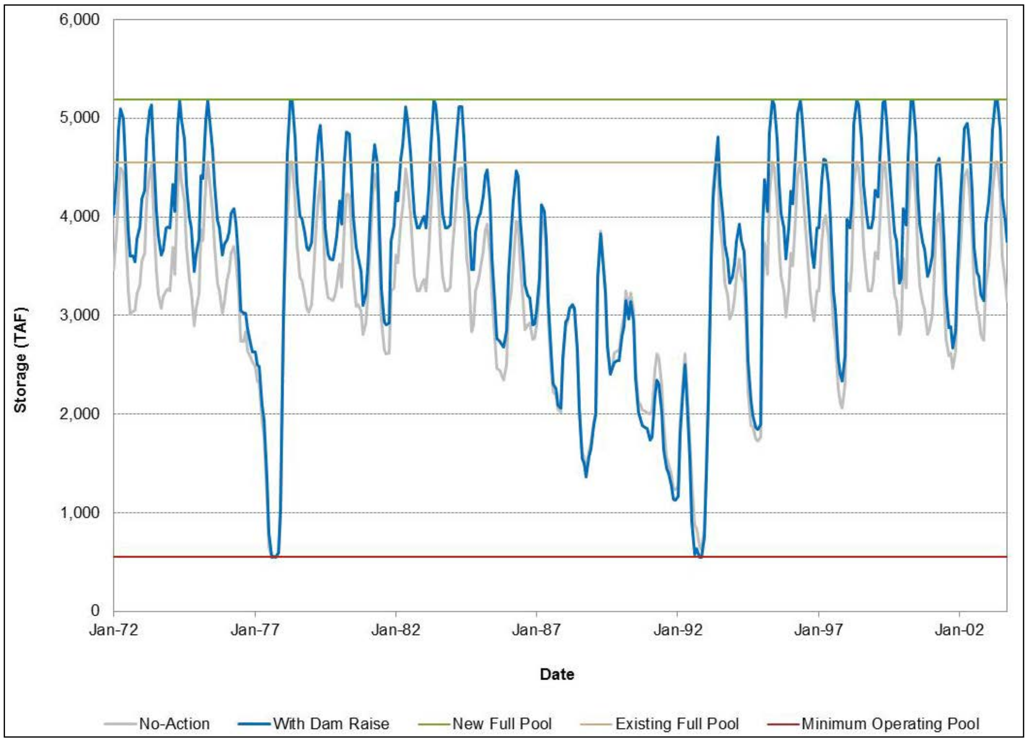



**Figure 4-16. Simulated Shasta Reservoir Storage from 1972 to 2003 for the No-Action Alternative and CP5**

The increased area of inundation for this plan is about 2,600 acres, which is the same for CP3, CP4, and CP4A. Accordingly, the effects of inundation on vegetation in the enlarged drawdown zone and on the lower McCloud River for CP5 would be similar to CP3, CP4, and CP4A.

As shown in Figure 4-16, water levels in the lake under CP5 would generally be higher than under without-project conditions. It although it is believed that recreation use would generally improve under this plan because of a larger lake surface area, water in the lake would be drawn down to existing conditions during the late fall and winter periods of some dry years, representing a drawdown 20.5 feet greater than under existing conditions. During these periods, the drawdown zone could increase by about 50 linear feet. Effects to clearances for boat traffic under the Pit River Bridge under CP5 would be similar to CP3, CP4, and CP4A.

Additional long-term effects on biological resources associated with the relocation of reservoir area infrastructure are anticipated. Short-term, construction-related impacts are also anticipated in the primary study area.

**Upper Sacramento River** As with the previous plan, potential effects on flow and stages of the upper Sacramento River from this and other comprehensive plans would be minimal. Figure 4-17 shows CalSim-II simulated Sacramento River flows above RBPP under wet, above- and below-normal, and dry and critical year conditions for the No-Action Alternative compared to CP5. Additional figures are included in the EIS Plan Formulation Appendix that show simulated Sacramento River flows below Keswick Dam and Stony Creek, under wet, above- and below-normal, and dry and critical year conditions for all of the alternatives. As shown, during most years, annual operations of Shasta Reservoir, and subsequent flows and stages in the Sacramento River, would be relatively unchanged. Also, flows and stages would increase slightly from June through November. Although small, this increase would be most pronounced during dry periods as more water is released from Shasta Dam for water supply reliability purposes. During dry periods, however, there are few to no changes in water flows or changes during the winter and spring periods. All potential noticeable changes in flows and stages would diminish rapidly downstream from the RBPP.

Changes in river flows and stages may impact geomorphic conditions along the river, existing riparian vegetation, and other wildlife resources. As described above, the changes in temperatures and flows are expected to have a beneficial impact on anadromous fish resources. A possibility exists, however, that by benefiting anadromous fish, a slightly altered temperature and flow regime may adversely impact warm-water species in the Sacramento River. This effect is not expected to be significant.

Some potential exists for impacting existing habitat at upper Sacramento River restoration sites, but these impacts would likely result from converting present land use back to a more typical riverine environment.

#### *Preliminary Economics Assessment of CP5*

**Estimated Costs** Estimated construction cost and annual cost of CP5 are included in Table 4-7. As shown, the estimated construction cost is $1,283 million. The estimated total annual cost of this plan is $61.0 million.

**Estimated Economic Benefits** As shown in Table 4-8, the estimated average annual monetary benefit of CP5, assuming the cost of water and energy supplies increases at the same rate as inflation, is about $74.2 million. Assuming the cost of water supplies and hydropower increases at 2 percent above inflation, to account for future diminishment of water and energy supplies and increasing demands, this benefit could exceed about $115.2 million per year. Added benefits for ecosystem restoration recreation enhancements in and around Shasta Lake are estimated to equal to their annual cost.

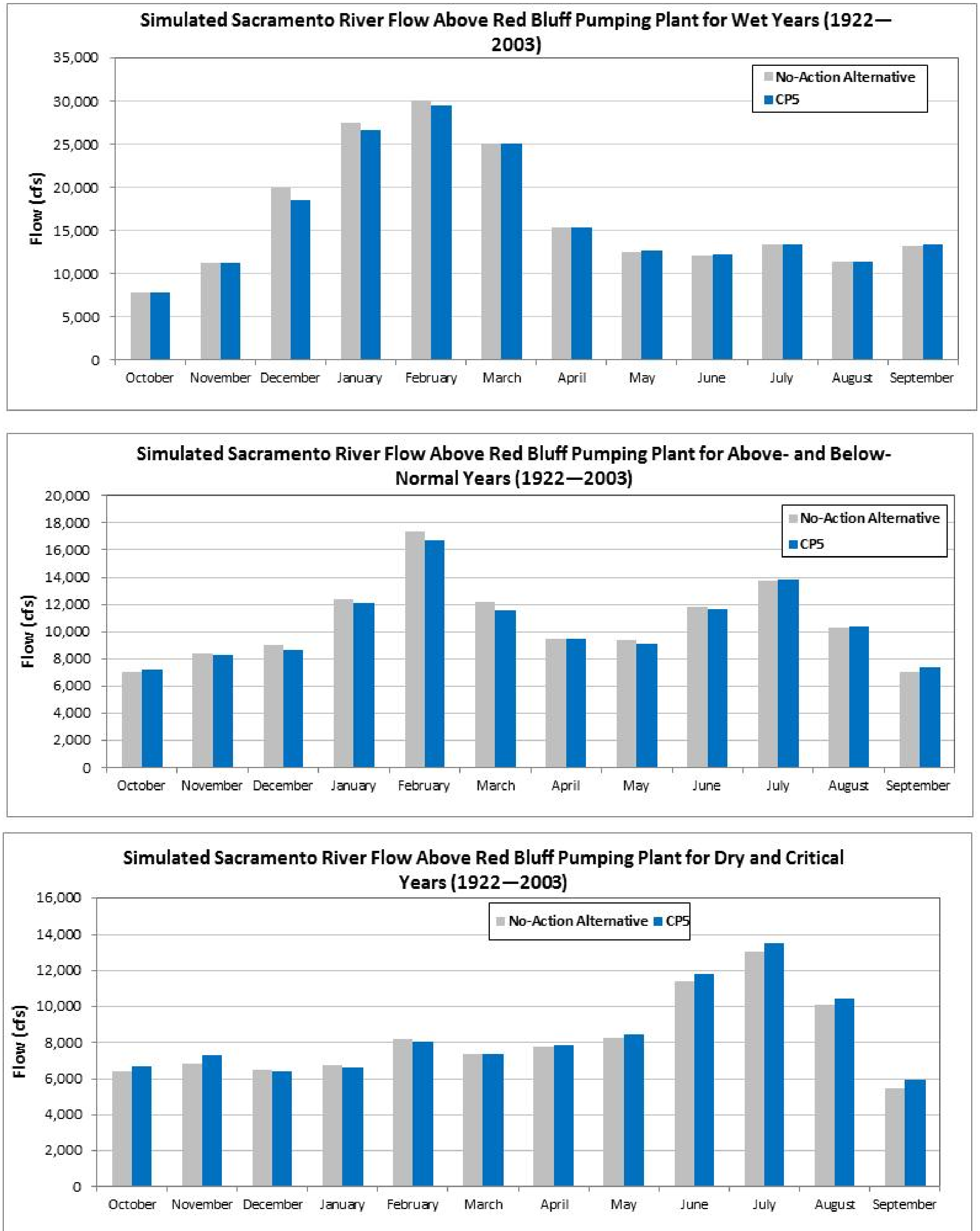



**Figure 4-17. Simulated Sacramento River Flow Above Red Bluff Pumping Plant in Wet, Above- and Below-Normal, and Dry and Critical Years for No-Action and CP5**

## Consistency of Comprehensive Plans with Other Programs

Comprehensive plans were evaluated on their consistency with the CVPIA and contributions toward the overall goals and objectives of the CALFED Programmatic ROD.

### Central Valley Project Improvement Act

The CVPIA is a Federal statute passed in 1992 with the following purposes:

> *To protect, restore, and enhance fish, wildlife, and associated habitats in the Central Valley and Trinity River basins of California; to address impacts of the CVP on fish, wildlife and associated habitats; to improve the operational flexibility of the CVP; to increase water-related benefits provided by the CVP to the state of California through expanded use of voluntary water transfers and improved water conservation; to contribute to the state of California's interim and long-term efforts to protect the Bay-Delta; and to achieve a reasonable balance among competing demands for use of CVP water, including the requirements of fish and wildlife, agricultural, municipal and industrial and power contractors.*

#### *Anadromous Fish*

CVPIA Section 3406(b)(1) required the Secretary to develop an Anadromous Fish Restoration Program. Continued implementation of CVPIA actions and programs, including the Anadromous Fish Restoration Program, constitute the mitigation, restoration, and enhancement requirements of the CVPIA (Section 3406(b)(1)). In comparison to the No-Action Alternative, all comprehensive plans would increase the ability of Shasta Dam to make cold-water releases, and regulate flow and water temperature in the upper Sacramento River. These flow and temperature improvements would result in increased survival of anadromous fish, particularly in dry and critically dry years. Accordingly, consistent with the P&G and Reclamation policy, these increases in anadromous fish survival under comprehensive plans are considered enhancements because they are above and beyond implementation of CVPIA actions and programs.

#### *Water Supply Replacement*

Since the CVPIA was enacted, 1.2 million acre-feet of CVP yield have been dedicated and managed annually for the primary purpose of implementing the fish, wildlife, and habitat mitigation and restoration purposes and measures authorized by the CVPIA. All alternatives would increase water supply reliability through increasing dry and critical year water supplies above and beyond the No-Action Alternative, primarily during dry and critical years. This action could contribute to the replacement of supplies redirected to other purposes in the CVPIA.

## CALFED Bay-Delta Program

CALFED, a coordinated Federal and State program, was established after the Bay-Delta Accord to address water quality, ecosystem quality, water supply reliability, and Delta levee system integrity. CALFED provides a programmatic framework to develop and implement a long-term comprehensive plan to restore ecological health and improve water management for beneficial uses of the Bay-Delta system. As described in Chapter 3, Section “Planning Constraints and Other Considerations,” enlarging Shasta Dam and Reservoir was included in the CALFED Preferred Program Alternative. The accompanying EIS to this Feasibility Report tiers to the CALFED PEIS/R.

CALFED developed the following program objectives for a solution:

- **Water Supply Reliability –** Reduce the mismatch between Bay-Delta water supplies and the current and projected beneficial uses dependent on the Bay-Delta system.
- **Water Quality –** Provide good water quality for all beneficial uses.
- **Ecosystem Quality –** Improve and increase aquatic and terrestrial habitats and improve ecological functions in the Bay-Delta to support sustainable populations of diverse and valuable plant and animal species.
- **Delta Levee Integrity –** Reduce the risk to land use and associated economic activities, water supply, infrastructure, and the ecosystem from catastrophic breaching of Delta levees.

Expanding water storage capacity is critical to the successful implementation of all aspects of CALFED. Not only is additional storage needed to meet the needs of a growing population but, if strategically located, such storage will provide much needed flexibility in the system to improve water quality and support fish restoration efforts. Table 4-9 summarizes potential overall contributions of the SLWRI toward CALFED goals. Table 4-10 qualitatively compares anticipated contributions of the comprehensive plans relative to CALFED goals and CALFED Storage Program objectives.

**Table 4-9. Summary of Contributions of SLWRI Comprehensive Plans to CALFED Bay-Delta Program Goals**

| Program Goal | Potential Contributions of SLWRI Comprehensive Plans Toward Program Goals |
|---|---|
| Water Supply Reliability | • Could increase the reliability of dry and critical year water supplies by up to 113,500 acre-feet per year<br>• Further implement demand reduction practices |
| Water Quality | • Could contribute to improved operational flexibility and provide increased high-flow releases to reestablish Delta water quality<br>• Could increase Delta outflow during drought years and reduce salinity during critical periods |
| Ecosystem Quality | • Could increase the ability of Shasta Dam to make cold-water releases and regulate water temperature in upper Sacramento River<br>• Could result in an average annual increase of up to 812,600 outmigrating juvenile Chinook salmon<br>• Could contribute to additional flow releases in Sacramento River and Delta during critical periods for fish species |
| Delta Levee Integrity | • Could provide greater flexibility in flood control releases, thereby reducing stress on Delta levees |

Key:
CALFED = CALFED Bay-Delta Program
Delta = Sacramento – San Joaquin Delta
SLWRI = Shasta Lake Water Resources Investigation

**Table 4-10. Comparison of Comprehensive Plans Relative to CALFED Goals and CALFED Storage Program Objectives**

| Objectives | CP1 | CP2 | CP3 | CP4 | CP4A | CP5 |
|---|---|---|---|---|---|---|
| **CALFED Bay-Delta Program Goals[1]** | | | | | | |
| **Water Quality:** Provide good water quality for all beneficial uses | + | ++ | +++ | +++ | +++ | +++ |
| **Ecosystem Quality:** Improve and increase aquatic and terrestrial habitats and improve ecological functions in the Bay-Delta to support sustainable populations of diverse and valuable plant and animal species | + | ++++ | +++ | +++++++ | ++++++ | ++++ |
| **Water Supply:** Reduce the mismatch between Bay-Delta water supplies and current and projected beneficial uses that depend on the Bay-Delta system | +++ | ++++ | ++++ | +++ | ++++ | ++++++ |
| **Delta Levee Integrity:** Reduce the risk to land use and associated economic activities, water supply, infrastructure and the ecosystem from catastrophic breaching of Delta levees | + | + | + | + | + | + |
| **CALFED Storage Program Element Objectives** | | | | | | |
| Pursue specific opportunities for new off-stream storage sites and expansion of existing on-stream storage sites as identified in the Programmatic Record of Decision | + | ++ | +++ | +++ | +++ | +++ |
| Provide financial and technical assistance to implement 1/2 million to 1 million acre-feet of new, locally managed groundwater storage | 0[2] | 0[2] | 0[2] | 0[2] | 0[2] | 0[2] |

Notes:

[1] Source: *CALFED Bay-Delta Program Programmatic Record of Decision* (CALFED 2000a)

[2] Although the SLWRI comprehensive plans do not include specific features to fund or assist groundwater storage, enlarging Shasta Reservoir could allow for additional system flexibility for surface water deliveries, decreasing reliance on groundwater pumping. This could reduce groundwater overdraft conditions in CVP and SWP service areas.

Key:

+ = net positive effect (benefit)
0 = no anticipated effect

CP = comprehensive plan
CALFED = CALFED Bay-Delta Program

### *Water Supply Reliability*

One of the primary goals of CALFED is to improve the reliability of California's water supply within the context of unpredictable hydrology and the competing needs of fish and wildlife and water users. In addition to hydrology, the CALFED Programmatic ROD assumes that water supply reliability is predicated partially on investment in infrastructure to improve storage and conveyance capacity. Included in the CALFED Storage Program Preferred Program Alternative is a proposed raise of Shasta Dam. Water supply reliability depends on capturing water during peak flows and during wet years, as well as on more efficient water use through conservation and recycling. All alternatives identified in this Feasibility Report would increase water supply reliability through increasing water supplies for CVP and SWP deliveries primarily during dry and critical years.

### *Water Quality*

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

### *Ecosystem Quality*

Enlarging Shasta Dam and Reservoir could contribute to ecosystem restoration along the Sacramento River and within the Delta. Improvements to water temperature and flows for Sacramento River aquatic species could be accomplished through enlarging Shasta Dam and Reservoir. All alternatives would 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 years, through new storage that would create a larger cold-water pool in Shasta Reservoir.

Increased Shasta Reservoir storage could contribute to additional flow releases to the Sacramento River during critical periods for fish species. Shasta Dam and Reservoir enlargement could also contribute to Delta species restoration through increased operational flexibility. Increased storage could allow CVP/SWP pumping operations to be shifted to times when fish are less vulnerable to the effects of these pumping operations.

### *Delta Levee Integrity*

Enlarging Shasta Dam and Reservoir could provide greater flexibility in flood control releases in the CVP/SWP system because of the potential for additional flood control space within Shasta Reservoir. Improved operational flexibility in the timing of flood control releases associated with the proposed Shasta Dam raise could reduce stress on Delta levees, and could contribute to maintaining their stability.

### *CALFED "Beneficiary Pays" Principle*

Federal cost allocation procedures and applicable cost-sharing laws/regulations govern how the costs of a project are allocated among project purposes, and apportioned to project beneficiaries. Federal laws and regulations also determine which Federal costs are reimbursable (paid back to the Federal Government by beneficiaries, typically over time) and nonreimbursable (the burden of the Federal taxpayer). Should the project be authorized by Congress, the Federal authorizing language would likely specify any cost-sharing or financing arrangements that deviate from previously established Federal laws.

It is believed that Federal cost allocation and cost-sharing practices are consistent with the CALFED "beneficiary pays" principle.

## Consistency with Department of Interior Climate Change Policy

Secretarial Order No. 3289 (as amended, Interior 2010) establishes an Interior-wide approach for applying scientific tools to increase understanding of climate change and to coordinate an effective response to its impacts on tribes and on the land, water, ocean, fish and wildlife, and cultural heritage resources that the Department manages. This Order requires that each bureau and office of the Interior must consider and analyze potential climate change impacts when undertaking long-range planning exercises, setting priorities for scientific research and investigations, developing multi-year management plans, and making major decisions regarding potential use of resources under the Department's purview. The SLWRI has been conducted in accordance with this Order.

As described in the Climate Change Modeling Appendix to the accompanying EIS, numerous studies have been conducted on the potential implications of climate change both on a global scale and in California. Consistent with the SECURE Water Act, Reclamation developed projections of future climate and hydrologic changes under climate change for the Sacramento and San Joaquin River basins (Reclamation 2011e). These projections are summarized in Table 4-11 for the Sacramento River at Bend Bridge and the San Joaquin River at Friant Dam. As shown in Table 4-11, climate change is expected to result in a shift from snow to rain in winter, leading to reduced snowpack, earlier snowmelt, and reduced river flows in summer. This would result in changes to the seasonal timing of flows, reservoir storage levels, flood management, recreation, and hydropower generation. Projected increases in temperatures and changes in timing and magnitude of stream runoff will have important implications for California's water supply and are also expected to affect aquatic species due to changes in river flows and water temperatures.

Climate change is also expected to cause sea level rise, resulting in increases in Delta water salinity. This increasing salinity will influence the suitability of Delta water for agricultural, urban, and environmental uses, likely having substantial impacts on water management throughout the Central Valley and other regions of the State.

**Table 4-11. Summary of Simulated Changes in Decade-Mean Hydroclimate for Two Subbasins in the Sacramento and San Joaquin River Basins[1]**

| Hydroclimate Metric | Change from 1990s | | |
|---|---|---|---|
| | 2020s | 2050s | 2070s |
| **Sacramento River at Bend Bridge** | | | |
| Mean Annual Temperature (°F) | 1.3 | 3.0 | 4.2 |
| Mean Annual Precipitation (%) | -0.3 | 0.6 | -2.7 |
| Mean April 1st Snow Water Equivalent (%) | -53.4 | -75.9 | -88.6 |
| Mean Annual Runoff (%) | 3.5 | 2.5 | -3.6 |
| Mean December–March Runoff (%) | 9.0 | 13.6 | 11.0 |
| Mean April–July Runoff (%) | -11.1 | -23.0 | -36.1 |
| Mean Annual Maximum Week Runoff (%) | 12.9 | 18.4 | 18.3 |
| Mean Annual Minimum Week Runoff (%) | -0.3 | -0.5 | -0.6 |
| **San Joaquin River at Friant Dam** | | | |
| Mean Annual Temperature (°F) | 1.4 | 3.3 | 4.5 |
| Mean Annual Precipitation (%) | -1.3 | -5.3 | -8.6 |
| Mean April 1st Snow Water Equivalent (%) | -23.1 | -39.6 | -48.7 |
| Mean Annual Runoff (%) | 0.7 | -8.7 | -10.7 |
| Mean December–March Runoff (%) | 13.9 | 15.8 | 31.0 |
| Mean April–July Runoff (%) | -6.1 | -20.2 | -25.0 |
| Mean Annual Maximum Week Runoff (%) | -2.3 | -6.6 | -16.0 |
| Mean Annual Minimum Week Runoff (%) | -4.0 | -6.4 | -7.6 |

*Source: Reclamation 2011e*

Notes:

[1] Projected changes for the three future decades (2020s, 2050s, 2070s) reflect the average for the subbasin and are measured relative to 1990s baseline conditions.

Key:

ºF = degree Fahrenheit

Each of the SLWRI comprehensive plans includes enlarging Shasta Dam and Reservoir and a variety of management measures to address, in varying degrees, all of the primary and secondary planning objectives. Although measures incorporated into comprehensive plans were not developed specifically to address climate change, increased storage in Shasta Reservoir would provide additional flexibility to adapt to potential changes in hydrology under climate change, such as increases in extreme events (e.g., flooding, droughts). The comprehensive plans would provide additional system flexibility to help offset the potential effects of future climate change as follows:

- Enlarging Shasta Reservoir and increasing seasonal carryover storage would enlarge the cold-water pool, increasing Reclamation’s ability to provide cold-water releases from Shasta Dam to improve water temperatures in the upper Sacramento River during drought periods.

- Increasing conservation storage in Shasta Reservoir would provide improved operational flexibility and increased water supply reliability to meet demands, helping to offset potential reductions in water supplies due to climate change.

- Increases in Shasta Reservoir storage and associated water levels could help offset reductions in hydropower generation.

- Increasing storage in Shasta Reservoir would provide greater flexibility for increased releases, including high-flow releases, to improve Delta water quality by increasing Delta outflow during drought years and reducing salinity during critical periods.

- Implementation of the water conservation program under all comprehensive plans would help reduce demands on available water supplies.

- Increased storage in Shasta Reservoir would allow for capture of additional flows during extreme events, reducing the frequency, magnitude, and duration of some potential future flood events.

Projected changes in climate are likely to influence the potential benefits of the SLWRI comprehensive plans. To assess the potential to achieve the SLWRI objectives under projected future climate change, two SLWRI comprehensive plans were selected and analyzed in the Climate Change Modeling Appendix to the accompanying EIS:

- **CP4**, which maximizes anadromous fish survival, was selected to assess the potential to benefit anadromous fish survival under climate change using a method based on the mean state of projected climate changes ("delta" method). The analysis indicated that anadromous fish populations would be substantially impacted by climate change, absent implementation of CP4. The analysis indicated that with implementation of CP4, anadromous fish survival would benefit from reduced water temperatures in the Sacramento River and increased flows.

- **CP5**, which maximizes the potential benefits to water supply reliability, was selected to assess the potential to benefit water supply reliability under climate change using climate modeling tools developed by Reclamation for the CVP Integrated Resource Plan (IRP). The analysis indicated that under climate change scenarios, implementation of CP5 would continue to benefit CVP and SWP operations and infrastructure, including water deliveries for agricultural, M&I, and environmental purposes; river water temperatures; hydropower generation and GHG emissions; and management of Delta salinity levels.

These evaluations indicate that the comprehensive plans are robust and would provide benefits under a range of future climate scenarios.

# Chapter 5
# Plan Evaluation, Comparison, and Selection

The evaluation and comparison of alternative plans provide the basis for plan selection. This chapter presents results of the evaluation and comparison of the final comprehensive plans (i.e., action alternatives) described in Chapter 4, and concludes with the rationale for plan selection, including identification of CP4A as the NED Plan.

## Summary of Comprehensive Plan Evaluation

The results of feasibility analyses for the SLWRI are presented in the form of four accounts established by the P&G (WRC 1983) to display, and facilitate evaluation of, the effects of alternative plans: NED, environmental quality (EQ), regional economic development (RED), and other social effects (OSE). These four accounts can encompass all significant beneficial and adverse effects of a plan on the human environment, as required by NEPA (42 USC 4321 et seq.). Further, effects of alternative plans are to be displayed as the difference in conditions compared to the No-Action Alternative.

### National Economic Development Account

The objective of an NED analysis is to determine the change in net value of the Nation's output of goods and services that would result from implementing each project alternative. Beneficial and adverse effects are evaluated in monetary terms, and measured in terms of changes in national income between the No-Action and various action alternatives. The NED account describes the part of the NEPA human environment that identifies beneficial and adverse effects on the economy. Beneficial effects in the NED account are (1) increases in the economic value of the national output of goods and services from a plan, (2) the value of output resulting from external economies caused by a plan, and (3) the value associated with the use of otherwise unemployed or underemployed labor resources. Adverse effects in the NED account are the opportunity costs of resources used in implementing a plan. These adverse effects include (1) implementation outlays, (2) associated costs, and (3) other direct costs. Specific guidelines, standards, and procedures used in the NED analysis are contained in the P&G (WRC 1983).

The NED account may include economic benefits to the following categories: irrigation water supply, M&I water supply, flood damage reduction, power (hydropower), transportation (inland navigation and deep draft navigation), recreation, commercial fishing, unemployed or underemployed labor resources, and other categories of benefits for which procedures are documented in the planning report and are consistent with the general measurement standard in the P&G. For this analysis, the NED account includes the M&I water supply, irrigation water supply, hydropower, recreation, as well as other categories of benefits for anadromous fish survival.

Environmental benefits, including fisheries and ecosystem resources, are typically included in the EQ account if monetary units cannot be attributed to these benefits. However, for this analysis, fisheries benefits were developed as monetary units, and are included in the NED account. The contribution of the various alternatives to anadromous fish survival is included in the NED account under "other categories of benefits."

#### *Monetized Benefits*

Estimating the economic value of potential effects is critical to establishing economic feasibility and identifying the plan with the highest net NED benefits (the NED plan). This section summarizes the valuation methods and valuation estimates for the benefit categories associated with the SLWRI planning objectives. Detailed valuation methods and results for each benefit category and associated sensitivity analyses are presented in the Economic Valuation Appendix.

**Increase Anadromous Fish Survival** The method for assessing the economic value of contributions of comprehensive plans to anadromous fish survival used a "cost of the most likely alternative" approach. The underlying premise for the approach was that increasing salmon populations would be a socially desirable goal, as indicated by the listing of several species as threatened or endangered, passage of the CVPIA, and expenditures on salmon restoration projects.

Because the increased potential to reduce water temperatures during critical periods provided by additional surface storage would be essential to increasing salmon production, the cost of the most likely alternative was based on the cost of various dam raises operated solely for the purpose of increasing the number of salmon smolt in the Sacramento River. Evaluating the cost of the most likely alternative included analysis of three separate dam raises operated solely for increased anadromous fish production, and was estimated using habitat units. While habitat units could be quantified in simplistic terms such as changes in flow or temperature conditions, such characterizations would not capture the complex physical and biological interrelationships within the system. Improvements in habitat conditions for anadromous fish in the Sacramento River were directly evaluated through the use of the SALMOD, a deterministic salmon production model. Habitat units were based on 1,000 smolt passing downstream at the location of the RBPP. A cost-per-habitat-unit estimate was calculated for each alternative through dividing annual costs by the expected change in habitat units. The lowest cost-per-habitat-unit estimate was used as a per-habitat-unit benefit estimate. Anadromous fish benefits were computed though multiplying the per-habitat unit benefit estimate by the estimated change in habitat units under each of the comprehensive plans (Table 5-1).

*Uncertainty* A sensitivity analysis was conducted to address risk and uncertainty of the benefit estimates for anadromous fish survival focused alternatives, CP4 and CP4A. This sensitivity analysis estimated the economic benefits of improving habitat for ESA-listed species of anadromous fish. This analysis was based on values from a recent study in the Klamath River basin which addressed benefit transfer methods for habitat improvements for fish. For example, this sensitivity analysis for CP4 and CP4A resulted in estimated total benefits of $423.5 million and $276.3 million per year, respectively. This is in comparison to the $38.1 and $33.3 million per year benefits for CP4 and CP4A, respectively, shown in Table 5-1 and used in the NED analysis.

**Increase Water Supply Reliability** The CalSim-II model was used to estimate potential increases in water supply reliability to the CVP and SWP for the comprehensive plans. Table 5-2 shows results of the water operations modeling analyses to determine the average year and dry/critically dry year conditions north and south of the Delta for the comprehensive plans.

