BUREAU OF RECLAMATION

Final Feasibility Report

North-of-the-Delta Offstream Storage Investigation

Costs to Produce this Report: $5,200,000

U.S. Department of the Interior

December 2020

Mission Statements

The Department of the Interior (DOI) conserves and manages the Nation's natural resources and cultural heritage for the benefit and enjoyment of the American people, provides scientific and other information about natural resources and natural hazards to address societal challenges and create opportunities for the American people, and honors the Nation's trust responsibilities or special commitments to American Indians, Alaska Natives, and affiliated island communities to help them prosper.

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.

Final Feasibility Report

North-of-the-Delta Offstream Storage Investigation, California
Interior Region 10 • California-Great Basin

prepared for Reclamation by AECOM under Contract/Order No. GS-00F-188CA, 140R2018F0052

Cover Photo: Sites Reservoir proposed site (Sites Project Authority)

This page intentionally left blank.

Contents

Appendices

Tables

Figures

This page intentionally left blank.

Executive Summary

This North-of-the-Delta Offstream Storage (NODOS) Investigation (Feasibility Report) evaluates new offstream surface water storage north of the Sacramento-San Joaquin Delta (Delta). Created for the NODOS Investigation, this Feasibility Report presents potential plans to accomplish the Sites Reservoir Project's (Project's) objectives and makes recommendations for further action.

Construction of the Project would be led by the Sites Project Authority (Authority), a joint exercise of powers authority. The Feasibility Report, along with the 2017 Draft Environmental Impact Report/Environmental Impact Statement (EIR/EIS), will be used by the Secretary of the Interior (Secretary) and U.S. Congress to determine both the type and extent of Federal interest in the Project.

Background

The NODOS Investigation would add a new offstream storage facility northwest of Sacramento, California. Sites Reservoir would store water that is diverted from the Sacramento River for later release by beneficiaries throughout the state of California. The reservoir would provide additional water supply for agriculture and municipal and industrial (M&I) purposes, Central Valley Project (CVP) operational flexibility, benefits to anadromous fish, Incremental Level 4 (IL4) water supply for Central Valley Project Improvement Act (CVPIA) refuges, Delta ecosystem enhancement, flood damage reduction, and recreation. In addition to the potential Federal interest, beneficiaries would include the State of California and the membership of other Authority.

NODOS was one of five potential surface water storage projects identified by the CALFED Bay-Delta Program (CALFED). In 2001, the U.S. Department of the Interior, the Bureau of Reclamation (Reclamation), and the California Department of Water Resources (DWR) began appraisal-level studies of the potential for new storage north of the Delta for water supply reliability needs. The appraisal-level studies evaluated reservoirs to as much as 2-million acre-feet (MAF) capacity.

Reclamation was directed by Public Law 108-7 (*Omnibus Appropriations Act of 2003*) to conduct a feasibility-level investigation for NODOS. The Sites Reservoir Project was further developed through public outreach and preparation of draft environmental documentation in accordance with the National Environmental Policy Act (NEPA) and the California Environmental Quality Act (CEQA).

Sites Project Authority

The Authority was formally established on August 26, 2010, as a joint exercise of powers authority in conformance with State law. The Authority will be responsible for constructing, operating, and maintaining the Sites Reservoir Project.

The current Authority membership (nine voting positions with 15 members) consists of Glenn County, Colusa County, Reclamation District 108, Glenn-Colusa Irrigation District (GCID), Tehama-Colusa Canal Authority (TCCA), Maxwell Irrigation District, Colusa County Water District, Westside Water District, Western Canal Water District, TC-4, City of Sacramento/ Sacramento County Water Agency, and Placer County Water Agency / City of Roseville. Reclamation and DWR are non-voting Board members.

Study Area

The Draft EIR/EIS describes three study areas that were developed to evaluate potential Project impacts: the Extended, Secondary, and Primary study areas.

Extended Study Area: The Extended Study Area, consisting of the CVP and State Water Project (SWP) service areas, is the largest and most diverse of the three study areas in terms of size, geography, land use, and habitat conditions. Given that no construction will occur in this study area, it is expected to experience minor effects with respect to changed operations and conditions. Changes in conditions at the CVP and SWP facilities located south of the Delta (including the San Luis Reservoir) are considered within the Extended Study Area. Changes within the CVP and SWP service areas, resulting only from changes in CVP and/or SWP water deliveries, are also considered within the Extended Study Area.

Secondary Study Area: The Secondary Study Area is smaller than the Extended Study Area and consists of the majority of CVP and SWP facilities that could be affected by potential operations associated with certain Project alternatives; this study area has been described and evaluated in the Draft EIR/EIS in more detail than the Extended Study Area. The Secondary Study Area consists of the geographical area with CVP and SWP facilities located north of the Delta and in the Delta, and the streams downstream of the CVP and SWP reservoirs that could experience water surface elevation fluctuations or stream flow changes. Those facilities are located in the following 18 counties: Alameda, Butte, Colusa, Contra Costa, Del Norte, El Dorado, Glenn, Humboldt, Placer, Sacramento, Santa Clara, Shasta, Solano, Sutter, Tehama, Trinity, Yolo, and Yuba. Operational changes could occur as a result of the coordinated and integrated operation of the Project's facilities with State and Federal projects that are located on the American River, Trinity River, Clear Creek, Sacramento River, Sutter Bypass, Yolo Bypass, Feather River, and the Delta.

Primary Study Area: The Primary Study Area is the focus of the resource evaluations in this Feasibility Report and the Draft EIR/EIS. The Primary Study Area includes the areas within Glenn and Colusa counties where short-term and long-term direct and indirect effects from constructing, operating, and/or maintaining the proposed Project facilities may occur.

Problems, Needs, and Opportunities

Water Supply

Water agencies throughout California are susceptible to dry-year deficiencies and are especially vulnerable to droughts. During extended droughts, reduced water availability eventually forces water users to either replace surface water supply by using groundwater, if they have this capability, or

remove agricultural acreage from production (DWR 2005). Additional use of groundwater supplies during droughts may result in adverse impacts, such as reduced groundwater quality or ground subsidence and groundwater overdraft. There is a need for additional water supply to provide drought resilience to local water agencies.

CVP Operational Flexibility

The CVP is operated to meet a variety of project purposes, including providing water for irrigation and domestic uses, fish and wildlife mitigation, fish and wildlife enhancement, and water quality. The CVP has the potential to deliver about 7 MAF annually to agricultural and M&I customers in addition to environmental purposes. California's Federal and State water systems have limited flexibility in timing, location, and capacity to meet the multiple purposes of the projects due to operational and demand constraints. Although the annual delivery capability of 7 MAF exists, actual deliveries have been much lower in recent years. For example, approximately 4.8 MAF were delivered for agricultural and M&I users on average between 2009 and 2014, with a high of 6.1 MAF in 2011 and a low of 2.9 MAF in 2014. There are several factors that have significantly affected the availability of the CVP to store and provide water for contract delivery: Delta pumping constraints; the establishment of three major regulations – the CVPIA, State Water Resources Control Board Decision 1641, and the Reasonable and Prudent Alternatives from the 2008/2009 Biological Opinions on Long-Term Operation of the CVP and SWP; and natural variations in water supply based on annual precipitation. These factors diminished CVP project deliveries to meet Project purposes. Constraints vary annually based on governing conditions that would result in water available for a particular purpose in any year being restricted for that purpose but potentially being available to serve an alternate CVP project purpose.

The Operational Flexibility purpose, according to the Water Infrastructure Improvements for the Nation (WIIN) Act, is defined as the benefit accruing to the Federal Government from an increased ability to allocate additional water supplies through an investment by the United States in a water supply project. The investment would enable the Federal Government to deliver benefits and better meet a project's purposes by increasing the efficiency, reuse, or multiple use of existing supplies or by reducing impacts of regulatory or capacity constraints on an existing Reclamation project.

The NODOS Project would provide additional water to relieve some of the existing operational constraints in the CVP system, and meet obligations under State and Federal law. This would include providing environmental benefits to anadromous fish, refuges, and water quality, as well as CVP yield diversification through new facilities. Operational flexibility water would be part of the CVP allocation, and the scheduling and delivery for any specific purpose would be subject to water right permit conditions and contractual requirements.

IL4 Water Supply to CVPIA Refuges

Section 3406 (d) of the CVPIA requires the Secretary of the Interior to provide firm water supplies of suitable quality to maintain and improve 19 identified wetland habitat areas in the Central Valley of California. Section 3406 (d)(2) directs Reclamation to supplement Level 2 water supplies to the full Level 4, which would enable optimum habitat management to support a broad range of species, including targeted threatened and endangered species. The Reclamation Refuge Water Supply Program (RWSP), created to implement Section 3604 (d) of the CVPIA, is administered by Reclamation and includes a U.S. Fish and Wildlife Service (USFWS) representative. The RWSP is tasked with delivering Level 2 water supplies to the refuges and acquiring and delivering IL4 water

supplies, including the construction of conveyance facilities to provide the capacity to deliver full Level 4 supplies to the refuges. The annual volumes of these acquisitions have varied historically, reflecting funding levels, hydrologic conditions, conveyance capacity to the refuges, and availability of conveyance capacity through the Delta. The RWSP has relied primarily on short-term water purchases and exchanges, and on a few medium- and long-term contracts to meet IL4 requirements; limited amounts of long-term water have been secured due to diminishing supplies and escalating costs. There is a need for additional IL4 water supplies to CVPIA refuges.

Anadromous Fish

Anadromous fish in the Sacramento River watershed are sensitive to water temperature. When California reservoirs are relatively full, the cold water released from the hypolimnion (the cold, non-circulating layer of water that lies below the thermocline in a thermally stratified lake) provides cooler water in the summer to downstream reaches. Since the early 1980s, reservoirs have been drawn down because of increased water demands, resulting in warmer water releases and higher egg mortality rates. The warmer water temperatures have especially harmed winter-run Chinook salmon, which spawn in spring and summer. There is a need for additional cold water to support anadromous fish in the Sacramento River watershed.

Delta Ecosystem Enhancement

Since 2004, monitoring programs in the Delta have documented a decline of several pelagic (open-water) fishes (Delta smelt, longfin smelt, juvenile striped bass, and threadfin shad) in the freshwater portion of the estuary. The decline may have several causes, but reduced food availability is a contributing factor. Additional food resources are needed in the lower Cache Slough and lower Sacramento River areas to sustain Delta smelt and other estuarine-dependent species (e.g., Delta smelt, longfin smelt, Sacramento splittail, starry flounder, and California bay shrimp).

DWR and CDFW performed a pilot study in collaboration with other agencies and farmers in the summer of 2016 that released water into the Delta through a wetland and tidal slough corridor. Monitoring showed that the nutrient-rich "pulse flow" resulted in a phytoplankton bloom and enhanced zooplankton growth and egg production. With the NODOS Sites Reservoir Project there is an opportunity to provide a dedicated source of water to convey water through the wetland and tidal slough corridor to provide a sustainable source of food for Delta species.

Planning Objectives, Constraints, and Considerations

This section discusses the planning objectives, constraints, and considerations specific to the NODOS Investigation.

National Planning Objectives

The Federal objective is defined in the *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* (WRC 1983), which focuses on national economic development. The National Water Resources Policy defined in the *Water Resources Development Act of 2007* (Public Law [P.L.]110-114, Section 2031), also specifies that Federal water resources investments should reflect national priorities, encourage sustainable economic development, and protect people and the natural environment.

Investigation-Specific Planning Objectives

The NODOS Investigation planning objectives were developed based on identified water resources problems, needs, and opportunities in the study area and specific direction in the study authorization. Planning objectives evolved over the course of the study. An initial objective for improvement of Delta Environmental and Export Water Quality was used for the evaluation of initial alternatives, but later refined and replaced with CVP Operational Flexibility and Delta Ecosystem Enhancement. Similarly, an initial secondary objective for sustainable hydropower was later dropped. The objectives for the final, refined analysis of alternatives are described below.

Final Primary Objectives

- **Water Supply:** The NODOS Sites Reservoir Project would provide increased water supply and improve the reliability of water deliveries for municipal, industrial, and agricultural uses, especially during drought conditions.
- **CVP Operational Flexibility:** CVP Operational Flexibility is the benefit accruing to the Federal Government from an increased ability to allocate additional water supplies through an investment by the United States in a water supply project. The investment would enable the Federal Government to deliver benefits and better meet project purposes by increasing the efficiency, reuse, or multiple use of existing supplies or by reducing the impacts of regulatory or capacity constraints on an existing Reclamation project. The NODOS Sites Reservoir Project would provide additional water to relieve some of the existing operational constraints in the CVP system, and meet obligations under Federal and State law. This would include providing environmental benefits to anadromous fish, refuges, and water quality, as well as providing CVP yield diversification through new facilities.
- **Anadromous Fish:** The NODOS Sites Reservoir Project would benefit anadromous fish (including endangered winter-run Chinook salmon) and other aquatic species by improving temperatures in the Sacramento, Feather, and American rivers. Conserving higher storage levels in CVP reservoirs to be used for operational flexibility provides a distinct opportunity for benefits through the preservation of coldwater pools; it also improves downstream water temperature management in Below Normal, Dry, and Critical water years.
- **IL4 Water Supply for CVPIA Refuges[1]:** The NODOS Sites Reservoir Project would provide water that is needed to meet the IL4 refuge water supply demands established in the CVPIA (P.L. 102-575, Title 34). IL4 refuge water supply obligations established by the CVPIA are not being fully met at all refuges.
- **Delta Ecosystem Enhancement[2]:** The NODOS Sites Reservoir Project would enhance the Delta ecosystem by providing water to convey food resources from the floodplain to the Delta, thereby improving the food chain and quality of the Delta's estuarine habitat for use by Delta smelt and other species.

[1] This objective is one of the two ecosystem benefits accepted by the California Water Commission that grants the NODOS Sites Reservoir Project the eligibility for the Water Storage Investment Program funding. The California Department of Fish and Wildlife is the authorized agency to oversee the implementation of this benefit.

[2] This objective is one of the two ecosystem benefits accepted by the California Water Commission that grants the NODOS Sites Reservoir Project the eligibility for the Water Storage Investment Program funding. The California Department of Fish and Wildlife is the authorized agency to oversee the implementation of this benefit.

Final Secondary Objectives

- **Flood Damage Reduction[3]:** The NODOS Sites Reservoir Project would provide an opportunity to reduce flooding in local watersheds.
- **Recreation[4]:** Recreation in the immediate vicinity of the NODOS Sites Reservoir Project would provide opportunities for hiking, fishing, camping, boating, and mountain biking.

Directives and Planning Considerations

Various Federal, State, and local authorizations and directives, as listed below, provide guidance and other considerations specific to the NODOS Investigation, which informed the development of alternatives.

- Title III, Subtitle J, of the 2016 *Water Infrastructure Improvements for the Nation Act* (P.L. 114-322) includes provisions for Federal investments in water storage projects. Section 4007 of the act requires the Secretary of the Interior to determine that a proposed state-led storage project is feasible in accordance with Reclamation laws and secure agreement(s) for upfront funding of the non-Federal share of the capital cost. Under the WIIN Act, the Secretary can participate in up to 25 percent of the total cost of a State-led project, such as the NODOS Sites Reservoir Project. Pursuant to Section 4007(c)(2)(C) of the WIIN Act, the Secretary must find that a proportionate share of the Project's benefits are Federal benefits.
- The objectives for the NODOS Investigation are consistent with the CALFED Programmatic Record of Decision (CALFED 2000a), signed by the Secretary of the Interior, which called for the investigation of new storage north of the Delta.
- The California *Water Quality, Supply, and Infrastructure Improvement Act of 2014* (Proposition 1) provided $2.7 billion for California water supply infrastructure projects and designated the California Water Commission as the State agency responsible for allocating these funds through the Water Storage Investment Program. The Authority applied for funding in August 2017, the California Water Commission made an initial funding decision of up to $816 million towards construction, including $40.8 million in early funding to support preconstruction activities.

Formulation of Alternative Plans

This Feasibility Report and its associated Draft EIR/EIS develop, evaluate, and compare four initial project alternatives (Alternatives A, B, C, and D) to the No Project Alternative. Prior to developing alternatives, a variety of reservoir locations and conveyance options were screened. Each resulting alternative, other than the No Project Alternative, addresses in varying degrees all of the NODOS planning objectives. The alternatives are the culmination of the plan formulation process (see Appendix A) and numerous studies, and the alternatives span the range of facilities and actions needed to support the goals and objectives, and the Federal decision making. The lead agencies may need to consider variations on these alternatives for permits and project construction. Should

[3] This objective is one of the public benefits accepted by the California Water Commission under the Water Storage Investment Program funding.
[4] This objective is one of the public benefits accepted by the California Water Commission under the Water Storage Investment Program funding.

alternative facilities, operations, or alternatives be developed, a post-authorization report would be needed to confirm benefits and costs.

No Project Alternative

The No Project Alternative provides a basis of comparison for evaluating the potential benefits, and effects of the alternative plans.

Cooperative Operations for Project Alternatives

All project alternatives were developed to improve the operational flexibility of the California water system (CVP, SWP, and systems operated by local water agencies). The benefits from Sites Reservoir (Figure ES-1) could be appreciably enhanced through cooperative operations with Shasta Lake to conserve the cold water stored in Shasta Lake throughout the summer and to support appropriate water temperatures in the Sacramento River during summer months, especially in drought years. This would be accomplished by using water stored in Sites Reservoir to conserve water in Shasta Lake for the benefit of anadromous fish. The water would be released from Sites Reservoir to meet Reclamation's environmental obligations and a portion of the CVP contract obligations in lieu of releases from Shasta Lake (CVP water deliveries would be made to CVP contractors downstream of Sites Reservoir in accordance with their existing CVP contracts). This would conserve water in Shasta Lake, allowing the coldwater pool to be maintained at higher levels than would be achievable without cooperative operations. Similar benefits could be achieved through cooperative operations with Folsom Lake (and Lake Oroville in the SWP). The cooperative operations would be implemented through the coordination of water rights and contractual foundations in partnership with the Authority, Reclamation, and DWR.

Initial Alternatives

Small Reservoir with New Diversion (Initial Alternative A)

Alternative A is a 1.3-MAF reservoir with a new intake (2,000 cubic feet per second [cfs]) on the Sacramento River (Delevan Intake). Alternative A operations would deliver water for agricultural and M&I purposes (with approximately 82 percent exported), Delta Environmental and Export Water Quality, Anadromous Fish benefits, and IL4 Water Supply for CVPIA Refuges.