**Table 5-1. Least Cost Alternative Estimates of Average Annual Salmon Production for Comprehensive Plans**

| Item | CP1 | CP2 | CP3 | CP4 | CP4A | CP5 |
|---|---|---|---|---|---|---|
| Change in Average Annual Salmon Production Relative to No-Action Alternative (thousands of fish) | 61.3 | 379.2 | 207.4 | 812.6 | 710.0 | 377.8 |
| Total Annual Benefits[1] ($ millions/year) | 2.9 | 17.8 | 9.7 | 38.1 | 33.3 | 17.7 |

Note:
[1] Dollar values are expressed in January 2014 price levels.
Key:
CP = comprehensive plan

**Table 5-2. Estimated Increases in Irrigation and M&I Deliveries and Water Supply Reliability Benefits for Comprehensive Plans**

| Item | CP1 | CP2 | CP3 | CP4 | CP4A | CP5 |
|---|---|---|---|---|---|---|
| **CVP/SWP Irrigation Water Supply Reliability** | | | | | | |
| Dry/Critical Years NOD (acre-feet/year)[1] | 4,200 | 9,500 | 29,400 | 4,200 | 9,500 | 21,100 |
| Dry/Critical Years SOD (acre-feet/year)[1] | 18,300 | 28,100 | 41,300 | 18,300 | 28,100 | 45,000 |
| Average – All Years NOD (acre-feet/year) | 5,900 | 10,900 | 25,900 | 5,900 | 10,900 | 19,600 |
| Average – All Years SOD (acre-feet/year) | 14,400 | 20,500 | 36,400 | 14,400 | 20,500 | 31,300 |
| ***Annual Benefit ($ millions/year)[2]*** | ***3.3*** | ***5.1*** | ***10.2*** | ***3.3*** | ***5.1*** | ***8.5*** |
| **CVP/SWP M&I Water Supply Reliability** | | | | | | |
| Dry/Critical Years NOD (acre-feet/year)[1] | 300 | 1,200 | 5,800 | 300 | 1,200 | 4,100 |
| Dry/Critical Years SOD (acre-feet/year)[1] | 24,400 | 39,000 | (13,300) | 24,400 | 39,000 | 43,300 |
| Average – All Years NOD (acre-feet/year) | 100 | 1,400 | 4,400 | 100 | 1,400 | 3,300 |
| Average – All Years SOD (acre-feet/year) | 10,600 | 18,500 | (4,900) | 10,600 | 18,500 | 21,700 |
| ***Annual Benefit ($ millions/year)[2]*** | ***11.9*** | ***21.8*** | – | ***11.9*** | ***21.8*** | ***26.3*** |
| **Total Water Supply Reliability[3]** | | | | | | |
| Dry/Critical Years[1] (acre-feet/year) | 47,300 | 77,800 | 63,100 | 47,300 | 77,800 | 113,500 |
| Average – All Years (acre-feet/year) | 31,000 | 51,300 | 61,700 | 31,000 | 51,300 | 75,900 |
| ***Total Annual Benefit*** | | | | | | |
| ***Estimated Value – At Inflation ($ millions/year)[2,3,4]*** | ***15.2*** | ***26.9*** | ***10.2*** | ***15.2*** | ***26.9*** | ***34.8*** |
| ***Estimated Value – 2% Above Inflation ($millions/year)[2,3,5]*** | ***28.1*** | ***49.8*** | ***18.8*** | ***28.1*** | ***49.8*** | ***64.4*** |

Notes:
[1] Year-types as defined in the Sacramento Valley Water Year Hydrologic Classification Index.
[2] Dollar values are expressed in January 2014 price levels.
[3] All numbers are rounded for display purposes; therefore, line items may not sum to totals.
[4] Assumes the costs of water supplies would increase at the same rate as inflation.
[5] Includes increase of water supply costs at 2 percent above inflation to account for growing scarcity in the future. Sensitivity analyses for change in water supply benefits are included in the Economic Valuation Appendix.

Key:
CP = comprehensive plan
CVP = Central Valley Project
M&I = municipal and industrial
NOD = North of Delta
SOD = South of Delta
SWP = State Water Project

*Irrigation Water Supply* This analysis provided benefit estimates produced through applying the "change in net income," method as estimated by the SWAP model. In the SWAP model, parameters ranging from crop mixes, prices, and yields to irrigation efficiency were modeled for CVP and SWP service areas. Then a potential new increment, such as increased storage at Shasta Reservoir was added, and the net increase in the value of increased production was estimated. The majority of increases in water supply reliability developed under SLWRI comprehensive plans would be achieved during drought periods when new increments of reliable water supply would be most needed. This is because, under current conditions, there would be an increased frequency of water supply shortages in dry and critical years. Similarly, under current conditions, there would be greater Delta export capacity in dry years due to less water in the system. Because of data limitations, the SWAP model is currently calibrated to 2005, a relatively normal water year. As a result, the effects of dry years on cropping decisions and production costs may not be fully represented by the model. In this analysis, the SWAP model was run for the long-term above/below normal, dry, and wet water supply conditions. The estimated annual benefit associated with comprehensive plans is represented by the probability weighted average across the three water year types. Table 5-2 displays average annual irrigation water supply benefits estimated with the SWAP model. Comprehensive plan irrigation water supply benefits range from $3.3 million per year for CP1 to $10.2 million for CP3.

*Municipal and Industrial Water Supply* All comprehensive plans except CP3 would increase water supplies to M&I water users, especially during dry years. Estimates of dry and critical year and average deliveries to M&I water users located north and south of the Delta for CP1 through CP5 are shown in Table 5-2. As shown in the table, M&I water supply benefits would largely accrue to CVP and SWP contract holders located south of the Delta. M&I water users have increasingly participated in the water transfer market to augment supplies. M&I water supply reliability benefits were estimated based on the average annual deliveries shown in Table 5-2. This analysis assumed that the next increment of water supply to M&I users would likely be obtained through water transfers. The analysis also relied on values estimated through application of a water transfer pricing model, and through consideration of the costs associated with conveying the water to the M&I service areas. This method is consistent with the "cost of the most likely alternative" method recommended by the P&G.

*Uncertainty* As described in Chapter 2, demands for water in California exceed available supplies. It is expected that the difference between available supplies and demands for water will increase in the future, especially during drought periods. Although recent facility improvements have improved delivery capability, no material increases in supply have been added to the CVP or the SWP for nearly 40 years. To date, increases in water demands have primarily been accommodated through operational changes in the existing CVP and SWP water supply systems, and increased reliance on groundwater, recycled water, and local conservation measures. California's population is expected to increase by more than 60 percent above 2005 levels by 2050 (California Department of Finance 2007). This increase in population, coupled with lack of new sources of supply, could appreciably transform the future of water in California. One of the expected results will be a shift in water deliveries from agricultural to urban uses. In addition, declines are likely in other water supply sources for reasons ranging from increased local and regional needs to groundwater overdraft and climate change.

Traditional approaches for estimating water supply benefits, using the methods described above, are appropriate as accounting tools and in estimating benefits for increases in reliability today. However, these methods do not account for the growing complexities resulting from increasing demands and dwindling supplies. Current models used to help estimate water benefits are static models and only useful for estimating the increase in production at one point in time, given numerous highly constrained assumptions.

To account for the significant uncertainties associated with estimating the value of new supplies, a sensitivity analysis was performed assuming the value of water increases above the inflation rate (up to 2 percent above inflation). Accordingly, the benefit of the increased supplies resulting from each comprehensive plan, based on a 2 percent rate above inflation, is included in Table 5-2. As described in the Economic Valuation Appendix, an additional sensitivity analysis was performed for irrigation water supply based on a statistical model of the California spot market water transfer activity. The results using the spot market model were similar to values assuming water increases above the inflation rate (e.g., 2 percent above inflation). The LCPSIM was used to evaluate the sensitivity of M&I water supply benefits. Although the LCPSIM provided lower estimated benefits for M&I water supply reliability in comparison to the NED analysis, this is due to several key assumptions and related model limitations as described in the Economic Valuation Appendix.

**Develop Additional Hydropower Generation** Increasing the size of Shasta Dam and Reservoir would also result in increased hydropower capacity, generation, and the ability to provide ancillary services[1] at Shasta Dam and other hydropower facilities throughout the CVP and SWP. As can be seen in Table 5-3, raising Shasta Dam by 6.5 feet to 18.5 feet would result in increased hydropower generation of 52 to 127 GWh per year and would provide capacity and ancillary service benefits. CP4 and CP4A would result in the largest increases in hydropower generation, capacity, and ancillary services because of the greater hydraulic head resulting from storing more water for anadromous fish purposes. As can be seen in Table 5-3, estimated average annual hydropower benefits of the plans would range from about $6.8 million for CP1 to about $14.9 million for CP4.

[1] The California Independent System Operator's (CAISO) ancillary service market is comprised of regulation up, regulation down, spinning reserve, and non-spinning reserve providing frequency support, voltage support, and load-following. These services are needed to allow CAISO to precisely match generation and load and operate the grid in a reliable manner.

Implementation of recent California renewable resources mandates will require significant increases in non-dispatchable intermittent renewable resources, such as wind and solar generation, in California's power system. This means that other significant flexible generation resources will be needed to support and integrate renewable generation. The California Independent System Operator has an ongoing Renewables Integration Initiative to evaluate the changing resources needed to meet California's Renewable Portfolio Standard goals. These potentially costly mandates will likely influence the value of future hydropower supplies at Shasta Dam. To account for this uncertainty, a sensitivity analysis was performed assuming the value of hydropower increases at 2 percent above the inflation rate. Accordingly, the benefit of the increased supplies resulting from each comprehensive plan, based on a 2 percent rate above inflation, is included in Table 5-3.

**Table 5-3. Summary of Estimated Hydropower Benefits of Comprehensive Plans**

| Item | CP1 | CP2 | CP3 | CP4 | CP4A | CP5 |
|---|---|---|---|---|---|---|
| **Increased CVP and SWP Hydropower Generation** | | | | | | |
| Increased CVP Generation (GWh/year) | 38.6 | 65.6 | 91.0 | 113.3 | 103.7 | 88.9 |
| Increased SWP Generation (GWh/year) | 13.7 | 21.2 | (5.3) | 13.7 | 21.2 | 23.5 |
| ***Total Increased Generation[1] (GWh/year)*** | ***52.3*** | ***86.8*** | ***85.7*** | ***127.1*** | ***124.8*** | ***112.4*** |
| **Annual Hydropower Benefits** | | | | | | |
| Increased CVP Generation ($ millions/year) | $2.6 | $4.4 | $6.0 | $7.5 | $6.9 | $5.9 |
| Increased SWP Generation ($ millions/year) | $0.9 | $1.5 | ($0.4) | $0.9 | $1.5 | $1.6 |
| Ancillary Services Benefit ($ millions/year) | $0.2 | $0.3 | $0.4 | $0.7 | $0.5 | $0.4 |
| Capacity Benefit ($ millions/year) | $3.1 | $4.1 | $5.1 | $5.7 | $5.5 | $5.6 |
| ***Total Annual Hydropower Benefits[2] (at inflation) ($ millions/year)*** | ***$6.8*** | ***$10.3*** | ***$11.1*** | ***$14.9*** | ***$14.4*** | ***$13.4*** |
| ***Total Annual Hydropower Benefit[3,4] (2% above inflation) ($millions/year)*** | ***$12.5*** | ***$19.0*** | ***$20.6*** | ***$27.6*** | ***$26.7*** | ***$24.8*** |

Notes:
[1] Power generation estimates represent the increased load center generation (accounting for transmission losses) at CVP and SWP facilities. Energy requirements for pumping and conveyance of increased water deliveries were accounted for in operations and maintenance costs for each alternative.
[2] Ancillary services and capacity benefits were based on at-plant hydropower parameters.
[3] All numbers are rounded for display purposes; therefore, line items may not sum to totals.
[4] Includes increase of hydropower costs at 2 percent above inflation.

Key:
CP = comprehensive plan
CVP = Central Valley Project
GWh/year = gigawatt-hours per year
SWP = State Water Project

**Maintain and Increase Recreation** Shasta Lake is a major recreational venue in California, and is the centerpiece of the Shasta Unit of the Whiskeytown-Shasta-Trinity NRA. The combination of large size, plentiful water-based recreation opportunities, favorable climate, and easy access make Shasta Lake one of the most visited recreation destinations in the State and region. Enlarging Shasta Dam, including relocating facilities to maintain at least the existing recreation opportunities, would affect recreation participation by providing modernized recreational facilities, increasing the reservoir surface area throughout the year, and decreasing reservoir drawdown during the peak recreation season (May to September). Table 5-4 displays user days (visitor days) and estimated recreation values for each comprehensive plan. The estimated resulting increase in user values was based on a recreation unit-day value of $57.85, the midpoint between the USFS (2005) benefit estimate for a unit day engaged in motorboating ($57.30 in 2014 dollars) and a unit day engaged in fishing ($58.40). The estimated benefit to recreation due to estimated increased visitor days ranges from $4.9 million to $17.8 million per year.

**Table 5-4. Average Annual Estimated Change in Visitor Days and Recreational Values**

| Item | CP1 | CP2 | CP3 | CP4 | CP4A | CP5 |
|---|---|---|---|---|---|---|
| Increase in Average Annual Visitor Days (1,000) | 85 | 116 | 201 | 307 | 246 | 142 |
| Increase in Average Annual Benefits ($ millions/year)[1] | 4.9 | 6.7 | 11.6 | 17.8 | 14.3 | 8.2 |

Note:
[1] Dollar values are expressed in January, 2014 price levels.
Key:
CP = comprehensive plan

**Benefit Summary** Table 5-5 summarizes the estimated annual average economic benefits from Tables 5-1 through 5-4 above.

**Table 5-5. Summary of Estimated Comprehensive Plan Economic Benefits [1, 2]**

| Item | CP1 ($ millions/ year) | CP2 ($ millions/ year) | CP3 ($ millions/ year) | CP4 ($ millions/ year) | CP4A ($ millions/ year) | CP5 ($ millions/ year) |
|---|---|---|---|---|---|---|
| Anadromous Fish Survival | 2.9 | 17.8 | 9.7 | 38.1 | 33.3 | 17.7 |
| Water Supply Reliability | | | | | | |
| Estimated Benefit (at inflation)[3] | 15.2 | 26.9 | 10.2 | 15.2 | 26.9 | 34.8 |
| Estimated Benefit (2% above inflation)[4] | 28.1 | 49.8 | 18.8 | 28.1 | 49.8 | 64.4 |
| Hydropower | | | | | | |
| Estimated Benefit (at inflation)[3] | 6.8 | 10.3 | 11.1 | 14.9 | 14.4 | 13.4 |
| Estimated Benefit (2% above inflation)[4] | 12.5 | 19.0 | 20.6 | 27.6 | 26.7 | 24.8 |
| Recreation | 4.9 | 6.7 | 11.6 | 17.8 | 14.3 | 8.2 |
| Flood Damage Reduction[5] | Not quantified | Not quantified | Not quantified | Not quantified | Not quantified | Not quantified |
| Water Quality[5] | Not quantified | Not quantified | Not quantified | Not quantified | Not quantified | Not quantified |
| ***Total Annual Benefits*** | | | | | | |
| ***Estimated Value (at inflation)[3, 6]*** | ***29.7*** | ***61.6*** | ***42.6*** | ***86.0*** | ***88.9*** | ***74.2*** |
| ***Estimated Value (2% above inflation)[4, 6]*** | ***48.4*** | ***93.3*** | ***60.7*** | ***111.6*** | ***124.1*** | ***115.2*** |

Notes:

[1] Any dam raise could provide incidental benefits to secondary objectives.

[2] Benefits were not monetized for ecosystem restoration including (1) restoring resident fish habitat in Shasta Lake, (2) restoring fisheries and riparian habitat at several locations along the lower reaches of the upper Sacramento River and tributaries to Shasta Lake, (3) augmenting spawning gravel in the upper Sacramento River, and (4) restoring riparian, floodplain, and side channel habitat in the upper Sacramento River.

[3] Assumes the costs of water supplies and hydropower would increase at the same rate as inflation.

[4] 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 Appendix.

[5] Benefits for flood damage reduction and water quality are limited and have not been monetized.

[6] All numbers are rounded for display purposes; therefore, line items may not sum to totals.

Key:

CP = comprehensive plan

**Cost Summary** Table 5-6 summarizes estimated construction, investment, and annual costs for each of the comprehensive plans. Total investment cost is the sum of total construction costs and interest during construction (IDC) cost. The IDC cost was computed using Reclamation-defined practices, and was based on an estimated construction period for all plans of approximately 5 years. Total investment cost was annualized over the project's assumed 100-year lifespan at the Federal interest rate of 3-1/2 percent to compute interest and amortization. Total annual cost is the sum of interest and amortization and estimated annual O&M costs. Cost estimates for comprehensive plans are presented in more detail in the Engineering Summary Appendix to the accompanying Final EIS.

**Table 5-6. Estimated Construction and Annual Costs of Comprehensive Plans[1]**

| Item | CP1 ($ millions) | CP2 ($ millions) | CP3 ($ millions) | CP4 ($ millions) | CP4A ($ millions) | CP5 ($ millions) |
|---|---|---|---|---|---|---|
| **Construction Cost** | | | | | | |
| Field Costs | $713 | $773 | $881 | $887 | $887 | $901 |
| Noncontract Costs | $278 | $316 | $376 | $378 | $379 | $383 |
| Total Construction Cost[2] | $990 | $1,089 | $1,257 | $1,264 | $1,265 | $1,283 |
| **Investment Cost** | | | | | | |
| Interest During Construction | $83 | $91 | $105 | $105 | $105 | $108 |
| Total Investment Cost[2] | $1,073 | $1,180 | $1,362 | $1,370 | $1,371 | $1,391 |
| **Annual Cost** | | | | | | |
| Interest and Amortization | $39 | $43 | $49 | $50 | $50 | $50 |
| Operations and Maintenance | $6.3 | $8.5 | $4.6 | $7.5 | $9.4 | $10.7 |
| Total Annual Cost[2] | $45.1 | $51.2 | $53.8 | $57.1 | $59.0 | $61.0 |

Notes:
[1] Based on January 2014 price levels, 100-year period of analysis, and 3-1/2 percent interest rate.
[2] All numbers are rounded for display purposes; therefore, line items may not sum to totals.

Key:
CP = comprehensive plan

### *Net National Economic Development Benefits*

The P&G states that the alternative that reasonably maximizes net NED benefits, consistent with the Federal objectives, is identified as the NED plan (WRC 1983). The alternative that would generate the maximum net NED benefit is CP4A (Table 5-7), and, accordingly, CP4A is identified as the NED plan. Assuming the cost of water and energy supplies increased at the same rate as inflation, CP4A would generate net benefits of $29.9 million annually. Assuming an increase of water supply and hydropower costs at 2 percent above inflation to account for growing scarcity of available supplies in the future, CP4A would generate $65.1 million in net benefits.

**Table 5-7. Summary of Estimated Annual Costs, Annual Benefits, and Net Benefits for Comprehensive Plans[1]**

| Item | CP1 ($ millions) | CP2 ($ millions) | CP3 ($ millions) | CP4 ($ millions) | CP4A ($ millions) | CP5 ($ millions) |
|---|---|---|---|---|---|---|
| **Annual Cost** | | | | | | |
| Total Annual Cost | 45.1 | 51.2 | 53.8 | 57.1 | 59.0 | 61.0 |
| **Annual Benefits** | | | | | | |
| Estimated Value (at inflation)[2] | 29.7 | 61.6 | 42.6 | 86.0 | 88.9 | 74.2 |
| Estimated Value (2% above inflation)[3] | 48.4 | 93.3 | 60.7 | 111.6 | 124.1 | 115.2 |
| **Benefit/Cost Ratio** | | | | | | |
| Estimated Value (at inflation)[2] | 0.66 | 1.20 | 0.79 | 1.51 | 1.51 | 1.22 |
| Estimated Value (2% above inflation)[3] | 1.07 | 1.82 | 1.13 | 1.95 | 2.10 | 1.89 |
| **Net Benefits** | | | | | | |
| Estimated Value (at inflation)[2,4] | -15.4 | 10.5 | -11.2 | 28.9 | 29.9 | 13.2 |
| Estimated Value (2% above inflation)[3, 4] | 3.3 | 42.1 | 6.9 | 54.5 | 65.1 | 54.2 |

Notes:
1 Based on 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 would increase 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 Appendix.
4 All numbers are rounded for display purposes; therefore, line items may not sum to totals.
Key:
CP = comprehensive plan

### *Nonmonetized Benefits*

Several potential benefit categories associated with comprehensive plans were not monetized or included under the NED account. All plans would contribute to maintaining or improving water quality in the Sacramento River and the Delta; however, the associated economic benefits have not been quantified and included in the NED account. All comprehensive plans would also increase operational flexibility and improve Delta emergency response, but benefits were not quantified. This is because methodologies for monetization of water quality and Delta emergency response benefits are not well established.

## Environmental Quality Account

The EQ account is a means of integrating information about the EQ resources and NEPA human environment effects (as defined in 40 CFR 1507.14) of alternative plans into water resources planning. This is essential to a reasoned choice among alternative plans.

For the SLWRI, benefits assessed in the EQ account include: (1) restoring resident fish habitat in Shasta Lake, (2) restoring fisheries and riparian habitat at several locations along the lower reaches of the upper Sacramento River and tributaries to Shasta Lake, (3) augmenting spawning gravel in the upper Sacramento River, and (4) restoring riparian, floodplain, and side channel habitat in the upper Sacramento River. Implementing these ecosystem restoration measures would not require implementing other project features (e.g., dam raise, reservoir area relocations).

A thorough evaluation of other positive and negative EQ benefits was performed as part of the NEPA environmental review and documentation process. A detailed discussion of potential effects of comprehensive plans and proposed mitigation measures is included in Chapters 4 through 25 of the accompanying Final EIS and summarized in Table S-3 in the Final EIS. The environmental commitments common to all comprehensive plans are described in Chapter 4 of this Feasibility Report. Also, Chapter 26 of the Final EIS describes short-term use of the human environment and the maintenance and enhancement of long-term productivity and presents potential irreversible or irretrievable commitments of resources for the comprehensive plans.

Table 5-8 summarizes key effects for all resource categories for the EQ account. All comprehensive plans would be similar in terms of their potential environmental effects, although some adverse effects would be exacerbated by larger dam raises and by the associated scale of the effects, such as expanded construction areas and increased area of inundation around Shasta Lake. Generally, the adverse effects would be mitigated to less-than-significant levels with prescribed mitigation measures. Some adverse effects for all of the action alternatives – e.g., the short-term generation of construction-generated emissions in excess of Shasta County Air Quality Management District (SCAQMD) thresholds and generation of increased daytime glare and/or night time lighting – would remain unavoidable despite mitigation measures. Altered flow regimes along the upper Sacramento River, changes to the areas inundated by Shasta Lake, and disturbances associated with construction activities would have the potential to affect environmental resources. However, these adverse effects would be mitigated to the extent practicable.

**Table 5-8. Summary of Potential Environmental Effects in the Environmental Quality Account**

| Resource Area | Alternatives | Primary Study Area | | Extended Study Area | | | Key Considerations and Exclusions |
|---|---|---|---|---|---|---|---|
| | | Shasta Lake & Vicinity | Sacramento River (Shasta Dam to RBPP) | Sacramento River (RBPP to Delta) | Delta | CVP/SWP Facilities and Water Service Areas | |
| Geology, Geomorphology, Minerals, and Soils | CP1 – CP5 | [orange] | [green] | [green] | [green] | [green] | Short-term adverse effects due to construction in primary study area; adverse effects reduced through mitigation. Long -term adverse effects associated with operations reduced through mitigation. |
| Air Quality and Climate | CP1 | [orange] | [green] | [green] | [green] | [green] | Long-term effects due to slight increase in net energy requirements. Short-term unavoidable adverse effects due to construction in primary study area; adverse effects reduced through mitigation. |
| | CP2, CP3, CP4, CP4A, CP5 | [orange] | [green] | [purple] | [purple] | [purple] | Long-term benefits related to reduced emissions due to increased hydropower generation. Short-term unavoidable adverse effects due to construction in primary study area; adverse effects reduced through mitigation. |
| Hydrology, Hydraulics, and Water Management | CP1-CP5 | [green] | [green] [blue] | [green] [blue] | [green] [blue] | [green] [purple] [blue] | Beneficial effects to groundwater levels in CVP/SWP water service areas. Long-term beneficial effects related to water supply reliability included in NED account. Long-term beneficial effects related to reduced flood risk included in OSE account. |
| Water Quality | CP1 – CP5 | [green] | [green] [blue] | [green] [blue] | [green] [blue] | [green] [blue] | Long-term beneficial effects to reservoir water quality due to replacement of reservoir area septic systems with centralized wastewater treatment plants. Short-term adverse effects due to construction in primary study area; adverse effects reduced through mitigation. Long-term beneficial water quality effects in Sacramento River and Delta included in NED account. |
| Noise and Vibration | CP1 – CP5 | [green] | [green] | [green] | [green] | [green] | Short-term adverse effects due to construction in primary study area; adverse effects reduced through mitigation. |
| Hazards and Hazardous Materials and Waste | CP1 – CP5 | [green] | [green] | [green] | [green] | [green] | Short-term adverse effects due to construction in primary study area; adverse effects reduced through mitigation. |
| Agriculture and Important Farmland | CP1 – CP5 | [green] | [green] | [green] | [green] | [green] [blue] | Long-term beneficial effects from improved agricultural/irrigation water supply reliability included in NED account. Long-term adverse effects due to conversion of forest lands. |

**Table 5-8. Summary of Potential Environmental Effects in the Environmental Quality Account (contd.)**

| Resource Area | Alternatives | Primary Study Area | | Extended Study Area | | | Key Considerations and Exclusions |
|---|---|---|---|---|---|---|---|
| | | Shasta Lake & Vicinity | Sacramento River (Shasta Dam to RBDD) | Sacramento River (RBPP to Delta) | Delta | CVP/SWP Facilities and Water Service Areas | |
| Fisheries and Aquatic Ecosystems | CP1 – CP5 | Green, Purple | Green, Blue, Purple | Green, Blue | Green, Blue | Green | Long-term beneficial effect on cold-water fisheries habitat in Shasta Lake. CP4, CP4A, and CP5 provide ecosystem restoration benefits for fisheries and aquatic habitat through (1) augmenting spawning gravel in the upper Sacramento River, and (2) restoring riparian, floodplain, and side channel habitat in the upper Sacramento River. CP5 provides ecosystem restoration benefits for fisheries and aquatic habitat, including (1) restoring resident fish habitat in Shasta Lake, and (2) restoring fisheries and riparian habitat at several locations along the lower reaches of tributaries to Shasta Lake. Long-term beneficial effects on anadromous fisheries included in NED account. |
| Botanical Resources and Wetlands | CP1 – CP5 | Orange | Green, Purple | Green | Green | Green | CP4, CP4A, and CP5 provide ecosystem restoration benefits for botanical resources through restoring riparian, floodplain, and side channel habitat in the upper Sacramento River. Long-term adverse effects due to inundation and relocations in primary study area. Short-term adverse effects due to construction in primary study area. Adverse effects reduced through mitigation. |
| Wildlife Resources | CP1 – CP5 | Orange | Green, Purple | Green | Green | Green | CP4, CP4A, and CP5 provide ecosystem restoration benefits for wildlife resources through restoring riparian, floodplain, and side channel habitat in the upper Sacramento River. Short-term adverse effects due to construction in primary study area; adverse effects reduced through mitigation. |
| Cultural Resources | CP1 – CP5 | Orange | Green | Green | Green | Green | Adverse effects due to construction in primary study area; adverse effects reduced through mitigation. Some adverse effects due to operations/inundation in the primary study area are unavoidable. |
| Socioeconomics, Population, and Housing | CP1 – CP5 | Green, Blue | Green, Blue | Green | Green | Green, Blue | Long-term beneficial effects from improved agricultural/irrigation water supply reliability included in NED account. Short-term beneficial effects of construction activities included in RED account. |
| Land Use and Planning | CP1 – CP5 | Orange | Green | Green | Green | Green | Long-term adverse effects to land use in reservoir area are unavoidable; adverse effects reduced through mitigation. |

**Table 5-8. Summary of Potential Environmental Effects in the Environmental Quality Account (contd.)**

| Resource Area | Resource Area/ Alternatives | Primary Study Area | | Extended Study Area | | | Key Considerations and Exclusions |
|---|---|---|---|---|---|---|---|
| | | Shasta Lake & Vicinity | Sacramento River (Shasta Dam to RBPP) | Sacramento River (RBPP to Delta) | Delta | CVP/SWP Facilities and Water Service Areas | |
| Recreation and Public Access | CP1 – CP5 | green, blue | green, purple | green | green | green | Long-term beneficial effects on recreation included in NED account. Short-term adverse effects due to construction in primary study area; adverse effects reduced through mitigation. Long-term beneficial effects due to enhanced angling opportunities in the upper Sacramento River. |
| Aesthetics and Visual Resources | CP1 – CP5 | orange | green | green | green | green | Long-term adverse effects to aesthetics in reservoir area are unavoidable; adverse effects reduced through mitigation. |
| Transportation and Traffic | CP1 – CP5 | green, purple | green | green | green | green | Long-term beneficial effects due to modernized roadway/bridge relocations. Short-term adverse effects due to construction in primary study area; adverse effects reduced through mitigation. |
| Utilities and Service Systems | CP1 – CP5 | green, purple | green | green | green | green | Long-term beneficial effects due to replacing and modernizing utilities. Short-term adverse effects due to construction in primary study area; adverse effects reduced through mitigation. |
| Public Services | CP1 – CP5 | green | green | green | green | green | Short-term adverse effects due to construction in primary study area; adverse effects reduced through mitigation. |
| Power and Energy | CP1 – CP5 | blue | green | green | green | blue | Long-term beneficial effects from increased hydropower generation included in NED account. |
| Environmental Justice | CP1 – CP5 | orange | green | green | green | green | Not disproportionately high and adverse effects to minority and low income populations in the vicinity of Shasta Lake and upper Sacramento River. Disproportionately high and adverse effects to Native American populations in vicinity of Shasta Lake. Not disproportionately high and adverse effects to Native American populations in the vicinity of the upper Sacramento River. |

**Table 5-8. Summary of Potential Environmental Effects in the Environmental Quality Account (contd.)**

| Resource Area | Alternatives | Primary Study Area | | Extended Study Area | | | Key Considerations and Exclusions |
|---|---|---|---|---|---|---|---|
| | | Shasta Lake & Vicinity | Sacramento River (Shasta Dam to RBPP) | Sacramento River (RBPP to Delta) | Delta | CVP/SWP Facilities and Water Service Areas | |
| Wild and Scenic Rivers | CP1 – CP5 | [orange] | [green] | [green] | [green] | [green] | Long-term adverse effects in wet years are unavoidable for up to 0.67 miles of the McCloud River, designated for special protection, but not as a Wild & Scenic River. |

Note:

For some resource categories, both no (or minimal) effects and beneficial effects are indicated for the same portion of the study area. This is because there may be differences between short-term environmental effects (from construction) and long-term environmental effects of project operations, or differences in effects to different portions of a resource category. Where multiple effects are indicated, an explanation is provided in the "Key Considerations and Exclusions" column.