This reservoir would require six saddle dams and two main dams (i.e., Sites Dam and Golden Gate Dam). Water would be diverted to fill the reservoir using the Tehama-Colusa Canal, GCID Main Canal, and Delevan Pipeline. The Delevan Intake Pumping/Generating Plant would be a new screened intake on the Sacramento River capable of pumping up to 2,000 cfs, and releasing up to 1,500 cfs back to the river.

Large Reservoir with Existing Diversions (Initial Alternative B)

Alternative B is the same as Alternative A, but has a 1.8-MAF reservoir, and it does not include a new intake on the Sacramento River. Alternative B operations would deliver water for agricultural and M&I supply (with approximately 90 percent exported), Delta Environmental and Export Water Quality, Anadromous Fish benefits, and IL4 Water Supply for CVPIA Refuges. The reservoir would require nine saddle dams and two main dams (i.e., Sites Dam and Golden Gate Dam). The main dams would be larger than they are under Alternative A.

Figure ES-1. Setting for NODOS Feasibility Study

The Delevan Pipeline would allow the release of up to 1,500 cfs back to the Sacramento River. The Delevan Intake Pumping/Generating Plant is not included in this alternative. With only the two existing diversions, it would be more difficult to fill the reservoir than it would be for the other project alternatives, which have three diversions. No new electric power transmission lines to the Delevan Pipeline release structure would be needed.

Large Reservoir with New Diversion (Initial Alternative C)

Alternative C (Figure ES-2) is the same as Alternative A, except that it uses a 1.8-MAF reservoir. Alternative C operations would deliver water for agricultural and M&I purposes (with approximately 84 percent export), Delta Environmental and Export Water Quality, Anadromous Fish benefits, and IL4 Water Supply for CVPIA Refuges. The larger reservoir under this alternative would require more saddle dams than are needed for Alternative A. The main dams (i.e., Sites Dam and Golden Gate Dam) would also be larger under this alternative than they are under Alternative A.

The Delevan Pipeline Intake Pumping/Generating Plant would include a new screened intake capable of pumping up to 2,000 cfs from the Sacramento River and releasing up to 1,500 cfs back to the river.

Local Alternative, including Large Reservoir with New Diversion (Initial Alternative D)

Alternative D (Figure ES-2) has been developed by the Authority. The facilities in this alternative are identical to those for Alternative C, except that the power transmission lines to the Delevan Pipeline Intake Pumping/Generating Plant have a different alignment; there are two recreation areas instead of three; and the Terminal Regulating Reservoir (TRR) is smaller. The operations are significantly different, with more Sites Reservoir Project water retained in the north and less exported south of the Delta.

Alternative D operations would deliver water for agricultural and M&I purposes (with approximately 36 percent of the water delivered for agricultural purposes in the Sacramento Valley, and the remainder exported), Delta Environmental and Export Water Quality, Anadromous Fish benefits, and IL4 Water Supply for CVPIA Refuges.

Alternative D would have a 1.8-MAF storage capacity. The larger reservoir would require more saddle dams than are needed for Alternative A, and the Sites Dam and Golden Gate Dam are larger than they are for Alternative A as well. Water would be diverted to fill the reservoir using the Tehama-Colusa Canal, GCID Main Canal, and the Delevan Pipeline. The Delevan Pipeline Intake Pumping/Generating Plant facilities would include a new screened intake capable of pumping up to 2,000 cfs from the Sacramento River and releasing up to 1,500 cfs back to the river. Transmission lines to the Delevan Pipeline Intake Pumping/Generating Plant would have a south-to-north alignment to bring power from the existing transmission lines near the city of Colusa.

Ownership

The Authority would own and operate Sites Reservoir, the TRR, the Delevan Pipeline, any forebay/afterbay facilities excluding Funks Reservoir, and the three new pumping/generating plants (Sites, TRR, and Delevan Intake).

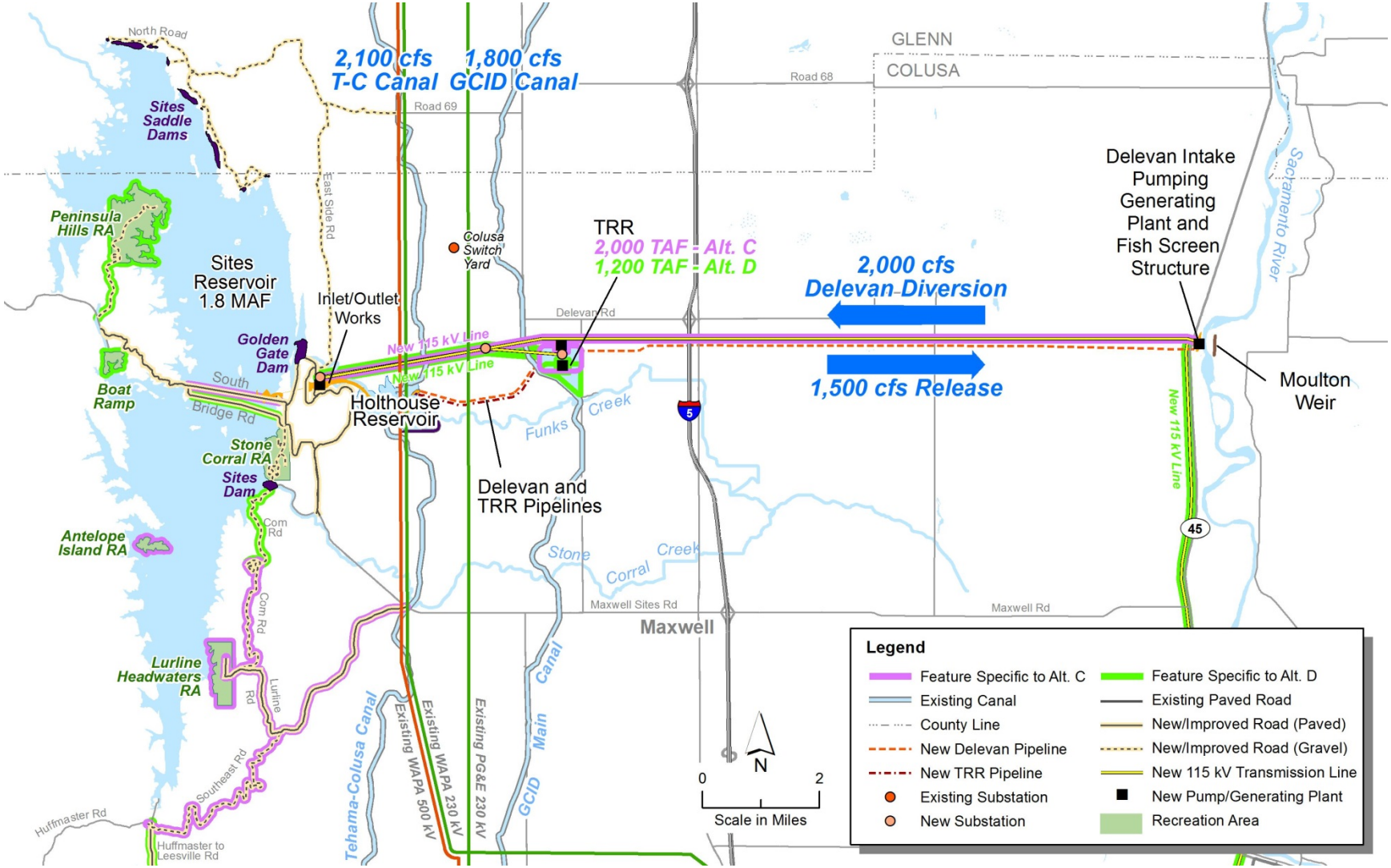


Figure ES-2. Features of Sites Reservoir Project Initial Alternatives C and D

Physical Accomplishments of Initial Alternatives

The Sites Reservoir Project would offer several benefits to society and the environment. The proposed operations will provide more flexibility to the CVP and SWP in their operations. Table ES-1 is a summary of the accomplishments of the alternatives with the initially modeled operations.

Water Supply

All of the alternatives except for the No Project Alternative would meet the planning objective and improve water supply and water supply reliability. Sites Reservoir would provide a supplemental water supply for the agencies participating in the project. Alternative D provides the highest Average long-term annual delivery increases (255 thousand acre-feet [TAF]) and Dry and Critical year increases (418 TAF) due to a greater operational focus on water supply.

Deliveries are estimated at the point of use based on CALSIM modeling. Alternative C (similar facilities to Alternative D, but operated differently) would provide the second-highest overall water supply deliveries. Alternative A (smaller reservoir) and Alternative B (only two intakes) would provide less water for water supply purposes.

The four project alternatives would also improve storage (see Figure ES-3), both in Sites Reservoir and in existing CVP reservoirs, which would increase the operational flexibility of the system. Increased storage in existing CVP reservoirs would be operationally achieved by using water in Sites Reservoir to fulfill CVP obligations. This would increase the resilience of the CVP to drought and provide Central Valley Operation (CVO) with an increased ability to meet critical water supply and environmental needs. Water conserved in CVP reservoirs would improve the coldwater pool and serve a water-quality purpose (improving temperature) when released from CVP reservoirs. Through operational flexibility, Sites Reservoir would be functionally integrated with the CVP in that the water stored in and delivered from Sites Reservoir would be for CVP places of use and CVP obligations under Reclamation water rights and biological requirements.

Figure ES-3 shows the potential/estimated storage increases for the long-term Average and Critical (driest) periods in CVP reservoirs for the four project alternatives. This increase in storage at the Folsom, Oroville, and Shasta reservoirs would be achieved through in lieu deliveries from Sites Reservoir.

The additional storage (800 to 1,600 TAF) could significantly increase the ability to respond to system needs and provide for greater flexibility in system operations.

Figure ES-4 shows how the benefits would be delivered. Storage and deliveries for CVP Operational Flexibility would be provided from Sites Reservoir, and benefits (including south-of-Delta benefits) would be realized throughout the CVP system.

IL4 Water Supply to CVPIA Refuges

Water has been purchased (an average of approximately 50 TAF per year) and acquired through exchange to provide IL4 refuge water supplies for optimum habitat management at CVPIA refuges. As modeled, the project alternatives show a significant ability to provide water—ranging from a long-term average of 44 TAF under Alternative A to 74 TAF under Alternative C. The model assumed all water would be conveyed through the Banks Pumping Plant. The ability to provide IL4 refuge water supply is reduced in Dry and Critical years (22 to 37 TAF could be provided).

Table ES-1. Increased Long-Term and Dry/Critical Year Deliveries for Initial Alternatives

Objectives and Accomplishments (above No Project Alternative conditions) [a]	Alternative A		Alternative B		Alternative C		Alternative D	
	Average (TAF)	Dry and Critical[1] (TAF)	Average (TAF)	Dry and Critical[1] (TAF)	Average (TAF)	Dry and Critical[1] (TAF)	Average (TAF)	Dry and Critical[1] (TAF)
Alternative Facilities	1.3 MAF Reservoir New Intake		1.8 MAF Reservoir No New Intake		1.8 MAF Reservoir New Intake		1.8 MAF Reservoir New Intake	
Alternative Operation	Export Focus		Export Focus		Export Focus		Sac Valley Focus	
Supplemental Deliveries in SWP Service Area[2]	**122**	**267**	**130**	**248**	**134**	**291**	**116**	**228**
NOD Ag	0	2	0	1	-1	-3	1	4
NOD M&I	1	2	1	2	1	3	1	2
SOD Ag	30	57	34	55	36	67	28	51
SOD M&I	91	206	95	190	98	224	86	171
Supplemental Deliveries in CVP Service Area[2]	**47**	**67**	**11**	**22**	**38**	**55**	**109**	**190**
NOD Ag	19	28	12	14	25	30	97	169
NOD M&I	2	1	0	0	2	1	1	0
SOD Ag	25	37	-1	8	10	22	11	21
SOD M&I	1	1	0	0	1	1	0	0
Sub-Total Deliveries for Water Supply[2]	**169**	**334**	**141**	**270**	**172**	**346**	**225**	**418**
IL4 Water Supply for CVPIA Refuges[2]	44	22	72	37	74	37	48	23
Water supply for Delta environmental water quality/salmonid improvement [b]	212	208	216	217	243	255	174	162
Sub-Total Deliveries for Environmental Benefits[2]	**256**	**230**	**288**	**254**	**317**	**292**	**222**	**185**
Total Deliveries[2]	**425**	**564**	**429**	**524**	**489**	**637**	**446**	**604**
Additional end-of-September storage in Shasta (TAF)	101	139	106	180	108	175	132	198

Notes: Totals may not sum exactly due to rounding

[1] Dry years occur in 22% and Critical years in 15% of all years for a combined frequency of 39% of all years.

[2] All deliveries are to point of use and exclude carriage water and conveyance losses (i.e., deliveries and not equal to releases from Sites Reservoir).

[a] Increases in deliveries above the No Project Alternative, including supplies for agriculture, M&I, and environmental purposes. Dry and Critical period average is the average quantity for the combination of the SWRCB's D-1641 40-30-30 Dry and Critical years for the period October 1921 to September 2003. The "Average (TAF)" is for this period.

[b] Releases from Sites Reservoir to the Delta solely for environmental benefit. This quantity excludes any water released for export or carriage water requirements. No specific releases were dedicated to water quality improvements for M&I or agriculture.

Source: Water Rights Decision 1641 Revised (SWRCB 2000).

Ag = agriculture
CVP = Central Valley Project
IL4 = Incremental Level 4
M&I = municipal and industrial
MAF = million acre-feet
NOD = north of the Delta
SOD = south of the Delta
SWP = State Water Project
SWRCB = State Water Resources Control Board
TAF = thousand acre-feet

Ag = agriculture
CVP = Central Valley Project
IL4 = Incremental Level 4
M&I = municipal and industrial
MAF = million acre-feet
NOD = north of the Delta
SOD = south of the Delta
SWP = State Water Project
SWRCB = State Water Resources Control Board
TAF = thousand acre-feet

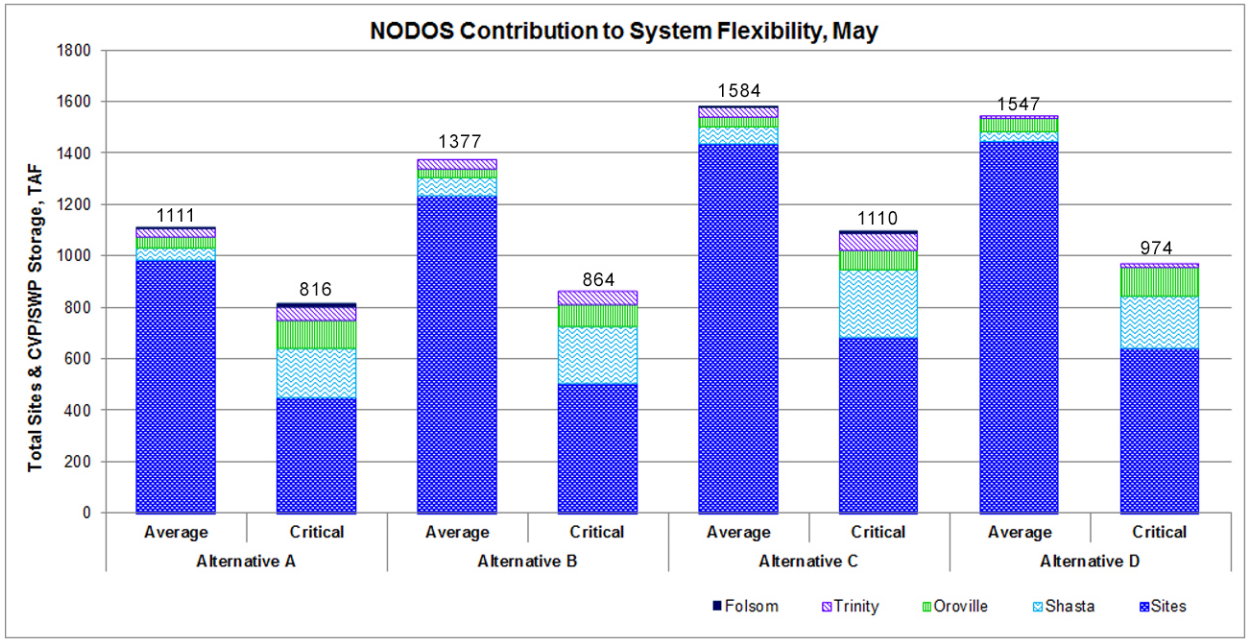


Figure ES-3. Increases Above the No Project Alternative in Average System Storage

Anadromous Fish

The Sites Reservoir Project provides additional flexibility to support CVP operations to deliver flows of suitable quality, quantity, and timing to protect all life stages of anadromous fish, consistent with CVPIA Section 3406(b)(1)(B). The coldwater pool benefits described in this Feasibility Report for anadromous fish are contingent on conservation of water in CVP reservoirs for operational flexibility with late summer/fall delivery. All project alternatives would improve conditions that support population increases of anadromous fish, including endangered winter-run Chinook salmon. Figure ES-4 shows a conceptual model of the benefits from Sites Reservoir, including how the potential benefits to fish would be derived from Project operations.

Delta Environmental and Export Water Quality

Releases from Sites Reservoir (ranging from average releases of 174 to 243 TAF per year, depending on the alternative) could be used to augment flows through the Delta (see Table ES-1).

Sustainable Hydropower

Hydropower could be generated when water is released from Sites Reservoir or could be generated through pumpback operations. This energy recovery operation would offset the cost of pumping, and modeling results suggest that the revenues generated would be greater than the energy costs.

Recreation

New facilities would be developed on the shore of the Sites Reservoir to support recreational activities (e.g., camping, hiking, picnicking, and sightseeing).

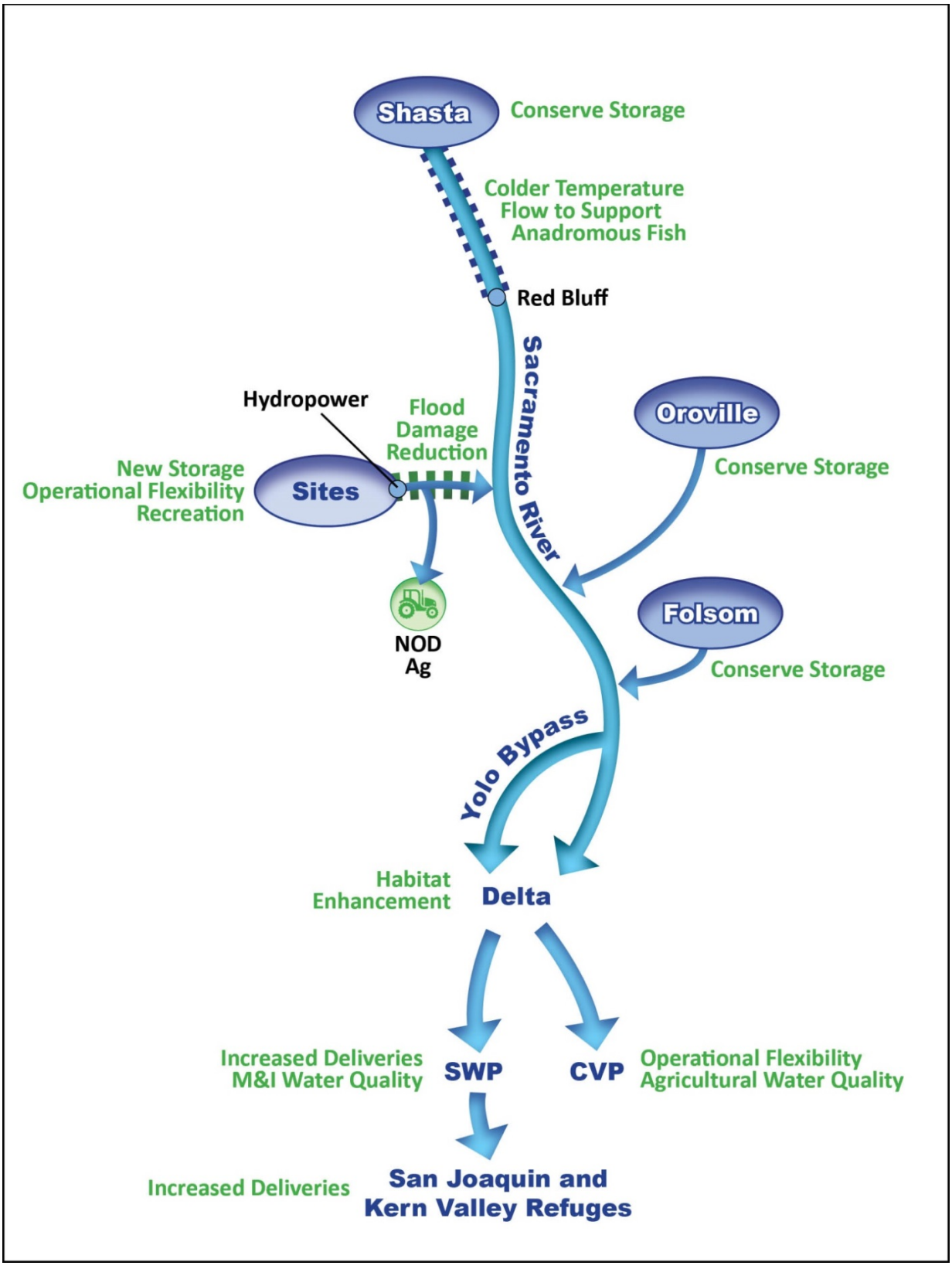


Figure ES-4. Conceptual Model of Benefits

Flood Damage Reduction

Of the 22,200 acres of land prone to flooding in these watersheds, approximately 43 percent (9,570 acres) would experience a reduction in flood-related damages during a 100-year flood event. This area includes the northern portion of the town of Maxwell, Interstate Highway 5 (I-5), and the adjacent railroad (the primary rail line on the western side of the Sacramento River Valley).

Estimated Benefits and Costs for Initial Alternatives

Annualized benefits for each project alternative are summarized in Table ES-2. Alternative C has the highest National Economic Development (NED) benefits due to higher deliveries for water supply. The benefit-cost ratio (BCR) for Alternative C is estimated to be 1.13. Alternative A has the second-highest total NED benefits. The BCR for Alternative A is estimated at 1.11. Alternative D has the lowest total NED benefits and BCR. It should be noted that although Alternative C has the highest NED benefits, this is attributed to an operation with the highest deliveries of any alternative for Southern California urban water supply. The Authority has not been able to find investors in Southern California to subscribe for this magnitude of water supply.

Table ES-2. Summary of Estimated Annual NED Benefits for Sites Reservoir Project Initial Project Alternatives ($ million/yr, 2019)

Beneficiary	Alternative A	Alternative B	Alternative C	Alternative D
Water Supply	$130.1	$125.3	$139.3	$129.2
Agricultural Supply [a]	$15.2	$8.6	$14.2	$22.7
M&I Supply [b]	$114.9	$116.7	$125.0	$106.5
IL4 Water Supply to CVPIA Wildlife Refuges [c]	$25.3	$40.2	$42.3	$26.9
Anadromous Fish [d]	$45.8	$33.5	$37.0	$48.3
Delta Environmental and Export Water Quality [e]	$65.5	$70.5	$80.7	$45.3
Sustainable Hydropower Generation [f]	$20.3	$14.5	$23.5	$21.5
Recreation [g]	$2.4	$2.4	$2.5	$2.5
Flood Damage Reduction [h]	$4.6	$4.6	$4.6	$4.6
Total Annual Benefits	**$294.1**	**$290.9**	**$330.0**	**$278.4**

Note: Annual benefits shown in 2019 dollars based on 2.75% discount rate and a 100-year period of analysis. Totals may not sum exactly due to rounding.

[a] Market-based estimates of cost for water transfers to NOD and SOD agricultural users
[b] Market-based estimates of cost for water transfers to NOD and SOD municipal and industrial water agencies
[c] Market-based estimates of cost for water transfers to NOD and SOD CVPIA refuges
[d] Cost of Most Likely Alternative for environmental benefits from Shasta Lake Water Resources Investigation
[e] Change in net income valuation of water deliveries for environmental, agricultural and M&I water quality improvements.
[f] Market-based estimates of power cost and revenues from pumpback hydropower operations
[g] Visitation day-based estimates using recreation data and Rosenberger 2016 unit day values for recreation
[h] Market-based estimates of avoided annual expected damages from flooding

$ million/yr = million dollars per year
CVPIA = Central Valley Project Improvement Act
IL4 = Incremental Level 4
M&I = municipal and industrial
NED = National Economic Development
NOD = North-of-the-Delta
SOD = South-of-the Delta

Potential Environmental Effects of Initial Alternatives

The Draft EIR/EIS describes the environmental setting; identifies the potential direct, indirect, and cumulative impacts that could result from implementation of each of the proposed project alternatives; and proposes mitigation measures for impacts found to be significant. Twenty-one resource areas were evaluated in the report. Significant and unavoidable impacts were identified for seven resource areas (terrestrial biological resources, aquatic biological resources, paleontological resources, historical and tribal resources, land use, air quality, and climate change/greenhouse gas emissions). Twenty-five Federally listed and State-listed species were identified in the Primary Study Area. The Record of Decision for the Sites Reservoir Project will not be completed until after the receipt of all permits and the publication of the Final EIR/EIS.

Final Alternatives

Following the review of the initial alternatives, the operations of the alternatives were further refined to capture the evolving nature of the NODOS Project. The project objectives that were initially developed were modified for consistency with the Water Storage Investment Program (WSIP) findings by the State. A Delta Ecosystem Enhancement objective was added to the project. No WSIP funds were awarded by the State for the water quality objective, making it difficult to assign the costs. There was also a concern regarding whether the modeled operations in the Delta during the WSIP process would be realized. As a result, the water quality objective was removed.

Furthermore, with the adoption of the amended Coordinated Operation Agreement (COA) and the 2019 Biological Opinions (BiOps), the operational and regulatory environment changed significantly during the course of this evaluation These new regulatory requirements were incorporated into the model for refined alternatives.

In addition, a decision was made to evaluate CVP Operational Flexibility as a project objective, consistent with all ongoing surface storage studies underway within Reclamation. Furthermore, the costs of pumpback storage were high compared to the benefits generated. Pumpback facilities were removed from the refined alternatives (this modification to the alternatives should be reassessed if the energy market changes).

Due to the extent of changes subsequent to the initial alternatives evaluation, it was deemed necessary to refine the alternatives and model with the refinements to assess the benefits for Alternatives A1 and D1. These alternatives have the same facilities, except for pumpback capability, as Alternatives A and D, respectively, but the operations have been altered to incorporate the refined project objectives. This analysis also provided an opportunity to incorporate the updated COA and 2019 BiOps into the model.

CVP Operational Flexibility would enhance the CVP's ability to meet CVP demands in an ever-changing environment. CVP Operational Flexibility under the WIIN Act is defined as the benefit accruing to the Federal Government from an increased ability to allocate additional water supplies through an investment by the United States in a water supply project. The investment would enable the Federal Government to deliver benefits and better meet project purposes by increasing the efficiency, reuse, or multiple use of existing supplies or by reducing the impacts of regulatory or capacity constraints on an existing Reclamation project. This would include providing environmental benefits to anadromous fish, refuges, and water quality, as well as restoration of CVP deliveries that

have been lost due to regulatory changes. Water from the CVP Operational Flexibility purpose would be allocated by Reclamation to any of Reclamation's authorized purposes based on need and the operational ability to fulfill that need.

Reclamation's CVO office would determine how water gained through CVP Operational Flexibility is used to meet CVP purposes. For the Sites Reservoir Project, in lieu releases of water from Sites Reservoir will enable the conservation of water stored in CVP reservoirs (i.e., Shasta and Folsom reservoirs). This water can then be used at a later time for a variety of purposes; in many instances, it may serve multiple purposes as it flows downstream. Purposes include the following:

- Restoring CVP yield
- Enhancing flows to improve habitat conditions and in-river rearing for juvenile salmonids
- Maintaining flows and ramping rates to minimize dewatering of redds and prevent stranding of juveniles
- Increasing attraction flows during upstream migration to reduce straying
- Maintaining groundwater and surface water interconnections to support groundwater-dependent ecosystems
- Enhancing flow to improve the quantity and quality of riparian and floodplain habitats
- Providing water for seasonal wetlands (e.g., inundated rice fields for migrating waterfowl north of the Delta) for the benefit of wildlife
- Enhancing access to fish spawning, rearing, and holding habitat (e.g., improving access to habitat in the bypasses)

Water delivered for the CVP Operational Flexibility purpose may be used downstream or for any CVP purpose.

Through CVP operational flexibility simulated in refined alternatives, dedicated CVP storage in Sites Reservoir would be functionally integrated with the CVP in that the water stored in and delivered from Sites Reservoir would be for CVP places of use and CVP obligations under Reclamation water rights and biological requirements.

The deliveries and other performance metrics for the refined alternatives are summarized in Table ES-1.

The refined Project objectives and operations have been better vetted through the WSIP process and with the Authority's investors. Refined alternative modeling also incorporates the updated COA and 2019 BiOps to better reflect current conditions. Alternative A1 has slightly higher net NED benefits and is the NED Plan. It also has a slightly higher BCR. The BCR for Alternative A1 is 1.07, and the BCR for Alternative D1 is 1.06.

Table ES-3 is a summary of the NED benefits estimated from the sensitivity modeling effort.

Table ES-3. Summary of Estimated Annual NED Benefits for Sites Reservoir Project Final Alternatives ($ million/yr, 2018)

Beneficiary	Alternative A1	Alternative D1
Water Supply	$138.6	$161.7
Agricultural Supply [a]	$15.4	$16.2
M&I Supply [b]	$123.2	$145.4
CVP Operational Flexibility [c]	$47.1	$48.4
IL4 Water Supply for CVPIA Refuges [d]	$19.6	$20.7
Anadromous Fish [e]	$14.4	$18.0
Delta Ecosystem Enhancement [f]	$16.7	$14.5
Recreation [g]	$2.4	$2.5
Flood Damage Reduction [h]	$4.6	$4.6
Total Annual Benefits	**$243.5**	**$270.4**

Notes: Annual benefits shown in 2019 dollars based on 2.75% discount rate and a 100-year period of analysis. Totals may not sum exactly due to rounding.

[a] Combined market-based and change in net income valuations of water transfers/deliveries to NOD and SOD agricultural users

[b] Change in net income valuation of deliveries to SOD municipal and industrial water agencies

[c] Combined market-based and change in net income valuations of water transfers/deliveries to NOD and SOD CVP agricultural users and change in net income valuation of deliveries to NOD and SOD municipal and industrial water agencies

[d] Combined market-based and change in net income valuations of water transfers/deliveries to NOD and SOD CVPIA refuge.

[e] Cost of Most Likely Alternative for environmental benefits from Shasta Lake Water Resources Investigation

[f] Combined market-based and change in net income valuations of NOD water transfers/deliveries to the Yolo Bypass

[g] Visitation day-based estimates using recreation data and Rosenberger 2016 unit day values for recreation

[h] Market-based estimates of avoided annual expected damages from flooding

$ million/yr = million dollars per year
CVP = Central Valley Project
CVPIA = Central Valley Project Improvement Act
IL4 = Incremental Level 4
M&I = municipal and industrial
NED = National Economic Development

Table ES-4 is a summary of the Project costs.

Table ES-4. Summary of Final Alternative Costs (cost in $ millions)

Parameter	Alternative A1	Alternative D1
Construction Cost to Midpoint of Construction	$5,792	$6,552
Total Capital Cost [1]	$6,510	$7,365
Annual OM&R Cost	$41.4	$44.3
Annual Cost [2]	$228	$255

[1] Total capital cost shown for April 2019 price level

[2] Includes both capital amortization and annual OM&R costs

$ millions = millions of dollars
OM&R = operation, maintenance, and replacement

Project Feasibility

Technical Feasibility

Alternatives A1 and D1 are constructible, and can be operated and maintained.

A Design, Estimate, and Constructability Cost (DEC) review evaluated the engineering and costs basis for this report in April 2020. The review found that the risks and uncertainties associated with the NODOS Project have been mitigated to reflect a feasibility level for designs and cost estimates.

Future work is planned for pre-construction to further reduce risk and uncertainty. The work includes further geotechnical investigation, engineering design, water rights, permitting of diversions, and operations.

Environmental Feasibility

The Draft EIR/EIS evaluated the potential direct, indirect, and cumulative impacts that could result from implementation of each of the proposed project alternatives, and proposes mitigation measures for impacts found to be significant. Twenty-one resource areas were evaluated in the report. Significant and unavoidable impacts were identified for seven resource areas (terrestrial biological resources, aquatic biological resources, paleontological resources, historical and tribal resources, land use, air quality, and climate change/greenhouse gas emissions). The environmental feasibility of implementing the project alternatives is evaluated in the Draft EIR/EIS, which is incorporated into this document by reference. Implementation of the NED Plan (Alternative A1) is considered environmentally feasible, pending the completion of the Final EIR/EIS.

Economic Feasibility

The relative accomplishments of Alternatives A1 and D1 are summarized in

Table ES-5 and the benefits are summarized in Table ES-3. The economic feasibility is evaluated to confirm that constructing and operating the project would result in positive net NED benefits. Alternative A1 provides the greatest net NED benefits, and was identified as the NED Plan. Alternatives A1 and D1 are economically feasible. Alternative A1 would generate $15.5 million in net NED benefits per year.

Alternate valuation methods and sensitivity analyses (provided in Appendix C – Economic Analysis) demonstrate that, overall, the estimated economic benefits values and assumptions are reasonable.

Financial Feasibility

Financial feasibility determination during the planning stage consists of (1) allocating costs to project purposes, (2) assigning Federal and non-Federal 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 operations, maintenance, and replacement costs.

Table ES-6, Table ES-7, and Table ES-8 summarize the allocation and assignment of the Alternative A1 construction cost (construction and Interest During Construction [IDC]) and operation, maintenance, and replacement (OM&R) costs to the Federal Government and the non-Federal partners. Table ES-9, Table ES-10, and Table ES-11 provide similar information for Alternative D1.

Table ES-5. Summary of Relative Accomplishments of Final Alternatives
(Refined Alternative Analysis with Updated COA and 2019 BiOps)

Purposes and Accomplishments (above No Project Alternative Conditions)	Alternative A1 1.3 MAF New Intake		Alternative D1 1.8 MAF New Intake	
	Average	Dry and Critical	Average	Dry and Critical
Deliveries for CVP Operational Flexibility (TAF)	69	87	73	114
Deliveries for Water Supply (M&I and agricultural purposes) (TAF) [a]	116	248	131	289
Deliveries for IL4 Water Supply to CVPIA Refuges (TAF)	32	44	34	48
Deliveries for Delta Ecosystem Enhancement (TAF)	57	44	51	33
Total (TAF)	274	423	289	484
Shasta Coldwater Pool – Average end-of-September in TAF	138		164	
Anadromous Fish – Chinook Fish Production (Habitat Units from SALMOD Model)[b]	214		268	
Sacramento River Critical year Temperature Improvement at Keswick (°F)	-1.3		-1.7	
Number of Recreation Sites	2		2	
Flood Damage Reduction (acres)	9,570		9,570	
Long-Term Direct and Indirect Jobs Created	49		56	
Short-Term Direct, Indirect, and Induced Jobs Created	453		496	
Construction Cost to Midpoint of Construction ($ millions)	$5,792		$6,552	
Total Capital Cost ($ millions)[c]	$6,510		$7,365	
Annual OM&R ($ million/yr)	$41.4		$44.3	
Annual Cost ($ million/yr)[d]	$228		$255	
Annual NED Benefits ($ million/yr)	$243		$270	
Net Annual NED Benefits ($ million/yr)	$15.5		$15.0	
BCR	1.07		1.06	

Notes:

[a] Water supply increases above the No Project Alternative, including supplies for agriculture and M&I. Deliveries are estimated at the point of use. Dry and Critical period average is the average quantity for the combination of the SWRCB D-1641 40-30-30 Dry and Critical years for the period of October 1921 through September 2003. Average annual is for the period of October 1921 through September 2003.

[b] Increase in production (SALMOD model) when compared to the No Project Alternative.