Key:

[green] No effect, minimal effect, not disproportionately high and adverse (environmental justice), and/or minimal effect after mitigation for the Environmental Quality account.

[orange] Unavoidable and/or disproportionately high and adverse (environmental justice) for the Environmental Quality account.

[purple] Beneficial effect for the Environmental Quality account.

[blue] Beneficial effects associated with anadromous fish survival, agricultural/irrigation water supply reliability, municipal and industrial water supply reliability, hydropower, and recreation accounted for in the NED account. Beneficial effects to regional economics (including jobs and income) included in RED accounts. Beneficial effects on life, health, and safety related to reduced flood risk are accounted for in the OSE account.

CP = comprehensive plan
CVP = Central Valley Project
Delta = Sacramento-San Joaquin Delta
NED = National Economic Development
OSE = other social effects
RBPP = Red Bluff Pumping Plant
RED = Regional Economic Development
SWP = State Water Project

## Regional Economic Development Account

Changes in the distribution of regional economic activity that would result from each alternative plan are included in the RED account. According to the P&G, two measures of regional economic effects are considered: regional income and regional employment. A region is generally defined as an area that encounters "significant" income and employment effects. Income and employment effects are further divided into "positive" and "negative" effects. Each of the four categories (positive income, positive employment, negative income, and negative employment) is equal to the sum of the NED effects that accrue in a region, plus transfers between the region and outside the region (i.e., positive income effects equal the NED benefits in the region plus the transfers of income to the region from outside the region). Transfers can come from implementation outlays, transfers of basic economic activity, indirect effects, and induced effects. The positive (and negative) effects on regional employment are directly parallel to effects on income; therefore, typically the analysis of regional employment effects is organized in the same categories as regional income effects. Regional employment effects are also analyzed according to relevant service, trade, industrial, and other sectors as well as skill levels (unskilled, semiskilled, and highly skilled).

Employment and income effects of the proposed alternatives were determined through the use of IMPLAN (IMpact analysis for PLANning) modeling. This modeling was completed based on an input/output (I/O) analysis. I/O models are essentially accounting tables that trace the linkages of inter-industry purchase and sales within a given region and year. In addition to inter-industry data, the IMPLAN model used several assumptions to analyze the RED benefits and impacts of all alternatives regarding construction duration, origin of the labor force, size of labor force, payroll costs as a percent of total construction costs, and origin of construction materials. For specific assumptions, see Chapter 8 of the Economic Valuation Appendix. The IMPLAN model yields "multipliers" that were used to calculate the total direct, indirect, and induced effects on employment and income, among other factors. The resulting benefits are displayed in Table 5-9.

Increased levels of income are expected to accompany the increase in employment (Table 5-10). The level of increased income is directly related to the quantity of employment opportunities and the duration of the project. Construction activity associated with each of the alternatives would take place over 4.5 to 5 years, depending on the alternative selected. Because economic impacts are typically measured and reported in annual terms, costs were converted to average annual expenditures for the duration of the construction period.

**Table 5-9. Summary of Estimated Annual Employment Benefits for RED Account**

| Item | CP1 | CP2 | CP3 | CP4 | CP4A | CP5 |
|---|---|---|---|---|---|---|
| Construction Duration (years) | 4.5 | 5 | 5 | 5 | 5 | 5 |
| **Short-Term Employment**[1] | | | | | | |
| New Direct Jobs | 300 | 300 | 350 | 350 | 350 | 360 |
| Local Labor Force | 300 | 300 | 350 | 350 | 350 | 360 |
| Construction | 300 | 300 | 350 | 350 | 350 | 360 |
| External Labor Force | 0 | 0 | 0 | 0 | 0 | 0 |
| Indirect and Induced Jobs | 1,010 | 1,010 | 1,160 | 1,170 | 1,170 | 1,190 |
| Construction Support | 400 | 400 | 460 | 460 | 460 | 470 |
| Total Direct, Indirect, and Induced Employment[2] | 1,320 | 1,320 | 1,510 | 1,520 | 1,520 | 1,540 |
| **Long-Term Employment** | | | | | | |
| Long-Term Maintenance Positions | 2 | 2 | 2 | 2 | 2 | 2 |

Notes:
[1] Results showing jobs per year for the construction duration were based on application of IMPLAN model.
[2] All numbers are rounded for display purposes; therefore, line items may not sum to totals.

Key:
CP = comprehensive plan
IMPLAN = IMpact analysis for PLANning
RED = Regional Economic Development

**Table 5-10. Summary of Estimated Annual Income Effects for RED Account**

| Item | CP1 | CP2 | CP3 | CP4 | CP4A | CP5 |
|---|---|---|---|---|---|---|
| Construction Duration (years) | 4.5 | 5 | 5 | 5 | 5 | 5 |
| **Income**[1] | | | | | | |
| Direct ($ millions/year) | 85.9 | 85.1 | 98.2 | 98.7 | 98.8 | 100.2 |
| Indirect/Induced ($ millions/year) | 48.3 | 47.8 | 55.2 | 55.4 | 55.4 | 56.3 |
| Total Income[2] ($ millions/year) | 134.2 | 132.8 | 153.3 | 154.2 | 154.3 | 156.5 |

Notes:
[1] Results showing personal income per year for the construction duration were based on application of IMPLAN model and are expressed in April 2012 price levels.
[2] All numbers are rounded for display purposes; therefore, line items may not sum to totals.

Key:
CP = comprehensive plan
IMPLAN = IMpact analysis for PLANning
RED = Regional Economic Development

In addition to employment and income benefits, all comprehensive plans would also provide additional benefits due to implementation outlays for construction activities. Construction activities would primarily occur in the immediate vicinity of Shasta Lake in Shasta County. RED effects due to implementation outlays are estimated to affect primarily the four-county region surrounding Shasta Lake, including Shasta, Tehama, Trinity, and Siskiyou counties. Effects to both regional employment and regional income are expected to be beneficial during the project construction period and would be approximately proportional to construction costs of the comprehensive plans.

## Other Social Effects Account

The OSE account provides a means of displaying information on alternative plan effects from perspectives that are not reflected in the other three accounts. Categories of effects included in the OSE account include: urban and community impacts; life, health, and safety factors; displacement; long-term productivity; and energy requirements and conservation. Both the beneficial and adverse effects in the OSE account are expected to be similar across all comprehensive plans, but generally proportional to the respective dam enlargement and newly inundated areas.

Threats to people, for loss of life and injury from flood events, must be addressed for public safety. Enlarging Shasta Dam and Reservoir has the potential to reduce flood flows in the upper Sacramento River. Through increased available storage in Shasta Reservoir, the comprehensive plans would reduce the frequency, magnitude, and duration of some potential future flood events, which have affected structures and residents in this part of the primary study area in the past. Table 5-11 illustrates the average monthly increase in available storage space from December through March (the peak of the flood season) for all of the comprehensive plans.

**Table 5-11. Estimated Increase in Shasta Lake Available Storage Space of Comprehensive Plans Relative to the No Action Alternative (Average Monthly[1])**

| Month | No-Action Alternative Available Storage | Increase in Available Storage Space (TAF) | | | | | |
|---|---|---|---|---|---|---|---|
| | | CP1 | CP2 | CP3 | CP4 | CP4A | CP5 |
| October | 1,965 | 115 (6%) | 198 (10%) | 268 (14%) | 115 (6%) | 198 (10%) | 283 (14%) |
| November | 1,979 | 122 (6%) | 209 (11%) | 283 (14%) | 122 (6%) | 209 (11%) | 296 (15%) |
| December | 1,817 | 104 (6%) | 180 (10%) | 242 (13%) | 104 (6%) | 180 (10%) | 257 (14%) |
| January | 1,542 | 92 (6%) | 164 (11%) | 221 (14%) | 92 (6%) | 164 (11%) | 237 (15%) |
| February | 1,273 | 78 (6%) | 144 (11%) | 199 (16%) | 78 (6%) | 144 (11%) | 210 (17%) |
| March | 916 | 75 (8%) | 136 (15%) | 187 (20%) | 75 (8%) | 136 (15%) | 198 (22%) |
| April | 618 | 83 (13%) | 145 (24%) | 200 (32%) | 83 (13%) | 145 (24%) | 210 (34%) |
| May | 591 | 82 (14%) | 144 (24%) | 203 (34%) | 82 (14%) | 144 (24%) | 211 (36%) |
| June | 899 | 87 (10%) | 152 (17%) | 208 (23%) | 87 (10%) | 152 (17%) | 220 (24%) |
| July | 1,385 | 89 (6%) | 160 (12%) | 217 (16%) | 89 (6%) | 160 (12%) | 233 (17%) |
| August | 1,711 | 97 (6%) | 170 (10%) | 236 (14%) | 97 (6%) | 170 (10%) | 247 (14%) |
| September | 1,890 | 106 (6%) | 183 (10%) | 252 (13%) | 106 (6%) | 183 (10%) | 265 (14%) |

Note:
[1] Highlighted months represent the flood control season, with darker highlighting indicating more critical periods for flood control when the maximum allowable storage may be at a minimum.

Key:
CP = comprehensive plan
TAF = thousand acre feet

As a result of greater reservoir capacity, the overall risk of flooding and related consequences below Shasta Dam are expected to be reduced. The potential for loss of life would also be reduced. Flood damage reduction benefits of the dam enlargement would not be expected to change the existing floodplain or Federal Emergency Management Agency flood zone designations; therefore, the comprehensive plans would not remove an obstacle to development. Thus, flood protection benefits are not considered growth inducing.

Environmental justice review is required to determine if a disproportionate share of a proposed project’s adverse socioeconomic and other environmental impacts are borne by low-income and minority communities. The disturbance or loss of resources associated with certain locations that are important to the Winnemem Wintu (a Native American group) and Pit River Madesi Band members for their religious and cultural significance would result in an unmitigable, disproportionately high and adverse effect on Native American populations in the vicinity of Shasta Lake.

All comprehensive plans are estimated to displace people and businesses in the Shasta Lake area because of expanded reservoir inundation areas. Any potential real estate acquisition, or necessary relocations of displaced parties, would be accomplished consistent with Public Law 91-646.

All comprehensive plans would provide beneficial effects on health and safety in the Shasta Lake area and downstream along the Sacramento River. Under all comprehensive plans, relocated roadways, bridges, utilities, and recreation facilities would be replaced with modernized and upgraded facilities, using current design standards and construction practices. Additionally, many reservoir area septic systems would be replaced with centralized wastewater treatment plants. USFS emergency response facilities would also be relocated to a more centralized location adjacent to major transportation corridors.

## Comparison of Comprehensive Plans

All of the comprehensive plans were developed based on the P&G (WRC 1983) criteria, as described in Chapter 3: (1) completeness, (2) effectiveness, (3) efficiency, and (4) acceptability. Table 5-12 displays the benefits and costs for each comprehensive plan, and Table 5-13 displays comparisons of the comprehensive plans according to the evaluation criteria.

**Table 5-12. Summary of Potential Benefits and Costs of Comprehensive Plans**

| Item | CP1 | CP2 | CP3 | CP4 | CP4A | CP5 |
|---|---|---|---|---|---|---|
| **Shasta Dam Raise (feet)** | **6.5** | **12.5** | **18.5** | **18.5** | **18.5** | **18.5** |
| Total Increased Storage (TAF) | 256 | 443 | 634 | 634 | 634 | 634 |
| **Benefits** | | | | | | |
| Increase Anadromous Fish Survival | | | | | | |
| Dedicated Storage (TAF) | - | - | - | 378 | 191 | - |
| Production Increase (thousand fish)[1] | 61.3 | 379.2 | 207.4 | 812.6 | 710.0 | 377.8 |
| Spawning Gravel Augmentation (tons)[2] | | | | 10,000 | 10,000 | 10,000 |
| Side Channel Rearing Habitat Restoration | | | | Yes | Yes | Yes |
| Increase Water Supply Reliability | | | | | | |
| Total Increased Dry and Critical Year Water Supplies (TAF/year)[3] | 47.3 | 77.8 | 63.1 | 47.3 | 77.8 | 113.5 |
| Increased NOD Dry and Critical Year Water Supplies (TAF/year)[3] | 4.5 | 10.7 | 35.2 | 4.5 | 10.7 | 25.2 |
| Increased SOD Dry and Critical Year Water Supplies (TAF/year)[3] | 42.7 | 67.1 | 28.0 | 42.7 | 67.1 | 88.3 |
| Increased Water Use Efficiency Funding | Yes | Yes | Yes | Yes | Yes | Yes |
| Increased Emergency Water Supply Response Capability | Yes | Yes | Yes | Yes | Yes | Yes |
| Reduce Flood Damages | | | | | | |
| Increased Reservoir Storage Capacity | Yes | Yes | Yes | Yes | Yes | Yes |
| Additional Hydropower Generation | | | | | | |
| Increased Hydropower Generation (GWh/year) | 52 - 54 | 87 - 90 | 86 - 90 | 127 - 133 | 125 - 130 | 112 - 117 |
| Conserve, Restore, and Enhance Ecosystem Resources | | | | | | |
| Shoreline Enhancement (acres) | - | - | - | - | - | 130 |
| Tributary Aquatic Habitat Enhancement (miles)[5] | - | - | - | - | - | 6 |
| Riparian, Floodplain, and Side Channel Habitat Restoration | - | - | - | Yes | Yes | Yes |
| Increased Ability to Meet Flow and Temperature Requirements Along Upper Sacramento River | Yes | Yes | Yes | Yes | Yes | Yes |
| Improve Water Quality | | | | | | |
| Improved Delta Water Quality | Yes | Yes | Yes | Yes | Yes | Yes |
| Increased Delta Emergency Response Capability | Yes | Yes | Yes | Yes | Yes | Yes |
| Increase Recreation | | | | | | |
| Recreation (user days, thousands)[6] | 85 - 89 | 116 - 134 | 201 - 205 | 307 - 370 | 246 - 259 | 142 - 175 |
| Modernization of Recreation Facilities | Yes | Yes | Yes | Yes | Yes | Yes |

**Table 5-12. Summary of Potential Benefits and Costs of Comprehensive Plans (contd.)**

| Item | CP1 | CP2 | CP3 | CP4 | CP4A | CP5 |
|---|---|---|---|---|---|---|
| **Economics [7]** | | | | | | |
| Cost | | | | | | |
| Construction Cost ($ millions) | 990 | 1,089 | 1,257 | 1,264 | 1,265 | 1,283 |
| Interest During Construction ($ millions) | 83 | 91 | 105 | 105 | 105 | 108 |
| Total Capital Cost ($ millions) | 1,073 | 1,180 | 1,362 | 1,370 | 1,371 | 1,391 |
| Annual Cost ($ millions/year) | 45.1 | 51.2 | 53.8 | 57.1 | 59.0 | 61.0 |
| Annual NED Benefits ($ millions/year)[8] | | | | | | |
| Estimated Value (at inflation)[9] | 29.7 | 61.6 | 42.6 | 86.0 | 88.9 | 74.2 |
| Estimated Value (2% above inflation)[10] | 48.4 | 93.3 | 60.7 | 111.6 | 124.1 | 115.2 |
| Net NED Benefits ($ millions/year)[7] | | | | | | |
| Estimated Value (at inflation)[9] | -15.4 | 10.5 | -11.2 | 28.9 | 29.9 | 13.2 |
| Estimated Value (2% above inflation)[10] | 3.3 | 42.1 | 6.9 | 54.5 | 65.1 | 54.2 |

Notes:

[1] 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 the RBPP.

[2] Average amount per year for 10-year period.

[3] Total increased deliveries during dry and critical years (based on the Sacramento Valley Water Year Hydrologic Water Classification) to CVP and SWP. Does not reflect benefits related to water use efficiency actions included in all comprehensive plans.

[4] Annual increases in hydropower generation were estimated using two methodologies – at load center (accounting for transmission losses) and at-plant (no transmission losses). To provide a more conservative estimate of potential hydropower benefits, load center generation values were used to estimate potential benefits of increased hydropower generation under comprehensive plans. However, increased generation values reported in Chapter 23 of the accompanying EIS were based on at-plant generation values to capture the largest potential effects from changes in hydropower generation and pumping.

[5] Tributary aquatic enhancement provides for the connectivity of native fish species and other aquatic organisms between Shasta Lake and its tributaries. Estimates of benefits reflect only connectivity with perennial streams and do not reflect additional miles of connectivity with intermittent streams.

[6] Annual recreation visitor user days were estimated using two methodologies. The minimum user day value was used to estimate potential recreation benefits to provide a more conservative estimate of the potential benefits of increased recreation under comprehensive plans. However, in the accompanying EIS, the maximum user value was used for direct and indirect effects evaluations in each resource area chapter to capture the largest potential effects from increased visitation. These values do not account for increased visitation due to modernization of recreation facilities associated with all comprehensive plans.

[7] Based on January 2014 price levels, 3-1/2 discount rate, and 100-year period of analysis.

[8] Economic benefits reflect increases in anadromous fish production, water supplies for CVP and SWP deliveries, hydropower generation and ancillary services/capacity benefits, and recreation (increased user days). Does not include monetized annual benefits for ecosystem restoration, flood damage reduction, or water quality.

[9] Assumes the costs of water supplies and hydropower would increase at the same rate as inflation.

[10] Includes increase of water supply and hydropower costs at 2 percent above inflation to account for growing scarcity in the future. Sensitivity analyses for changes in water supply and hydropower benefits are included in Economic Valuation Appendix.

Key:
- \- = not applicable
- CP = comprehensive plan
- CVP = Central Valley Project
- Delta = Sacramento-San Joaquin Delta
- GWh/year = gigawatt-hours per year
- NED = National Economic Development
- NOD = north of Delta
- SALMOD = Salmonid Population Model
- SOD = south of Delta
- SWP = State Water Project
- TAF = thousand acre-feet

**Table 5-13. Summary Comparison of Comprehensive Plans**

| Comprehensive Plan | Comparison Criteria | | | | Relative Ranking |
|---|---|---|---|---|---|
| | **Completeness** | **Effectiveness[1]** | **Efficiency[2]** | **Acceptability** | |
| **No-Action Alternative** | Although the No-Action Alternative would require no additional future action, it would address none of the planning objectives. | Water supply reliability and hydropower needs would continue to increase. High anadromous fish survival, ecosystem restoration, and recreation needs would remain unchanged. | Highly cost inefficient. By taking no additional action, as problems and needs continued and grew, either other significantly more costly actions would be undertaken, especially to address water supply and power needs, or problems and needs would continue unabated. | Would not further address any CALFED or CVPIA goal. | *Very Low* |
| *Relative Rank* | *Very Low* | *None* | *None* | *Very Low* | |
| **CP1 – 6.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability** | Could be implemented with minimum impact and would not require future elements. Would not preclude future action at Shasta Dam and Reservoir or elsewhere in CVP. Would address primary planning objectives. | Relatively low potential to effectively increase water supply reliability and improve fish survival. Would contribute to hydropower and recreation planning objectives. | Low cost efficiency. Unit cost for water supply reliability would likely be superior to other new sources. | Would meet goals of CALFED and consistent with plan in 2000 CALFED Programmatic ROD. High potential for avoiding perceived impacts. | *Moderate* |
| *Relative Rank* | *Very High* | *Low* | *Low* | *High* | |
| **CP2 – 12.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability** | Similar to CP1. Significant potential for avoiding/mitigating potential increased impacts. | Moderate potential to effectively address primary objectives. Would significantly contribute to water supply reliability. Would contribute to hydropower and recreation planning objectives. | High cost efficiency. Unit cost for water supply reliability would likely be superior to other new sources. | Would be consistent with goals of CVPIA, CALFED, and other related programs. Significant potential for avoiding perceived impacts. | *Moderate to High* |
| *Relative Rank* | *Very High* | *Moderate* | *Moderate to High* | *Moderate to High* | |

**Table 5-13. Summary Comparison of Comprehensive Plans (contd.)**

| Comprehensive Plans | Comparison Criteria | | | | Relative Ranking |
|---|---|---|---|---|---|
| | Completeness | Effectiveness[1] | Efficiency[2] | Acceptability | |
| **CP3 – 18.5-Foot Dam Raise, Agricultural Water Supply Reliability and Anadromous Fish Survival** | Similar to CP1. Significant potential for avoiding/mitigating potential increased impacts. | High potential to effectively address anadromous fish survival and agricultural water supply reliability. Low potential to address M&I water supply reliability. Would contribute to hydropower and recreation objectives. | Low cost efficiency. Unit cost for water supply reliability would likely be superior to other new sources. | Would be consistent with goals of CVPIA, CALFED, and other related programs. | *Moderate* |
| *Relative Rank* | *Very High* | *Moderate* | *Low* | *Moderate to High* | |
| **CP4 – 18.5-Foot Dam Raise, Anadromous Fish Focus with Water Supply Reliability** | Significant potential for avoiding/mitigating potential increased impacts. Moderate degree of uncertainty about permanently implementing changed operation for anadromous fish. | Would have major increases in benefits to anadromous fish but relatively lower potential to effectively increase water supply reliability. Highest potential to contribute to hydropower and recreation objectives. | Very high overall cost efficiency. High cost efficiency for anadromous fish survival. Moderate cost efficiency for water supply reliability. | Would be consistent with goals of CVPIA, CALFED, and other related programs. | *High* |
| *Relative Rank* | *High* | *High* | *Very High* | *Moderate to High* | |
| **CP4A – 18.5-Foot Dam Raise, Anadromous Fish Focus with Water Supply Reliability** | Significant potential for avoiding/mitigating potential increased impacts. Moderate degree of uncertainty about permanently implementing changed operation for anadromous fish. | Would have major increases in benefits to anadromous fish and significant contribution to water supply reliability. High potential to contribute to hydropower and recreation objectives. | Very high overall cost efficiency. High cost efficiency for both anadromous fish survival and water supply reliability. | Would be consistent with goals of CVPIA, CALFED, and other related programs. Consistent with the goals of CALFED for various programs, including water supply reliability and ecosystem restoration. | *Very High* |
| *Relative Rank* | *High* | *Very High* | *Very High* | *High* | |

**Table 5-13. Summary Comparison of Comprehensive Plans (contd.)**

| Comprehensive Plans | Comparison Criteria | | | | Relative Ranking |
|---|---|---|---|---|---|
| | Completeness | Effectiveness[1] | Efficiency[2] | Acceptability | |
| **CP5 – 18.5-Foot Dam Raise, Combination Plan** | Could be implemented with minimum impact and would not require future elements. Would not preclude future action at Shasta Dam and Reservoir or elsewhere in CVP. Would address all planning objectives. | High potential to address primary planning objectives. Would contribute to secondary objectives with emphasis on ecosystem restoration and recreation. | High cost efficiency. Unit cost for water supply reliability would likely be superior to other new sources. Would have high potential for helping restore ecosystem resources and additional recreation at and near Shasta Lake. | Would be consistent with goals of CVPIA, CALFED, and other related programs. Would be consistent with the goals of CALFED for various programs, including water supply reliability and ecosystem restoration. | *High* |
| *Relative Rank* | *High* | *High* | *High* | *Moderate to High* | |

Notes:

[1] For the primary planning objective of anadromous fish survival, two major relative ranking factors were considered: (1) increasing salmon survival (decreasing salmon mortality) and (2) increasing habitat for spawning. For the primary planning objective of increasing water supply reliability, ranking was based on the relative amount of estimated increased dry and critical year deliveries under each comprehensive plan. For the secondary planning objectives, four relative ranking factors were considered: (1) whether a comprehensive plan included ecosystem restoration, (2) potential to affect flood peaks downstream from Keswick Dam, (3) potential to increase net power generation, and (4) amount of increased recreation opportunities at Shasta Lake.

[2] The relative rankings for efficiency were based primarily on estimated net NED benefits obtained under each plan.

Key:

CALFED = CALFED Bay-Delta Program

CP = comprehensive plan

CVP = Central Valley Project

CVPIA = Central Valley Project Improvement Act

NED = National Economic Development

ROD = Record of Decision

### Completeness

Completeness is a determination of whether a plan includes all elements necessary to realize planned effects, and the degree that intended benefits of the plan depend on the actions of others. Each of the comprehensive plans is estimated to be complete. Several subfactors that are important in measuring this criterion include the following:

- **Authorization –** All comprehensive plans would be consistent with the SLWRI feasibility study authorizations, including Public Law 96-375 (1980) and Public Law 108-361 (2004).
- **Spectrum of objectives being addressed –** As shown in Table 5-12, each of the comprehensive plans would contribute to both primary and secondary objectives.
- **Reliability –** All comprehensive plans would stand alone and would not rely on other actions. Further, the likely reliability and certainty of each of the comprehensive plans to meet overall objectives under a wide range of future conditions would be high. The analyses documented in the Climate Change Modeling Appendix to the accompanying EIS indicate that the comprehensive plans would be robust and would provide benefits under a range of future climate scenarios. However, plan components involving ecosystem restoration along the Sacramento River and in the Shasta Lake area have uncertainty related to O&M requirements to achieve objectives (e.g., siltation of restored channels), and therefore would have less reliability over the long-term. Accordingly, overall reliability would be slightly reduced for CP4, CP4A, and CP5.
- **Physical implementability –** All comprehensive plans generally consist of the same physical implementation components and are projected to be technically feasible, constructible, and able to be operated and maintained.
- **Environmental effects and mitigation –** Anticipated impacts are generally comparable between comprehensive plans, with some impacts exacerbated by larger dam raises and the associated scale of those impacts.

### Effectiveness

Effectiveness is the extent to which an alternative alleviates problems and achieves objectives. As shown in Table 5-12, each of the comprehensive plans would contribute in varying degrees to the primary and secondary planning objectives. CP4, CP4A, and CP5 are estimated to have the greatest effectiveness in meeting planning objectives. This is primarily because CP4 and CP4A would provide the largest contributions toward anadromous fish survival and CP5 would provide the largest contribution toward water supply reliability. CP4A ranks slightly higher than CP4 because, as shown in Figure 5-1, in addition to high contributions to anadromous fish survival, CP4A would also provide substantial contributions to water supply reliability.

### Efficiency

Efficiency is the measure of how efficiently an alternative alleviates identified problems while realizing specified objectives consistent with protecting the Nation's environment. As shown in Table 5-12, assuming the cost of water and energy supplies increases at the same rate as inflation, CP2, CP4, CP4A, and CP5 would be economically feasible. Assuming the cost of water and energy supplies increased at 2 percent above inflation to account for increasing value of water and energy supplies, all comprehensive plans would be economically feasible. Under either condition, CP4A would have the potential to provide the greatest net economic benefits.

### Acceptability

Acceptability is the workability and viability of a plan with respect to its potential acceptance by other Federal agencies, State and local government agencies, and public interest groups and individuals. Acceptability would vary based on the dam raise height, focus of the comprehensive plan, and associated benefits. For CP1, CP2, and CP5, acceptability by both CVP and SWP water users would increase with higher dam raises. CP3 would rank highest for acceptability by CVP water users, but would rank lowest for acceptability by SWP water users. Acceptability by CVP and SWP water users for CP4 and CP4A would be similar to CP1 and CP2, respectively. CP4 and CP4A would rank highest in acceptability by fisheries agencies and related resource interests.

### Summary of Comparisons

Each of the comprehensive plans is estimated to be complete, and it appears that each would be effective in achieving its intended objectives. As shown in Table 5-12, all comprehensive plans except CP1 and CP3 would be cost-efficient. Three comprehensive plans with an 18.5-foot dam raise, CP4, CP4A, and CP5, would best address the planning objectives, based on benefits and costs derived. This is primarily because of (1) a high certainty (completeness) that the plans could achieve their intended benefits, and (2) relatively high effectiveness and economic efficiency. CP1 and CP2 would have less of an adverse effect on land uses within the dam inundation area than the other comprehensive plans because CP1 and CP2 would raise the dam by 6.5 feet and 12.5 feet, respectively, compared to the 18.5-foot increase proposed for CP3, CP4, CP4A, and CP5. However, a majority of the construction activities, annual costs, and reservoir area relocations would be required under any dam raise. In addition, the smaller Shasta Dam raise alternatives would provide only a portion of the increased storage capacity of an 18.5-foot raise.