[c] Total capital cost shown for April 2019 price level

[d] Including both capital amortization and OM&R costs

°F = degrees Fahrenheit
$ millions = millions of dollars
$ million/yr = million dollars per year
BCR = benefit-cost ratio
BiOps = biological opinions
COA = Coordinated Operation Agreement
CVP = Central Valley Project
CVPIA = Central Valley Project Improvement Act
D-1641 = Water Rights Decision 1641 Revised (SWRCB 2000)
IL4 = Incremental Level 4
M&I = municipal and industrial
MAF = million acre-feet
NED = National Economic Development
OM&R = operation, maintenance, and replacement
SALMOD = a computer model that simulates the dynamics of freshwater salmonid populations
SWRCB = State Water Resources Control Board
TAF = thousand acre-feet

Table ES-6. Summary of Initial Cost Allocation by Project Purpose for Alternative A1

	Water Supply	CVP Operational Flexibility	Anadromous Fish	IL4 Water Supply to CVPIA Refuges	Delta Ecosystem Enhancement	Recreation	Flood Damage Reduction	Total
Total Construction Costs ($ million/yr)	$3,238	$1,156	$483	$363	$421	$64	$71	$5,794
(% of total)	55.%	20.0%	8.3%	6.3%	7.3%	1.1%	1.2%	100%
Total Annual OM&R Costs ($ million/yr)	$26.6	$7.1	$2.9	$1.9	$2.2	$0.4	$0.4	$41.4
(% of total)	64.3%	17.3%	6.9%	4.5%	5.2%	0.9%	0.9%	100%

Note:
General: April 2019 price levels. Annualized construction costs shown in 2019 dollars based on 2.75% discount rate and a 100-year period of analysis. Totals may not sum exactly due to rounding.
$ million/yr = million dollars per year
CVP = Central Valley Project
CVPIA = Central Valley Project Improvement Act
IL4 = Incremental Level 4
OM&R = operation, maintenance, and replacement

Table ES-7. Construction Cost Assignment: Alternative A1

Purpose/Project	Total Percent	Total Cost	Cost Assignment ($ millions)			
			Federal		Non-Federal Partners[a]	
			Percent	Cost	Percent	Cost
Alternative A1: Construction Cost Assignment – Nominal Value						
Anadromous Fish	6.3%	$363	80.0%	$290	20.0%	**$73**
CVP Operational Flexibility	20.0%	$1,156	100%	$1,156		
Water Supply	55.9%	$3,238			**100%**	$3,238
M&I Water Supply	*88.9%*	*$2,878*			***100%***	*$2,878*
Agricultural Water Supply	*11.1%*	*$360*			***100%***	*$360*
Delta Ecosystem Enhancement	7.3%	$421			**100%**	**$421**
IL4 Water Supply for CVPIA Refuges	8.3%	$483			**100%**	$483
Recreation	1.1%	$64			**100%**	**$64**
Flood Damage Reduction	1.2%	$71			**100%**	**$71**
Total	**100%**	**$5,794**	**25.0%**	**$1,446**	**75.0%**	**$4,348**

Note:

[a] Includes State and Authority members' paid funding.
Sub-allocations between M&I and agricultural use are based on relative benefits. Totals may not sum exactly due to rounding.
$ millions = millions of dollars
CVP = Central Valley Project
CVPIA = Central Valley Project Improvement Act
IDC = interest during construction
IL4 = Incremental Level 4
M&I = municipal and industrial

Table ES-8. Annual OM&R Cost Assignment: Alternative A1

Purpose/Project	Total Annual Percent	Total Annual Cost	Cost Assignment ($ millions per year)			
			Federal		Non-Federal Partners[a]	
			Percent	Cost	Percent	Cost
Alternative A1: OM&R Cost Assignment – Annual						
Anadromous Fish	4.5%	$1.9			100%	$1.9
CVP Operational Flexibility	17.3%	$7.1	100%	$7.1		
Water Supply	64.3%	$26.6			100%	$26.6
M&I Water Supply	*92.2%*	*$24.5*			*100%*	*$24.5*
Agricultural Water Supply	*7.8%*	*$2.1*			*100%*	*$2.1*
Delta Ecosystem Enhancement	5.2%	$2.2			100%	$2.2
IL4 Water Supply for CVPIA Refuges[b]	6.9%	$2.9	9.9%	$0.3	90.1%	$2.6
Joint		*$2.5*			*100%*	*$2.5*
Separable		*$0.4*	*75%*	*$0.3*	*25%*	*$0.1*
Recreation	0.9%	$0.4			100%	$0.4
Flood Damage Reduction	0.9%	$0.4			100%	$0.4
Total	**100%**	$41.4	**18.0%**	**$7.4**	**82.0%**	$33.9

Notes:

[a] Includes State and Authority members' paid funding.

[b] OM&R costs associated with IL4 refuge water supplies can be broken down into two categories: (1) the cost of filling the reservoir, which is a joint cost that will be paid for by the Non-Federal partners, and (2) the cost of delivering water from the Delevan Pipeline Discharge to the Refuge, which a separable cost that is subject to the cost-share requirements of CVPIA. The annual OM&R cost for IL4 refuge water supply has two distinct components:

1. The cost to divert water to fill the reservoir and other reservoir O&M costs ($2.5 million for Alt A1)
2. The cost to deliver water from the reservoir (end of the Delevan Pipeline) to the refuge boundary ($0.4 million for Alt A1)

The first component is treated as a joint cost and allocated 100% to the JPA. The second component is a separable conveyance cost and subject to the 75/25 cost share requirement under CVPIA. Therefore, $0.3 million is allocated to the Federal government and $0.1 million is allocated to the non-Federal partners. The Federal government is allocated approximately 9.9% ($0.3 million) of the $2.9 million in total annual OM&R costs allocated to IL4 refuge water supply.

Sub-allocations between M&I and agricultural use are based on relative benefits and water delivery quantities. Totals may not sum exactly due to rounding.

CVP = Central Valley Project
CVPIA = Central Valley Project Improvement Act
IL4 = Incremental Level 4
M&I = municipal and industrial
OM&R = operation, maintenance, and replacement

Table ES-9. Summary of Initial Cost Allocation by Project Purpose for Alternative D1

	Water Supply	CVP Operational Flexibility	Anadromous Fish	IL4 Water Supply to CVPIA Refuges	Delta Ecosystem Enhancement	Recreation	Flood Damage Reduction	Total
Total Construction Costs ($ million/yr)	$3,752	$1,258	$538	$479	$385	$68	$75	$6,554
(% of total)	57.2%	19.2%	8.2%	7.3%	5.9%	1.0%	1.1%	100%
Total Annual OM&R Costs ($ million/yr)	$29.7	$6.9	$2.9	$2.2	$1.8	$0.4	$0.4	$44.3
(% of total)	67.0%	15.6%	6.6%	5.1%	4.1%	0.9%	0.8%	100%

Note:

General: April 2019 price levels. Annualized construction costs shown in 2019 dollars based on 2.75% discount rate and a 100-year period of analysis. Totals may not sum exactly due to rounding.

$ million/yr = million dollars per year
CVP = Central Valley Project
CVPIA = Central Valley Project Improvement Act
IL4 = Incremental Level 4
OM&R = operation, maintenance, and replacement

Table ES-10. Construction Cost Assignment: Alternative D1

Purpose/Project	Total Percent	Total Cost	Cost Assignment ($ millions)			
			Federal		Non-Federal Partners[a]	
			Percent	Cost	Percent	Cost
Alternative D1: Construction Cost Assignment – Nominal Value						
Anadromous Fish	7.3%	$479	80.0%	$383	20.0%	$96
CVP Operational Flexibility	19.2%	$1,258	100%	$1,258		
Water Supply	57.2%	$3,752			100%	$3,752
M&I Water Supply	*90.0%*	*$3,375*			*100%*	*$3,375*
Agricultural Water Supply	*10.0%*	*$376*			*100%*	*$376*
Delta Ecosystem Enhancement	5.9%	$385			100%	$385
IL4 Water Supply for CVPIA Refuges	8.2%	$538			100%	$538
Recreation	1.0%	$68			100%	$68
Flood Damage Reduction	1.1%	$75			100%	$75
Total	100%	$6,554	25.0%	$1,641	75.0%	$4,913

[a] Includes State and Authority members' paid funding.

Sub-allocations between M&I and agricultural use are based on relative benefits. Totals may not sum exactly due to rounding.

$ millions = millions of dollars
CVP = Central Valley Project
CVPIA = Central Valley Project Improvement Act
IDC = interest during construction
IL4 = Incremental Level 4
M&I = municipal and industrial

Table ES-11. Annual OM&R Cost Assignment: Alternative D1

Purpose/Project	Total Annual Percent	Total Annual Cost	Cost Assignment ($ millions per year)			
			Federal		Non-Federal Partners[a]	
			Percent	Cost	Percent	Cost
Alternative D1: OM&R Cost Assignment – Annual						
Coldwater for Anadromous Fish	5.1%	$2.2			100%	$2.2
CVP Operational Flexibility	15.6%	$6.9	100%	$6.9		
Water Supply	67.0%	$29.7			100%	$29.7
M&I Water Supply	*93.2%*	*$27.7*			*100%*	*$27.7*
Agricultural Water Supply	*6.8%*	*$2.0*			*100%*	*$2.0*
Delta Ecosystem Enhancement	4.1%	$1.8			100%	$1.8
IL4 Water Supply for CVPIA Refuges[b]	6.4%	$2.9	10.3%	$0.3	89.7%	$2.6
Joint		*$2.5*			*100%*	*$2.5*
Separable		*$0.4*	*75%*	*$0.3*	*25%*	*$0.1*
Recreation	0.9%	$0.4			100%	$0.4
Flood Damage Reduction	0.8%	$0.3			100%	$0.3
Total	100%	$44.3	16.2%	$7.2	83.8%	$37.1

[a] Includes State and Authority members' paid funding.

[b] OM&R costs associated with IL4 refuge water supplies can be broken down into two categories: (1) the cost of filling the reservoir, which is a joint cost that will be paid for by the Non-Federal partners, and (2) the cost of delivering water from the Delevan Pipeline Discharge to the Refuge, which a separable cost that is subject to the cost-share requirements of CVPIA. The annual OM&R cost for IL4 refuge water supply has two distinct components:

1. The cost to divert water to fill the reservoir and other reservoir O&M costs ($2.5 million for Alt D1)
2. The cost to deliver water from the reservoir (end of the Delevan Pipeline) to the refuge boundary ($0.4 million for Alt D1)

The first component is treated as a joint cost and allocated 100% to the JPA. The second component is a separable conveyance cost and subject to the 75/25 cost share requirement under CVPIA. Therefore, $0.3 million is allocated to the Federal government and $0.1 million is allocated to the non-Federal partners. The Federal government is allocated approximately 10.3% ($0.3 million) of the $2.9 million in total annual OM&R costs allocated to IL4 refuge water supply.

Sub-allocations between M&I and agricultural use are based on relative benefits and water delivery quantities. Totals may not sum exactly due to rounding.

CVP = Central Valley Project
CVPIA = Central Valley Project Improvement
IDC = interest during construction
IL4 = Incremental Level 4
M&I = municipal and industrial
OM&R = operation, maintenance, and replacement

The Federal Government is assigned the full construction cost for CVP Operational Flexibility purposes and the partial construction cost for Anadromous Fish. Federal funds are requested under the WIIN Act. No aid-to-irrigation is allowed for construction costs of CVP Operational Flexibility, and where ability to pay analysis determines the payment capacity is insufficient, the water will not go to that purpose. All other construction costs would be paid by the non-Federal partners.

All OM&R costs under the CVP Operational Flexibility project purpose would be assigned to beneficiaries, as determined in the financial plans for these supplies. OM&R costs associated with deliveries for agricultural and M&I supply will be addressed using the existing rate-setting policies and cost pools, and will be recovered through the existing rate-setting process. Non-Federal costs for OM&R will be funded by the non-Federal partners.

Reclamation will receive IL4 Water Supplies for CVPIA Refuges at no cost. The Project's non-Federal partners will pay 100 percent of the IL4 Water Supply for CVPIA Refuges purpose's OM&R expenses that are not attributable to conveyance (i.e., diversions and filling). Under the planned assignment of costs, the cost to convey IL4 Water Supply for CVPIA Refuges from the Delevan pipeline discharge to the refuges would be consistent with CVPIA cost-share requirements (75 percent Federal and 25 percent State). These costs would vary by year, depending on hydrology and the amount of water delivered from the Project.

All other future OM&R costs associated with other project purposes will be paid by the non-Federal partners. Federal funding under the WIIN Act or State funding under Proposition 1 and the WSIP is not subject to any cost sharing under the CVPIA. The Authority will need to enter into an agreement that makes water available each year to the RWSP at no cost (i.e., the water is a donation), consistent with the IL4 Water Supply for CVPIA Refuges benefits analyzed in this Feasibility Report.

The Federal share of the total cost for Alternative A1 or Alternative D1 is 25 percent, consistent with the WIIN Act's maximum funding limit of 25 percent of the total cost of a State-led project (Section 4007(c)(1) of the WIIN Act).

Risk and Uncertainty

Implementation risks and uncertainties include the following:

- **Project Implementation** – The lead agencies would need to determine the Project's implementation strategy prior to developing the applications for permits and before beginning Project construction. Implementation of the Project may be phased to meet the current needs of the participating agencies who are investing in the Project; however, there is no phased implementation plan at this time. This may initially alter the magnitude of the benefits and effects of the Project. In general, if the Project were to be constructed in phases, the initial benefits would be realized over time. This Feasibility Report does not consider the benefits and costs associated with potential phases of implementation.
- **Future Water System Operations** – There is a risk that future conditions, including the regulatory environment, could reduce the allowable diversions into Sites Reservoir, thereby reducing the benefits.
- **IL4 Water Supply for CVPIA Refuges –** Real-time operations may vary from the modeled performance due to prioritization and availability. To address this uncertainty, operations

were modeled using both SWP and CVP pumping to convey water to south-of-Delta refuges. Pumping was not restricted in the model to the transfer window. Export for IL4 refuge supply will be limited to times when there is no negative impact to SWP or CVP deliveries.

- **Hydropower Operations** – Additional work is underway to better define the integration of the Sites Reservoir Project with the power grid, including the possible identification of partnering power utilities and the nature of their participation in the Project. Pumpback generation has been removed from Alternatives A1 and D1 due to the high cost and relatively low benefit from pumpback power; however, this is very sensitive to the energy market and may be reconsidered in the future.
- **Cost Estimates** – Varying uncertainties are associated with the material and unit costs used to develop the estimates.
- **Water Supply Reliability and Demands** – Water supplies and demands will continue to vary into the future.
- **Energy Costs for Conveyance** – There is high volatility in wholesale energy markets, especially price risk and uncertainty in the underlying fuel markets.
- **Impacts to CVP Power** – There are potential impacts to CVP power users from changes in the timing of releases from Shasta Dam and the use of the Red Bluff Pumping Plant for diversions. Additional impacts would result if the Jones Pumping Plant were used for deliveries south of the Delta. These impacts are being further characterized.

Summary of the NED Plan

The NED Plan (Alternative A1) would include the construction of Sites Reservoir with a capacity of 1.8 MAF. The reservoir would be filled using a new intake on the Sacramento River (Delevan Intake) in addition to using two existing canals (Tehama-Colusa and Glen Colusa Irrigation District Main Canals).

The reservoir would be filled with diversions during periods of high flows in the Sacramento River. Diversions would be made from the Sacramento River at the Red Bluff, Hamilton City, and new Delevan Intake pumping facilities. Water would be stored in Sites Reservoir until released for use in drier conditions. Releases would be directed to the southern portions of the Tehama-Colusa or Glenn Colusa Irrigation District Main Canals, or released through the Delevan Pipeline back to the Sacramento River for downstream use.

All project alternatives were developed to improve the operational flexibility and reliability of the California water system (CVP, SWP, and systems operated by local water agencies). Sites Reservoir would be cooperatively operated with Shasta Lake to conserve the cold water stored in Shasta Lake throughout the summer and to support appropriate water temperatures in the Sacramento River.

Water released from Sites Reservoir would meet Reclamation's environmental obligations and a portion of the CVP contract obligations in lieu of releases from Shasta Lake (CVP water deliveries would be made to CVP contractors downstream of Sites Reservoir in accordance with their existing CVP contracts). Similar benefits could be achieved through cooperative operations with Folsom

Lake (and Lake Oroville in the SWP). The cooperative operations would be implemented through the coordination of water rights and contractual foundations in partnership with the Authority, Reclamation, and DWR.

The Recommended Plan would provide increased water supplies to M&I users, agricultural users, and to Refuges; and would improve CVP operational flexibility and enhance the Delta ecosystem. Water supplies provided would vary by year type.

- **Irrigation and M&I supplies** provided to Local Agency Partners are estimated to be about 131 TAF/year (long-term average).
- **Refuge water supplies** are estimated to be about 34 TAF/year (long-term average).
- **CVP operational flexibility** would increase by 73 TAF/year (long-term average).
- **Delta ecosystem enhancement** would be achieved through the delivery of 51 TAF/year (long-term average) through the toe drain of the Yolo Bypass to reduce food scarcity for Delta smelt.
- **Anadromous fish** would benefit from colder temperatures in the Sacramento River.
- **Flood damage reduction and Recreation** would be provided with the construction of new project facilities.

The estimated total annual monetary benefit is about $278.4 million. The annual net economic benefit is to be about $23 million per year. The overall B/C ratio is 1.09.

The Recommended Plan is determined to be technically, environmentally, economically, and financially feasible.

Recommendations

As the NED Plan (Alternative A1) is being reviewed for approval, the NODOS Investigation recommends the following actions.

Recommendations for the Secretary of the Interior:

- Determine that the Project is feasible. There are Federal benefits, as framed by Alternatives A1 and D1 in this Feasibility Report, and submit the following determinations to Congress, in accordance with Section 4007(c)(2)(D) of the WIIN Act:
    - The Project is technically and financially feasible.
    - Sufficient non-Federal funding is available to complete the Project.
    - The Project sponsors are financially solvent.
    - A proportional share of the Project's benefits are Federal benefits.
- Request that Congress fund the Federal share of construction.

    - Request that Congress authorize Reclamation to increase the construction cost to allow for escalation from stated price levels (2019) to the notice to proceed for each contract or work package, based upon Reclamation's Construction Cost Trends publication or a similar source.
- Request that Congress annually appropriate funds so Project construction can occur in the most efficient and expeditious manner to avoid cost overruns and ensure timely completion.
- Request that Congress authorize and annually appropriate funds for OM&R to improve CVP Operational Flexibility.

Reclamation will study the use of excess storage capacity, when available, in Sites Reservoir for storage of CVP water to improve CVP Operational Flexibility.

Due to the complexity of the Project and the high Federal investment, Reclamation recommends validating the feasibility results in pre-construction and documenting any changes in a post-authorization report.

Approvals and Funding

The following approvals would be required for Project implementation.

Costs – The Federal cost request for construction (i.e., without IDC) assigned for Alternative A1 is $1,448 million, and the construction cost assigned for Alternative D1 is $1,638 million. This includes $93 million of funding for pre-construction for the Project. The non-Federal Project partners would be responsible for the balance of construction costs.