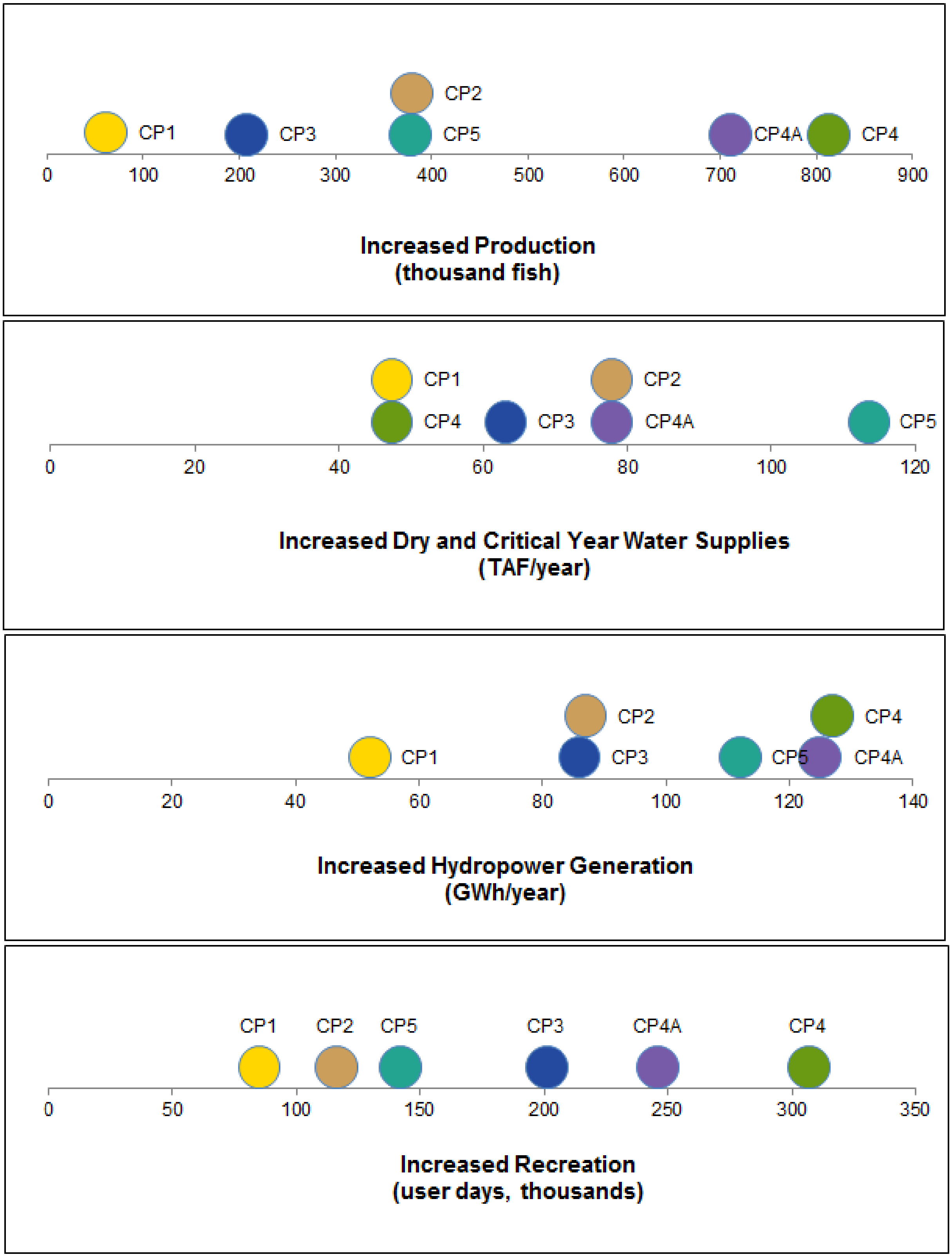



**Figure 5-1. Comparison of Ability of Comprehensive Plans to Address Planning Objectives**

Table 5-14 displays a comparison of the No-Action Alternative and comprehensive plans overall. Of the three highest ranking plans, CP4A is ranked highest because it would be the most effective in meeting both primary planning objectives, would be the most cost-effective, and would likely be ranked the highest in overall acceptability considering a broad range of stakeholders.

**Table 5-14. Summary Comparison of No-Action and Comprehensive Plans**

| Alternative | Effectiveness | Efficiency | Completeness | Acceptability | Combined Ranking |
|---|---|---|---|---|---|
| No-Action Alternative | None | None | Very Low | Very Low | Very Low |
| CP1 | Low | Low | Very High | High | Moderate |
| CP2 | Moderate | Moderate to High | Very High | Moderate to High | Moderate to High |
| CP3 | Moderate | Low | Very High | Moderate to High | Moderate |
| CP4 | High | Very High | High | Moderate to High | High |
| CP4A | Very High | Very High | High | High | Very High |
| CP5 | High | High | High | Moderate to High | High |

Key:
CP = comprehensive plan

# Rationale for Plan Selection

At this stage of the Federal planning and NEPA processes, the potential physical accomplishments and the benefits and costs of the alternative plans have been evaluated and compared based on established criteria. A plan recommending Federal action is to be the plan that best addresses the targeted water resources problems considering public benefits relative to costs. The basis for selecting the recommended plan is to be fully reported and documented, including the criteria and considerations used in selecting a recommended course of action by the Federal Government.

The Secretary of the Interior will provide this Final Feasibility Report, the accompanying Final EIS, and supporting information to Congress. The U.S. Congress will use these documents, as well as any additional information they believe appropriate, to determine the public interest in the project, and the specific project authorization language. Most of the activities pursued by the Federal Government require assessing trade-offs and, in many cases, the final decision requires judgment regarding the appropriate extent that monetized and non-monetized benefits and impacts are factored into the decision.

Based on the evaluation of the potential physical accomplishments and the benefits and costs of the alternative plans, CP4A would achieve the highest net NED benefits while protecting the environment and ranks the highest among the comprehensive plans in meeting the P&G criteria. Consistent with the P&Gs,

since CP4A generates maximum net NED benefits, CP4A is identified as the NED Plan. CP4A is also identified as the Preferred Alternative pursuant to NEPA (as described in Chapter 32 of the Final EIS) and is synonymous with the Selected Plan and Preferred Plan pursuant to Reclamation Directives and Standards and Policy (CMP 09-02). Additionally, it is anticipated that CP4A will be identified as the Least Environmentally Damaging Practicable Alternative (LEDPA) pursuant to Section 404 of the Clean Water Act, which is ultimately subject to determination by USACE. In addition, consistent with Department of the Interior climate change policy, CP4A is anticipated to provide benefits under a wide range of future climate scenarios and to provide additional flexibility to adapt to potential changes in hydrology under climate change.

# Chapter 6
# National Economic Development Plan and Implementation Requirements

This chapter summarizes the NED Plan and project implementation requirements. It includes the determination of the feasibility of the NED Plan, identification of areas of risk and uncertainty, implementation requirements, Federal and non-Federal responsibilities, and project timeline.

## NED Plan

As required by the P&G, the plan with the greatest NED benefits is to be identified as the NED Plan and is usually selected for recommendation to Congress for approval, unless the Secretary of the Interior grants an exception based on overriding considerations and merits of another plan. If another plan is recommended instead of the NED Plan, such as a locally preferred plan (LPP), the NED Plan is still presented as a basis of comparison to define the extent of Federal financial interest in the plan for recommendation.

CP4A is the NED Plan based upon the evaluation and comparisons described in Chapter 5. The initial description of CP4A is presented in Chapter 4, and the following provides supplemental information on the major components and potential benefits of this comprehensive plan.

### Major Components

Major components of CP4A include the following:

- Raising Shasta Dam and appurtenant facilities by 18.5 feet.
- Reserving 191,000 acre-feet of the increased storage in Shasta Lake for maintaining cold-water volume or augmenting flows as part of an adaptive management plan for anadromous fish survival.
- Augmenting spawning gravel in the upper Sacramento River.
- Restoring riparian, floodplain, and side channel habitat in the upper Sacramento River.
- Raising the existing TCD structure and modifying the shutter control to increase the operating range or effectiveness of the structure.

- Implementing a water conservation program for the additional water supplies.
- Modifying the existing flood operational guidelines or rule curves to reflect physical modifications.
- Modifying the existing hydropower facilities at the dam to enable their continued efficient use.
- Relocation and modernization of recreation facilities to maintain the overall recreation capacity at Shasta Lake.
- Implementing the common environmental commitments described in Chapter 4 and in the Preliminary Environmental Commitments and Mitigation Plan Appendix to the accompanying EIS.
- Implementing the mitigation measures identified for CP4A which are summarized in Chapter 4 and described in detail in the Preliminary Environmental Commitments and Mitigation Plan Appendix to the accompanying EIS.

With a dam raise of 18.5 feet, the full pool elevation in Shasta Reservoir would be raised by 20.5 feet. The capacity of the reservoir would be increased by 634,000 acre-feet to a total of 5.19 MAF. Main features of the plan are summarized below:

- **Lands –** CP4A would result in an increase in full pool area of about 2,600 acres, the majority of which would be on Federal property. This amounts to an average increase in landward encroachment of water surface around the reservoir of about 50 feet at full pool. This distance would be greater along inflowing streams and creeks.
- **Clearing of Reservoir Area –** Acreage that would be inundated within the new full pool would be cleared to reduce hazards to the public and provide access to the shoreline near high-use recreation areas. This includes removing trees and other vegetation from around the reservoir shoreline. Approximately 832 acres of the newly inundated area would need either overstory vegetation removal (removing all trees greater than 10 inches in diameter at breast height or 15 feet in height) or complete vegetation removal (removing all existing vegetation).
- **Dam Crest Structure Removal –** Existing structures on the dam crest would be removed. These structures include the gantry crane, existing spillway drum gates and frames, spillway bridge, concrete in the spillway crest and abutments, parapet walls, sidewalks, curbing, crane rails, and control equipment.

- **Main Gravity Dam –** Raising Shasta Dam would be accomplished 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).

- **Wing Dams –** The existing wing dams at Shasta Dam would be raised to tie the concrete gravity section into the left and right abutments. The left wing dam would be composed of compacted core material and rockfill, similar to the material used in the original wing dam construction. The upstream face of the left wing dam would include a reinforced concrete or mechanically stabilized earth wall, and a concrete parapet wall. The right wing dam would be composed of mass concrete, similar to the main gravity dam.

- **Spillway –** The three existing 110-foot-wide by 28-foot-high drum gates would be removed and replaced with six sloping, fixed-wheel gates. Four gates would be approximately 48 feet wide by 38 feet high and two gates would be approximately 54 feet wide by 38 feet high.

- **River Outlets –** Shasta Dam has 18 river outlets arranged in three tiers. The four lower tier tube valves would be replaced because of operational limitations.

- **Temperature Control Device –** Modifying the TCD at Shasta Dam would primarily include 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; and lengthening/replacing the shutter operating cables.

- **Reservoir Area Dikes –** Dikes would be constructed in the Lakeshore and Bridge Bay areas to protect Caltrans highways, the UPRR, and other infrastructure from inundation.

- **Pit 7 Project Facilities –**If a plan is authorized for construction, Reclamation would perform additional studies to further refine potential modifications to the Pit 7 Project facilities. Minor modifications are recommended for the Pit 7 Dam spillway, including raising the concrete training walls. With an increased tailwater elevation, it would be necessary to install a tailwater depression system to lower the water level in the draft tubes. Installation of an addition submersible pump in the powerhouse would collect any additional seepage. Minor modification would be required for Pit 7 Afterbay Dam and ancillary facilities. Reclamation would also provide in-kind replacement power to PG&E for reduced power generation of the Pit 7 Project due to increased tailwater elevations.

- **Railroad Bridge Relocations –** Three UPRR bridges would be relocated or modified: Doney Creek Bridge, Sacramento River Second Bridge Crossing, and Pit River Bridge.

- **Vehicle Bridge Relocations –**The following vehicle bridges would be relocated: Charlie Creek Bridge, Doney Creek Bridge, McCloud River Bridge, and Didallas Creek Bridge. Modifications to Fender's Ferry Bridge would include enlarging and extending the existing reinforced-concrete footing and pier, and modifying the existing steel tower to prevent inundation.

- **Major Roads and Road Segments –** Approximately 30 segments of roadway would be relocated, including portions of Lakeshore Drive, Gillman Road, Salt Creek Road, and other roads in the vicinity of Turntable Bay, Jones Valley, and Silverthorn marinas.

- **Recreation Facilities –** Inundated recreation facilities and associated utilities would be relocated and new facilities would be developed that meet current recreational facility standards. For recreation facilities on Federal lands, Reclamation and 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.

- **Nonrecreation Structures –** Sugarloaf and Lakeshore are the main areas with buildings that would be affected, and these structures would be demolished according to requirements of the Shasta County Department of Resource Management Building Division.

- **Utilities and Miscellaneous Minor Infrastructure –** Relocating various utility facilities, septic systems, and other miscellaneous minor infrastructure would be required, including replacing a number of reservoir area septic systems with centralized wastewater treatment plants.

## Major Benefits

Following are the major benefits of the NED Plan:

- **Anadromous Fish Survival –** Implementing the NED Plan would increase the depth and volume of the cold-water pool in Shasta Reservoir. This would increase the ability of Reclamation to make cold-water releases and to regulate water temperatures for fish in the upper Sacramento River, particularly in dry and critical years. The NED Plan includes dedicating 191,000 acre-feet of the increased storage to increasing the cold-water pool in Shasta Reservoir, which may be managed under an adaptive management plan. Improved water temperature and flow conditions are expected to increase the salmon population by about 710,000 outmigrating juvenile salmon per year on average. The adaptive management plan may include operational changes to the timing and magnitude of releases from Shasta Dam for the benefit of anadromous fish, as long as there are no conflicts with current operational guidelines or adverse impacts to water supply reliability.

Under the NED Plan, augmenting spawning gravel and restoring riparian, floodplain, and side channel habitat is expected to improve anadromous fish survival in the Sacramento River. Spawning-sized gravel would be applied for a 10-year period and would be placed at discrete locations in the Sacramento River between Keswick Dam and the RBPP. Riparian, floodplain, and side channel habitat restoration would be constructed at one or more suitable locations along the upper Sacramento River.

- **Water Supply Reliability –** The NED Plan would increase water supply reliability by increasing water supplies for irrigation and M&I deliveries primarily during dry and critical years. This action would contribute to replacing supplies redirected to other purposes in the CVPIA. The NED Plan would help reduce 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. In addition, water use efficiency would reduce current and future water shortages.

- **Hydropower Generation –** The higher water surface elevation in the reservoir would result in a net increase in power generation of about 125 GWh per year. Other hydropower 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 –** Adding spawning gravel and restoring riparian, floodplain, and side channel habitat are expected to improve the complexity of aquatic habitat and its suitability for anadromous salmonid spawning and rearing. In addition, improved fisheries conditions from cold-water storage and management increase flexibility to meet flow and temperature requirements, and could enhance overall ecosystem resources in the Sacramento River.

- **Recreation –** Benefits to the water-oriented recreation experience at Shasta Lake would occur because of the increase in average lake surface area, reduced drawdown during the recreation season, and modernization of recreation facilities.

- **Additional Benefits –** The NED Plan would also provide: incidental increased reservoir capacity to capture flood flows, which could reduce flood damage along the upper Sacramento River; improved Delta water quality conditions by increasing Delta outflow during drought years, reducing salinity during critical periods, and increased Delta emergency response capabilities; increase emergency response capability for CVP/SWP water supply deliveries; benefits to reservoir water quality, traffic and transportation, and public services from modernization and upgrades of relocated facilities; and long-term benefits to air quality, groundwater, Shasta Lake fisheries, and system-wide operations due to increased overall system capacity, allowing for increases in clean energy production, surface water deliveries, and storage capacity in Shasta Reservoir.

### National Economic Development Benefits

Following is a summary of the costs and benefits of the NED Plan:

- **Estimated Costs –** The estimated total construction cost is $1,265 million. The estimated total annual cost of this plan is $59.0 million.

- **Estimated Benefits –** The estimated total annual monetary benefit is about $88.9 million, assuming the cost of water and energy supplies increases at the same rate as inflation.

- **Estimated Net Benefits –** The estimated net economic benefit is about $29.9 million per year, assuming the cost of water and energy supplies increases at the same rate as inflation.

## Feasibility Determination for the NED Plan

This section summarizes the technical, environmental, economic, and financial feasibility of the NED Plan.

Feasibility determination includes the following four elements:

- Technical feasibility, consisting of engineering, operations, and constructability analyses verifying that it is physically and technically possible to construct, operate, and maintain the project.

- Environmental feasibility, consisting of analyses verifying that constructing or operating the project will not result in unacceptable environmental consequences.

- Economic feasibility, consisting of analyses verifying that constructing and operating the project would result in net NED benefits.

- Financial feasibility, consisting of examining and evaluating project beneficiaries' ability to repay their allocated portion of the Federal investment in the project over a period of time, consistent with applicable law.

The following summarizes the technical, environmental, economic and financial feasibility of the NED Plan.

## Technical Feasibility

The NED Plan is projected to be technically feasible; it is constructible, and can be operated and maintained. Designs and cost estimates have been developed to a feasibility level. A Design, Estimating, and Construction (DEC) Review was performed in August 2008 (Reclamation 2008d). Based on recommendations from the DEC review, designs and costs were refined to bring all construction features to a feasibility level. The DEC Review concluded that when the DEC recommendations were adequately addressed, the design and cost estimate for the NED Plan would be at a level suitable (i.e., feasibility level) for use for Congressional authorization and appropriation. In April 2014, a DEC Special Assessment was performed to verify completion of DEC recommendations. Recommendations from both the DEC Review and DEC Special Assessment have been addressed and resolved.

Operations of an enlarged Shasta Dam and Reservoir and other related CVP and SWP facilities 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. The NED Plan may also include adaptive management of the 191,000 acre-feet of new storage dedicated for anadromous fish survival. Adaptive management may include operational changes to the timing and magnitude of releases from Shasta Dam for the benefit of anadromous fish, if there are no conflicts with current operational guidelines or adverse impacts to water supply reliability.

Operations of other project features, which primarily include relocated infrastructure along the Shasta Lake shoreline, would also be similar to operations of existing facilities. Because the majority of project features include replacing or modifying existing facilities, minimal changes are expected in maintenance requirements for project features. Other O&M considerations include increased pumping requirements of CVP and SWP facilities for delivery of increased water supplies, operation of consolidated reservoir area wastewater treatment facilities, and in-kind power replacement to PG&E to offset reduced energy generation at Pit 7 Dam and Powerhouse.

## Environmental Feasibility

The NED Plan is evaluated in the accompanying Final EIS. Environmental effects were evaluated and mitigation measures were identified. CP4A was identified as the Preferred Alternative, consistent with NEPA, in the Final EIS (see Chapter 32 of the Final EIS).

The NED Plan would affect environmental resources in the primary and extended study areas, as summarized in Table 5-8. Beneficial effects correspond to the following resource areas: hydrology, hydraulics, and water management; water quality; fisheries and aquatic resources; socioeconomics, population, and housing; recreation and public access; transportation and traffic; and power and energy. Some of the adverse effects anticipated for raising Shasta Dam would be temporary, construction-related effects that would be less than significant or would be reduced to less-than-significant levels through mitigation. Other adverse effects would be long-term, such as effects on botanical, wildlife, and cultural resources, within newly inundated areas of Shasta Lake. Some adverse effects (e.g., the short-term generation of construction-generated emissions in excess of SCAQMD thresholds and generation of increased daytime glare and/or night time lighting) would remain unavoidable despite mitigation measures. Table S-3 in the Executive Summary of the accompanying Final EIS summarizes environmental effects and proposed mitigation for the NED Plan. The Preliminary Environmental Commitments and Mitigation Plan Appendix to the accompanying EIS describes all proposed mitigation measures for the NED Plan.

Reclamation will incorporate environmental commitments and best management practices to avoid or minimize potential effects (see Chapter 4). Reclamation will, contingent on Congressional authorization, coordinate the planning, engineering, design and construction, and operations and maintenance phases of the project with applicable resource agencies.

## Economic Feasibility

The NED Plan provides the greatest net NED benefits of the alternatives evaluated, while protecting the environment, as discussed in Chapter 5. The NED Plan is projected to be economically feasible, generating net benefits of $29.9 million annually, assuming water supply and hydropower costs increase at the same rate as inflation. Assuming an increase of water supply and hydropower costs at 2 percent above inflation to account for growing scarcity of water and energy supplies in the future and increasing demand, the NED Plan would generate $65.1 million annually in net benefits.

## Financial Feasibility

Financial feasibility determination during the planning stage consists of (1) allocating costs to project purposes, (2) assigning reimbursable and nonreimbursable costs for each identified project purpose, (3) identifying potential project beneficiaries, and (4) determining project beneficiaries' potential ability to pay their allocated and assigned costs, including capital and long-term O&M costs. This process informs the Federal decision maker of the appropriateness of the investment in individual components and the overall project.

The analysis of the financial feasibility of the NED Plan is described below. Additional information on the allocation of costs for the NED Plan is included in the Cost Allocation Appendix.

### *Cost Allocation*

Reclamation law and policy require an initial and final allocation of costs to project purposes. The initial allocation of costs is conducted to test financial feasibility of reimbursable costs during the planning phase, by comparing estimated project costs with anticipated revenues. When construction of the project is determined to be substantially complete, the final allocation of costs is conducted to determine actual reimbursable and nonreimbursable costs and is the basis for assignment of costs to beneficiaries. However, in this particular context, in light of the considerations in Chapter 9, it is recommended the non-Federal share of costs be determined prior to any final recommendation of a particular alternative. The information below is illustrative of the traditional repayment paradigm for informational purposes, but not a reflection of how Reclamation anticipates construction or repayment to occur.

The primary purpose of cost allocation is to determine the assignment of costs to beneficiaries for repayment. As reimbursement requirements differ by law among the purposes served by a project, a systematic and impartial cost allocation process is required to determine and allocate those costs that are clearly identifiable with a single purpose served, and to equitably allocate the remaining costs serving two or more purposes.

Costs to be allocated include construction costs, other costs, interest during construction, annual O&M costs, and replacement costs. Cost allocation is a financial exercise rather than an economic evaluation. Consequently, project costs may be presented differently in a cost allocation than in an economic analysis.

The NED Plan has four project purposes: irrigation water supply, M&I water supply, fish and wildlife enhancement (e.g., anadromous fish survival), and hydropower. Project purposes for which benefits have not been monetized (e.g., flood damage reduction) are not included in this cost allocation process. Although Shasta Lake is an important element of the Whiskeytown-Shasta-Trinity NRA, costs were not allocated to recreation because it is not an identified purpose of the Shasta Division of the CVP.

Once costs are allocated to the appropriate purpose, costs can be assigned to Federal and/or State taxpayers (nonreimbursable) and project beneficiaries (reimbursable) based on specific project authorization, existing Federal law, existing cost sharing requirements, and laws and objectives of non-Federal entities, including states, counties, and non-profit organizations. Existing legislation that describes Federal financial participation for purposes that could be used for allocating costs for the NED Plan is summarized in Table 6-1.

For the purposes of this initial cost allocation for CP4A, based on existing Federal law, costs allocated to irrigation water supply, M&I water supply, and hydropower purposes are considered reimbursable by project beneficiaries. Fish and wildlife enhancement is nonreimbursable. As shown in Table 6-1, Federal authorities vary on Federal and non-Federal cost-share responsibilities for fish and wildlife enhancement.

**Table 6-1. Existing Authorities for Federal Financial Participation for Monetized Benefit Categories of the NED Plan**

| Purpose/NED Benefit Category | Pertinent Legislation | Description |
|---|---|---|
| **Irrigation Water Supply** | Reclamation Act of 1902, as amended | Reimbursable. This act allows for up-front Federal financing of irrigation water supply purposes, with 100% repayment of capital costs and O&M costs by non-Federal project sponsor. |
| **M&I Water Supply** | Reclamation Act of 1939, as amended | Reimbursable. This act allows for up-front Federal financing of M&I water supply purposes, with 100% repayment of capital costs (including IDC and interest over the repayment period); 100% of O&M costs are non-Federal. |
| **Hydropower** | Reclamation Act of 1906, as amended | Reimbursable. Similar to M&I Water Supply. |
| **Fish and Wildlife Enhancement** | Federal Water Project Recreation Act of 1965 (Public Law 89-72), as amended | Nonreimbursable; 100% Federal financing of all fish and wildlife enhancement areas or facilities within the Whiskeytown-Shasta-Trinity NRA. |
| | Federal Water Project Recreation Act of 1965 (Public Law 89-72), as amended | Public Law 89-72 allows Federal nonreimbursable share of up to 75% and non-Federal share of at least 25% for fish and wildlife enhancements outside of the NRA, including planning, design, and IDC. In addition, 50% of the annual O&M and replacement costs would be a non-Federal responsibility. |
| **Recreation** | Whiskeytown-Shasta-Trinity National Recreation Area (Public Law 89-336) | Nonreimbursable; 100% Federal financing for Federal development of recreation facilities in the Whiskeytown-Shasta-Trinity NRA pursuant to Public Law 89-336. |
| | Federal Water Project Recreation Act of 1965 (Public Law 89-72), as amended | Nonreimbursable; 100% Federal financing of all facilities or project modifications which furnish recreation benefits within the Whiskeytown-Shasta-Trinity NRA. |

Key:
IDC = interest during construction
M&I = municipal and industrial
NED = National Economic Development
NRA = National Recreation Area
O&M = operations and maintenance

The Federal Water Project Recreation Act of 1965 (Public Law 89-72), as amended, provides for either 100 percent or 75 percent Federal financing for fish and wildlife enhancement. Although the CVPIA includes specific actions for fish and wildlife mitigation, protection, restoration, and enhancement, CVPIA legislation and related programs (e.g., AFRP) do not specifically identify enlargement of Shasta Dam and Reservoir as a CVPIA action or program element and does not provide authority for Federal financing.

**Initial Cost Allocation** The following provides an illustration of how costs for the NED Plan could be allocated to project purposes. A separable costs-remaining benefits (SC-RB) analysis was performed to equitably allocate costs to the project purposes. The largest portion of construction costs would be expended to implement plan features required to accomplish the primary planning objectives to improve anadromous fish survival and water supply reliability.

Table 6-2 displays a step-by-step process for determining the construction cost to be allocated to each project purpose. The annual construction cost allocated to each project purpose is the total annual cost with O&M costs and IDC removed.

*Annual Cost – O&M Cost – IDC Cost = Construction Cost*

Specific costs are for project components that contribute to a single purpose. Separable costs are costs that are specifically necessary because a single purpose is included in a multipurpose project. Separable costs include specific costs and may include a portion of joint costs; they are estimated as the reduction in financial costs that would result if a purpose were excluded from an alternative.

Annual separable costs are subtracted from the total annual cost to determine the total annual joint cost. The resulting allocated joint cost is based on the percentage of the remaining benefits of each project purpose. Total allocated costs are the sum of the separable annual costs and allocated joint costs.

A similar approach was used for developing the allocated O&M costs. Subtracting the O&M costs from the annual costs leaves the capital costs to be allocated to each project purpose.

Finally, IDC is subtracted to determine the construction cost allocated to each project purpose. IDC is calculated as the percentage of the total capital cost multiplied by the total IDC. Subtracting IDC from the capital cost leaves the construction cost allocated to each project purpose.

**Initial Cost Assignment** Table 6-3 shows an estimate of costs assigned to reimbursable and nonreimbursable project purposes consistent with existing Reclamation law. The assignment percentages are based on existing Federal authorities included in Table 6-2. The assignment of costs includes costs to accomplish the four purposes consistent with the planning objectives; these costs amount to $1,265 million. Also shown in Table 6-3, of the costs allocated for CP4A, approximately 48.6 percent are estimated to be nonreimbursable and about 51.4 percent are estimated to be reimbursable.

**Table 6-2. Initial Construction Cost Allocation Summary for CP4A ($ millions)[1 2]**

| Item/ Calculation | Irrigation Water Supply | M&I Water Supply | Fish and Wildlife Enhancement | Hydro-power | Total |
|---|---|---|---|---|---|
| | A | B | C | D | E |
| **Allocated Total Annual Costs** | | | | | |
| 1 Average Annual Benefits | 5.1 | 21.8 | 33.3 | 14.4 | 74.6 |
| 2 Single-Purpose Projects | 43.6 | 44.5 | 42.2 | 14.4 | - |
| 3 Justifiable Expenditure (Lessor of Benefits/Single Purpose Alt Costs) | 5.1 | 21.8 | 33.3 | 14.4 | 74.6 |
| 4 Separable Annual Costs | 4.5 | 7.0 | 6.5 | 0.0 | 18.0 |
| 5 Remaining Benefits/Justifiable Expenditure (3) - (4) | 0.6 | 14.8 | 26.8 | 14.4 | 56.6 |
| 6 % Remaining Benefits (A5 to D5) ÷ (E5) | 1% | 26% | 47% | 25% | 100% |
| 7 Allocated Joint Cost (A6 to D6) x (E7) | 0.5 | 10.7 | 19.4 | 10.4 | 41.0 |
| 8 Total Allocated Costs (4) + (7) | 4.9 | 17.7 | 25.9 | 10.4 | 59.0 |
| **Allocated O&M Annual Costs** | | | | | |
| 9 Separable O&M Cost | 0.8 | 4.9 | 0.2 | 0.0 | 5.9 |
| 10 Allocated Remaining Joint Cost (A6 to D6) x (E10) | 0.04 | 0.9 | 1.7 | 0.9 | 3.5 |
| 11 Total O&M Allocated (9) + (10) | 0.9 | 5.8 | 1.9 | 0.9 | 9.4 |
| **Allocation of Capital Cost** | | | | | |
| 12 Annual Capital Cost (8) – (11) | 4.1 | 11.9 | 24.1 | 9.5 | 49.6 |
| 13 % Annual Capital Cost (A12 to D12) ÷ (E12) | 8% | 24% | 49% | 19% | 100% |
| 14 Allocated Capital Cost (A13 to D13) x (E14) | 112.4 | 328.9 | 665.7 | 264.0 | 1,371.0 |
| **Allocated Construction Costs** | | | | | |
| 15 Allocated IDC [(A13 to D13) ÷ (E13)] x (E14) | 8.7 | 25.3 | 51.2 | 20.3 | 105.5 |
| 16 Construction Cost (14) – (15) | 103.8 | 303.6 | 614.5 | 243.6 | 1,265.5 |
| 17 % of Total Construction Cost (A16 to D16) ÷ (E16) | 8% | 24% | 49% | 19% | 100% |

Notes:
[1] January 2014 price level, 3.5 percent interest rate, and 100-year period of analysis.
[2] All numbers are rounded for display purposes, and therefore line items may not sum to totals.

Key:
IDC = interest during construction
M&I = municipal and industrial
O&M = operation and maintenance

**Table 6-3. Initial Construction Cost Assignment for the NED Plan[1] ($ millions)**

| Purpose/Action | Total | | Cost Assignment | | | |
|---|---|---|---|---|---|---|
| | | | Nonreimbursable | | Reimbursable | |
| | Percent | Cost | Percent | Cost | Percent | Cost |
| **Study Objectives** | | | | | | |
| Irrigation Water Supply | 8% | 103.8 | 0% | 0.0 | 100% | 103.8 |
| M&I Water Supply[2] | 24% | 303.6 | 0% | 0.0 | 100% | 303.6 |
| Fish & Wildlife Enhancement | 49% | 614.5 | 100% | 614.5 | 0% | 0.0 |
| Hydropower[2] | 19% | 243.6 | 0% | 0.0 | 100% | 243.6 |
| Total | 100% | 1,265.5 | 48.6% | 614.5 | 51.4% | 651.0 |

Notes:
[1] All numbers are rounded for display purposes, and therefore line items may not sum to totals.
[2] In addition to construction costs, interest during construction would also be assigned to M&I water supply and hydropower purposes. Although construction costs assigned for irrigation water supply are reimbursable, interest during construction is not assigned to irrigation water supply.

Key:
M&I = municipal and industrial
NED = National Economic Development

### *Payment Capacity and Ability to Pay*

Reclamation law requires that investments be repaid by the beneficiaries of that investment, except where that benefit is for the common welfare or defense of the Nation. Financial feasibility is ultimately based on the ability of project beneficiaries to collectively pay the costs associated with an implemented plan in accordance with Reclamation law. Costs beyond particular beneficiaries' repayment ability may be paid by other project beneficiaries as Reclamation policy allows and where resources are available. If beneficiaries have the collective financial resources, in accordance with Reclamation law, to pay the costs allocated to them, then the project is considered financially feasible. This ability to pay analysis was conducted to support evaluation of financial feasibility for CP4A, the NED Plan, and assesses the long-term financial capacity of project beneficiaries to absorb additional costs associated with benefits they would receive.[1]

Assessments of agricultural, M&I, and hydropower beneficiaries' ability to pay were conducted for the NED Plan. Methodologies for these analyses vary by project purpose, as summarized below:

- Typically, agricultural water users' ability to pay is based on a crop budget analysis for representative farm types to estimate farm-level payment capacity, which is aggregated to the water district level and adjusted to account for district-level O&M costs and any additional financial capacity of the district. For cost allocated to irrigation water

[1] This analysis for the SLWRI was not conducted as an ability to pay study for use in determining need for relief for individual contractors from CVP capital repayment costs and CVPIA Restoration Fund charges for a specific 5-year period.

supply for the NED Plan, an initial ability to pay analysis was conducted for representative contractors in four regions of the CVP.

- The most common measures of ability to pay for municipal water supply are the percent of water costs relative to median household income and other socioeconomic measures. For potential municipal water supply beneficiaries of the NED Plan, ability to pay and payment capacity of potential beneficiaries is estimated with an "affordability threshold" represented as a percent of median household income.

- For hydropower, it is expected that allocated costs from an enlarged Shasta Dam would increase the revenue requirement by a small percentage and the increase in rates would be supportable by those that purchase power from WAPA.

A number of observable trends also indicate ability to pay is increasing for each type of beneficiary with the potential to benefit from the NED Plan. These trends include: increasing crop prices and yields; increased plantings of higher-valued permanent crops throughout the State; repayment of existing CVP facility capital costs by 2030; and, increasing California populations. Costs that would be included in irrigation ability to pay analyses include the cost of all water supplies, including the use of groundwater wells and other sources of surface water, and existing CVP obligations.  Because the majority of existing capital obligations will be repaid by law by 2030, it is assumed that current CVP water contractors would continue to have the ability to pay at least their current allocated share of existing CVP capital obligations less any aid to irrigation received.  Accordingly, payment capacities for each type of beneficiary and the ability of project beneficiaries to collectively pay the costs associated with the NED Plan will increase over time as existing obligations are paid down.

Agricultural, M&I, and hydropower beneficiaries' ability to pay assessments are described below.

**Agricultural Water Supply Beneficiaries** Irrigation contractor ability to pay analyses assess the financial capability of an irrigation district (or contracting entity) to pay for existing or increased Reclamation water charges and services (Reclamation 2004d).  An ability to pay analysis is completed following a payment capacity study that evaluates the net farm income generated by a typical agricultural operator (or operators) in the district. Given that there are over 250 current contracting entities that supply water to farmers producing hundreds of commodities within the CVP service area across a large geographic area in California (Shasta County to the north to Kern County to the south), detailed analyses for each contracting entity has not been conducted due to the significant level of effort and associated cost. For this Feasibility Report, an initial ability to pay analysis was performed for representative irrigation contractors located in four regions of the CVP.

Ability to pay is defined as the farm-level payment capacity aggregated to the entire district, less district existing obligations, operations and maintenance costs, power costs, and reserve fund requirements. Non-agricultural revenue sources (e.g., hydropower production) may also be incorporated into the ability to pay analysis.

The estimation of a district's ability to pay begins with a payment capacity analysis. Payment capacity is the estimated residual net farm income of irrigators available for payment of both Federally and non-Federally assessed water costs, after deduction for on-farm production and investment expenses, as well as appropriate allowances for management, equity, and labor. Nonfarm revenues are not included in the payment capacity assessment. To estimate payment capacity, farms that are representative of typical agricultural operations in the district are identified. The number of representative farms selected is subjective, but should adequately capture the different types of operations present in the district and should reflect differences in crops grown, farm sizes, and water sources and costs. Each representative farm is modeled using available crop budget information. The estimated payment capacity for each representative farm is then aggregated to the district level according to the proportion of the district's total acreage or total water deliveries associated with each farm type.

For the SLWRI, an initial ability to pay analysis for potential agricultural water supply beneficiaries was developed in 2011 for four regions of the CVP corresponding to four representative contractors. Table 6-4 displays the representative ability to pay per acre-foot results for agricultural water supply beneficiaries in each region (Reclamation 2011f).

**Table 6-4. Ability to Pay Results for Four Representative CVP Agricultural Contractors**

| | Friant/ San Joaquin River | Sacramento River | South of Delta | Northern Sacramento |
|---|---|---|---|---|
| Ability to Pay ($[1,2]/acre-foot) | $7.50 | $324.55 | $150.59 | $97.40 |

*Source: Reclamation 2011f*

Notes:
[1] Dollar values presented at 2011 price level.
[2] Estimated ability to pay values are net of current CVP capital and operations and maintenance obligations.

Key:
CVP = Central Valley Project
Delta = Sacramento-San Joaquin Delta

For this study, financial feasibility is determined by comparing the representative CVP agricultural contractors' ability to pay with the allocated construction costs, IDC, and O&M costs of the NED Plan. Table 6-5 summarizes the allocated irrigation water supply costs for the NED Plan as follows:

- Construction costs allocated to the irrigation water supply purpose (shown in Tables 6-2 and 6-3) are estimated to be $103.8 million.

- Annual irrigation water supply repayment cost is then calculated for a 40-year repayment period with no interest, which equals $2.6 million per year.

- Annual irrigation water supply O&M (non-pumping) costs associated with the new supplies are calculated as the sum of separable and joint non-pumping costs, which equals $0.2 million.

- Additional CVP annual pumping costs associated with the new supplies and assigned to irrigation are estimated to be $0.7 million based on LongTermGen (LTGen) power modeling documented in the Modeling Appendix.

**Table 6-5. NED Plan Allocated Irrigation Water Supply Costs ($ million)**

| Cost Type | Cost ($ million) |
|---|---|
| **Total Construction Cost[1]** | **$103.8** |
| **Annualized Costs** | |
| Irrigation Water Supply Repayment Cost (40-year repayment with no interest) | $2.6 |
| Operations and Maintenance | $0.2 |
| Central Valley Project Additional Pumping Cost | $0.7 |
| **Total Annual Irrigation Water Supply Cost[1] (40-Year Repayment)** | **$3.4** |

Note:
[1] Project features and costs are described in detail in the Engineering Summary Appendix. Costs are presented in millions at a January 2014 price level.
Key:
NED = National Economic Development

Financial feasibility for agricultural water supply was evaluated by comparing the representative beneficiaries' ability to pay with potential irrigation water costs developed with two scenarios. Scenario 1 is based on the assumption that the increment of irrigation water supply and costs from the NED Plan are fully integrated into the CVP to meet existing contracts. The CVP Irrigation Ratesetting Policy (Reclamation 1988) would be used to recover O&M costs and provide repayment of construction costs through water service contracts with all irrigation contractors. Scenario 2 assumes the increment of agricultural water supply from the representative plan would require new repayment contracts with existing CVP and SWP contractors who are willing and able to pay the incremental costs to receive the incremental benefits. For both scenarios, the costs of the NED Plan would be repaid over a 40-year period.

An increase in the annual capital cost of irrigation water supply of $2.6 million would be allocated to CVP agricultural water supply contractors for repayment (Table 6-5). To derive the increase in the cost of water using Scenario 1, the total annual irrigation water supply cost $3.4 million is divided by the 5-year average of total annual CVP water deliveries, 2.2 million acre-feet (Reclamation 2011d). This results in a marginal increase of irrigation water of $1.56 per acre-foot ($1.18 for repayment and $0.38 for other annualized costs). This marginal increase would fall within the ability to pay for each of the four representative contractors described in Table 6-5.

For Scenario 2, financial feasibility was also assessed by comparing only the beneficiaries' ability to pay the annualized costs. At present, the specific agricultural contractors considered to be beneficiaries have not been identified. If new contracts were established, the $3.4 million in allocated irrigation water supply costs would be distributed over the average annual estimated increase of 31,400 acre-feet of agricultural deliveries under the NED Plan. The resulting cost per acre-foot is estimated at $110 for CVP agricultural water supply contractors ($83 for repayment and $27 for other annualized costs). Specific analysis for any contractor would be conducted to provide a determination of financial feasibility and would consider the 2030 deadline for repayment of current CVP capital costs, per Public Law 99-546.

*Status of Existing CVP Irrigation Costs Repayment Status and Ability to Pay Trends* Reclamation provides relief from CVP capital repayment and CVPIA Restoration Fund charges to contractors who are determined to be eligible for aid to irrigation based on a comprehensive ability to pay study. Table 6-6, below, provides a summary of historic and projected repayment of CVP construction costs allocated to irrigation for existing facilities.

Historically, a number of the contractors located north of the Delta that would benefit from the NED Plan have received "aid to irrigation."[2] However, the number of irrigation districts located north of the Delta receiving "aid to irrigation" has been declining in recent years. For example, eight CVP contractors located on the Tehama-Colusa Canal that had been receiving aid to irrigation since the mid-1990s were no longer eligible for the program in 2012 (Reclamation 2014c) due to improved financial circumstances. This trend may be attributed to increased prices and yields for crops, such as rice, which are commonly irrigated in the region. In addition, there has been a trend toward increased permanent crop plantings in Tehama and Colusa counties, which typically generate positive returns. For example, acres planted to almonds in Colusa County increased from 23,240 in 2003 to 45,335 in 2012 (U.S. Department of Agriculture 2014). Similarly, walnut acres have nearly doubled in the two counties over the same time period.

[2] South of Delta contractors currently receiving aid to irrigation would not receive additional surface water from SLWRI alternatives directly.

**Table 6-6. CVP Irrigation Construction Cost Repayment Status as of End of Fiscal Year 2012**

| Allocated CVP Construction Cost and Repayment Item | CVP Costs and Repayment ($ million) |
|---|---|
| **Existing CVP Facility Construction Costs Allocated to Irrigation** | **$1,871** |
| **Repayments of Irrigation Costs** | |
| Irrigation Districts Repayment | $730 |
| Other Repayments Realized[1] | $73 |
| Credits[2] | $17 |
| **Total Repayments of Irrigation Costs** | **$820** |
| **Anticipated Future Repayment of Irrigation Costs** | |
| Repayment of Costs by Irrigation Districts | $829 |
| Repayment of Costs by Irrigation Assistance[3] | $47 |
| Other[4] Anticipated Future Repayment | $175 |
| **Total Anticipated Future Repayments of Irrigation Costs** | **$1,051** |

*Source: United States Government Accountability Office. 2014. Repayment of Water Project Construction Costs. GAO-14-764. September.*

Notes:

[1] Other repayments realized include contributions and revenues that Reclamation calls “incidental revenues,” such as excess water sold to irrigation districts or revenue from land leased for grazing.

[2] Credits relieve water users from a portion of their allocated repayment obligations. Types of credits include Congressionally authorized repayment reductions and construction expenses determined to be nonreimbursable.

[3] Irrigation assistance is the amount of construction costs allocated to irrigation that the Secretary of the Interior determines that irrigation districts are unable to pay for a given project, which is repaid from other revenue sources, where available.

[4] Other anticipated future repayment includes repayment anticipated through future repayment contracts and contracts that have been deferred, among other things.

Key:
CVP = Central Valley Project

Section 105 of Public Law 99-546 provided for adjustments in CVP water contracts in order to recover the existing Federal investment by 2030. If the NED Plan was authorized, and implementation and construction proceeded as planned, an enlarged Shasta Dam and Reservoir would be completed in 2025. Assuming that in 2025 CVP water contractors are on track with Public Law 99-546 requirements, if the remaining costs for existing CVP facilities (see Table 6-6) were integrated with costs allocated to irrigation for the NED Plan (see Table 6-5) and repayment occurred over a 40-year period, the resulting annual repayment obligations would be approximately 20 percent of existing obligations. Accordingly, if in 2025 existing costs were integrated with new costs for the NED Plan, agricultural water contractors would have a substantially increased ability to repay obligations.

*Summary* Based on the initial ability to pay analysis performed for representative CVP irrigation contractors, in relation to the repayment scenarios analyzed, and considering repayment of existing CVP facility capital costs by 2030, CVP irrigation contractors that would receive water supply benefits from the NED Plan would likely be able to repay the allocated project costs once the project is constructed. Further, increasing crop prices and yields and transition to more valuable permanent crops indicate that the ability to pay is increasing for irrigation districts with the potential to benefit from the NED Plan.

**Municipal and Industrial Beneficiaries** Financial feasibility must also address the affordability of water supply for M&I users. The financial feasibility analysis for M&I users assesses how much water users can afford to pay for water supply improvements (i.e., payment capacity) and provides the basis to determine if their payment capacity is sufficient to pay for the allocated project costs (Reclamation 2009). There are a number of accepted methods to estimate payment capacity for municipal water supplies. In general, two approaches are commonly applied. The first applies the use of an "affordability threshold" which is applied relative to median household income in the region. Under this approach, the threshold is applied to median household income for all households within the water service area to arrive at the total payment capacity. Another approach that can be applied to estimate M&I payment capacity is to assess actual water payments relative to net household income for households in the region that will not benefit from the project. The resulting ratios can be used to approximate payment capacity for the households that will benefit from the project. The payment capability ratios represent the proportion of discretionary income that households served by various utilities must spend for domestic water supplies. Therefore, they are a measure of dollars spent on water service per dollar of discretionary household income. This methodology provides an estimate of ability to pay that accounts for variation in household income, household expenses, and costs of living that are not considered when using set percentages of household income (Piper and Martin 1999). Each of these approaches will generally produce similar results and are dependent on the selection of affordability threshold percentage.

For potential municipal water supply beneficiaries of the NED Plan, ability to pay and payment capacity of potential beneficiaries is estimated with an "affordability threshold" represented as a percent of median household income. This analysis applies the affordability threshold established by the EPA. In 1980, the EPA Office of Drinking Water completed a study to assess the costs of complying with new drinking water regulations. The study determined that costs of water service exceeding 2.5 percent of household income were not affordable (EPA 1980). A range of affordability thresholds from other water system analyses were also considered in this analysis, but were not applied because they lacked regional relevance to the study area.

The NED Plan could provide water supply benefits to a range of CVP and SWP M&I water contractors. As a result, this generalized payment capacity analysis is based on a range of representative SWP M&I contractors that could receive project water supplies; therefore, representative regional data was used rather than data specific to individual water agencies. Population data for areas served by 10 potential SWP M&I water supply beneficiaries were obtained from 2010 urban water management plans. The number of households was estimated with

U.S. Census Bureau data (U.S. Census Bureau 2013) by dividing the population estimates by the median household size for the county that comprises the majority of each water agency's service area. Similarly, median household income levels were obtained from county-level data for the county that comprises the largest portion of each water service provider's service area.

In this analysis, the projected number of households in 2030 within each water service area is used to estimate payment capacity for each water service area individually. Table 6-7 provides the average payment capacity analysis results for the 10 representative SWP M&I contractors. As described above, payment capacity is estimated as 2.5 percent of median household income. To account for existing water payments, an estimate of current water rates for Southern California residential customers (obtained from Raftelis Financial Consultants, Inc. and American Water Works Association 2011) is subtracted from the gross payment capacity estimate to arrive at the estimated residual payment capacity that are available to support new water projects. As shown in Table 6-7, the estimated annual average total payment capacity of representative M&I contractors is approximately $700 million. Total estimated annual payment capacity of representative M&I beneficiaries is approximately $6.9 billion.

**Table 6-7. Average Payment Capacity Results for Representative Municipal and Industrial Contractors**

| Average Estimated Households in 2030 | Average Median Household Income ($[1]/hhld/yr) | Average Estimated Current Water Rates ($[1]/hhld/yr) | Average Household Payment Capacity ($[1]/hhld/yr) | Average Estimated Total Payment Capacity ($ million[1]/yr) |
|---|---|---|---|---|
| 826,300 | $62,600 | $656 | $909 | $703.2 |

Note:
[1] January 2014 price level
Key:
hhld = household
yr = year

Financial feasibility for M&I users is determined by comparing the beneficiaries' ability to pay with the annualized repayment of construction costs, IDC, and O&M costs of the NED Plan. Table 6-8 summarizes the allocated M&I water supply costs for the NED Plan, which were estimated as follows:

- Construction costs allocated to the M&I water supply purpose (shown in Tables 6-2 and 6-3) are estimated to be $328.9 million.

- Annual M&I water supply repayment cost is then calculated over a 40-year repayment period with 5.357 percent annual interest rate (U.S. Department of Treasury 2013), which equals $20.1 million.

- Annual M&I water supply O&M (non-pumping) costs are calculated as the sum of separable and joint non-pumping costs, which equals $1.0 million.

- Additional SWP annual pumping costs are estimated to be $4.9 million based on SWPPower modeling documented in the Modeling Appendix to the accompanying EIS.

This analysis assumes the increment of M&I water supply from the NED Plan would require repayment contracts with existing CVP and SWP contractors who are willing and able to pay the incremental costs to receive the incremental benefits. In addition to the M&I water supply repayment cost, the analysis assumes the M&I beneficiaries would need the payment capacity for O&M (non-pumping) and pumping costs.

**Table 6-8. NED Plan Allocated Municipal and Industrial Water Supply Costs ($ million)**

| Cost Type | Cost ($ million) |
|---|---|
| **Total Investment Cost[1]** | **$328.9** |
| **Annualized Costs** | |
| M&I Water Supply Repayment Cost (40-year repayment with interest[2]) | $20.1 |
| Operations and Maintenance | $1.0 |
| SWP Additional Pumping Cost | $4.9 |
| **Total[3] Annual M&I Water Supply Cost[1] (40-Year Repayment)** | **$25.9** |

Notes:
[1] Project features and costs are described in detail in the Engineering Summary Appendix. Costs are presented in millions at a January 2014 price level.
[2] 5.357 percent annual interest rate (U.S. Department of Treasury 2013).
[3] All numbers are rounded for display purposes; therefore, line items may not sum to total.

Key:
M&I = municipal and industrial
NED = National Economic Development
SWP = State Water Project

Financial feasibility was determined by comparing the representative M&I beneficiaries' payment capacity with the annualized costs. At present, the specific M&I water supply beneficiaries have not been identified beyond SWP M&I contractors generally. If new contracts are established as part of the NED Plan, the $25.9 million in allocated M&I water supply costs would be spread over an average annual increase of 19,900 acre-feet, and the cost per acre-foot is estimated at $1,304 for M&I water supply beneficiaries ($1,011 for repayment, and $293 for O&M (non-pumping) and pumping costs). The total annual M&I water supply cost ($25.9 million) would be significantly less than the average annual payment capacity for representative M&I contractors ($703.2 million).

The large estimated average annual payment capacity of M&I users (Table 6-7) in comparison to the estimated total annual M&I water supply cost (Table 6-8) indicates that potential M&I contractors that would benefit from the NED Plan will be able to repay the allocated project costs. In addition, expected increases in population and related regional income will increase regional payment capacity and further support potential M&I contractors' ability to pay allocated project costs.

**Hydropower Beneficiaries** Financial feasibility for hydropower beneficiaries addresses the affordability of CVP power in relation to power market rates in the region. CVP power contractors develop electricity generation portfolios to reliably meet their load obligations in a cost-effective manner consistent with local, State, and Federal mandates. Historically, power market rates have exceeded CVP power costs on a long-term average annual basis, and it is expected that CVP power will remain an attractive component of power contractors' electricity generation portfolios with changes in repayment obligations associated with implementing the NED Plan.

Hydropower generated through CVP facilities is first used to meet CVP operation needs or loads, and hydropower generated beyond CVP operational needs is marketed by the Western Area Power Administration (WAPA). WAPA owns and maintains power lines that transmit power from Federal dams in the CVP system to power customers. WAPA collects allocated construction costs and operation, maintenance, and replacement (OM&R) costs, as well as CVPIA Restoration Fund charges from CVP power contractors.

WAPA calculates an annual power revenue requirement (PRR) to recover construction costs, OM&R, interest payments, and requirements for other services and products provided by WAPA. Each power customer is then assigned its percentage share of the annual PRR to generate sufficient revenues to meet the revenue requirement. WAPA reconciles actual and estimated revenue requirements within the fiscal year, and shortfalls or excesses are accounted for in the next year's PRR. As of the end of fiscal year 2009, approximately 75 percent of CVP construction costs allocated to power had been repaid.

In addition to CVP construction costs allocated to hydropower for repayment, CVP power contractors are also obligated to repay construction costs and mitigation charges for agricultural water contractors receiving aid to irrigation relief. As of September 30, 2010, the power contractors' aid to irrigation relief was estimated at over $43 million. Historically, WAPA has not included these costs in the PRR.

Variability in hydrology and a variety of regulatory requirements have impacted water supply deliveries, affecting power contractors' repayment obligations and the price of CVP power. Generally, in dry year conditions, when less water is available for water supply deliveries, less CVPIA Restoration Fund charges are collected from water supply users, and power contractors are required to pay a larger share of these costs. Conversely, in wet year conditions, when more water is available for water supply deliveries, more CVPIA Restoration Fund charges are collected from water users and power contractors are required to pay a smaller share of these costs.

Table 6-9, below, displays the base rate of CVP power and the percentage increase in rates due to additional CVPIA Restoration Fund charges from 2002 to 2011, and associated power market rates. As shown, the percent of CVPIA Restoration Fund charges to total CVP power costs ranged from 7.6 percent to 34.3 percent and the percent of total CVP power cost to the market rate ranged from 20 percent to 124 percent. Table 6-9 also shows the variability in the power market rate due to other energy sources (e.g. natural gas) and regulatory requirements.

As shown in Figure 6-1, on a long-term average annual basis, the cost of CVP power has been lower than the power market rate, and an attractive component of power contractors' electricity generation portfolios.  It should be noted that external factors that impact the power market rate will continue to affect the cost competitiveness of CVP power in the future.

**Table 6-9. CVP Power Rates, Restoration Charges, and Power Market Rates**

| Fiscal Year | Water Year Type | Base Rate for Power ($/MWh) | Additional Restoration Charge ($/MWh) | Restoration Charge Percent of Total CVP Power Cost | Total Cost of CVP Power[1] ($/MWh) | Power Market Rates (NP-15)[2] | Total CVP Power Cost Percent of Market Rate |
|---|---|---|---|---|---|---|---|
| **2002** | Dry | $23.83 | $3.28 | 12.10% | $27.11 | $26.03 | 104% |
| **2003** | Above Normal | $24.63 | $2.02 | 7.60% | $26.65 | $42.24 | 63% |
| **2004** | Below Normal | $24.73 | $0.60 | 2.40% | $25.33 | $45.39 | 56% |
| **2005** | Above Normal | $13.18 | $6.78 | 33.90% | $19.96 | $56.17 | 36% |
| **2006** | Wet | $8.71 | $3.23 | 27.10% | $11.94 | $60.70 | 20% |
| **2007** | Dry | $20.19 | $2.02 | 9.10% | $22.21 | $56.81 | 39% |
| **2008** | Critical | $28.50 | $11.04 | 27.90% | $39.54 | $73.88 | 54% |
| **2009** | Dry | $29.89 | $15.65 | 34.30% | $45.54 | $36.81 | 124% |
| **2010** | Below Normal | $31.76 | $5.29 | 14.30% | $37.05 | $38.19 | 97% |
| **2011** | Wet | $21.24 | $7.77 | 26.80% | $29.01 | $39.09 | 74% |

*Source: Western Area Power Administration Rates Department, March 2011*
Notes:
[1] Does not include additional aid to irrigation costs.
[2] Power market rates are estimated at North Path-15, a delivery point and energy trading hub for California Independent System Operator.
Key:
MWh = Megawatt-hour
NP-15 = North Path-15

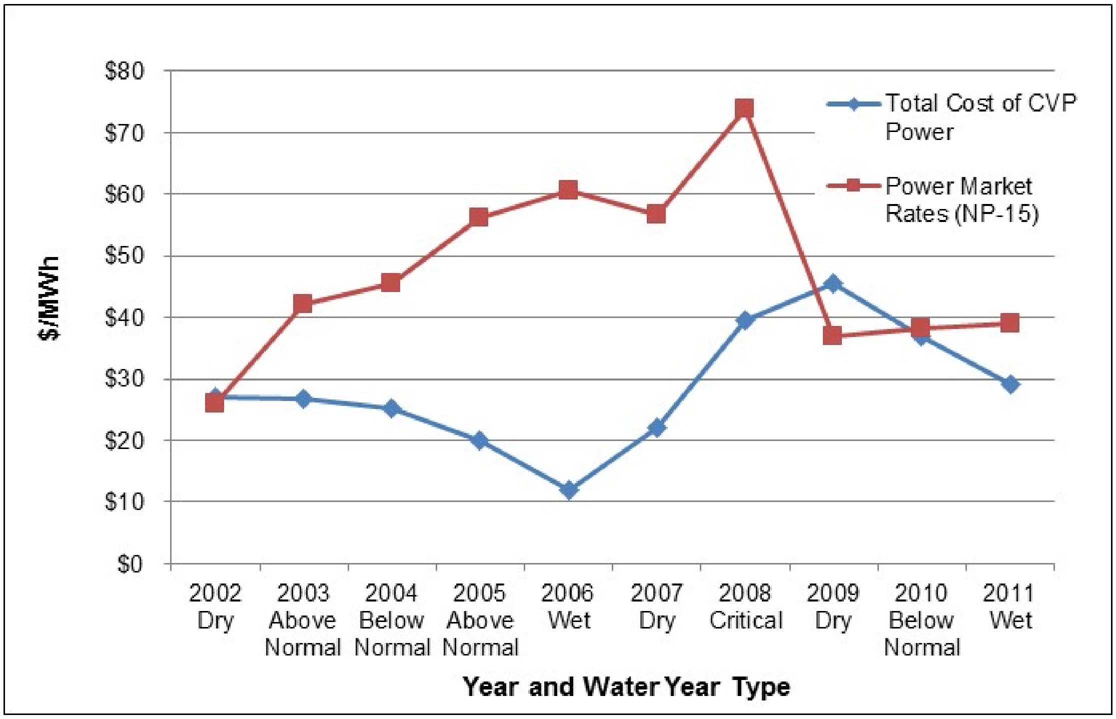



**Figure 6-1. Cost of CVP Power in Relation to Power Market Rate**

Forecasting CVP and market-based energy prices on a long-term basis is difficult due to the high degree of uncertainty associated with energy markets and hydrologic conditions. However, it is still possible to develop a cost comparison analysis evaluating the relative cost competitiveness of CVP hydropower resources against forecasted power market rates. Reclamation worked with WAPA to develop analyses based on regional power rate projections estimated for three potential future hydrology and power generation scenarios. As described in the "Payment Capacity of Hydropower Beneficiaries" Attachment to the Cost Allocation Appendix, results of these analyses indicate that power market rates will continue to exceed CVP hydropower costs on a long-term average annual basis, and CVP power costs will not exceed alternative costs of power for prolonged periods of time.

It is anticipated that changes in power repayment obligations associated with implementing the NED Plan would not significantly affect the price competitiveness of CVP power in relation to regional power market rates. Repayment of existing CVP facility capital obligations by law by 2030 will reduce existing power cost recovery obligations and CVP power is anticipated to remain an attractive component of power contractors' electricity generation portfolios. In the interim period between completion of construction of the NED Plan and repayment of existing CVP facility capital costs (2025 to 2030), CVP power price competitiveness could be impacted, depending on hydrology and regulatory requirements, though long-term average annual CVP power costs would likely remain lower than the power market rate.

# Risk and Uncertainty

Certain assumptions were made for aspects of the feasibility study based on engineering, economic, and scientific judgment. Careful consideration was given to the methodologies and evaluations for hydrology and system operations, cost estimates, and biological analyses, as described in the Modeling Appendix and Engineering Summary Appendix to the accompanying EIS. Analyses were developed with advanced modeling and estimating tools using historical data and trends. While this is effective in helping predict outcomes for future operations, benefits, costs, and biological conditions, many uncertainties could affect the findings of this Feasibility Report. Various risks and uncertainties associated with the SLWRI and potential modification of Shasta Dam are discussed below.

## Hydrology and Climate Change

Potential climate change could produce conditions that differ from today. The potential for, and magnitude of, climate change is widely debated. The State is investing significant resources to study how global climate changes could affect the way hydrology in California is affected. Results indicate that climate changes in the State could affect rainfall, snowfall, temperature, water temperature, and future water project operations for both flood management and water supply deliveries.