The Federal Government is assigned the full OM&R cost for CVP Operational Flexibility. The Federal Government is also assigned a share of the CVP conveyance costs for the IL4 Water Supply for CVPIA Refuges purpose.

Cost Allocation and Assignment – The WIIN Act (P.L. 114-322) Section 4007 allows the Secretary of the Interior to participate in a State-led storage project in an amount equal to 25 percent or less of the total cost of the project. The non-Federal partner is the Authority, which would be responsible for all costs that are not allocated to the Federal Government. The CWC has determined that the Sites Reservoir Project is eligible for $816 million in funding, including $40.8 million for pre-construction funding, from California through the WSIP process under Proposition 1. The State's investment would fund the Authority for the capital costs allocated by the State to Project benefits that are considered public, including IL4 Water Supply for CVPIA Refuges, Delta Ecosystem Enhancement, Recreation, and Flood Damage Reduction benefits.

The Federal cost-share is representative of feasibility, and the Federal Government may change cost-sharing percentages within the project purposes as the Project continues to be developed by Reclamation and the Authority. Changes to cost sharing would be documented in a post-authorization report and could be reflected in the capital costs and/or OM&R.

In the NED Plan, the proposed Federal construction cost share for CVP Operational Flexibility is 100 percent; for Anadromous Fish it is 80 percent.

The Federal Government is assigned the full construction cost for the CVP Operational Flexibility purpose and approximately half the costs for the Anadromous Fish purpose. All other construction costs would be paid by the non-Federal partners.

All OM&R costs under the CVP Operational Flexibility purpose are assigned to the Federal Government and will be assigned using the existing rate-setting policies and cost pools and recovered through the existing rate-setting process.

It is assumed that the non-Federal Sponsors would make water available annually at no charge (i.e., make a donation to cover 100 percent of the OM&R expenses for the IL4 Water Supply for CVPIA Refuges purpose that are not attributable to conveyance) to the RWSP for the IL4 Water Supply for CVPIA Refuges purpose, consistent with the benefits analyzed in this report. The Federal Government would incur no cost for OM&R associated with this water other than the cost to deliver the water from the Sites Reservoir Project (i.e., the release of the water from the Delevan Pipeline) to the CVPIA refuges. The OM&R cost related to the conveyance of water to the refuges would be shared with the State, consistent with the CVPIA (75 percent Federal/25 percent State). This document makes no commitment of the use of CVPIA funds for any purpose.

The cost assignment, including the funding for OM&R, will be reevaluated in the post-authorization report,

Approval – As determined by the Secretary of the Interior, in accordance with the WIIN Act, and funded by Congress, the Authority and Reclamation can begin pre-construction activities.

Prior to physical construction, the Authority and Reclamation will develop a post-authorization report consistent with the final design, final EIR/EIS, permits, and other project agreements. The post-authorization report will define the final Federal participation, benefits, operations plan, and use of Federal facilities.

According to the WIIN Act, approvals are needed from the Secretary and Congress to proceed with construction (to include pre-construction activities). Funding appropriated in Fiscal Year 2021 would enable the Project to meet the anticipated construction schedule that has been developed by the Authority.

Implementation Considerations

Water Rights

The Authority will need to obtain water rights for a new storage facility from the State Water Resources Control Board (SWRCB) for the delivery and beneficial use of water, either by assignment of a State-filed application and/or through an application for a new water right. This would include the necessary points of diversion and rediversion, diversion rates and quantities, season of diversion, places of use, and purposes of use.

The Authority will be in partnership with Reclamation and DWR to modify the agencies water rights if the new storage facility will be taking excess Sacramento River water, which is water that is covered under Reclamation/DWR water rights, and storing that water in the Reservoir for use at a

later time in CVP/SWP places of use north and south of the Delta to meet or satisfy CVP/SWP obligations and/or environmental purposes under Reclamation and DWR water rights and BiOps.

Agreements and Plans

An Agreement in Principal and Project Partnership Agreement between Reclamation and the Authority will be developed to define various roles, responsibilities, and obligations for the construction of the Project for both parties as further defined in this chapter.

Operational Agreements and Plans

Per Article XIV and Article XVI of the 1986 operations agreement between the United States and the State of California for Coordinated Operation of the CVP and SWP[5], project operations must be reviewed when adding a state or Federal facility to the system. Although the facilities proposed under the P Alternatives would be locally owned (not Federal or state), an operations agreement between Reclamation and the Authority would be developed to address the long-term planning and integration processes and how the additional water supplies provided by the Project would be managed in coordination with existing water supplies and system features.

The Authority's and/or its participating members' use of Federal conveyance and appurtenant facilities will be subject to available capacity, and shall not impede the delivery of CVP water. The determination of available capacity and impediment of delivery of CVP water is at Reclamation's sole discretion.

If electrical power is required to convey or pump the non-Project water into, through or from the project facilities, the Authority shall be responsible for the acquisition and payment of all electrical power and associated transmission service charges.

Sites Reservoir Project Contracts with existing CVP Contractors

The Authority will enter into agreements (consistent with the Operations Framework) with their Project Agreement Members, some of whom are existing CVP contractors, for a supplemental water source delivered from Sites Reservoir, purchased through the upfront capital project cost. The Authority shall not provide Sites Reservoir Project water to an existing CVP contractor in lieu of a CVP allocation under the Authority's existing CVP contracts, including any water transferred out by the CVP contractor.

Users of Sites Reservoir water shall hold the United States harmless for any change in water quality caused by the conveyance of water through or in Sites Reservoir.

Use of Storage Capacity in Sites Reservoir

The United States would enter into an agreement with the Authority that would allow Reclamation to use excess storage capacity in Sites Reservoir to improve the operational flexibility of the CVP.

Regulatory and Related Requirements for Environmental Compliance

Construction and operation of the NED Plan would be subject to the requirements of Federal, State, and local laws, policies, and environmental regulations, as described in this Feasibility Report, and/or as supplemented or modified by authorizing legislation. Reclamation and/or the Authority

[5] Note that DWR and Reclamation agreed to an addendum to COA in December 2018 outlining key changes on how reservoir releases and export capacity will be shared.

would need to obtain various Federal, State, and local permits and regulatory authorizations before Project construction would begin. A list of potential permits and approvals is included in Appendix K.

Federal, State, and local agencies with permitting or approval authority are expected to use the forthcoming Final EIS/EIR and the Supplement to make decisions and/or issue permits for an authorized project. Implementation of an authorized project would include review of prior consultation under the Fish and Wildlife Coordination Act and implementation of any associated recommendations, as appropriate. In addition, permits and consultations may be required with the U.S. Army Corps of Engineers, the California Department of Fish and Wildlife, the National Marine Fisheries Service, and USFWS.

Pre-Construction Activities

The Federal cost share of pre-construction activities is estimated at $104 million (the total pre-construction cost is estimated at $420 million). Pre-construction activities consist of development of a post-authorization report, engineering, development of operations plans, development of the Project Partnership Agreement, permits and approvals, and land acquisition.

Construction

Early construction activities (primarily associated with providing access to the major facilities for construction) will begin in 2021. The Authority plans to complete design by the end of 2022. Construction of the dams, pumping plants, and pipelines is expected to require 7 to 8 years.

Timeline

Figure ES-5 shows a timeline of major actions to complete the NODOS Investigation and future milestones leading to implementation of the Sites Reservoir Project.

	1	2			3	4							
Phase	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
NEPA/ CEQA			Draft EIR/S		Final EIR/S ROD								
Permitting		Permitting				Mitigation and Monitoring							
Water Rights				Obtain Rights									
Engineering		Preliminary and Final Design											
Real Estate		Right–of-Entry			Real Estate								
Construction					Construction								
Operations													Start - Up

CEQA = California Environmental Quality Act
EIR = Environmental Impact Report
EIS = Environmental Impact Statement
NEPA = National Environmental Policy Act
NOD = Notice of Determination
ROD = Record of Decision

Figure ES-5. Sites Reservoir Project Timeline

This page intentionally left blank.

Chapter 1 Introduction

This North-of-the-Delta Offstream Storage (NODOS) Investigation Feasibility Report evaluates new offstream surface water storage north of the Sacramento-San Joaquin Delta (Delta). This investigation was developed consistent with the requirements of Section 4007 of the Water Infrastructure Improvements for the Nation [WIIN] Act (Public Law [P.L.] 114-612 [2016]). Enacted in December 2016. Section 4007 of the WIIN Act authorizes the Secretary of the Interior to participate in both Federally owned (4007(b)) and State-led (4007(c)) storage projects. Under WIIN, the Secretary can participate in up to 25% of the total cost of a State-led project, such as NODOS. Pursuant to Section 4007(c)(2)(C) of the WIIN Act, the Secretary must find that a proportionate share of the project benefits are Federal benefits.

The Federal benefits associated with the NODOS project that have been identified in this Feasibility Report include Central Valley Project (CVP) Operational Flexibility and Anadromous Fish. This investigation was developed consistent with the requirements of Section 4007 of the WIIN Act (P.L. 114-612 [2016]) and the 1983 United States Water Resources Council (WRC) *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* (P&Gs). This Feasibility Report was completed by the United States Department of the Interior, Bureau of Reclamation (Reclamation), the Sites Project Authority (Authority), and the California Department of Water Resources (DWR), in coordination with cooperating agencies, other resource agencies, Native American tribes, stakeholders, and the public.

The NODOS Investigation is one of five surface water storage studies recommended in the *CALFED Bay-Delta Program Final Programmatic Environmental Impact Statement / Environmental Impact Report* (CALFED PEIS/EIR) and *CALFED Bay-Delta Programmatic Record of Decision* (CALFED ROD) of August 2000 (CALFED 2000a, 2000b). Preliminary studies in support of the CALFED PEIS/EIR considered over 50 surface water storage sites throughout California, and recommended more detailed study of five locations, one of which was north of the Delta (NODOS).

Purpose Statement for Study

The purposes of this Feasibility Report are to:

- Determine the potential Federal and non-Federal interest (type and extent) in the NODOS/Sites Reservoir Project (Figure 1-1).
- Evaluate the benefits and effects of the alternatives.
- Determine the engineering, environmental, social, economic, and financial feasibility of the National Economic Development (NED) Plan.
- Identify the Preferred Alternative

Source: Reclamation 2016a.

Figure 1-1. Area Map

Organization of the Feasibility Report

This Feasibility Report is organized as follows:

- Chapter 1, Introduction, describes the Study authorizations and project background.
- Chapter 2, Problems, Needs, and Opportunities, describes the problems, needs, and opportunities and the existing and likely future conditions in the Feasibility Study Area.
- Chapter 3, Planning Objectives and Constraints and the Alternative Development Process, describes the plan formulation process, including the planning objectives, management measures, and formulation and evaluation of concept plans and alternatives.
- Chapter 4, Potential Offstream Storage Locations, describes the alternative reservoir locations considered for this Study.
- Chapter 5, Evaluation of Conveyance and Reservoir Size, describes the conveyance measures considered for this Study.
- Chapter 6, Alternative Development, summarizes the development of the alternatives.
- Chapter 7, Initial Evaluation of Alternatives, describes the evaluation of the alternatives.
- Chapter 8. Refined Alternatives, adds operational flexibility and Delta ecosystem enhancement as project objectives and includes updated operations
- Chapter 9, National Economic Development (NED) Analysis, provides a description and determination of the feasibility of the refined alternatives with the cost allocation and cost assignment.
- Chapter 10, Risk and Uncertainty, summarizes the risks and uncertainties that could affect the findings of this Feasibility Report.
- Chapter 11, Findings and Conclusions, summarizes the major findings and conclusions of this Report.
- Chapter 12, Recommendations, provides recommendations and further considerations for the Feasibility Study.
- Chapter 13, Glossary, contains definitions of key terms used throughout this Report.
- Chapter 14, References, lists the sources used to prepare this Report.

This Feasibility Report has the following appendices:

- Appendix A – Plan Formulation
- Appendix B – Engineering
- Appendix C – Economics
- Appendix D – Real Estate
- Appendix E – Recreation

- Appendix F – Fish
- Appendix G – Sites Reservoir Project Operations Plan (Alternative D)
- Appendix H – Hydropower
    - H-1 – Power Planning Study
    - H-2 – North-of-the-Delta Offstream Storage (NODOS) Project Benefits Study
    - H-3 – Updated Pumpback Evaluation
- Appendix I – Draft Risk Assessment Report
- Appendix J – Deleted
- Appendix K – Implementation Consideration
- Appendix L – Cost Allocation
- Appendix M – Sites Reservoir Project Environmental Feasibility Summary Report

The Draft Environmental Impact Report/Environmental Impact Statement (EIR/EIS) is incorporated into this Report by reference. Several appendices to the Draft EIR/EIS include modeling results that support the analysis in this Feasibility Report. Appendix 1A to the Draft EIR/EIS is the Mitigation Monitoring Plan, which was used in the evaluation of environmental feasibility.

Study Authorization

Multiple agencies have been engaged in the development of Sites Reservoir.

Table 1-1 identifies the participating agencies and their current roles.

Federal Authorization for Feasibility Investigation

Reclamation received feasibility study authority for the NODOS Investigation in the Consolidated Appropriations Resolution Act of 2003 (Public Law [P.L.] 108-7), which states:

> "The Secretary of the Interior, in carrying out CALFED-related activities, may undertake feasibility studies for Sites Reservoir, Los Vaqueros Reservoir Enlargement, and Upper San Joaquin Storage projects. These storage studies should be pursued along with ongoing environmental and other projects in a balanced manner."

After Federal and State funds were appropriated in 2003, Reclamation and DWR initiated the NODOS Investigation.

In October 2004, the Water Supply, Reliability, and Environmental Improvement Act (P.L. 108-361) authorized the implementation of activities consistent with the CALFED ROD as a general framework for addressing CALFED, including its components related to water storage, ecosystem restoration, water supply reliability, and water quality. The law authorized Federal agencies to

participate in the multiple-purpose CALFED Bay-Delta Program, and authorized Reclamation to conduct planning and feasibility studies for NODOS:

Table 1-1. Partnering, Responsible, Cooperating, and Participating Agencies

Agency	Role
Partnering Agencies	
Bureau of Reclamation	NEPA lead agency, Federal Feasibility Study lead
Sites Project Authority	CEQA lead agency, California Water Storage Investment Program applicant, landowner outreach, members participated in prior Sites studies with DWR
Responsible Agencies	
California Department of Water Resources	Prior involvement in Federal Feasibility Study and CEQA, ongoing review
Cooperating Agencies	
Bureau of Indian Affairs	Tribal consultation
Colusa Community Indian Council	Tribal participation
United States Army Corps of Engineers	Permitting agency
United States Environmental Protection Agency	NEPA review
Participating Agencies	
National Marine Fisheries Service	Permitting agency
United States Fish and Wildlife Service	Permitting agency
United States Department of the Interior	Management and review
California Water Commission	State lead for distributing funds under the California Water Storage Investment Program
California Department of Fish and Wildlife	Permitting agency. Also established ecosystem priorities for State funding program; potential funding contract participant
California State Water Resources Control Board	Permitting agency responsible for assigning/issuing water rights for diversions. Also established water quality priorities for State funding program; potential funding contract participant.

CEQA = California Environmental Quality Act
DWR = California Department of Water Resources
NEPA = National Environmental Policy Act

> "The Secretary of the Interior is authorized to carry out the activities described in paragraphs (1) through (10) of subsection (d), to the extent authorized under the reclamation laws, the Central Valley Project Improvement Act (title XXXIV of Public Law 102-575; 106 Stat. 4706), the Fish and Wildlife Coordination Act (FWCA) (16 United States Code [U.S.C.] 661 et seq.), the Endangered Species Act of 1973 (16 U.S.C. 1531 et seq.), and other applicable law."

Section 103, paragraph (d)(1)(A)(ii) of P.L. 108-361 further defines authorized activities related to water storage:

> "…planning and feasibility studies for the following projects requiring further consideration – (I) the Sites Reservoir in Colusa County…"

There have been subsequent ongoing authorizations for the studies. Table 1-2 provides a list of the Federal authorizations to date.

Table 1-2. Federal Authorizations for the NODOS Investigation

Date	Authorization
February 20, 2003	P.L. 108-7, Division D, Title II, Section 215 of the Consolidated Appropriations Resolution Act, 2003
October 25, 2004	P.L. 108-361, Section 103 of the Water Supply, Reliability, and Environmental Improvement Act, 2004
December 18, 2015	P.L. 114-113, Division D, Title II, Section 205 of the Consolidated Appropriations Act, 2016

P.L. = Public Law

Department of Water Resources and State Authorization for Feasibility Investigation

State authorizations related to the Study of Sites Reservoir are summarized in Table 1-3. Beginning in 1996, DWR received authorization to study NODOS under State of California Proposition 204, the Safe, Clean, Reliable Water Supply Act, which provided funding for feasibility and environmental studies of offstream storage projects upstream from the Delta. In addition, the State Budget Act of 1998 authorized DWR to continue feasibility and environmental studies pertaining to NODOS and alternatives. Subsequent funding was allocated as part of the CALFED Integrated Storage Investigations Program. In November 2002, Proposition 50—the Water Security, Clean Drinking Water, Coastal and Beach Protection Act of 2002—was approved, authorizing funding for surface water storage planning and feasibility studies under CALFED. State of California Proposition 84, The Safe Drinking Water, Water Quality and Supply, Flood Control, River and Coastal Protection Act of 2006, as amended in 2009 and 2012, was approved to provide funding to ensure that safe drinking water is available to all Californians; protect the public from catastrophic floods; protect the rivers, lakes, and streams of the state from pollution, loss of water quality, and destruction of fish and wildlife habitat; protect the beaches, bays, and coastal waters of the state for future generations; and revitalize state communities and make them more sustainable and livable by investing in sound land use planning, local parks, and urban greening.

Sites Project Authority

The Authority was established on August 26, 2010, following the passage of the 2009 Comprehensive Water Package, which included Senate Bill 2. This bill allowed the formation of local joint powers authorities with the intent to govern, manage, and operate a surface water storage project.

The current Authority membership (9 voting positions with 15 members) consists of Glenn County, Colusa County, Reclamation District 108, Glenn-Colusa Irrigation District (GCID), Tehama-Colusa Canal Authority (TCCA), Maxwell Irrigation District, Colusa County Water District, Westside Water District, Western Canal Water District, TC-4, City of Sacramento/ Sacramento County Water Agency, and Placer County Water Agency / City of Roseville. Reclamation and DWR are non-voting Board members.

Table 1-3. State Authorizations for the NODOS Investigation

Enacted	Law	Authorization
1996	Proposition 204, the Safe, Clean, Reliable Water Supply Act, Chapter 6, Water Supply Reliability, Article 2, Feasibility Projects, Section 78656	Continuously appropriated funds to DWR for feasibility and environmental investigations for projects, including offstream storage upstream of the Delta that would provide storage and flood control benefits in an environmentally sensitive and cost-effective manner.
1998	State Budget Act of 1998	Authorized NODOS feasibility and environmental studies.
2002	Proposition 50, the Water Security, Clean Drinking Water, Coastal and Beach Protection Act	Funding made available for appropriation by the Legislature from the fund for the balanced implementation of the CALFED Bay-Delta Program. Expenditures and grants, including $50 million for surface water storage planning and feasibility studies.
2006	Proposition 84, The Safe Drinking Water, Water Quality and Supply, Flood Control, River and Coastal Protection Bond Act, Chapter 4, Statewide Water Planning and Design, Section 75041	$65 million available to DWR for planning and feasibility studies related to the existing and potential future needs for California's water supply, conveyance, and flood control systems. The studies shall be designed to promote integrated, multi-benefit approaches that maximize the public benefits of the overall system, including protection of the public from floods; water supply reliability; water quality; and fish, wildlife, and habitat protection and restoration. Projects to be funded include surface water storage planning and feasibility studies pursuant to the CALFED Bay-Delta Program.

DWR = California Department of Water Resources

On July 14, 2015, the Authority and Reclamation signed a Memorandum of Understanding (MOU) to cost-share the completion of feasibility studies and related environmental documents to support Federal and State decision making.

The Authority will operate the Sites Reservoir Project so as not to negatively impact CVP or State Water Project (SWP) operations, CVP or SWP contractors, or the environment, and to not impact the United States Treasury or State of California budget. No additional costs to CVP or SWP contractors or to Reclamation or DWR would result from implementation of Sites Reservoir. Potential policy issues that may arise would be codified through the permitting and consultation process.

State-Led Project Under Water Infrastructure Improvements for the Nation Act

The WIIN Act Section 4007(c) allows the Secretary to participate in surface water storage projects that are State or agency organized pursuant to State law, and provides a benefit in meeting any obligation under Federal law, including regulations. "[T]he Secretary of the Interior may participate in a State-led storage project in an amount equal to not more than 25 percent of the total cost of the State-led storage project" 4007(c)(1). Similar to federally owned storage projects "at least a proportional share of the project benefits are the Federal benefits, including water supplies dedicated to specific purposes such as environmental enhancement and wildlife refuges" 4007(c)(2)(C).

WIIN 4007(c) further requires a request from the Governor of relevant State for the Secretary of the Interior to participate in the State-led project (4007(c)(2)(A)), and under 4007(c)(2)(B):

> [T]he State or local sponsor determines, and the Secretary of the Interior concurs, that

(i) the State-led storage project is technically and financially feasible and provides a Federal benefit in accordance with the reclamation laws;

(ii) sufficient non-Federal funding is available to complete the State-led storage project; and

(iii) the State-led storage project sponsors are financially solvent.

Under 4007(e), subject to compliance with State water rights laws, the Secretary of the Interior may enter into agreements with each party to the Federal- or State-led project for use of the storage capacity of the project. The next subsection, 4007(f), states that Federal funding for a State-led project in the State of California is contingent on the California Water Commission determining that the project is consistent with the California Water Quality, Supply, and Infrastructure Improvement Act, approved by California voters on November 4, 2014. For individual projects to receive funding, enacted appropriations legislation must name the project. Prior to enacting the legislation, the Secretary must transmit to Congress a recommendations letter with the projects to be funded (4007(h)(2)). WIIN Section 4007 contains a sunset clause, 4007(i). Funding provided by WIIN for storage facilities shall only apply to projects that the Secretary of the Interior determines to be feasible by January 1, 2021.

Participation of the Federal Government has been requested by the California Governor in a letter dated August 27, 2018. This Report determines that the project is technically feasible, financially feasible, and that the Authority and State of California are financially solvent. The Secretary of the Interior is authorized to enter into financial assistance agreements with the Sites Authority. The California Water Commission determined the Sites Reservoir Project is consistent with the California Water Quality, Supply, and Infrastructure Improvement Act, approved by California voters on November 4, 2014. The CWC has found the Sites Project eligible for $816 million in State of California funding. The Secretary of the Interior intends to use excess capacity in the Sites Reservoir when available for CVP water, as mutually agreeable by the Secretary of Interior and the Authority.

In addition, Section 4010(b)(6)(A)(i through iii) allows the Secretary of Interior to acquire water from willing sellers in California:

- To benefit listed or candidate species under the Endangered Species Act of 1973 (16 U.S.C. 1531 et seq.) or the California Endangered Species Act (California Fish and Game Code sections 2050 through 2116);
- To meet requirements of, or otherwise provide water quality benefits under, the Federal Water Pollution Control Act (33 U.S.C. 1251 et seq.) or the Porter Cologne Water Quality Control Act (division 7 of the California Water Code); or
- For protection and enhancement of the environment, as determined by the Secretary of the Interior.

Any costs associated with Federal participation in pursuing these benefits are not reimbursable and non-returnable to the United States (Section 4010(b)(6)(C)).

California Water Commission and Water Storage Investment Program

The Authority has applied for funding through the Water Storage Investment Program (WSIP) to seek funding from the California Water Quality, Supply, and Infrastructure Improvement Act of 2014 (Proposition 1, California Water Bond). The application has been reviewed by the California Water Commission (CWC), and the CWC has determined that the Sites Reservoir Project can receive up to $816 million in funding from the State. The CWC has made the following determinations as required by the statute (California Water Commission, 2018):

- The project is cost effective
- The project improves the operations of the State water system
- The project provides a net improvement in ecosystem and water quality conditions
- The project provides measurable improvement to the Delta ecosystem or to tributaries of the Delta
- The project's cost share is less than or equal to 50 percent of the proposed project's total capital costs
- The project's program-funded ecosystem improvement benefits make up at least 50 percent of the total project benefits funded by WSIP
- The project appears to be feasible
- The project will advance the long-term objectives of restoring ecological health and improving water management for beneficial uses in the Delta
- The project is consistent with all applicable laws and regulations

The draft Feasibility Report, draft EIR/EIS, and other documents were included as supporting documentation in the WSIP application to the CWC.

The CWC advises the Director of DWR on matters within DWR's jurisdiction, approves rules and regulations, and monitors and reports on the construction and operation of the SWP. California's comprehensive water legislation, enacted in 2009, gave the CWC new responsibilities regarding the distribution of public funds set aside for the public benefits of water storage projects, and the development of regulations for the quantification and management of those benefits. The roles and responsibilities of the CWC are defined in the California Water Code (WC), sections of the Government Code, and the Civil Procedures code; including but not limited to:

> "Selecting water storage projects for funding under the 'Water Quality, Supply, and Infrastructure Improvement Act of 2014' (Proposition 1) through a competitive public process. Funding must go towards the public benefits portions of projects that improve the operation of the state water system, are cost effective, and provide a net improvement in ecosystem and water quality conditions. (WC § 79750)"
>
> "Developing and adopting, by regulation, methods for quantification and management of public benefits of water storage projects by December 15, 2016, in consultation with the Department of Fish and Wildlife, the State Water Resources Control Board (SWRCB), and the department. (WC § 79754)"

> "The commission has found and determined that the project is feasible, is consistent with all applicable laws and regulations, and will advance the long-term objectives of restoring ecological health and improving water management for beneficial uses of the Delta. (WC § 79755(a)(5)(B))"

> "Limits funding to eligible projects to benefits associated with: (1) Ecosystem improvements, (2) Water quality improvements in the Delta, or in other river systems, (3) Flood control, (4) Emergency response, and (5) Recreation; but allows funds to be expended 'for the costs of environmental mitigation measures or compliance obligations' associated with providing these public benefits." (WC § 79753)"

Guidance in the CALFED ROD

CALFED is a cooperative effort between Federal and California agencies and California's environmental, urban, and agricultural communities. The CALFED ROD (CALFED 2000b) provided a 30-year plan to address ecosystem health and water supply reliability problems in the San Francisco Bay–Sacramento River and San Joaquin River Delta (Bay-Delta). The ROD plan addressed four interrelated, interdependent resource management objectives: water quality, ecosystem quality, water supply reliability, and levee integrity.

The National Environmental Policy Act (NEPA) and California Environmental Quality Act (CEQA) lead agencies for the CALFED PEIS/EIR were Reclamation and DWR, respectively.

Under the water supply reliability management objective, the storage element included five investigations of potential increased surface water storage capabilities at various locations in the Central Valley, including north of the Delta, and efforts to increase groundwater storage through conjunctive management. For NODOS, the CALFED ROD (Section 2.2.5, Storage) states the following:

> "This project [Sites Reservoir], with a capacity of up to 1.9 million acre-feet, could enhance water management flexibility in the Sacramento Valley. By reducing water diversion on the Sacramento River during critical fish migration periods, this project can greatly increase reliability of supplies for a significant portion of the Sacramento Valley. It can also provide storage and operational benefits for other CALFED programs including Delta water quality…"

The CALFED ROD directed Reclamation and DWR to develop a joint planning program through an MOU with local water interests, and to complete environmental review and planning documentation for the NODOS investigation.

As a result of the passage of time since the CALFED EIS/EIR and ROD, California water management facilities, regulatory requirements (including biological opinions, incidental take authorizations, and species listings) and other existing conditions have changed. The Draft Sites Reservoir EIR/EIS relies on the portions of the CALFED EIS/EIR and ROD that remain applicable. The features of the CALFED EIS/EIR and ROD that have been augmented and updated for the Sites Reservoir EIS/EIR include:

- The CALFED PEIS/EIR does not include adequate detail to describe the range of alternatives considered in defining Sites Reservoir for a new NODOS facility. The Sites Reservoir EIR/EIS includes a detailed description of the alternatives screening analysis, which summarizes screening analyses from 1980 through today.
- The CALFED PEIS/EIR Existing Conditions/Affected Environment, No Action Alternative, and cumulative impact analysis assumptions were developed in the mid-1990s, and are not consistent with current assumptions. Therefore, the Sites Reservoir EIR/EIS currently includes updated descriptions.
- The CALFED ROD identified Programmatic Environmental Compliance process is based on previous 2000 biological opinions and other regulatory conditions that have since been superseded. Therefore, the Sites Reservoir EIR/EIS includes the current requirements for Federal Endangered Species Act (ESA) and California Endangered Species Act (CESA) compliance and other applicable regulatory conditions.

Feasibility Study Process

An iterative planning process consistent with the 1983 *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* (P&Gs) (WRC 1983) was used to identify and evaluate potential storage alternatives. The previous results of the initial phase of the feasibility studies are documented in the *North-of-the-Delta Offstream Storage Investigation Final Initial Alternatives Information Report* (IAIR) (Reclamation and DWR 2006b), and in *North-of-the-Delta Offstream Storage Investigation Plan Formulation Report* (PFR) (Reclamation and DWR 2008).

The progress and results of the NODOS Investigation have been documented in a series of interim reports that culminate in this *North-of-the-Delta Offstream Storage Investigation Feasibility Report* (Feasibility Report) and a Sites Reservoir Draft EIR/ EIS (Reclamation and Authority 2017).

The NODOS Investigation uses methodologies consistent with the P&Gs; and when possible, the Principles, Requirements and Guidelines for Federal Investments in Water Resources (WRC 2013). The NODOS Investigation is also consistent with Reclamation Manual: Directives and Standards (Subject: Water and Related Resources Feasibility Studies) (CMP 09-02) (Reclamation 2012a), the NEPA, the CEQA, and other pertinent Federal, State of California (State), and local laws and policies. The Study is also consistent with the CALFED ROD.

New offstream storage north of the Delta offers the potential to improve the flexibility of the CVP and SWP systems to ensure they continue to contribute to the water supply, water quality, and environmental needs of California and the Nation. Consistent with the CALFED ROD and Federal and State Study authorizations, this Feasibility Report evaluates the potential effects and benefits of the proposed Sites Reservoir. The proposed Sites Reservoir is shown on Figure 1-1, along with its proximity to the existing T-C and Glenn-Colusa Canals.

This Feasibility Report also describes the efforts under way to develop an Operating Agreement to allow for collaborative operation of Sites Reservoir with the existing CVP and SWP facilities. Cooperative operations will be required to achieve the project objectives.

As shown on Figure 1-2, the emphasis in the planning phases changes as the feasibility studies progress. Initially, emphasis is placed on defining problems, needs, and opportunities, and compiling and forecasting future conditions in the Study Area (defined in section titled "Study Area," below) to support the development of planning objectives. The emphasis then shifts to defining management measures, and combining them to formulate and evaluate alternative plans.

Previous studies and documents include:

- Notice of Preparation (NOP), filed with the State Clearinghouse on November 5, 2001, and amended NOP dated January 23, 2017, which established the Authority as the state's lead agency for compliance with CEQA.
- Federal Notice of Intent (NOI), published in the *Federal Register* on November 9, 2001.
- *North-of-the-Delta Offstream Storage Investigation Scoping Report* (Scoping Report), completed in 2002 following formal public scoping in 2001–2002 (Reclamation and DWR 2002).
- IAIR, completed in 2006, which narrowed the range of possible locations for a new offstream reservoir (Reclamation and DWR 2006b).
- PFR, completed in 2008, which supported a decision to proceed based on the conclusion that there are potentially feasible alternative plans that could be considered in the Federal interest as a partial solution to the California water storage challenge (Reclamation and DWR 2008).
- *Final Value Planning Study, North-of-the-Delta Offstream Storage Investigation*, completed in 2012, which identified various cost-saving measures for proposed facilities, including construction methods and road and dam designs (Reclamation 2012b).
- *Progress Report,* completed in 2013, which updated analysis and summarized the results of previous studies (Reclamation and DWR 2013).
- *Design, Estimating, and Construction* (DEC) review, completed in 2014, which identified additional cost savings and technical issues that need resolution before the Final Feasibility Report is completed (Reclamation 2014a).
- *Preliminary Design and Cost Estimating Report*, completed in May 2014 by the California Department of Water Resources (DWR 2014a).
- *Preliminary Administrative Draft EIR*, completed in May 2014 by DWR (and reviewed by Reclamation) (DWR 2014b).
- *Sites Reservoir Alternatives Evaluation*, completed in November 2014 by the Authority (Authority 2014).
- Design, Estimating, and Constructability Special Assessment (Reclamation 2017c).
- *Draft Feasibility Report* (Authority and Reclamation, 2017a).
- *Sites Reservoir Draft EIR/EIS* (Authority and Reclamation, 2017b).

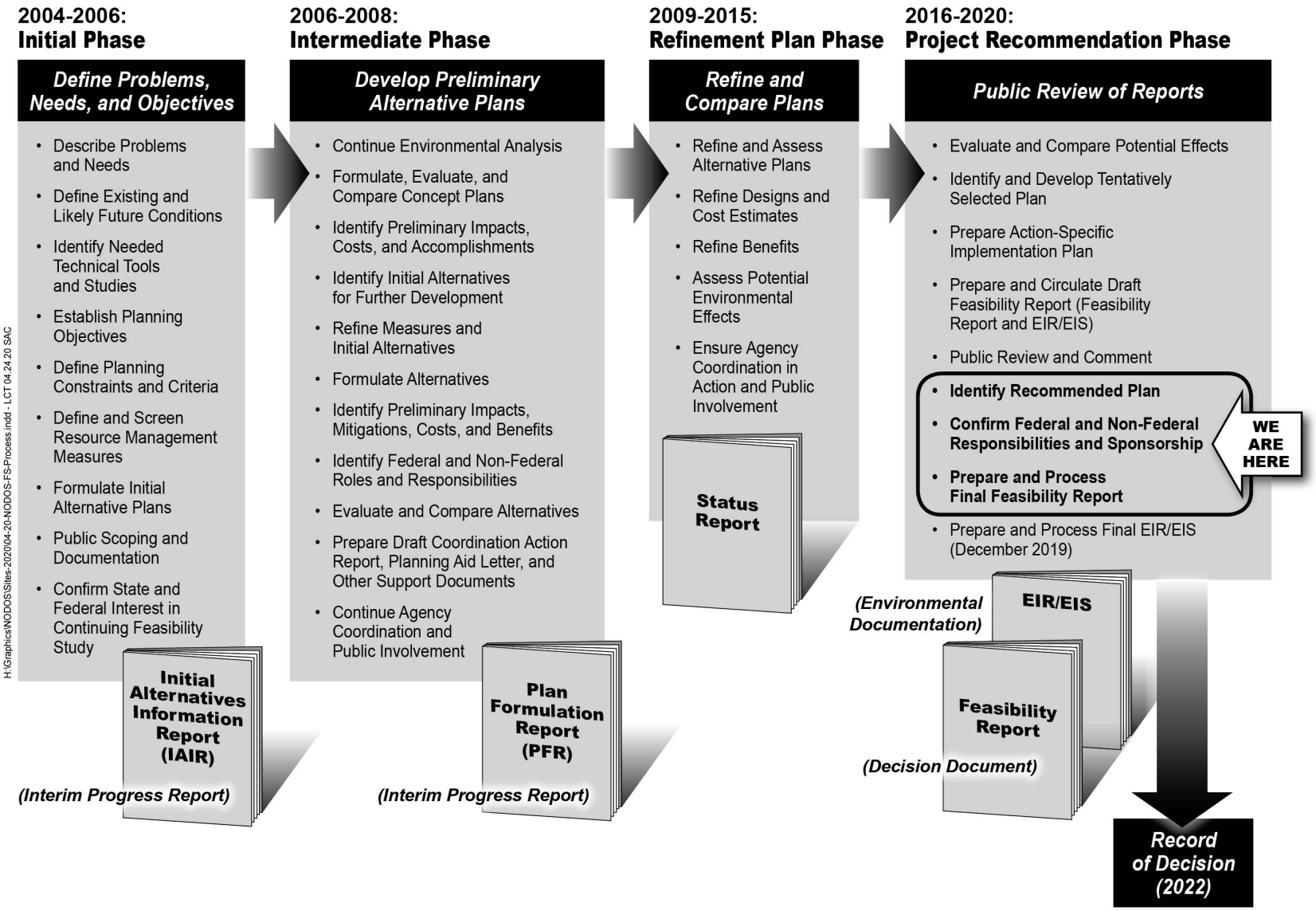


Figure 1-2. Feasibility Study Process

Public Scoping

The P&Gs (WRC 1983), NEPA, and CEQA each require that interested and affected agencies, groups, and persons be provided opportunities to participate throughout the planning process. Specifically, P&Gs Section IV states, "planning should include an early and open process termed 'scoping' to identify the likely significant issues to be addressed and the range of those issues." This requirement is complementary with the NEPA regulations (40 Code of Federal Regulations [C.F.R.] Parts 1501.1–1501.8) and CEQA (California Public Resources Code Section 21000 et seq.).