California could experience changes in temperature, precipitation, and snow level (DWR 2014b). Any measurable change in these climate indicators could affect future water operations in California. It is unlikely that changes in snow levels would significantly affect Shasta Reservoir because the reservoir is primarily filled by direct rainfall runoff, as opposed to snowmelt. However, changes in water management operations downstream and in the Delta could affect Shasta Reservoir operations. If precipitation increases, it may further enhance the benefits of increased reservoir capacity. According to the *California Water Plan Update 2013* (DWR 2014b), more studies are needed:

> *Uncertainties will never be eliminated, but better data and improved analytical tools will allow water and resource managers to better understand risks within the system. Many water agencies in California have begun incorporating climate change information into their operation and planning processes to reduce uncertainty of how climate may affect California's water resources in the future. Additional efforts are needed to develop the accurate climate data needed to reduce uncertainty and risk in California water management in the future.*

The Climate Change Modeling Appendix to the accompanying EIS contains additional information on the implications of climate change for California water resources. In addition, the Climate Change Modeling Appendix documents a sensitivity analysis of the potential for the alternative that maximized increased water supply reliability (CP5) to address primary project objectives under climate change. The Climate Change Modeling Appendix also provides a similar analysis for the alternative that maximizes increased anadromous fish survival (CP4). Although all alternatives were not directly evaluated, it is anticipated that the trends related to climate change for water supply and anadromous fish would be similar. As described in Chapter 4, these evaluations indicate that the comprehensive plans are robust and would provide benefits under a range of future climate scenarios.

## Water Supply Reliability and Demands

Water supplies and demand will continue to vary annually. Demands are expected to exceed supplies in the future, but predicting the absolute value of future water supplies and/or shortages in the Central Valley of California is not possible. Such predictions would depend upon numerous variables with differing opinions regarding each variable. For example, there are many opinions regarding population growth. The *California Water Plan Update 2013* (DWR 2014b) estimates demand for different growth scenarios, ranging from “lower than current trends,” which assumes that population growth will be slower than currently projected,” to “higher than current trends,” which assumes that population growth will be faster than currently projected, with nearly 70 million people living in California in 2050.

Potential circumstances that would result in an overall reduction in future demands for agricultural water supplies include land conversion from agricultural to urban land uses and improved efficiency for irrigation water applications.

### *Future Land Use*

Population growth is a major factor in California’s future water use and management. California’s population is expected to increase by just over 60 percent relative to 2005 levels by 2050 (California Department of Finance 2007). Water supplies for the larger population could come from a conversion of agricultural supplies, efficiency measures, reuse, and/or recycling. Some portion of increased population growth in the Central Valley would occur on lands currently used for irrigated agriculture. Therefore, water that would have been needed for these lands for irrigation would instead be used to serve urban demands. However, this would only partially offset the required agricultural-to-urban water conversion, since growth would also occur on nonirrigated agricultural lands. If it was assumed that all of the urban growth in the Central Valley would occur on lands currently under irrigation, this would only account for up to about 40 percent of the expected future increase in water supply needs. The remainder of the agricultural-to-urban water conversion to help sustain urban growth would be located primarily in other areas of the State.

### *Agricultural Water Use Efficiency*

Agricultural interests are continually improving irrigation efficiencies, including use of irrigation technology. Users who have already increased efficiency may find it more challenging to achieve additional water use reductions during droughts. This hardening of demands and associated water availability during droughts is likely to influence planting decisions related to crop types. The type of crops grown heavily influences potential for improved agricultural water use efficiency. For example, more advanced irrigation technology is typically used for permanent crop types. Potential future changes in cropping patterns and related irrigation efficiency will heavily influence agricultural water demands.

### Anadromous Fish Populations

Anadromous fish are highly affected by changes in their surrounding conditions; therefore, predicting fish production is difficult because of the many influencing factors. The SALMOD model used to estimate Chinook salmon production for this Feasibility Report contains assumptions with varying levels of uncertainty. A key uncertainty stems from using the same number of spawners in each year of the SALMOD simulation. That is, any increase or decrease in production at the end of a cohort year is not carried forward into another set of spawners. This is because SALMOD is not a life-cycle model, and only takes into account the environmental and biological factors that affect survival of Chinook salmon between Keswick Dam and RBPP. For the SLWRI, SALMOD is not used as a population dynamics model or a predictive tool for explicit population estimation; rather it is used as an operation screening tool, or a comparative tool to evaluate relative change between alternatives. This allowed Reclamation, under each year, to evaluate what would happen to each run of Chinook salmon under the specific water operations Because each alternative starts each year with the same number of spawners, when used comparatively, the effects on each run of Chinook salmon become clear and easy to evaluate. Additionally, the use of SALMOD allows the focus of impacts to be where the greatest direct effects of the project occur – that is, the Sacramento River upstream from RBPP.

Although all models are subject to uncertainty, SALMOD was chosen as the best available model for performing population comparisons on the Sacramento River for multiple reasons. First, it is the best available model that calculates survival and mortality to all four runs of Chinook salmon resulting from changes in both water temperature and flow. Second, SALMOD has been applied previously on the Sacramento River (Kent 1999, Bartholow 2003, Reclamation 2008a). The U.S. Geological Survey (USGS) completed a thorough review and update of model parameters and techniques on the Klamath River and reviewed Sacramento River-specific Chinook salmon information obtained from USFWS and CDFW fisheries biologists, enabling a smooth transfer of relevant model parameters to Sacramento River modeling for the SLWRI (Bartholow and Henriksen 2006). SALMOD was peer reviewed by Thompson and Mosser (2011). Finally, SALMOD was approved for use in several other Federal-level studies, including the Reclamation’s 2008 Long-Term Operation BA for compliance with Section 7 of the ESA (Reclamation 2008a) and resulting NMFS 2009 BO (NMFS 2009a).

Independent of the SALMOD model, uncertainty in anadromous fish survival is also related to water conditions outside the area of influence of the dam raise, including the Sacramento River downstream from RBPP, the Delta, and the Pacific Ocean. Potential climate change could also influence fish survival.

The 2009 NMFS BO (NMFS 2009a) RPA as well as the 2014 Recovery Plan for Chinook salmon and steelhead (NMFS 2014) identified actions that, if implemented, could lead to improved conditions for Chinook salmon, steelhead and green sturgeon. Most of the actions, including fish passage above Shasta Dam and floodplain habitat restoration projects downstream from RBPP, could provide additional benefits to the Sacramento River anadromous fish populations. However, there is uncertainty as to the level of benefit (e.g., number of fish produced) or even the potential success (e.g., feasibility of fish passage) of the programs identified in both the BO and the Recovery Plan, as well as other restoration programs in the planning stages.

#### *Adaptive Management*

Adaptive management of system operations could reduce uncertainty in anadromous fish survival. Adaptive management is a deliberate, iterative, and scientific process of designing, implementing, monitoring, and adjusting an action, measure, or project to reduce uncertainty and maximize one or more goals over time. If applied appropriately, this approach would allow for flexible operations based on best available science and new information as it becomes available. For this project, an adaptive management plan may include operational changes to the timing and magnitude of releases from Shasta Dam primarily to improve the quality and quantity of aquatic habitat. These changes could include increasing minimum flows, timing releases from Shasta Dam to mimic more natural seasonal flows, meeting flow targets for side channels, or retaining additional storage to meet temperature requirements to improve conditions supporting anadromous fish survival.

### Water System Operations Analysis

Predictions of future water system operations depend on assumptions about future facilities, operational constraints, hydrology, and changes in Delta exports based on Federal regulations, including the ongoing remand process and planning policies that are subject to change. As described in Chapter 1, Section “Related Studies, Projects, and Programs,” operational constraints for the CVP and SWP are affected by changing regulatory conditions in California. For this Feasibility Report, CVP and SWP operational assumptions were based on operations described in Reclamation’s 2008 Long-Term Operation BA, the 2008 USFWS BO, the 2009 NMFS BO, and the Coordinated Operations Agreement between Reclamation and DWR, as ratified by Congress. These assumptions were used to guide refinement, modeling, and evaluation of alternatives and were used as the basis of analysis in this Final Feasibility Report. The ongoing consultation processes for the 2008 USFWS and 2009 NMFS BOs have resulted in some uncertainty in future CVP and SWP operational constraints. However, the 2008 Long-Term Operation BA and the

2008 and 2009 BOs issued by the fishery agencies contain the most recent estimate of potential changes in water operations that could occur in the near future. However, these legal challenges may result in changes to CVP and SWP operational constraints if the revised USFWS and NMFS BOs contain new or amended RPAs.

In addition, potential implementation of an alternative under the BDCP could affect the estimated benefits of SLWRI comprehensive plans. The discussion below describes the nature of potential effects.

#### *Analysis of Potential BDCP Alternatives*

The BDCP is being prepared collaboratively by Federal, State, and local agencies, environmental organizations, and other interested parties. The BDCP is intended as a comprehensive conservation strategy for the Delta, designed to advance the coequal planning goals of restoring ecological functions of the Delta and improving water supply reliability for large portions of the State of California.

A range of alternatives for providing Delta species/habitat protection and improving water supply reliability is being evaluated through development of an EIS/EIR. The current CEQA Preferred Alternative outlined in the BDCP Draft EIS/EIR includes a dual-conveyance water delivery system that would consist of new isolated north Delta diversion facilities and the existing SWP/CVP export facilities in the south Delta (Reclamation, USFWS, NMFS, and DWR 2013). The north Delta diversion would be the primary diversion point and would be operated in conjunction with the existing south Delta diversion; the existing south Delta diversion would only operate on its own when the north Delta diversion is nonoperational during infrequent periods for maintenance or repair. Facilities associated with the new north Delta diversion described under the current CEQA Preferred Alternative, Conservation Measure 1 – Water Facilities and Operation, include the following (Reclamation, USFWS, NMFS, and DWR 2013):

- Three new intakes located along the Sacramento River, each with an intake capacity of 3,000 cfs
- An intermediate forebay located near the town of Hood
- A dual-bore 40-foot-inside-diameter tunnel with conveyance capacity of 9,000 cfs by gravity flow from the location of the new intermediate forebay to Clifton Court Forebay

The following discussion describes how implementation of the BDCP could affect the existing system, and how the estimated benefits of SLWRI comprehensive plans could change if a BDCP alternative was implemented.

**Anadromous Fish Survival** All SLWRI comprehensive plans were formulated specifically to benefit anadromous fish in the upper Sacramento River, with a specific focus on increasing outmigration of salmonids downstream from RBPP. The BDCP is anticipated to improve habitat conditions in the Delta for anadromous fish species and increase the survival of outmigrating salmonids in the Delta. Improved habitat conditions in the Delta through implementation of any BDCP alternative are anticipated to further increase the survival in the Delta of outmigrating salmonids resulting from an enlarged Shasta Dam and Reservoir. However, there is significant uncertainty related to the magnitude of these benefits.

**Water Supply Reliability** All SLWRI comprehensive plans were formulated specifically to increase CVP and SWP water deliveries and water supply reliability. Isolated north Delta diversion facilities implemented as part of the BDCP could increase water deliveries to CVP and SWP SOD water users and improve water quality for urban and agricultural water users. Implementation of an enlarged Shasta Dam and Reservoir in combination with any BDCP alternative would likely provide greater water supply benefits than implementing either proposed project independently. Modifications of Shasta Dam and Reservoir could increase system flexibility and potential use of new Delta conveyance facilities, providing for even greater water supply reliability. However, the magnitude of the combined benefits is dependent upon type and size of conveyance facilities included in BDCP alternatives.

**Secondary Planning Objectives** SLWRI benefits for ecosystem restoration, hydropower generation, flood damage reduction, recreation and water quality could also be affected for comprehensive plans if BDCP is implemented. Increases in water supply reliability due to increased system flexibility and potential use of new Delta conveyance facilities could change average water levels in Shasta Reservoir, potentially affecting benefits to secondary objectives. However, the magnitude and timing of these affects are unknown.

## Cost Estimates

Cost estimates developed for comprehensive plans included in this report are based on January 2014 price levels and a 100-year period of analysis. All cost estimates, even at a feasibility-level, have inherent risks and uncertainties, including labor costs, materials availability, competitive bidding environments, unidentified field conditions, financial and/or commodity market conditions, and changing regulatory environments.

Of primary consideration, varying uncertainties are associated with the material and unit costs used to develop the estimates. Unknowns include the price of construction materials and labor costs. In particular, the construction market has experienced extreme price volatility in the last several years. A significant market anomaly occurring from 2002 to 2009 skews the calculation of forward cost trends using short-term linear regression techniques.

Although the recent economic downturn has resulted in price decreases, it is expected that prices will continue to escalate over the long term. While future inflation trends are difficult to predict, new market forces (e.g., higher material commodity pricing, energy costs, lack of competition) will likely continue to have significant impacts on heavy civil infrastructure construction costs for the foreseeable future. Because of uncertainty and variability among the short-term regressions, a longer view of the market is preferred. Consequently, while forward cost trends are always difficult to predict, there is some basis to believe that cost escalation is normalizing back to historical levels at approximately 3 percent per year.

To better understand how uncertainties in quantities and unit pricing may affect project costs, a Monte Carlo simulation and risk analysis was conducted for CP4A using Oracle Crystal Ball software. Based on this Monte Carlo simulation at 10 percent and 90 percent, the total construction cost of CP4A ranges from $1,240 million to $1,399 million, respectively. Specifically, the 90 percent estimate has a 90 percent probability that the actual construction cost will not exceed $1,399 million. The feasibility-level estimate for total construction cost of CP4A is $1,265 million and falls within the range of the confidence interval of the crystal ball risk analysis.

### Construction Schedule and Funding

The construction schedule and associated costs for the NED Plan are based on receiving appropriations consistent with the schedule. Partial or no appropriations would likely extend the construction schedule. This would likely result in increased costs, both construction field costs and non-contracts costs. As described in the Engineering Summary Appendix to the accompanying Final EIS, there may be potential to accelerate the construction schedule. The current schedule estimates about a 5-year construction period. However, this 5 year period could potentially be substantially reduced through measures such as optimizing contract packaging, selective use of design-build for certain facilities, and requiring shorter, more aggressive contract durations employing multiple shift work. Implementing measures to accelerate the schedule could potentially reduce schedule risk, raising the confidence in the overall 5 year construction period.

### Monetizing Project Benefits

Estimating economic (monetized) benefits of potential project accomplishments is critical to establishing economic feasibility and identifying a corresponding NED plan. For each comprehensive plan, monetized benefits were estimated for increased agricultural water supply reliability, M&I water supply reliability, anadromous fish survival, hydropower, and recreation. Valuation methods for each NED benefit category are presented in the Economic Valuation Appendix and summarized in Chapter 5. As described, varying uncertainties are associated with each valuation method.

To address the risk and uncertainty related to valuation of benefits, alternate valuation methods are presented in the Economic Valuation Appendix for each benefit category as a sensitivity analysis. Table 6-10 below summarizes results of the NED and sensitivity evaluations for the NED Plan, CP4A. As shown in Table 6-10, sensitivity analysis estimates were generally higher than NED estimates for all benefit categories except M&I water supply, which is lower because a substantial portion of the M&I deliveries under comprehensive plans are excluded in LCPSIM due to model limitations. Sensitivity analysis estimates for agricultural water supply, anadromous fish, and hydropower are substantially higher than NED benefit estimates. Resulting total economic benefits and benefit/cost ratio for the sensitivity analysis of CP4A are approximately four times higher than the NED benefit estimates.

**Table 6-10. Sensitivity Analysis Comparison of Annual Benefits for CP4A ($ millions/year)[1]**

| | Agricultural Water Supply Reliability[2] | M&I Water Supply Reliability[3] | Anadromous Fish Survival[4] | Hydropower[5] | Recreation[6] | Total | B/C Ratio |
|---|---|---|---|---|---|---|---|
| **NED Benefit Estimate** | 5.1 | 21.8 | 33.3 | 14.4 | 14.3 | 88.9 | 1.51 |
| **Sensitivity Analysis** | 10.0 | 10.6 | 276.3 | 26.7 | 15.0 | 338.6 | 5.74 |

Notes:
[1] Dollar values are expressed in January 2014 price levels.
[2] NED benefits estimated using the SWAP model. Sensitivity analysis benefits estimated using a statistical model of California spot market water transfer activity.
[3] NED benefits estimated using the M&I Water Transfer Pricing Model. Sensitivity analysis benefits estimated using LCPSIM. Benefits estimated using LCPSIM are lower because model limitations in LCPSIM exclude a substantial portion of the M&I deliveries under CP4A.
[4] NED benefits estimated based on the least-cost alternative approach. Sensitivity analysis benefits estimated using results of 2012 annual household willingness to pay surveys for the Klamath River Basin Restoration investigation.
[5] NED benefits estimated based on increased energy generation, ancillary services benefits, and capacity benefits. Sensitivity analysis benefits include increase of hydropower costs at 2 percent above inflation to account for growing scarcity in the future.
[6] NED benefits estimated based on lower bound predicted changes in annual recreation visitation. Sensitivity analysis benefits based on upper bound predicted changes in annual recreation visitation.

Key: B/C = Benefit/Cost
CP= Comprehensive Plan
LCPSIM = Least Cost Planning Simulation Model
M&I = municipal and industrial
NED = National Economic Development
SWAP = Statewide Agricultural Production

# Unresolved Issues

The following subject areas are issues that Reclamation will continue to address if a project is authorized for implementation. In addition, Chapter 1 of the Final EIS contains additional discussion related to areas of controversy.

## Non-Federal Cost-share Partners

Agreements with project participants must be negotiated that address an up-front cost share, consistent with the beneficiary pays principle. A final recommendation cannot be made until such a cost share agreement is addressed.

## Native American and Cultural Resources

Numerous cultural resources would be significantly affected by all of the action alternatives. Reclamation has invited Federally recognized tribes and non-Federally recognized tribal groups to be consulting parties to the National Historic Preservation Act Section 106 process. No Federally recognized tribes reside in the immediate Shasta Lake area. However, the Winnemem Wintu (a Native American group) continue to raise concerns about impacts of the original construction of Shasta Dam and potential impacts of enlarging Shasta Dam on sites they value for historical and cultural significance. The Winnemem Wintu would continue to have the opportunity to participate, and are anticipated to continue to provide input as an invited consulting party, through the Section 106 process.

# Implementation Requirements

After this Final Feasibility Report is completed, a number of requirements will remain before a project can be implemented. These requirements are described below.

### *Agreement on Up-Front Cost-Share with Project Participants*

A cost-share agreement addressing an up-front cost share must be negotiated prior to any recommendation being made. As noted, current Federal Budget conditions and the impacts those conditions have on Reclamation's budgetary resources significantly constrain Reclamation's ability to fully fund new construction activities of the scope and magnitude required by the SLWRI. As a result, the traditional model under Federal reclamation law, with Congress providing funding from annual appropriations to cover all the costs of construction over a relatively short period of time, and a portion of those funds being repaid to the Treasury over 40 – 50 years, is unrealistic for the identified SLWRI NED Plan. Alternative means of financing (primarily non- Federal) for a majority of the construction costs of the NED Plan would have to be identified and secured in order for the Secretary of the Interior to be able to recommend a construction authorization to Congress.

### *Project Authorization*

The proposed project, in light of any potential agreement on up-front cost-share as discussed above, would then be considered for authorization by Congress. Congress may (1) approve the NED Plan or any other plan, with or without further modification; (2) decide not to approve any action alternative; or (3) request additional information from the Secretary. If authorized, Congress may provide further direction through legislation and provide appropriations to implement the authorized project.

### *Project Funding/Appropriations*

If authorized, a separate appropriation authorization would be required. Unless otherwise established by law, funding for construction of an authorized project is typically included in the President's budget based on (1) national priorities, (2) magnitude of the Federal commitment, (3) level of local support, (4) willingness of the non-Federal sponsor to fund its share of the project costs, and (5) budgetary constraints that may exist at the time of construction. The source, availability, appropriation process, and timing may affect the estimated construction schedule included in this Final Feasibility Report, Final EIS and supporting documents.

### *Regulatory and Related Requirements for Environmental Compliance*

Modifications to Shasta Dam and Reservoir would be subject to the requirements of Federal, State, and local laws, policies, and environmental regulations, as described in this Feasibility Report and accompanying Final EIS and/or as supplemented or modified by authorizing legislation. Reclamation or a CEQA lead agency, assuming one is identified in the future, would need to obtain various permits and regulatory authorizations before any project construction could begin. If Congress authorizes and funds construction to enlarge Shasta Dam and Reservoir, then preconstruction activities will be conducted to refine the designs and costs of project features and mitigation commitments, finalize implementation responsibilities, and complete supplemental documentation before preparing and submitting various permit applications to regulatory agencies for approval. Table 6-11 identifies the likely permits, responsible agencies, and their responsibilities that are required before the start of any physical project implementation activities. After the approval of all required permits, and/or waivers as may be appropriate, then the implementation of mitigation measures may proceed before, or consistent with other physical features, in compliance with NEPA and standard Federal practices.

### *Advanced Planning and Design Activities*

If Congress authorizes and appropriates funds for construction of a project to enlarge Shasta Dam and Reservoir, then Reclamation would initiate activities in coordination with project partners and stakeholders to conduct and complete required advanced planning and design activities before implementation of the project. Several key activities include: (1) developing a post-authorization report to present the results of subsequent advanced planning actions, refinement of designs, cost estimates, updated analyses of potential effects and economics, and related NEPA and/or CEQA analyses and documentation, if necessary; (2) preparing detailed plans, specifications, and bid packages; (3) establishing agreements for reimbursable project purposes; (4) developing and/or revising operations, maintenance, and related plans; and (5) acquiring required lands, easements, and rights-of-way.

**Table 6-11. Summary of Potential Major Permits and Approvals for Project Implementation**

| Agency Permit/Approval | Recommended Prerequisites for Submittal[1] | Estimated Processing Time[2] | Anticipated Fees |
|---|---|---|---|
| **Federal** | | | |
| **USACE**<br>Clean Water Act Section 404 | • Application<br>• ESA compliance document for submittal to USFWS/NMFS/CDFW<br>• Section 401 Water Quality Certification permit or application<br>• NEPA documentation (environmental compliance documents)<br>• Section 106 compliance documentation<br>• Wetland delineation<br>• Section 404 (b)(1) evaluation and identification of the Least Environmentally Damaging Practical Alternative<br>• Mitigation and monitoring plan | 24 months | $100 for Individual permit |
| **USFWS/NMFS**<br>Endangered Species Act Section 7 Consultation | • Regular informal technical consultation<br>• ESA compliance document<br>• Draft environmental compliance documents | 12 months | None |
| **USFWS/NMFS/CDFW**<br>Fish and Wildlife Coordination Act | • Regular Informal technical consultation<br>• ESA compliance document<br>• Draft environmental compliance documents | 12 months | None |
| **SHPO[3]/ACHP**<br>National Historic Preservation Act, Section 106 | • Historic Property Inventory Report<br>• Native American consultation | 24 months | None |
| **State** – PRC 5093.542 (c) and (d), pertaining to the McCloud River, may limit the ability of State agencies to review and process permits and related approvals for modifications of Shasta Dam and Reservoir. | | | |
| **RWQCB**<br>Clean Water Act Section 401 | • Application<br>• Fish and Game Code Section 1602 application<br>• CWA Section 404 permit or application<br>• Draft environmental compliance documents<br>• Mitigation and monitoring plan (if needed) | 6 months | $500+ |
| **CDFW**<br>California Endangered Species Act Section 2081—Incidental Take Permit<br>or<br>2080.1 Consistency Determination | • Informal technical consultation<br>• Application, if requesting a 2081 Incidental Take Permit<br>• Biological opinion and incidental take statement, if requesting a consistency determination (preferred approach) | 6 months after Biological Opinions issued | None |
| **CDFW**<br>Fish and Game Code Section 1600 Streambed Alteration Agreement | • Application<br>• Section 401 Water Quality Certification permit or application<br>• CWA Section 404 permit or application<br>• Draft environmental compliance documents<br>• Mitigation plan | 9 months | $4,000 |
| **Central Valley Flood Protection Board California Code, Title 23: Encroachment Permit** | • Application | 9 months | None |
| **State Lands Commission Land Use Lease** | • Application<br>• Draft environmental compliance documents | 9 months | $25 |

**Table 6-11. Summary of Potential Major Permits and Approvals for Project Implementation (contd.)**

| Agency Permit /Approval | Recommended Prerequisites for Submittal[1] | Estimated Processing Time[2] | Anticipated Fees |
|---|---|---|---|
| **State of California Department of Transportation**<br>Encroachment Permit | • Application<br>• Permit Engineering Evaluation Report | 60 days | None |
| **Local** | | | |
| **SCAQMD**<br>Authority to Construct and Permit to Operate | • Application<br>• Preapplication meeting (encouraged) | 6 months | $75 |

Notes:
[1] All permit applications require detailed project description information.
[2] Anticipated processing time is estimated based on submittal of initial permit applications to permit issuance.
[3] PRC 5093.542 (c) and (d), pertaining to the McCloud River, may limit the ability of State agencies to review and process permits and related approvals for modifications of Shasta Dam and Reservoir.

Key:
ACHP = Advisory Council on Historic Preservation
CWA = Clean Water Act
CDFW = California Department of Fish and Wildlife
ESA = Endangered Species Act
NEPA = National Environmental Policy Act
NMFS = National Marine Fisheries Service
PRC = Public Resources Code
RWQCB = Regional Water Quality Control Board
SCAQMD = Shasta County Air Quality Management District
SHPO = State Historic Preservation Officer
State = State of California
State Water Board = State Water Resources Control Board
USACE = U.S. Army Corps of Engineers
USFWS = U.S. Fish and Wildlife Service

### *Project Construction and Transfer to O&M Status*

After the feasibility study and resultant decision making, post-authorization environmental compliance, advanced planning and design efforts described above, then project implementation efforts would transition to the preparing and executing construction contracts, starting implementation of mitigation measures and/or construction activities, completing such construction activities, commissioning new facilities, and, finally, operating and establishing and/or transferring O&M responsibilities.

If Congress authorizes and funds construction to enlarge Shasta Dam and Reservoir, then preconstruction activities would be conducted to refine the designs and costs of project features and mitigation commitments, finalize implementation responsibilities, and complete supplemental documentation before preparing and submitting various permit applications to regulatory agencies for approval. After the approval of all required permits, and/or waivers as may be appropriate, then the implementation of mitigation measures may proceed before, or consistent with other physical features, in compliance with NEPA and standard Federal practices.

In addition to the major Federal, State, and local environmental requirements detailed in Table 6-11, the NED Plan may be subject to other laws, policies, or plans. Table 6-12 summarizes other laws, policies, and plans that may potentially affect the implementation of any plan authorized for construction.

**Table 6-12. Summary of Applicable Laws, Policies, Plans, and Permits Potentially Required**

| Level | Laws, Policies, Plans, and Permits |
|---|---|
| Federal | Federal Endangered Species Act |
| | Section 404 of the Clean Water Act |
| | Rivers and Harbors Act Section 10 |
| | National Historic Preservation Act, Section 106 (1966) |
| | Migratory Bird Treaty Act |
| | Fish and Wildlife Coordination Act |
| | Executive Orders 11990 (Wetlands Policy), 11988 (Flood Hazard Policy), and 12898 (Environmental Justice Policy) |
| | Indian Trust Assets |
| | Americans with Disabilities Act |
| | Rehabilitation Act |
| | Farmland Protection Policy |
| | Federal Transit Administration Activities and Programs |
| | Essential Fish Habitat |
| | Architectural Barriers Act |
| | Federal Cave Resources Protection Act (1988) |
| | Executive Order 11312 (National Invasive Species Management Plan) |
| | Magnuson-Stevens Fishery Conservation and Management Act |
| | National Wild and Scenic Rivers System |
| | Federal Land Use Policies |
| | Federal Water Project Recreation Act |
| | Whiskeytown-Shasta-Trinity National Recreation Area Management Guide |
| | Whiskeytown-Shasta-Trinity National Recreation Act |
| | Shasta-Trinity National Forest Management Plan |
| | Federal Endangered Species Act |
| | U.S. Army Corps of Engineers – Shasta Dam and Reservoir Regulation Requirements |
| | U.S. Coast Guard Activities and Programs |
| | Uniform Relocations Assistance and Real Properties Acquisition Act of 1970, as amended (Public Law 91-646 and Public Law 100-17) |
| State | California Public Resources Code |
| | California Environmental Quality Act |
| | Clean Water Act Section 401 |
| | California Endangered Species Act |
| | California Fish and Game Code – Fully Protected Species |
| | California Fish and Game Code Section 1600 – Streambed Alteration |
| | Porter-Cologne Water Quality Control Act |
| | California Native Plant Society California Rare Plant Ranking System |
| | Reclamation Board Encroachment Permit |
| | California Water Rights |
| | State Lands Commission Land Use Lease |
| | State of California General Plan Guidelines |
| | California Department of Transportation Encroachment Permit and Activities, Programs |
| | California Land Conservation Act of 1965 (Williamson Act) |
| | California Native Plant Protection Act |
| | California Department of Boating Activities and Programs |
| | California Scenic Highway Program |
| | California Wild and Scenic Rivers Act |

**Table 6-12. Summary of Applicable Laws, Policies, Plans, and Permits Potentially Required (contd.)**

| Level | Laws, Policies, Plans, and Permits |
|---|---|
| Local | Shasta County Air Quality Management District Authority to Construct and Permit to Operate |
| | Shasta County Building Division Grading Permit |
| | Shasta County Zone Plan |
| | Shasta County Department of Public Works Encroachment Permit |
| | Shasta County General Plan |
| | Other Local Permits and Requirements |

### *Special Considerations Specific to Shasta Dam and Reservoir*

Additional considerations specific to implementing the NED Plan, involving Shasta Dam and Reservoir, are discussed below.

**Shasta-Trinity National Forest and National Recreation Area** Two important examples of laws, policies, and plans not directly relating to typical environmental compliance and coordination activities include the Whiskeytown-Shasta-Trinity NRA Management Guide (USFS 2014) and STNF LRMP (USFS 1995). These plans prescribe management practices for much of the Shasta Lake area and would be important in implementing any project authorized for construction. Shasta Lake is located within the Whiskeytown-Shasta-Trinity NRA, which consists of the Shasta and Trinity units (managed by USFS) and the Whiskeytown Unit (managed by the National Park Service). The Whiskeytown-Shasta-Trinity NRA Management Guide (USFS 2014) addresses management of resources, changes in technology, and recreation trends in the Shasta-Trinity National Forest and vicinity and is subject to the STNF LRMP including the applicable elements of the Northwest Forest Plan. It contains USFS goals and objectives, USFS standards and guidelines, management prescriptions to be applied to land areas, and management area direction.

**McCloud River** The McCloud River is not formally designated as either a National or State wild and scenic river; however, Section 5093.542 of the California PRC includes provisions that are intended to protect the free-flowing condition and wild trout fishery of the McCloud River. Section 5093.542(a) states that "maintaining the McCloud River in its free-flowing condition to protect its fishery is the highest and most beneficial use of the waters of the McCloud River within the segments designated in subdivision (b)." Section 5093.542(b) prohibits any "dam, reservoir, diversion, or other water impoundment facility" from 0.25 mile below McCloud Dam downstream to the McCloud River Bridge. McCloud Dam, which regulates flows into this reach of the McCloud River, is a PG&E facility that diverts a majority of the McCloud River flows into the Pit River basin. Section 5093.542 was established through enactment of the Wild and Scenic Rivers Act, as amended (PRC, Sections 5093.50 through 5093.70). Up to about 3,500 feet of the lower McCloud River above the McCloud River Bridge and within the special designation reach would be occasionally inundated if Shasta Dam were modified. Thus, the NED

Plan and other comprehensive plans would have some effect on the free-flowing condition of the McCloud River and the wild trout fishery within the part of the lower McCloud River protected by Section 5093.542 of the PRC. DWR and other State agencies, landowners, and various environmental groups have expressed concerns about potential impacts on McCloud River resources resulting from enlarging Shasta Dam and Lake.

Additionally, it is possible that State agency participation in potential enlargement of Shasta Dam and Reservoir could be limited due to the PRC. Section 5093.542(c) of the PRC states the following:

> *Except for participation by DWR in studies involving the technical and economic feasibility of enlargement of Shasta Dam, no department or agency of the state shall assist or cooperate with, whether by loan, grant, license, or otherwise, any agency of the federal, state, or local government in the planning or construction of any dam, reservoir, diversion, or other water impoundment facility that could have an adverse effect on the free-flowing condition of the McCloud River, or on its wild trout fishery.*

In addition, Section 5093.542(d) of the PRC states the following:

> *All state agencies exercising powers under any other provision of law with respect to the protection and restoration of fishery resources shall continue to exercise those powers in a manner to protect and enhance the fishery [of the protected segments of the McCloud River].*

Participation by various State agencies in planning and potential construction activities associated with modifying Shasta Dam and Reservoir, including related permitting and approval processes, has varied by the agency's mandate and Section 5093.542 of the PRC. CDFW has taken the position that it must participate in preparing the EIS to comply with Section 5093.542(d). Other State agencies, including DWR and the State Water Board, have participated to a limited extent or expressed their intent to participate in the SLWRI. The CALFED Program Plan (CALFED 2000d) concluded that although Section 5093.542 seeks to protect the free-flowing condition of the McCloud River, it also provides for investigations of enlarging Shasta Dam. If the NED Plan or another plan is ultimately authorized and approved, it is possible that some State agencies will be unable to process and issue permits and approvals. This could preclude Reclamation from obtaining State approvals and permits, which could impede a project and frustrate Congressional intent.

In addition, effects to the McCloud River and related provisions in the PRC are also relevant to the recently passed Proposition 1. California voters approved Proposition 1, "Water Bond. Funding for Water Quality, Supply, Treatment, and Storage Projects," on November 4, 2014, for $7.5 billion, which includes $2.7 billion for storage projects. However, provisions in Proposition 1, section 79751(a), related to Chapter 1.4 (commencing with Section 5093.50) of Division 5 of the PRC, may limit bond funding for a project if the State or its agencies determine that such actions are prohibited by Chapter 1.4 of the PRC. Section 79751 does not amend or modify the State PRC. Whether the State of California can use Proposition 1 funds in support of any plan potentially authorized related to enlargement of Shasta Dam and Reservoir is outside of Reclamation's authority and to be determined by the State of California.

**Reclamation Water Rights for Shasta Reservoir** The existing water rights for storage of water in Shasta Reservoir, along with historical storage data from 1944 to 2013, were evaluated to determine if additional storage rights would be needed for the NED Plan, CP4A. As described below, based on these evaluations it is not anticipated that additional or amended storage rights would be necessary to fully exercise the increase in storage provided by enlargement of Shasta Reservoir under the NED Plan.

As shown in Table 6-13, Reclamation holds three permits for storage in Shasta Reservoir, for a total combined storage of 4,493,000 acre-feet per year, representing the total amount of storage that can be added to Shasta Reservoir during the storage season.[3] Storage under these permits is further limited by the maximum amount actually stored in any one storage season during the development period (the period for determining beneficial use under the water right). The development period for Permits 12721, 12722, and 12723 ended on December 1, 1990. Maximum combined storage under these permits during the development period was 3,906,336 acre-feet, which occurred in the 1977/1978 storage season.

**Table 6-13. Water Right Permits for Storage in Shasta Reservoir**

| Storage Permit Information | Storage in Shasta Reservoir (acre-feet) | Storage Season | Maximum Storage During Development Period[1] (acre-feet) |
|---|---|---|---|
| Permit 12721 | 3,190,000 | October 1 to June 30 | 3,190,000 |
| Permits 12722 and 12723 (combined) | 1,303,000 | October 1 to June 30 | 716,336 |
| Total Shasta Reservoir Storage | 4,493,000 | - | 3,906, 336 |

Note:
[1] The development period for determining beneficial use for Permits 12721, 12722, and 12723 ended December 1, 1990. Highest storage under these permits during the development period occurred during the 1977/1978 storage season.

[3] Storage under water rights permits is calculated on a daily basis and includes both initial storage volumes filled during the storage season and refill volumes (when storage is added, used, then refilled in a single storage season).

Storage conditions in 1977/1978 have not occurred in any other storage season to date. During water year 1977/1978, reservoir storage levels on October 1 were close to dead pool, the winter and spring were extremely wet, and there were no environmental release requirements. This allowed almost the entire active storage space in Shasta Reservoir to fill in a single storage season (see Figure 6-2). This combination of events has not occurred in any other water year since storage began in Shasta Reservoir in 1944. After 1977/1978, the next highest storage season to date was 1992/1993, when 2,869,335 acre-feet was stored. The difference between the 1977/1978 season of storage and second highest season of storage is 1,037,001 acre-feet. This 1,037,001 acre-feet difference in storage under Shasta Reservoir water rights permits is substantially greater than the increased storage capacity from an 18.5-foot dam raise under CP4A (634,000 acre-feet).

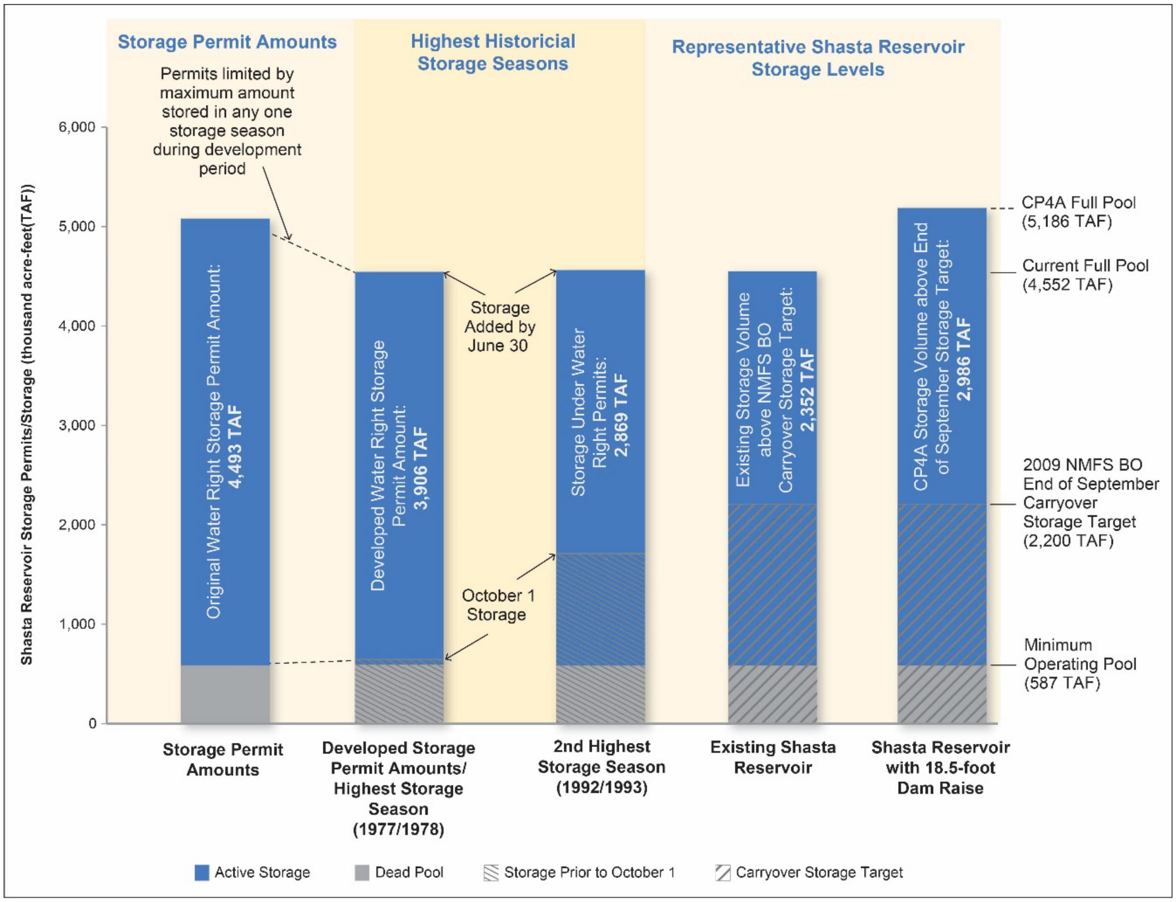



**Figure 6-2. Shasta Reservoir Water Rights, Historical Storage, and Representative Storage Volumes**

Conditions resulting in the highest historical storage seasons, such as 1977/1978, are unlikely to be repeated due to current regulatory requirements. This is primarily because environmental regulations, such as RPAs in the 2008 USFWS BO and the 2009 NMFS BO, have mandated increased environmental requirements, such as Shasta Reservoir carryover storage and flows in the Sacramento River and the Delta. For example, the 2009 NMFS BO RPA includes an end-of-September carryover storage target for Shasta Reservoir of 2,200,000 acre-feet (to be met in at least 87 percent of years). To surpass the year of highest storage for an 18.5-foot dam raise under CP4A, October 1 storage would have to be less than 58 percent of the carryover storage target and a combination of high precipitation and limited environmental release requirements would have to allow complete refilling of the reservoir by the following June.

The State Water Board indicated that a new or amended storage right would not be necessary to fully exercise increased storage under CP4A if the volumes fall within the highest past authorized storage volume. Accordingly, Reclamation does not anticipate needing to apply for additional storage rights for Shasta Reservoir as part implementing CP4A.A full evaluation of the historic exercise of Shasta Reservoir storage rights will be made to demonstrate that no changes in water rights are needed to fully exercise increased storage under the NED Plan, as requested by the State Water Board. If the evaluation determines amended or new permits are needed, Reclamation would coordinate with the State Water Board to obtain amendments or new permits as necessary.

## Advanced Planning and Design Activities

If Congress authorizes and appropriates funds for construction of a project to enlarge Shasta Dam and Reservoir, then Reclamation would initiate activities in coordination with project partners and stakeholders to conduct and complete required advanced planning and design activities before implementation of the project. Several key activities include the following:

- Developing a post-authorization report to present the results of subsequent advanced planning actions, refinement of designs, cost estimates, updated analyses of potential effects and economics, and related NEPA and/or CEQA analyses and documentation, if necessary
- Establishing agreements with key project partners and stakeholders (e.g., USFS, Shasta County, PG&E, UPRR) related to planning, design, and construction activities
- Preparing detailed plans, specifications, and bid packages
- Establishing agreements for reimbursable project purposes, including repayment contracts
- Developing and/or revising operations, maintenance, and related plans
- Acquiring required lands, easements, and rights-of-way

### Project Construction and Transfer to O&M Status

After the feasibility study and resultant decision making, post-authorization environmental compliance and design efforts, permit application and approval process, and acquisition process described above, then project implementation efforts would transition to preparing and executing construction contracts, starting implementation of mitigation measures and/or construction activities, completing such construction activities, commissioning new facilities, and, finally, operating and establishing and/or transferring O&M responsibilities.

As described in the Engineering Summary Appendix (Attachment 5) to the accompanying EIS, for procurement and construction, project features have been divided into several work packages – the clearing package, dam raise package, Lakeshore Drive package, Pit River Bridge modification package, multiple vehicular roads and bridges packages, recreation facilities package, visitor center package, transmission line package, Pit 7 powerplant package, gravel augmentation package, and ecosystem restoration. Several key activities for each work package include the following:

- Procurement of construction contracts
- Construction of work packages, including mobilization, construction, and commissioning/start-up
- Transfer of facilities to O&M Status

## Federal and Non-Federal Responsibilities

If a plan is recommended for implementation, Federal and non-Federal obligations and requirements would be contained in a Project Cooperation Agreement (PCA).

### Federal Responsibilities

If recommended for implementation, Reclamation and/or future project partners or beneficiaries would perform preconstruction and design studies for the NED Plan, which may require updated economic and/or environmental analyses and documentation. After PCAs are signed and non-Federal sponsors have provided any required financial contributions and assurances, the Federal Government would acquire real estate and/or relocate displaced parties according to Public Law 91-646 and construct the project modifications and related mitigation requirements. Reclamation and other Federal agencies (e.g., USFS) would be responsible for various O&M activities, as shown in Table 6-14.

**Table 6-14. Potential Federal and Non-Federal Responsibilities for Various Project Component O&M**

| Facility | Responsibility |
|---|---|
| Shasta Dam and Powerplant | Reclamation |
| Reservoir Area Dikes | Reclamation |
| Railroad Bridges and Embankments | UPRR |
| Road Relocations (USFS facilities) | USFS |
| Road Relocation (Shasta County facilities) | Shasta County |
| Vehicular Bridges (Shasta County facilities) | Shasta County |
| Pit River Bridge Protection | UPRR/Caltrans |
| Recreation Facilities (USFS facilities) | USFS |
| Pit 7 Dam and Powerhouse Modifications | PG&E |
| Utilities | Various Federal and Non-Federal |

Key:
Caltrans = California Department of Transportation
O&M = operations and maintenance
PG&E = Pacific Gas and Electric Company
Reclamation = U.S. Department of the Interior, Bureau of Reclamation
UPRR = Union Pacific Railroad
USFS = U.S. Forest Service

### Non-Federal Responsibilities

Before implementation, the non-Federal sponsor(s) (i.e., beneficiaries) for reimbursable costs would agree to perform items of local and state cooperation specific to the authorized purposes of the project. One or more non-Federal sponsors needs to be identified for each of the reimbursable project purposes. For most and possibly all of the reimbursable purposes, the non-Federal sponsor would need to share in the cost of the NED Plan.

## Timeline and Status of Feasibility Study

Table 6-15 summarizes major activities that have either occurred, or are planned to occur, as a part of the SLWRI feasibility study. A timeline of major milestones, documents, and actions to complete the feasibility study, preconstruction planning and design, and construction phases is shown in Figure 6-3. If and when Congressional authorization and related appropriations occur, project implementation would take place in two phases. The initial phase would span approximately five years and would include developing detailed project designs, acquiring necessary permits, and acquiring required real estate interests and/or relocating displaced parties according to Public Law 91-646. Once these initial phase activities are complete, construction of major project features would begin.  Construction activities would likely span approximately five years.  Estimated timelines are based upon availability of sufficient funding on an annual basis.

**Table 6-15. Timeline and Status of Feasibility Study**

| Activity | Description |
|---|---|
| **Completed and On-going Activities** | |
| Appraisal Assessment for the Potential Enlargement of Shasta Dam and Reservoir | This appraisal-level study analyzes the range of enlargement options for the dam and reservoir and the potential costs. Report issued May 1999. |
| Feasibility Study Reinitiation | Based on the results of the Appraisal Assessment and completion of the Programmatic CALFED ROD in 2000, Reclamation reinitiates feasibility-scope studies in mid-2000 on the potential to enlarge Shasta Dam and Reservoir. |
| Feasibility Investigation Plan Formulation Strategy Summary | This report outlines four phases of the plan formulation process, the various decision documents, and the subsequent Draft and Final Feasibility Reports. Report issued July 2002. |
| Shasta Reservoir Area Inventory | The primary purpose of this report is to identify major infrastructure that may be subject to modification or relocation if Shasta Dam were raised up to 30 feet. Report issued February 2003. |
| Mission Statement Milestone Report | As first of the four Plan Formulation Phase reports, this report describes existing and future conditions, problems, needs, and opportunities, project objectives and planning considerations, and baseline technical information, and develops a mission statement to guide the study process. Report issued March 2003. |
| Office Report: Breakpoint Analysis | This office report primarily describes results of an analysis to identify dam raise elevations for which project costs significantly change because of the need for relocation or modification of major project features. (Report issued June 2003) |
| Office Report: Ecosystem Restoration Opportunities in the Upper Sacramento River Region | This report highlights existing environmental conditions and problems, ongoing conservation and environmental restoration programs in the study area, potential ecosystem restoration opportunities, and potential ecosystem restoration plan components for consideration in future planning efforts. Report issued November 2003. |
| Initial Alternatives Information Report | As second of the four Plan Formulation Phase reports, this report describes the formulation of initial alternatives to address planning objectives of the SLWRI. (Report issued June 2004) |
| SLWRI Notice of Intent | Pursuant to the National Environmental Policy Act, Reclamation issues a Notice of Intent to prepare an EIS for the SLWRI. Published in the Federal Register Oct. 7, 2005. |
| Environmental Scoping Report | This document reports on comments from, responses to, and results from, a series of public scoping meetings held throughout California for the SLWRI. Report issued February 2006. |
| Plan Formulation Report | As third of the four Plan Formulation Phase reports, this report outlines the formulation, comparison, and evaluation of comprehensive alternative plans that address SLWRI planning objectives. Report issued December 2007. |
| Draft Feasibility Report and Accompanying Preliminary Draft EIS | The Draft Feasibility Report included a Federal decision document and environmental compliance documentation by reference. The report described the study process, major results, preliminary proposed plan, Federal/non-Federal responsibilities and sponsorship, and future actions. |
| Draft EIS and Related Documents | The Draft EIS and related documents were circulated for public review and comment. |
| Final Feasibility Report and Accompanying Final EIS | This Final Feasibility Report evaluates and compares comprehensive plans and identifies the NED Plan. The Final EIS includes responses to public comments and identifies the Preferred Alternative. |

**Table 6-15. Timeline and Status of Feasibility Study (contd.)**

| Activity | Description |
|---|---|
| **Future Activities** | |
| Washington D.C.-level Review and Processing | The Final Feasibility Report and Final EIS will be reviewed and processed within the Department of the Interior and the President's Office of Management and Budget before public release. |
| Congressional Authorization | Congress will review and vote on whether to authorize the project. Legislation containing construction authorization would be sent to the President for approval. |
| Record of Decision | Interior will issue a ROD for the SLWRI. |

Key:
CALFED = CALFED Bay-Delta Program
EIS = Environmental Impact Statement
Final EIS = Final Environmental Impact Statement
Reclamation = U.S. Department of the Interior, Bureau of Reclamation
ROD = Record of Decision
SLWRI = Shasta Lake Water Resources Investigation

## Estimated Timeline to Complete Feasibility Study, Pre-Construction Design, and Construction Phases for Proposed Enlargement of Shasta Dam and Reservoir

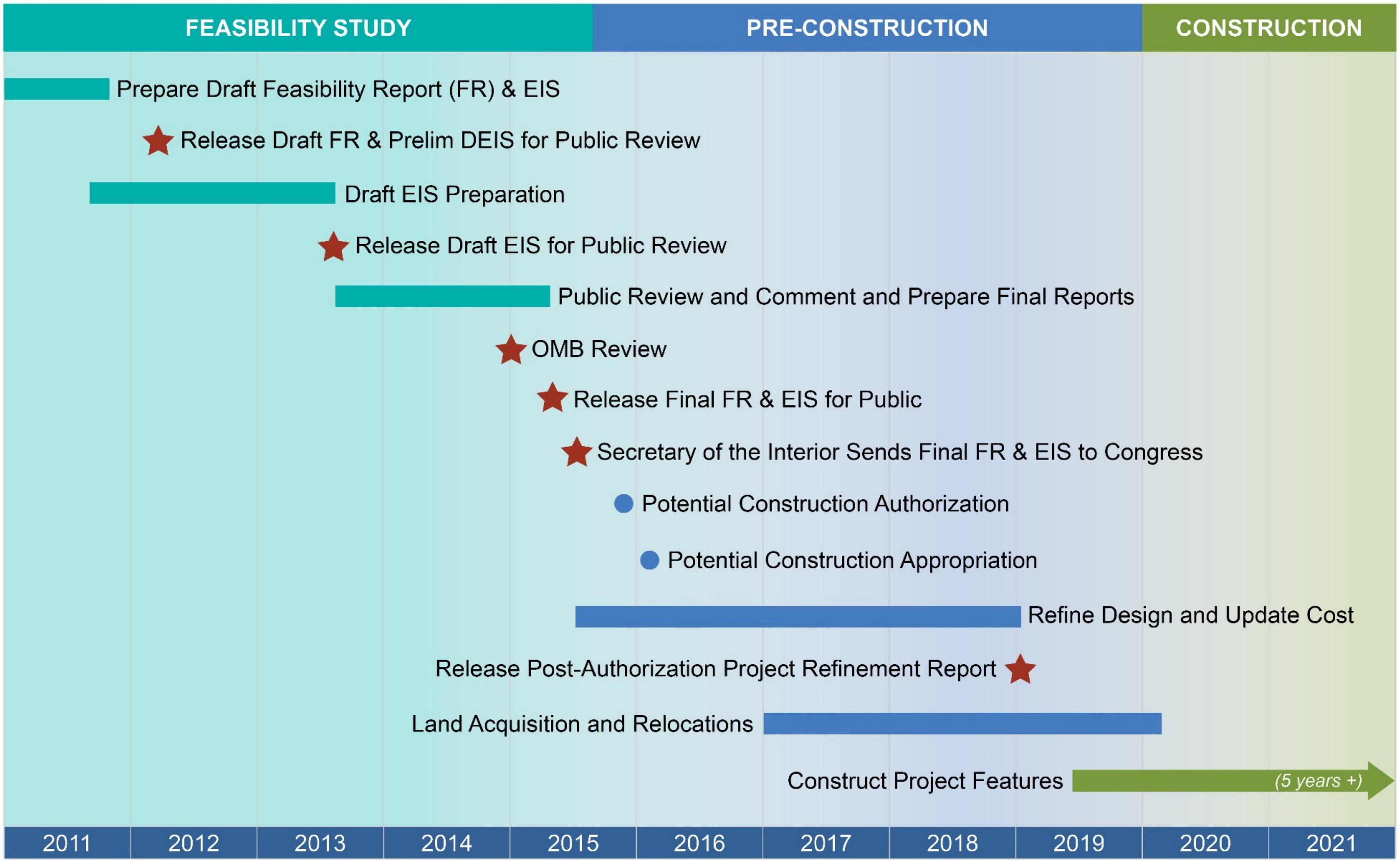



**Figure 6-3. Shasta Lake Water Resources Investigation Project Timeline**

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# Chapter 7
# Coordination and Public Involvement

Communication and engagement efforts with the public, Federally recognized Indian Tribes, Native American groups, public agencies, and other stakeholders is an important component of the SLWRI. Through periodic and proactive outreach activities, the SLWRI has kept stakeholders up-to-date with the progress, accomplishments and next steps of the investigation. These efforts are guided by the *Strategic Agency and Public Involvement Plan* (Reclamation 2003a), and include a broad range of activities designed to accomplish official and supplementary outreach goals.

In addition to ongoing public and stakeholder outreach, the Project Coordination Team (PCT) continues to facilitate participation by the SLWRI's numerous cooperating agencies.

This chapter describes the outreach and coordination approach for the SLWRI, progress of the investigation in executing the public involvement plan, and continuing PCT activities throughout the investigation in coordinating with stakeholders, Federally recognized Indian Tribes, Native American groups, and cooperating agencies. Cooperating agencies for the SLWRI, pursuant to NEPA, include USFS, Colusa Indian Community Council of the Cachil Dehe Band of Wintun Indians, USACE, and U.S. Bureau of Indian Affairs.

## Strategic Agency and Public Involvement Plan

The *Strategic Agency and Public Involvement Plan* (Reclamation 2003a) was designed to help the PCT effectively communicate with individuals, groups, and agencies that are affected by, or could benefit from, enlarging or modifying Shasta Dam and Reservoir. While the document is updated periodically to reflect the needs and objectives of the investigation, its critical components are compliance with the requirements of NEPA, Executive Order 12898 (Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations), and President Clinton's memorandum regarding the engagement of Federally recognized tribal governments (*Presidential Memorandum for the Heads of Executive Departments and Agencies, Subject: Government-to-Government Relations with Native American Tribal Governments*, published in the *Federal Register*, Vol. 59, No. 85, April 29, 1994).

The four objectives of the *Strategic Agency and Public Involvement Plan* are as follows:

- **Stakeholder Identification –** Identifying and involving individuals, groups, and other entities that have an expressed or implied interest in the SLWRI.

- **Project Transparency –** Informing stakeholders and the public of study results in a timely, unbiased fashion through a variety of methods, including stakeholder and/or public meetings, Web postings, and mailings.

- **Issues and Concerns Resolution –** Gaining awareness of the issues and concerns of stakeholders and the public early in the process, and responding to these issues in an effective and timely manner.

- **Project Implementation –** Assisting policy-makers in understanding project purposes and benefits, and demonstrating that the project has met all necessary requirements to be implemented.

The plan has two primary themes, outreach and information, as discussed in the following sections.

## Outreach

The *Strategic Agency and Public Involvement Plan* has five main outreach elements to assist in coordinating SLWRI efforts: (1) stakeholder and public meetings and workshops, (2) tribal coordination, (3) environmental justice, (4) Technical Working Group (TWG) coordination, and (5) PCT and Study Management Team (SMT) activities. In response to study data needs and requests from reservoir area landowners, a sixth outreach element was added to the effort: Surveys and Site Investigation Coordination. These outreach elements are described as follows:

- **Stakeholder/Public Meetings/Workshops –** Stakeholder and public meetings and workshops are important not only to enable the overall SLWRI to satisfy the public involvement requirements of NEPA and CEQA, but to afford stakeholders and the public the opportunity to effectively participate in development of the investigation. Specific outreach activities oriented toward stakeholders and the public are discussed later in this chapter.

- **Tribal Coordination –** The plan describes the intent of the SLWRI to consult with Federally recognized tribal governments, and outlines the investigation’s overall strategy for communicating with Federally recognized Indian Tribes and Native American groups. Specific outreach activities oriented toward tribal groups are discussed later in this chapter.

- **Environmental Justice –** Consistent with Executive Order 12898 (Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations), Reclamation has actively engaged minority populations and low-income populations in planning and developing the SLWRI. Outreach efforts for this component mirrored outreach efforts developed under the plan, and were modified to meet any specific communication needs necessary to effectively communicate with minority populations.

- **Technical Working Groups –** The TWGs provided critical support in defining and clarifying comprehensive alternative plans. Resource areas of importance include water supply reliability, ecosystems and ecosystem restoration and enhancement, water marketing and exchange, water policy and legislation, local land and property rights, regional economic impacts, environmental justice, and recreation.

- **Project Coordination Team and Study Management Team Activities –** The PCT includes the Reclamation Project Manager and technical experts from various disciplines and organizations, while the SMT comprises key policy and decision makers with direct influence over policy guidance for the study. The SMT provides overall guidance, suggestions, and comments for the study, representing viewpoints from all participating agencies.

- **Surveys and Site Investigation Coordination –** In support SLWRI, field surveys and investigations were conducted on private and public property to gather data for engineering and cost estimation purposes and to respond to landowner requests for site-specific data. These activities included, in part, biological, geotechnical and topographical surveys. Details of these surveys are discussed later in this chapter.

## Information Dissemination

For project transparency and to inform stakeholders and the public, study-related information was disseminated in a number of ways:

- **Project Updates –** Project update notices were developed at major study milestones to keep stakeholders advised of the SLWRI status. The purpose of the updates was to inform stakeholders and the public of study progress and alert them to major upcoming events.

- **Project Information Papers –** Two project information papers have been prepared. One supported outreach efforts for the 2003 *Mission Statement Milestone Report* (Reclamation 2003b) and the second was released in summer 2004 to support the *Initial Alternatives Information Report* (Reclamation 2004a).

- **Field Survey Information Materials and Signage –** As part of engineering and cost estimation activities, Reclamation conducted geologic, topographic and other surveys in the reservoir area since 2007. These activities were supported, where appropriate, with door hangers, road signs, letters to landowners and information sheets.

- **Web Site –** A comprehensive project Web site was created to provide information about stakeholder functions and project information. Located at www.usbr.gov/mp/slwri (Reclamation 2011g), the Web site provides electronic copies of major project milestone documents and reports, a site elevation tool to determine a percent chance of inundation, a method to submit comments or join the project contact database, contact information for key project leads, and serves as a vehicle to announce project meetings and distribute collateral materials provided during project meetings.

- **Media Relations –** Media relations for the SLWRI have included distribution of news releases, media advisories and calendar advisories in advance of the release of major project documents, reports and public meetings. Associated with this activity has been response to requests for interviews with print, radio and television media outlets. The media relations effort is flexible to facilitate prompt responses to comments, questions, or information regarding the study.

- **Stakeholder and Agency Briefings –** The SLWRI has employed speakers from the PCT at the request of stakeholder groups and agencies to present information on study topics of interest. Numerous presentations have been made by the Reclamation Project Manager and others to date on various topics, including presentations to the California Water Commission in 2010 and 2011. The stakeholder briefing program will continue to serve as an outreach mechanism for disseminating information and gathering comments and providing responses.