For the NODOS Investigation, the formal public scoping effort to solicit public and stakeholder input was initiated on November 5, 2001, with the filing of the State's CEQA-compliant NOP with the State Clearinghouse. The Federal NOI to comply with NEPA was published in the *Federal Register* on November 9, 2001. The formal scoping process concluded on February 8, 2002. During the scoping period, Reclamation and DWR developed the scope of the NODOS Investigation and took public comments, including comments regarding potential alternatives in the Primary Study Area, at one tribal and three other public scoping meetings. A summary of these comments is provided in the Scoping Report (Reclamation and DWR 2002).

The Authority has assumed the role of the CEQA lead agency in lieu of DWR, and will be responsible for constructing, operating, and maintaining (including repair and replacement) the project. Due to the change in lead agency, the Authority issued a Supplemental NOP on February 13, 2017, for the Draft EIR for the project and conducted two scoping meetings the same month. In addition to the original Scoping Report, a Supplemental Scoping Report is included in the Draft EIR/EIS.

Reclamation provided an update to the Colusa Indian Community Council on October 21, 2016. The Colusa Indian Community Council and the Cortina Rancheria are NEPA cooperating agencies, along with the Bureau of Indian Affairs.

In compliance with CEQA, specifically the requirements of State of California Assembly Bill (AB) 52, the Authority initiated consultation with Native Americans during the preparation of the Draft EIR/EIS. The following tribes were sent written notification of the project on February 10, 2017: Colusa Indian Community Council (Cachil Dehe Band of Wintun Indians); Cortina Indian Rancheria of Wintun Indians; Estom Yumeka Maidu Tribe of the Enterprise Rancheria; Grindstone Indian Rancheria of Wintun-Wailak; Mechoopda Indian Tribe; Paskenta Band of Nomlaki Indians; and, Yocha Dehe Wintun Nation. A letter from the Colusa Indian Community Council requesting consultation was received by the Authority in February 2017 and there has been ongoing consultation since that time. The Authority also sent follow-up letters to the other tribal governments on April 6, 2017 but there were no other formal requests for consultation under AB 52. However, the Yoche Dehe Winton Nation later requested additional information on the project and in a recent meeting expressed their desire to consult on the project. The Authority will continue to consult with tribes that have a traditional and cultural affiliation throughout development and construction of the Project.

Public Review of Draft Feasibility Report and Draft EIR/EIS

The Draft Feasibility Report and Draft EIR/EIS were both made available for public review during the period of August 15, 2017 – January 15, 2018. Approximately 142 comments were received through email, public meeting transcripts, public meeting comment cards, letters, and a petition. Commenters included Federal, State, tribal, and local agencies, as well as individuals (Table 1-4).

Table 1-4. Comments on Draft EIR/EIS (Reclamation and Authority, 2018)

Commenter Affiliation	Number of Commenters
Federal	3
State	8
Tribal	4
Local/Regional	12
NGO*	12
Individuals**	103
Comment Letters, Emails, and Petitions	142

NGO = non-governmental organization*

* Some NGO letters included comments from multiple NGOs

** Includes individual petition on Change.com containing 1001 signees as of 2/8/18

Letters received from the U.S. Environmental Protection Agency (EPA), National Marine Fisheries Service (NMFS), and Western Area Power Association (WAPA) requested additional detail, as follows:

- Final operational approach (including bypass flows and weirs) – requested by the National Oceanic and Atmospheric Association (*NOAA [NMFS]), EPA, and WAPA*
- Water quality – requested by *EPA and NMFS*
- Fish screens – requested by *NMFS*
- Wetlands – requested by *EPA*
- Power benefits methodology – requested by *WAPA*

In addition, the United States Fish and Wildlife Service (USFWS) notified the Authority and Reclamation that it will be providing comments through their FWCA report.

Letters received from California Department of Fish and Wildlife (CDFW), SWRCB, Delta Stewardship Council, Cal FIRE, the California Department of Transportation (Caltrans), and the Department of Conservation included comments on:

- Additional alternatives to address proposed diversions/bypass flows and impacts to fisheries
- Water quality (including river and reservoir temperatures)
- Terrestrial resources impacts
- Delta species impacts
- Enforceable mitigation measures and related details

- Avoidance of run-off to state roads and highways
- Fire suppression and access
- First responders and required communications
- Conversion of agricultural lands and conservation easements

Efforts to complete the joint EIR/EIS for the Project are ongoing. Initial review has indicated that issues raised in the comments on the Draft EIR/EIS can be addressed through thematic and individual responses to comments and/or clarified through revisions to the text of the Draft EIR/EIS and appendices. Revisions are not anticipated to change the environmental impact findings of the Draft EIR/EIS.

Study Area

Any of the storage projects considered in the NODOS investigation would result in water deliveries over a large geographic area. To evaluate the full range of effects on the environmental resources in different geographic areas, the Authority and Reclamation have identified three study areas for analysis:

- Extended Study Area – Consists of the geographic areas that use water provided by CVP and SWP
- Secondary Study Area – Consists of the geographic areas that are directly or indirectly affected by operations of CVP and SWP facilities north of the Delta
- Primary Study Area – Consists of the geographic areas that are directly affected by construction and/or operations of the NODOS/Sites Reservoir Project facilities

These three study areas are described in more detail in the following sections.

Extended Study Area

The Extended Study Area is the largest and most diverse of the three study areas in terms of size, geography, land use, and habitat conditions. It is anticipated to experience minor effects to changed operations and conditions, given no construction will occur in this area.

The Extended Study Area includes the entire service areas of the CVP and SWP. These two service areas are located in all, or portions of, the following counties: Alameda, Butte, Colusa, Contra Costa, El Dorado, Fresno, Glenn, Kern, Kings, Los Angeles, Madera, Merced, Napa, Orange, Placer, Plumas, Riverside, Sacramento, San Benito, San Bernardino, San Diego, San Joaquin, San Luis Obispo, Santa Barbara, Santa Clara, Shasta, Solano, Stanislaus, Sutter, Tehama, Tulare, Ventura, and Yolo. The Extended Study Area also includes units of the National Wildlife Refuge System in the Central Valley of California, five state wildlife areas, and the Grassland Resource Conservation District in the Central Valley of California, hereinafter refuges, which could receive Incremental Level 4 water supply from the NODOS/Sites Reservoir Project. Those refuges are located in seven counties in the Extended Study Area.

Secondary Study Area

The Secondary Study Area is smaller than the Extended Study Area and consists of the majority of CVP and SWP facilities that could be affected by potential operations associated with certain Sites Reservoir project alternatives. The Secondary Study Area includes the geographical area with CVP and SWP facilities located north of the Delta, and in the Delta and the streams downstream of the CVP and SWP reservoirs that could experience water surface elevation fluctuations or stream flow changes. Those facilities are located in the following 18 counties: Alameda, Butte, Colusa, Contra Costa, Del Norte, El Dorado, Glenn, Humboldt, Placer, Sacramento, Santa Clara, Shasta, Solano, Sutter, Tehama, Trinity, Yolo, and Yuba.

The potential for operational changes that could occur as a result of the coordinated and integrated operation of the Sites Reservoir Project's facilities with the CVP and SWP facilities was evaluated on the Trinity River, Clear Creek, Spring Creek, Sacramento River, Sutter Bypass, Yolo Bypass, Feather River, American River, and the Delta. The Secondary Study Area also includes the existing TCCA Red Bluff Pumping Plant in Tehama County. Project activities in this area would be limited to minor construction and installation of equipment in existing facilities.

Primary Study Area

The Primary Study Area consists of the geographical areas that could be directly affected by the construction and operations of the NODOS/Sites Reservoir Project facilities and the land immediately surrounding them. The Primary Study Area includes the "footprints" of the Sites Reservoir Project facilities (including dams, intakes/discharge facilities, fish screens, pipelines, transmission line, pumping/generating plants, recreation areas, road relocation areas, borrow areas, and associated facilities) other than the TCCA and GCID diversion facilities. The Primary Study Area is in Glenn and Colusa Counties.

Considerations in the Project Setting

CVP and SWP operations: Both the CVP and SWP operate pursuant to conditions of existing water rights and contracts while complying with the requirements of the Federal and California Endangered Species Acts and other requirements, including the Coordinated Operations Agreement (COA).

In 2016, Reclamation and DWR requested the reinitiation of consultation pursuant to the Endangered Species Act for long-term coordinated operations of the CVP and SWP with the U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS). Multiple years of drought, several low population species, and new scientific information were considered in updating the Biological Opinions (BiOps). The Services transmitted their findings to Reclamation and DWR on October 21, 2019, concluding that the proposed action is consistent with the requirements of the Endangered Species Act.

If Sites Reservoir is constructed, it must be operated in a mutually beneficial and cooperative manner with the CVP and SWP to meet the project objectives and provide the desired benefits.

Coordinated Operations Agreement and reallocation of contract water supplies: The agreement between the United States and the State of California for Coordinated Operations of the

CVP and SWP, commonly known as the COA, was executed in November 1986 and amended December 2018 pursuant to P.L. 99-546, the California Central Valley Project Act (California Water Code Part 3, Division 6 [starting at Section 11100]), and the California Water Resources Development Bond Act (California Water Code Chapter 8, Part 6, Division 6 [starting at Section 12930]). The COA coordinates the operations of CVP and SWP facilities to meet Sacramento Valley in-basin uses, maintain the respective annual water supplies, and establish how the two agencies share surplus flows. The Federal and State authorizations for the NODOS feasibility studies focus on CALFED-related storage studies to provide additional supply reliability and water management flexibility to support CALFED objectives. The authorizations do not provide authority to reallocate CVP water supplies among the long-term contractual commitments. The Authority will work collaboratively with Reclamation and DWR to develop Principles of Agreement, an Operations Framework, and an Operations Plan for Sites Reservoir that would be independent of the COA.

Water rights: Implementation of the Sites Reservoir Project would require new water rights. Further coordination between Reclamation, the Authority, DWR, and the State Water Resources Control Board is required to develop the application for water rights and/or to request assignment of the previous State-filed application.

Chapter 2 Problems, Needs, and Opportunities

This chapter discusses specific water resources problems, needs, and opportunities that are used to direct the development of the NODOS/Sites Reservoir Project Investigation alternatives.

Identification Process

The identification of problems, needs, and opportunities began with the CALFED ROD. This section discusses some of the key processes and plans that have guided the process of identifying problems, needs, and opportunities.

CALFED Record of Decision

Many prior studies have suggested the potential benefits that could be obtained from new surface water storage north of the Delta. The CALFED ROD identified several problems, needs, and opportunities, including a need to improve:

- Water supply and water supply reliability
- Survival of anadromous fish
- Water quality
- Levee system integrity for levees in the Delta

The NODOS project has the potential to address all of these needs, except for levee system integrity in the Delta. The NODOS project does not appreciably affect levees in the Delta.

Public Scoping

Comments received during the aforementioned public scoping meetings also informed the identification of problems, needs, and opportunities. Public scoping was conducted in accordance with the P&Gs (WRC 1983), NEPA, and CEQA. This process provided an opportunity for interested and affected agencies, groups, and persons to offer early input into the planning process. Specifically, P&Gs Section IV states, "planning should include an early and open process termed 'scoping' to identify the likely significant issues to be addressed and the range of those issues." This requirement is complementary to both NEPA (40 C.F.R. Parts 1501.1–1501.8) and CEQA (California Public Resources Code Section 21000 et seq.) regulations.

On November 5, 2001, the State NOP was filed with the State Clearinghouse, and on November 9, 2001, the Federal NOI was published in the *Federal Register*. The formal scoping process for the NODOS project began with the publication of the NOP and NOI, and concluded on February 8, 2002. During the scoping period, one tribal and three public scoping meetings were held. The Authority recently held a supplemental NOP from February 2, 2017 to March 2, 2017.

The study team received 57 comments that addressed various program alternatives. Some comments were specific suggestions related to the types or range of alternatives, such as water-use efficiency, conjunctive use, land fallowing, wastewater reclamation and recycling, and Shasta Lake enlargement. Others were more general about what alternatives should or should not be developed, and the possible benefits/impacts of certain alternatives. The Scoping Report (Reclamation and DWR 2002) includes a complete summary of the comments received during the scoping period. These comments have been considered in the definition of problems, needs, and opportunities; the development of the planning objectives; and the identification of measures to meet those objectives. This effort is documented in the IAIR (Reclamation and DWR 2006b).

California Water Action Plan

The Governor issued the *California Water Action Plan* in January 2014 (NRA, CDFA, and CalEPA 2014). It is intended to be a 5-year roadmap toward achieving sustainable water management in California. The plan was updated in 2016 (NRA, CDFA, and CalEPA n.d.).

Although the plan comprehensively addresses water resources planning for the State, it was primarily a response to the deficiencies in drought preparedness that have been exposed over the last 5 years. In 2016, California ended its fifth consecutive year of below-average rainfall and snowpack (9 of the preceding 10 years also had below-average rainfall). This extended drought produced chronic and exceptional shortages in municipal and industrial, environmental, agricultural, and wildlife refuge water supplies, and led to historically low groundwater levels. Calendar years 2014 and 2015 saw record-low water allocations for CVP and SWP contractors (see Drought Contingency Plan [Reclamation and DWR 2016]). The California Water Action Plan provides a response that is informed by both the conditions observed throughout this drought and the anticipated future requirements due to climate change.

The extent of the recent drought has highlighted the vulnerability of California's water supply system to long-term drought and climate change. In January 2015, the Governor declared a drought State of Emergency. Effects of the drought in the Central Valley included the subsidence of agricultural lands. Streams that salmon and steelhead depend on experienced higher temperatures and other water quality issues in the absence of rain. Communities throughout the state focused on boosting water conservation efforts and developing new sources of supply to alleviate the impacts of the drought. The problems and needs considered in the NODOS Investigation are far more apparent as a result of the drought than they were six years ago.

An update to the California Water Action Plan, released in 2016, reaffirms the goals from the original plan. From the 2016 update (NRA, CDFA, and CalEPA n.d.),

> "There is broad agreement that the state's water management system is currently unable to satisfactorily meet both ecological and human needs, too exposed to wet and dry climate cycles and natural disasters, and inadequate to handle the additional pressures of future population growth and climate change. Solutions are complex and expensive, and they require the cooperation and sustained commitment of all Californians working together. To be sustainable, solutions must strike a balance between the need to provide for public health and safety (e.g., safe drinking water,

clean rivers and beaches, flood protection), protect the environment, and support a stable California economy."

Similar to the WIIN Act, the California Water Action Plan acknowledges a role for locally led projects by stating:

> "The administration will work with the Legislature to make funding available to share in the cost of storage projects if funding partners step forward. The state will facilitate among willing local partners and stakeholders the development of financeable, multi-benefit storage projects, including working with local partners to complete feasibility studies. For example, the Sites Project Joint Powers Agreement, formed by a group of local government entities in the Sacramento Valley, is a potential emerging partnership that can help federal and state government determine the viability of a proposed off stream storage project – Sites Reservoir."

Several of the actions included in the *California Water Action Plan 2016 Update* were considered in the identification of problems, needs, and opportunities for this Study (NRA, CDFA, and CalEPA n.d.). These actions include the following:

- Increase regional self-reliance and integrated water management across all levels of government
- Achieve co-equal goals for the Delta
- Protect and restore important ecosystems
- Manage and prepare for dry periods
- Expand water storage capacity and improve groundwater management
- Provide safe water for all communities
- Increase flood protection
- Increase operational and regulatory efficiency

Proposition 1, Water Quality, Supply, and Infrastructure Improvement Act of 2014

In November 2014, Proposition 1 was approved by California voters. It authorizes $7.545 billion in general obligation bonds to fund various water-related programs, including $2.7 billion for new water storage projects. The program supports the California Water Action Plan. Like the California Water Action Plan, passage of the bond was notably influenced by the effects of the drought. The bond focuses on providing funds to secure public benefits, and to the extent that the Sites Reservoir Project can provide these public benefits, could be used to fund construction.

This bond funding can only be used to cover costs related to the "public benefits" associated with water storage projects, including restoring habitats, improving water quality, reducing damage from floods, responding to emergencies, and improving recreation. Local governments and other entities

that rely on the water storage project would be responsible for paying the remaining project costs. These costs would generally be associated with private benefits (such as water provided to their customers or hydropower generation). Water storage projects eligible for Proposition 1 bond funding include surface storage projects identified in the CALFED ROD (including the NODOS project), groundwater storage projects and groundwater contamination prevention or remediation projects that provide water storage benefits, conjunctive use and reservoir reoperation projects, and local and regional storage projects that improve the operation of water systems in the state and provide public benefits.

Projects that could be funded by a State water bond would be selected by the California Water Commission through the WSIP, which includes a competitive public process, ranking potential projects based on the expected return on public investment as measured by the magnitude of the public benefits provided. The public benefit categories include:

- 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 ecosystems and fish and wildlife in the Delta
- Water quality improvements in the Delta—or in other river systems—that provide important public trust resources or that clean up and restore groundwater resources
- 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
- 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
- Recreational purposes, including, but not limited to, those recreational pursuits generally associated with the outdoors

These public benefit categories were also considered in the identification of problems, needs, and opportunities for this Study.

Sustainable Groundwater Management Act

In 2014, California enacted legislation known as the Sustainable Groundwater Management Act (SGMA). The act provides a framework for sustainable management of groundwater supplies, including the formation of local groundwater sustainability agencies. These agencies must assess conditions in their local water basins and adopt locally based groundwater management plans. In addition, SGMA protects existing surface water and groundwater rights. This framework encourages better groundwater management that could contribute to reliable water supplies regardless of drought or climate variability effects. SGMA is important to NODOS project planning in three specific ways:

1. Groundwater is likely to become more costly. The historic use of groundwater in California has been relatively free of regulatory constraints and their associated costs. Compliance costs for groundwater pumping will alter the cost of water and its associated economic benefit.
2. Water agencies throughout the Central Valley (both north and south of the Delta) need to adaptively manage both surface and groundwater resources to achieve a sustainable water supply. The use of surface water in lieu of groundwater, particularly during wet years, provides increased opportunity for groundwater recharge. Regional management of these resources throughout watersheds is also becoming increasingly important.
3. The planning of surface water projects should include an evaluation of opportunities to support groundwater recharge.