- **Elected Official Briefings and Engagement –** Early in the planning process, Reclamation initiated a series of briefings for elected officials and their aides to disseminate project information and its direction. These 2003 briefings by the Project Manager and PCT served to support on-going attendance at various outreach meetings by elected officials and their aides. Reclamation continues to hold briefings with Federal and state elected officials upon request.

## Agency Coordination

The SLWRI study management structure includes the active participation of numerous cooperating agencies and other stakeholders, involving representatives from resources agencies in the PCT, SMT, and TWGs. Cooperating agencies for the SLWRI, pursuant to NEPA, include USFS, Colusa Indian Community Council of the Cachil Dehe Band of Wintun Indians, USACE, and U.S. Bureau of Indian Affairs. Other participants in the PCT include USFWS, NMFS, U.S. Bureau of Land Management, and other Federal and State agencies.

These groups were active contributors to development and/or review of the comprehensive plans. Key elements of these coordination activities are the *Planning Aid Memorandum* and *Coordination Act Report*, documents issued by USFWS.

# Stakeholder Outreach

Meetings and workshops with the stakeholder community play a major role in the SLWRI's overall study process. Each meeting or workshop has been scheduled at critical milestones of the investigation. However, between milestones, the PCT continues to conduct numerous focused meetings and presentations aimed at maintaining frequent stakeholder communication regarding study status, results to date, and direction.

## Initial Stakeholder Engagement

One of the SLWRI's consistent activities is to conduct stakeholder briefings at various intervals during the investigation with groups ranging from governmental agencies to nongovernmental groups and coalitions.

Early in the SLWRI's development, a series of meetings was held with stakeholders and the public to provide information on the SLWRI and to support the completion and release of two documents: the *Mission Statement Milestone Report* (Reclamation 2003b) and the *Initial Alternatives Information Report* (Reclamation 2004a).

In fall 2003, six stakeholder and tribal briefings were held:

- **Congressional Briefing –** This briefing was held on October 15, 2003, at the State Capitol Building in Sacramento, and focused on providing Federal and State legislators and their aides information about the SLWRI and its direction.

- **Local Elected Officials Briefing –** This briefing was held on October 16, 2003, in Redding and focused on providing information about the study to State, local, city, and county government representatives of Northern California.

- **Tribal Briefing –** This briefing was held on October 17, 2003, also in Redding, and focused on providing study information to representatives from local tribes.

- **Immediate Study Area Interests Briefing –** This briefing was held on October 22, 2003, at Shasta Lake. The goal of the meeting was to inform individuals, businesses, and groups around Shasta Lake about the study and its direction.

- **Water and Hydropower Interests Briefing –** This briefing was held on October 24, 2003, at the Reclamation office in Sacramento and focused on describing the SLWRI to representatives of water and hydropower interests.

- **Environmental Interests Briefing –** This briefing was held on November 5, 2004, in Willows with representatives from various Federal, State, and local environmental groups to inform them about the SLWRI feasibility study and future efforts.

Additionally, two stakeholder workshops were held to discuss results of SLWRI studies to date at that time, and gain input for future study efforts:

- **Workshop 1 –** Held December 11, 2003, at the Red Bluff Community Center. The workshop presented information about the purpose and objectives of the SLWRI, status and current activities; identified water resources related problems and needs; and potential solutions to those problems. The workshop was also used to elicit input on management measures and review future actions and the SLWRI schedule.

- **Workshop 2 –** Held August 11, 2004, at the Redding Convention Center. The primary purpose of the workshop was to coordinate with stakeholders on the status of the investigation, initial alternatives being considered, and next steps in the feasibility study.

### Environmental Scoping

Scoping allows agencies, stakeholders, and interested parties the opportunity to identify or suggest resources to be evaluated, issues that may require environmental review, reasonable alternatives to consider, and potential mitigation if significant adverse effects of a planned action are identified.

Consistent with NEPA, Reclamation completed scoping for the SLWRI feasibility study in fall 2005, with public scoping meetings held in Sacramento, Fresno, Los Angeles, Concord, Dunsmuir, Redding, and Red Bluff during October and November. The resulting *Environmental Scoping Report* (Reclamation 2006) describes the scoping process, comments received during scoping, and how these comments would be addressed.

More detailed information on the environmental scoping process is provided in Chapter 27 of the Final EIS.

### Ongoing Stakeholder and Agency Briefings

Outreach for the SLWRI has included Reclamation representatives attending public meetings at the request of agencies and stakeholder groups, including the California Water Commission, McCloud River Coordinated Resource Management Plan signatories, Shasta Lake Business Owners Association, City of Redding, City of Red Bluff, City of Shasta Lake, Lakehead Community

Development Association, Shasta Board of Realtors, and project area chapters of the Lion's Club, Rotary International, and League of Women Voters. Reclamation further has on-going coordination and briefings with the following Federal agencies: USFS, BLM, NMFS, USFWS, EPA, USACE, and BIA. On-going coordination with state agencies include California Water Commission, DWR, CalTrans, CDFW, Central Valley Regional Water Quality Control Board, and the Resources Agency. Reclamation has also provided presentations/tours associated with the Investigation with the Association of California Water Agencies, the Water Education Foundation, and the Central Valley Project Water Users Conference. The purpose of the briefings is to update stakeholders on completed analyses and evaluations, upcoming efforts and studies, and overall project status and schedule. This briefings program also serves as a mechanism for gathering comments and providing responses to interested parties.

## Field Surveys and Investigations

Reclamation conducted geologic, topographic and other surveys in the reservoir area between 2007 and 2012 to support engineering and cost estimation for the SLWRI. These activities resulted in the coordination with more than 450 landowners to obtain right-of-entry to conduct engineering, geologic, cultural, and biological studies, and identified costs for 228 non-federal parcels affected by inundation and/or reservoir area facility relocation.

- **Geologic Investigations –** In 2007 and 2008, Reclamation conducted a series of geologic borings and excavations in three reservoir areas for engineering and cost estimation. These sites included Bridge Bay, Lakeshore Drive and Shasta Dam. At each site, an a-frame informational sign was positioned to explain the activity and provide a point of contact to passing motorists and pedestrians. Where such activities were conducted in residential areas, Reclamation delivered letters to nearby landowners before the arrival of survey equipment and left informational door hangers at nearby homes.

- **Biological and Archeological Surveys –** In 2011, Reclamation contacted more than 450 reservoir area landowners to request right-of-entry to conduct biological and archeological surveys. These environmental studies around and near the existing reservoir shoreline sought to evaluate the presence of cultural resources and document existing wildlife and botanical conditions.

- **Topographic Surveys –** In 2012, property owners in the Lakehead area of Shasta Reservoir requested that Reclamation provide site-specific topographic data to illustrate the potential effect on structures under the various reservoir enlargement options. The request was submitted during a February 25, 2012, presentation to the Lakehead Community Development Association. Based on this request, Reclamation distributed right-of-entry request letters to landowners potentially affected by the reservoir enlargement to authorize foundation surveys of structures on their property. Landowners who provided written permission received in November 2012 survey results that included an aerial view map of their property with contour lines that represented the likely water level under various enlargement options. Coordination with Tribal Governments and Native American Groups

Regular engagement and coordination with Indian Tribal governments and Native American groups is a vital component of the SLWRI. Guided by the SLWRI's *Strategic Agency and Public Involvement Plan* (Reclamation 2003a), this engagement has included coordination and government-to-government consultation with Indian Tribal governments in California, as well as coordination and engagement with Native American groups within the project area.

Indian tribal governments are American Indian or Alaska Native tribal entities registered with BIA as having a formal government-to-government relationship – inclusive of the responsibilities, powers, limitations, and obligations attached to that designation – with the United States. This federal registration further recognizes the tribal government's possession of certain inherent rights of self-government (i.e., tribal sovereignty) and carries with it entitlements to certain federal benefits, services, and protections because of their special relationship with the United States.

A Native American group is comprised of individuals who self-identify as Native American, but have not been conferred formal tribal sovereignty by the United States.  Native American groups/individuals are consulted with as "interested parties" under National Historic Preservation Act (NHPA) Section 106. Under 36 CFR §800.4(3), Federal agencies seek information from these parties, who are identified as likely having knowledge of, or concerns with, historic properties in the area, and may identify issues related to potential effects.

### Tribal Government Coordination

Consistent with a memorandum from the President on April 29, 1994, Reclamation will actively engage Federally recognized tribal governments in planning and developing the investigation, and will consult with each tribe on a government-to-government basis before taking actions that could affect such tribal governments. Under Federal Trust responsibility, Reclamation will provide full disclosure (benefits and negative impacts) of the project, allow time for tribal review/consultation, and receive comments and/or suggestions for alternatives.

The PCT held several coordination meetings with Federally recognized tribes during 2007 and 2008. Tribes were invited to an informal meeting held on April 4, 2007, in Redding, California. The purpose of the meeting was to provide the tribes with general information about the SLWRI, and to determine tribal participation interests. Additionally, from August 2007 to November 2008, members of the PCT held six separate meetings with four Federally recognized tribes whose traditional territories overlap the SLWRI project area. The meetings were held to solicit, clarify, and document major concerns and issues regarding the SLWRI, and to establish a preferred method or approach for maintaining effective communication with each tribe during the remainder of the feasibility study and in future endeavors.

### Native American Coordination

In accordance with Executive Order 12898, Native Americans — including Federally registered tribes and Native American groups — are considered minority populations, and are included as stakeholder groups. Several Native American groups, such as the Winnemem Wintu and Shasta Nation, have expressed significant interest in the SLWRI. In response, the PCT conducted – in addition to the six Tribal Government Coordination meetings – four meetings with Native American groups in 2007 and 2008. This engagement began with an informal meeting with Native American groups on April 4, 2007, to distribute general information about the SLWRI and to identify their interests for project participation. As with Federally registered tribes, the meetings held with Native American groups were to solicit, clarify, and document major concerns and issues regarding the SLWRI, and to establish each group's preferred method or approach for receiving communications about the SLWRI during the remainder of the study.

## Public and Agency Review and Comment

Reclamation released the Draft Feasibility Report and Preliminary DEIS in February 2012. These documents were released to the public to share information generated since the completion of the SLWRI Plan Formulation Report in December 2007 and to provide additional opportunity for public and stakeholder input. The February 2012 release was followed by an October 2012 Reclamation news release requesting additional public comment on the Draft Feasibility Report for input on potential cost, benefits and impacts of enlarging Shasta Dam and Reservoir. The SLWRI DEIS was released for public and agency review and comment on July 1, 2013. As part of the release of the DEIS, a NEPA Notice of Availability was published by the U.S. Environmental Protection Agency on July 1, 2013 for a 90-day public review and comment period that ended September 30, 2013.

During the DEIS public comment period, three public workshops and three public hearings were held in the communities of Los Banos, Redding and Sacramento to receive public input. The public workshops were held July 16-18, 2013, in Redding, Sacramento and Los Banos, respectively. The purpose of these workshops were to present updated information about the purpose and objectives of the SLWRI; status and current activities; identify water resources related problems and needs; and describe potential solutions to those problems.

The workshops provided an opportunity to elicit input on the draft EIS and to assist the public in reviewing the document. Three NEPA-compliant public hearings were held before the close of the public comment period on September 10-13, 2013, in Redding, Sacramento and Los Banos, respectively. Each hearing allowed the public to address the hearing officer and to make official public comment on the project for the record. A stenographer staffed each hearing to record public comments verbatim. More detailed information on the public workshops and the public hearings are provided in Chapter 27 of the accompanying Final EIS.

The Feasibility Report and accompanying Final EIS have been revised in consideration of public and agency comments. A Notice of Availability (NOA) was released for the Final EIS. Elected officials and representatives, government agencies, private organizations, businesses, and individual members of the public on the mailing list have received a copy of this document or a notification of document availability.

### Major Topics of Interest

Members of the public, stakeholders, other Federal agencies, and state and local agencies identified several areas of concern during the SLWRI planning process. The focus of interest varied among participants, but a common theme centered on potential impacts in the Shasta Lake area that could result from enlarging the dam and reservoir. Key topics of concern include potential adverse effects on cultural resources in the Shasta Lake area; recreation and recreation providers in the Whiskeytown-Shasta-Trinity NRA; special-status species around Shasta Lake, including terrestrial state-designated fully protected species and aquatic special-status species in the Sacramento River and Delta (including Delta smelt); the lower McCloud River and its special designation under California PRC Section 5093.542; Delta water quality; south Delta water levels; and potential effects on Central Valley hydrology below CVP and SWP reservoirs and related facilities and resulting effects on water supplies for water contractors and other water users. These topics are described in more detail in Section 1.6 of the Final EIS, “Areas of Controversy.”

# Chapter 8
# Findings and Conclusions

The SLWRI is a feasibility study being conducted by Reclamation and includes development, evaluation, and comparison of alternatives consistent with the Federal P&G (WRC 1983). In coordination with this Feasibility Report, a Final EIS has been prepared consistent with NEPA. This chapter summarizes major findings and conclusions of this feasibility study.

## Need for the Project

There is a compelling need to implement actions to increase survival of anadromous fish populations in the upper Sacramento River and increase the reliability of water supplies for agricultural, M&I, and environmental purposes. The population of Chinook salmon in the Sacramento River has significantly declined over the last 40 years (CDFW 2014a). Water temperature is among the most significant factors affecting Chinook salmon abundance in the Sacramento River, especially in dry and critically dry years. Demands for water in the Central Valley and elsewhere in the State of California exceed available supplies, and this condition is expected to become more pronounced in the future. Developing projects to increase the reliability of water supplies for agricultural, M&I, and environmental purposes is necessary to meet future demands, consistent with the CALFED Programmatic ROD.

## Multiple Cost Effective Plans

A range of alternatives were formulated and evaluated to address the primary and secondary objectives. Four of the comprehensive plans, CP2, CP4, CP4A, and CP5, provide net NED benefits. As shown in Table 8-1, CP4A is estimated to provide the greatest net benefits.

Although CP3 does not provide net NED benefits based on analyses to date, if institutional constraints allowed all developed water to be delivered to CVP water contractors, and if agricultural water supplies were valued based on recent market data, CP3 could also have net NED benefits.

**Table 8-1. Estimated Costs and Benefits for Comprehensive Plans ($ millions)[1]**

| Item | CP1 | CP2 | CP3 | CP4 | CP4A | CP5 |
|---|---|---|---|---|---|---|
| Estimated Construction Cost ($ millions) | 990 | 1,089 | 1,257 | 1,264 | 1,265 | 1,283 |
| Annual Cost ($ millions/year) | 45.1 | 51.2 | 53.8 | 57.1 | 59.0 | 61.0 |
| Total Annual Estimated Benefits ($ millions/year) | 29.7 | 61.6 | 42.6 | 86.0 | 88.9 | 74.2 |
| Annual Net Benefits ($ millions/year) | (15.4) | 10.5 | (11.2) | 28.9 | 29.9 | 13.2 |

Note:
[1] January 2014 price levels, 100-year period of analysis, and 3-1/2 percent interest rate.

Key:
CP = comprehensive plan

# National Economic Development Plan – CP4A – 18.5-Foot Dam Raise, Anadromous Fish Focus with Water Supply Reliability

Based on evaluation of the potential physical accomplishments and the benefits and costs of the alternative plans, CP4A is the alternative that would achieve the highest net NED benefits while protecting the environment and ranks the highest among the comprehensive plans in meeting the P&G criteria. Consistent with the P&Gs, since CP4A generates maximum net NED benefits, CP4A is identified as the NED Plan. CP4A is also identified as the Preferred Alternative pursuant to NEPA (as described in Chapter 32 of the Final EIS) and is synonymous with the Selected Plan and Preferred Plan pursuant to Reclamation Directives and Standards on Water and Related Resources Feasibility Studies (CMP 09-02). Additionally, it is anticipated that CP4A will be identified as the LEDPA pursuant to Section 404 of the Clean Water Act, which is ultimately subject to determination by USACE.

## Costs of National Economic Development Plan

Estimated feasibility-level costs for the NED Plan, CP4A, are shown in Table 8-2. Key assumptions for the cost estimate include availability of sufficient funding on an annual basis, and full and open market competition during the procurement processes. All cost estimates, even at a feasibility-level, have inherent risks and uncertainties. A Monte Carlo simulation and risk analysis was prepared for the total construction cost of CP4A. Based on this Monte Carlo simulation at 10 percent and 90 percent, the total construction cost of CP4A ranges from $1,240 million to $1,399 million, respectively. Specifically, the 90 percent estimate has a 90 percent probability that the actual construction cost will not exceed $1,399 million. The feasibility-level estimate for total construction cost of CP4A is $1,265 million. Based on the risk analysis, allowance for a 15 percent increase in total construction cost for CP4A would provide for over 90 percent probability that the actual construction cost would not be exceeded.

**Table 8-2. Estimated Costs for the NED Plan[1]**

| Item | NED Plan |
|---|---|
| Field Cost ($ millions) | 887 |
| Non-Contract Cost ($ millions) | 378 |
| Total Construction Cost ($ millions) | 1,265 |
| Interest During Construction ($ millions) | 105 |
| Annual Cost ($ millions/year) | 59.0 |

Note:
[1] Based on January 2014 price levels, 100-year period of analysis, and 3-1/2 percent interest rate.
Key:
NED = National Economic Development

Although the economic downturn in the late 2000s resulted in price decreases, it is expected that prices will continue to escalate over the long term. The total construction cost in Table 8-2 only includes escalation during the construction period, but does not include an allowance for escalation from the January 2014 price level to the notice to proceed milestone. The notice to proceed milestone is anticipated to be in early 2020, resulting in an approximate 6 year period where escalation is not reflected in the cost estimates.

## Benefits of National Economic Development Plan

The NED Plan would contribute to each of the primary and secondary objectives, as shown in Table 8-3. Although some uncertainties remain about future physical, biological, and socioeconomic conditions, the NED Plan is expected to be adaptable and effective under a broad range of future conditions. However, the current Coordinated Operations Agreement (COA) between Reclamation and DWR for the CVP and SWP, as ratified by Congress (Reclamation and DWR 1986), and other water rights decisions limit the benefits of the project to the CVP.

**Table 8-3. Summary of Estimated Benefits for the NED Plan**

| Item | NED Plan |
|---|---|
| **Increase Anadromous Fish Survival** | |
| Dedicated Storage (AF) | 191,000 |
| Production Increase (fish)[1] | 710,000 |
| Spawning Gravel Augmentation (tons)[2] | 10,000 |
| Side Channel Rearing Habitat Restoration | Yes |
| **Increase Water Supply Reliability** | |
| Total Increased CVP/SWP Dry and Critical Year Water Supplies (AF/year)[3] | 77,800 |
| Increased CVP/SWP NOD Dry and Critical Year Water Supplies (AF/year)[3] | 10,700 |
| Increased CVP/SWP SOD Dry and Critical Year Water Supplies (AF/year)[3] | 67,100 |
| Increased Water Use Efficiency Funding | Yes |
| Increased Emergency Water Supply Response Capability | Yes |

**Table 8-3. Summary of Estimated Benefits for the NED Plan (contd.)**

| Item | NED Plan |
|---|---|
| **Reduce Flood Damages** | |
| Increased Reservoir Storage Capacity | Yes |
| **Additional Hydropower Generation**[4] | |
| Increased Hydropower Generation (GWh/year)[5] | 125 - 130 |
| **Conserve, Restore, and Enhance Ecosystem Resources** | |
| Riparian, Floodplain, and Side Channel Habitat Restoration | Yes |
| Increased Ability to Meet Flow and Temperature Requirements along Upper Sacramento River | Yes |
| **Improve Water Quality** | |
| Improved Delta Water Quality | Yes |
| Increased Delta Emergency Response Capability | Yes |
| **Increase Recreation** | |
| Recreation (user days, thousands)[6] | 246 - 259 |
| Modernization of Recreation Facilities | Yes |

Notes:
[1] 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 the RBPP.
[2] Average amount per year for 10-year period.
[3] Total increased CVP and SWP deliveries during dry and critical years (based on the Sacramento Valley Water Year Hydrologic Water Classification). Does not reflect benefits related to water use efficiency actions.
[4] In addition to increased hydropower generation, all comprehensive plans provide increased capacity benefits (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.
[5] Annual increases in hydropower generation were estimated using two methodologies – at load center (accounting for transmission losses) and at-plant (no transmission losses).
[6] Annual recreation visitor user days were estimated using two methodologies.

Key:
- = not applicable
AF = acre-feet
CVP = Central Valley Project
Delta = Sacramento-San Joaquin Delta
GWh/year = gigawatt-hours per year
NED = National Economic Development
NOD = north of Delta
SALMOD = Salmonid Population Model
SOD = south of Delta
SWP = State Water Project

## Feasibility of the National Economic Development Plan

The NED Plan is feasible from technical, environmental, economic, and financial perspectives, as summarized below.

### *Technical Feasibility*

The NED Plan, CP4A, is projected to be technically feasible, constructible, and can be operated and maintained. Designs and cost estimates for CP4A have been developed to a feasibility-level as verified through Reclamation's DEC Review process.

### *Environmental Feasibility*

The NED Plan, CP4A, is included in the accompanying Final EIS. Environmental effects were evaluated and mitigation measures for CP4A were identified. Based on evaluations of environmental benefits and impacts in the

Final EIS, CP4A has been identified as the Preferred Alternative under NEPA because it would best balance and meet both of the primary objectives and maximize benefits relative to costs while protecting the environment (see Chapter 32 of the Final EIS).

### *Economic Feasibility*

CP4A provides the greatest net NED economic benefits of the comprehensive plans and was identified as the NED Plan. CP4A is projected to be economically feasible, generating net benefits of $29.9 million annually, assuming water supply and hydropower costs increase at the same rate as inflation.

### *Financial Feasibility*

An initial allocation of construction costs according to project benefits and the subsequent assignment of costs to reimbursable and nonreimbursable purposes for the NED Plan is shown in Table 8-4. As shown, approximately 51.4 percent of the total construction costs are estimated to be reimbursable and approximately 48.6 percent are estimated to be nonreimbursable.

**Table 8-4. Initial Construction Cost Assignment for NED Plan**

| Purpose/Action | Total | | Cost Assignment[1] | | | |
|---|---|---|---|---|---|---|
| | | | Nonreimbursable | | Reimbursable | |
| | Percent | Cost ($ millions) | Percent | Cost ($ millions) | Percent | Cost ($ millions) |
| Irrigation Water Supply | 8% | 103.8 | 0% | 0.0 | 100% | 103.8 |
| Municipal and Industrial Water Supply | 24% | 303.6 | 0% | 0.0 | 100% | 303.6 |
| Fish and Wildlife Enhancement | 49% | 614.5 | 100% | 614.5 | 0% | 0.0 |
| Hydropower | 19% | 243.6 | 0% | 0.0 | 100% | 243.6 |
| **Total** | 100% | 1,265.5 | 48.6% | 614.5 | 51.4% | 651.0 |

Note:
1 Reimbursable costs are borne by beneficiaries via construction cost sharing, or repaid via rates or repayment contracts. Nonreimbursable costs are costs that cannot be identified for a specific beneficiary group from which costs can be recovered. Nonreimbursable costs are borne by the Federal, state, or local government via tax or bond revenues because the benefits generally accrue to taxpayers.
2 All numbers are rounded for display purposes; therefore, line items may not sum to totals.
Key:
NED = National Economic Development

Based on costs allocated to various project purposes, an initial assessment of financial repayment capability of project beneficiaries was conducted for CP4A. Based on this initial assessment, under CP4A, beneficiaries for irrigation water supply, M&I water supply, and hydropower would have the ability to pay the allocated costs, even considering these beneficiaries would still be repaying the outstanding construction costs of the CVP. To fully recover CP4A costs allocated to irrigation and M&I water supply, these allocated costs could be treated as new construction under existing water service contracts and/or new or amended contracts could be developed with existing CVP and SWP water contractors.

For costs allocated to fish and wildlife enhancement, existing Federal law passed in 1965 provides for either 75% or 100% Federal financing. However, there are many potential beneficiaries, there are more recent cost sharing models, and the Federal budget is constrained. Therefore, it is reasonable to increase the non-Federal share of construction costs allocated to fish and wildlife enhancement.

## Federal Interest

For an action to be implementable, there must be a Federal interest in the action and the action must be feasible, as defined by the P&G. Federal actions must contribute to the NED under the P&G. The NED Plan, CP4A, provides net NED benefits while protecting the environment.

### *Reclamation's Interest*

The Secretary of the Interior delegated the responsibility for development of feasibility studies on enlarging Shasta Dam to Reclamation. Reclamation's interest in the action is based upon the agency's mission: to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public. Implementing the NED Plan would help improve survival of anadromous fish in the upper Sacramento River and reduce chronic water shortages in the State of California in an environmentally and economically sound manner. The economic benefits of implementing the NED Plan exceed the cost when evaluated at the National level. In addition, implementing the project would reduce the adverse effects to existing CVP contractors from dedicating project water to fish and wildlife with the passage of the CVPIA in a least-cost manner.

## Consistency with CALFED and CVPIA

CP4A would contribute to CALFED objectives, including ecosystem quality, water supply reliability, and water quality. CP4A also would be complementary to the objectives of the CVPIA, providing additional increases in anadromous fish survival. The CVPIA identifies actions and programs to mitigate for the impacts for the existing CVP. Although the enhancements (e.g., increases in anadromous fish survival) associated with the NED Plan may precede fulfillment of all CVPIA mitigation activities, these mitigation activities are expected to be completed as required, independent of the enhancements associated with the NED Plan.

## Environmental Compliance and Regulatory Requirements for Project Implementation

The SLWRI Final EIS satisfies NEPA by providing a meaningful analysis of all issues relevant to the human environment. However, implementation of the NED Plan or any other plan authorized by Congress would be subject to additional Federal, State, and local laws, policies, and environmental regulations. All cooperating agencies and other Federal, State, and local agencies with permitting or approval authority over any aspect of project implementation are expected to use the information contained in the Final EIS to meet most, if not all, of their information needs, to make decisions, and/or issue permits with respect to the authorized project. Due to multiple factors, including the ongoing ESA consultation on coordinated long-term operation of the CVP and SWP, a sequenced approach to post-authorization compliance and permitting activities will be needed to meet the proposed project schedule. For example, some compliance and permitting efforts will likely need to proceed for reservoir area construction activities independently from similar efforts required for long-term water operations.

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# Chapter 9
# Considerations and Recommendations

## No Recommendation at This Time

In light of the outstanding considerations articulated below, the Secretary is unable to provide a recommendation for implementation of the SLWRI NED Plan until these considerations are addressed. Although there is no recommendation at this time for Congressional action, all of the alternatives analyzed are feasible from an engineering standpoint. Based on the economic analysis of the alternatives, alternative CP4A has the highest net NED benefits.

## Outstanding Considerations

### Funding Concerns

Current Federal Budget conditions and the impacts those conditions have on Reclamation's budgetary resources significantly constrain Reclamation's ability to fully fund new construction activities of the scope and magnitude required by the SLWRI. As a result, the traditional model under Federal reclamation law, with Congress providing funding from annual appropriations to cover all the costs of construction over a relatively short period of time, and a portion of those funds being repaid to the Treasury over 40 – 50 years, is unrealistic for the identified SLWRI NED Plan. Alternative means of financing (primarily non-Federal) for a majority of the construction costs of the NED Plan would have to be identified and secured in order for the Secretary of the Interior to be able to recommend a construction authorization to Congress. These alternative financing arrangements are being actively explored at a conceptual level.

Significant concerns have been raised by existing CVP water service and repayment contractors regarding water supply benefits from the proposed project being made available to California SWP contractors outside the existing service area of the CVP. In part, their concern emanates from a desire to have water supply developed under any of the alternatives meet existing demands of Federal contractors within the existing CVP service area before being utilized to meet water supply needs of public water agencies that do not currently contract for delivery of CVP water. To address this concern, Reclamation will work with public water agencies that do currently contract for the delivery of CVP water, and other interested governmental and non-governmental organizations to explore alternative, non-traditional methods of financing. The alternative ultimately chosen as the recommended plan will need to be consistent with State water law and include the use of new storage to provide increased cold water protection for anadromous fish in the Sacramento River. Additionally, it should include water supply benefits for those public water agencies that are willing to contribute non-Federal funds for the construction of the project, with preference given to those agencies that are within the existing service area of the CVP.

### State of California Support and Participation

Section 103(d)B(i) of Public Law 108-361 makes clear the intent of Congress that the Secretary consult with the State prior submitting the report. From discussions with the State, it is our understanding there has been a determination that the PRC protecting the McCloud River prohibits State participation in the planning or construction of enlarging Shasta Dam other than participating in technical and economic feasibility studies.

### Environmental Considerations

While the Fish and Wildlife Coordination Act process has been completed through the exchange of comments and responses outlined in an appendix to the EIS, there are listed species under both the Federal and State endangered species laws that may be affected by this action. While it is clear that a consultation under Section 7 of the Federal Endangered Species Act will be required prior to implementation of any alternative, until the financing issues are resolved, it is unclear whether California's endangered species laws and other State environmental statutes will apply. Should any State legal requirements apply, the costs of attaining compliance with these State laws shall be the responsibility of the non-Federal participant.

## Process Considerations and Required Authorities

Prior to a recommendation, the Secretary is of the view that there must be resolution of the outstanding considerations raised. In the absence of a Congressional authorization to the contrary, resolution of these issues could be achieved through an agreement between the Secretary and appropriate non-Federal entities on a specific alternative and how the funding will be provided for that specific alternative. Any such agreement must address: total funding, payment up-front by the non-Federal partner, ability to use the non-Federal funds in the construction process, a plan to meet all environmental commitments, and agreement on the operations of the revised facility and conveyance of the associated water to the intended beneficiary. Such an agreement would then be presented to Congress for authorization.

If Congress were to authorize construction based on an agreement that addresses the Secretary's outstanding concerns, additional technical issues would need to be considered and addressed regarding Federal appropriations and the associated ceiling, treatment of additional operations and maintenance costs, completion of applicable State and Federal permitting actions, and Congressional authorization of required authorities.

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MARCH 3, 1849

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