Availability of Water for North-of-the-Delta Storage

The Sacramento River is the largest surface water resource in California, carrying roughly one-third of total runoff water in the state into the Delta. Its drainage area includes the Sacramento, Feather, and American River Basins, covering an area of more than 26,000 square miles. The Draft *Water Available for Replenishment Report* (DWR, 2017) identified the Sacramento River watershed as the most abundant source of water for replenishment in California.

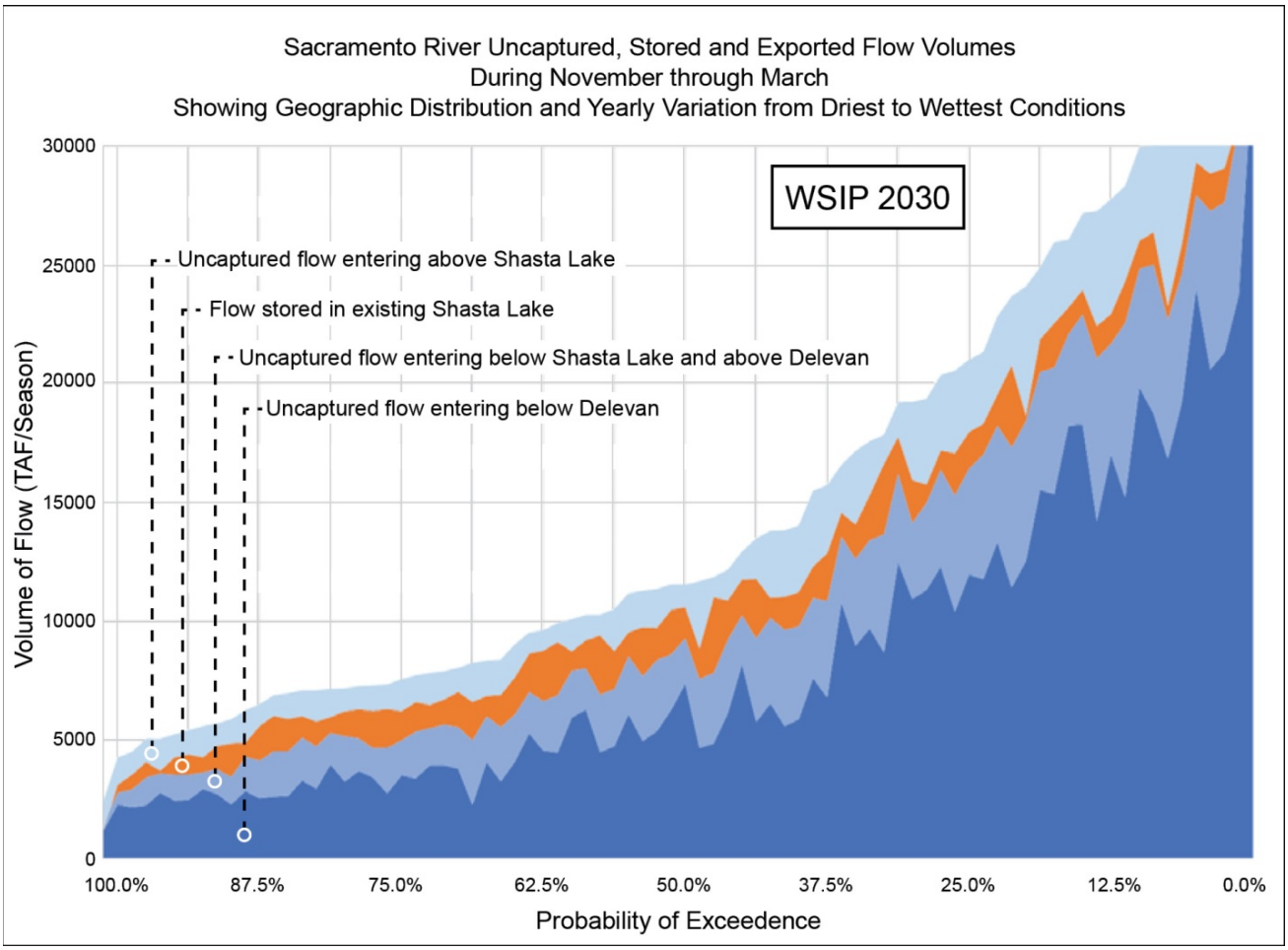
The amount of water that could potentially be diverted into storage is a primary consideration in siting offstream storage. Generally, the availability of water increases at locations farther south in the Sacramento River Valley, downstream of tributaries entering the Sacramento River. Fifteen gauged tributaries enter the Sacramento River between Keswick Dam (downstream of Shasta Dam) and the city of Colusa, appreciably increasing the river flow. Average monthly streamflow in the Sacramento River downstream of Keswick Reservoir varies between 6,248 cubic feet per second (cfs) in October and 10,154 cfs in February. By the time the river reaches Hamilton City, the average monthly downstream flow in the Sacramento River increases to 6,619 cfs in October and 20,300 cfs in February. Figure 2-1 depicts the flow in the Sacramento River.

Annual diversions from the Sacramento River upstream of the confluence with the Feather River average approximately 1.7 million acre-feet (MAF). Major diversions include the Red Bluff Pumping Plant (RBPP) into the T-C and Corning Canals, the Hamilton City Pumping Plant into the GCID Canal, and the Wilkins Slough and Emery Poundstone Pumping Plants operated by RD108. In the Sacramento River, between Red Bluff and Colusa, surface water demands exceed the average annual available supply, with an average annual demand of 2.3 MAF, including water diverted for Sacramento Valley refuges, and agricultural activities between Red Bluff and Knights Landing.

Problems, Needs, and Opportunities for the NODOS Investigation

Water Supply and Water Supply Reliability

The CVP and SWP are two of the largest water storage and conveyance projects in the world. By the time construction of the initial facilities for both systems concluded in the 1970s, the two systems combined to provide notable flexibility for water resources management in California. This operational flexibility has eroded over the last 40 years due to:



Source: CH2M Hill 2016a.

Figure 2-1. Sacramento River Flow Volumes November through March, Showing Geographic Distribution and Yearly Variation from Driest to Wettest Conditions

- Increased usage of water in the source watersheds
- Increased usage of water under contract with the United States and the State of California to meet growing agriculture and municipal and industrial (M&I) water demands
- Increased environmental requirements to meet endangered species and refuge water supply commitments

In addition, variability in climate could further diminish the ability of these projects to sustain their current levels of water supply. According to the *Sacramento and San Joaquin Basins Study Climate Impact Assessment* (Reclamation 2014c), overall 21st century projected impacts include increases in unmet demands, diminishing coldwater pools in existing reservoirs, and reduced Delta exports. Factors contributing to these impacts include earlier releases for flood management to address warmer storms with less snowpack that would reduce overall storage capacity and sea level rise requiring additional Delta outflow.

The challenge is especially acute and the consequences are exacerbated during multiple dry years, as evidenced by the 1976–1977, 1987–1992, 2007–2009, and 2012–2016 droughts. The Preferred Program Alternative in the CALFED ROD identified a need for up to 6 MAF of new storage in California, including up to 3 MAF of storage north of the Delta.

The *California Water Plan Update 2013* (DWR 2013) noted the following:

> "California's changing and increasingly competing demands for water come from many sectors. All uses generally can be characterized as urban, agricultural, or environmental. The state's population continues to grow, and the trend has been toward faster growth in warmer inland regions. From 1990 to 2010, California's population increased from about 30 million to about 37.3 million. The California Department of Finance projects that this trend indicates a state population of roughly 51 million by 2050.

The Current Trends and Expansive Growth scenarios without climate variability indicate an additional 3.6 MAF/year of water would be needed by 2050 to stop groundwater overdraft statewide. The effects of potential climate variability (including potential loss of snowpack) have been projected to further increase the need for water. The ability of the CVP and SWP to respond to these demands will likely be constrained by existing conveyance facilities, area-of-origin water right protections, and environmental impacts.

Table 2-1 provides details on the statewide water balance (surface and groundwater).

Water Supply

The Sacramento River Basin's CVP water service and settlement contractors are susceptible to dry-year deficiencies and are especially vulnerable to droughts. During extended droughts, reduced water availability eventually force water users to either replace surface water supply by using groundwater, if they have this capability, or remove agricultural acreage from production (DWR 2005). Additional use of groundwater supplies during droughts may result in adverse impacts, such as reduced groundwater quality or ground subsidence, and groundwater overdraft.

The CALFED ROD specifically addressed the linkage of surface water storage to the successful implementation of all other elements of CALFED:

> "Expanding water storage capacity is critical to the successful implementation of all aspects of the CALFED Program. Not only is additional storage needed to meet the needs of a growing population, but, if strategically located, it would provide much needed flexibility in the system to improve water quality and support fish restoration efforts. Water supply reliability depends upon capturing water during peak flows and during wet years, as well as more efficient water use through conservation and recycling."

California depends on groundwater for a major portion of its annual water supply, especially during extended droughts. In the Sacramento River Hydrologic Region (NODOS project location), groundwater contributes about 31 percent of the total water supply. Groundwater meets about one-third of the agricultural water demands and half of the urban water demands in the region (DWR 2013).

Table 2-1. Statewide Water Balance (MAF)

	2001 (72%)	2002 (81%)	2003 (93%)	2004 (94%)	2005 (127%)	2006 (127%)	2007 (62%)	2008 (77%)	2009 (77%)	2010 (104%)
Applied Water Use										
Urban	8.6	9.1	9.0	9.5	9.0	9.5	9.6	9.3	8.9	8.3
Irrigated Agriculture	33.7	35.9	32.8	36.1	31.2	33.3	36.9	37.0	36.0	32.9
Managed Wetlands	1.3	1.6	1.5	1.6	1.4	1.6	1.6	1.6	1.5	1.5
Required Delta Flow	4.5	4.8	6.4	6.5	7.0	10.1	4.5	4.5	4.7	5.3
Instream Flow	6.8	6.6	6.9	7.0	7.8	8.5	6.5	6.2	6.3	6.8
Wild & Scenic Rivers	9.8	21.9	29.5	23.0	26.2	44.8	18.1	19.5	18.1	25.1
Total Uses	**64.7**	**79.9**	**86.1**	**83.7**	**82.6**	**107.8**	**77.2**	**78.1**	**75.5**	**79.9**
Depleted Water Use (stippling)										
Urban	7.0	6.7	6.3	6.4	6.1	6.2	6.2	6.1	5.8	5.2
Irrigated Agriculture	26.0	26.2	24.3	26.8	22.7	24.2	27.1	27.6	26.6	23.8
Managed Wetlands	0.9	0.8	0.7	0.8	0.7	0.8	0.9	1.1	0.8	1.0
Required Delta Outflow	4.5	4.8	6.4	6.5	7.0	10.1	4.5	4.5	4.7	5.3
Instream Flow	2.2	2.6	2.7	2.7	3.3	6.1	4.4	2.2	4.1	4.4
Wild & Scenic Rivers	6.9	17.5	22.8	18.9	18.7	33.8	14.7	15.4	13.2	18.5
Total Uses	**47.5**	**58.6**	**63.2**	**62.1**	**58.5**	**81.32**	**57.8**	**56.9**	**55.2**	**58.2**
Dedicated and Developed Water Supply										
Instream	8.0	29.9	34.7	32.7	32.3	49.2	22.8	21.2	21.4	27.4
Local Projects	15.4	2.6	4.2	3.2	6.0	9.3	8.0	8.8	7.9	8.8
Local Imported Deliveries	0.8	0.8	0.8	0.8	0.9	1.1	1.5	1.2	1.3	1.1
Colorado Project	5.2	5.0	4.5	4.8	4.2	4.6	4.7	4.9	4.6	4.7
Federal Projects	6.8	7.3	7.1	6.9	7.2	7.4	6.6	6.1	5.7	6.4
State Project	2.1	2.9	3.1	3.2	3.4	3.7	3.3	1.9	1.8	2.2
Groundwater Extraction	17.6	17.5	15.5	17.7	12.0	13.1	18.8	20.0	20.1	14.7
Inflow & Storage	0.0	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1
Reuse & Seepage	8.5	13.6	15.8	14.0	16.3	19.2	11.1	13.5	12.3	14.1
Recycled Water	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3
Total Supplies	**64.7**	**79.9**	**86.0**	**83.7**	**82.6**	**107.9**	**77.1**	**77.9**	**75.4**	**79.8**

Source: Adapted from California Water Plan Update 2013 (DWR 2013).
MAF = million acre-feet

The unmet needs for water deliveries to municipal/industrial water users participating in the Sites Reservoir Project were evaluated based on water supply and demand information presented in participating agencies' urban water management plans, submitted to the DWR in 2015. The urban water management plans prepared in 2015 presented projected water demands and water supplies from 2015 through 2030 or 2035, including assumptions about projected availability of CVP and SWP water supplies through 2030. Table 2-2 presents a summary of information contained in the Urban Water Management Plans submitted by the Sites Reservoir Project municipal and industrial participating agencies regarding their future (2030) water supplies and demands.

Table 2-2. Water Supply and Demand Estimates for Currently Participating Municipal and Industrial Water Agencies/Districts Sites Reservoir Project Water Request

	Supply (2030)		Demand (2030)	
	Normal Year	Single Dry Year	Average Year	Single Dry Year
City of American Canyon	8,470	3,825	6,328	6,328
Antelope Valley-East Kern Water Agency	124,550	46,750	85,670	85,920
Castaic Lake Water Agency	118,309	118,664	80,800	88,900
Coachella Valley Water District	157,700	157,700	157,700	157,700
Desert Water Agency	55,600	47,160	47,157	47,157
San Bernardino Valley Municipal Water District	352,552	342,227	270,747	276,613
San Gorgonio Pass Water District	20,700	5,474	20,400	5,500
Santa Clara Valley Water District	435,800	407,900	435,800	407,900
Alameda – Zone 7 Water Agency	99,500	78,200	89,500	48,500
Metropolitan Water District of Southern California	2,657,000	2,523,000	1,677,000	1,826,000

Source: Urban Water Management Plans for individual agencies

It is anticipated that increased availability of total water supplies from a NODOS project would generally result in a corresponding decrease in the purchase of water through transfers, and/or reduced use of groundwater in drier years. Implementation of the project would not improve infrastructure capacity or remove regulatory constraints that limit growth in municipal and industrial water purveyors' service areas.

Water Supply Reliability

Water supply reliability is defined as delivering a specific quantity of water with a determined frequency to a particular location at a particular time. There is a need for increased dependability (i.e., certainty of timing) of water delivery to the people receiving it. As one of CALFED's four primary interrelated objectives, water supply reliability integrates the water supply elements of storage, conveyance, and quality. Federal, State, local, and regional governments and water suppliers have a role in ensuring water resource sustainability and improving water supply reliability for the existing and future population and the environment. The decline in water supply reliability poses an opportunity to add new surface storage to improve CVP/SWP system operations, and thereby increase water supply reliability.

Water supply reliability is complicated by the need for consistent and expedited delivery of water to downstream environmental, agricultural, and urban users. During prolonged drought, water supplies are less reliable, which increases competition and can lead to conflict between water users. The Delta serves as the diversion point for water supply for 27 million people, but it is experiencing an ecosystem crisis where anadromous salmonids, Delta smelt, and other species populations are all at their lowest recorded levels. New offstream surface storage could provide a means of addressing the competition for water supply in the Delta by capturing water when it is available and then releasing it during drier periods.

The NODOS feasibility Study focuses on the use of offstream storage to capture runoff from major storm events to improve water supply reliability. Water stored in the winter during high-flow conditions in the Sacramento River would be available for use throughout the year. In addition, increased storage would allow more water to be carried over from year to year. This water would be especially helpful in mitigating the effects of drought or multiple dry years and the potential effects of climate variability. Potential climate change effects include sea level rise, variability in precipitation, less snowpack, and variability in the timing of runoff. Offstream storage can capture runoff water when it is available without having to maintain storage capacity for flood control purposes, and then release the water when it is needed for water supply or environmental purposes.

Water supply needs that can potentially be supported directly by the NODOS project include:

- Agricultural water supply reliability (CVP water contractors, SWP water contractors, and local agricultural water districts)
- M&I water supply reliability (CVP water contractors, SWP water contractors, and local agencies)

Climate Variability and Water Supply Reliability

Climate variability threatens to further reduce water supply reliability throughout California. Sea level rise along the coast is beginning to threaten Delta water supplies and estuarine habitat as seawater intrudes into the Delta.

As a result of climate variability, the Central Valley may experience more runoff during storm events in the future, but see less extended runoff from melting snowpack. The Northern California mountain snowpack is projected to decrease over time, and tend towards melting earlier in the spring. Storage in the Sierra and Trinity snowpack is particularly vulnerable to climate change. Estimates indicate that a rise of 3 degrees Celsius in California would result in the loss of snow at lower elevations, increasing the snowline elevation by as much as 1,500 feet, with a corresponding loss of up to 5 MAF of April 1 snowpack storage (DWR 2005). According to the *Technical Memorandum Report on Progress on Incorporating Climate Change into Management of California's Water Resources* (DWR 2006), the state's snowpack is estimated to contribute an average of approximately 15 MAF of runoff each year, approximately 14 MAF of which are estimated to occur in the Central Valley.

The *Sacramento and San Joaquin Basins Study* (Reclamation 2016b) developed and evaluated five representative climate futures. Under the Central Tendency climate scenario, unmet demands, end-of-September storage, and CVP/SWP exports were negatively impacted. The report includes a risk and reliability assessment.

Some existing reservoirs rely heavily on snowmelt and could be affected by natural snowpack decreases.

Summary of Problems, Needs, and Opportunities for Water Supply and Water Supply Reliability

Table 2-3 summarizes the problems, needs, and opportunities associated with water supply and water supply reliability.

Table 2-3. Problems, Needs, and Opportunities: Water Supply and Water Supply Reliability

Problem	Need	Opportunity
Water supply reliability for municipal and industrial, and agriculture has decreased appreciably, resulting in loss of system resiliency. Delta water quality concerns associated with flows, salinity, water temperature, and toxins negatively affect water supplies for urban and agricultural needs.	Need improved water supply reliability to meet current and future challenges associated with increasing population, agriculture production, environmental needs, and climate variability. Additional water of sufficient quantity is needed to meet drinking water and agricultural needs.	The NODOS project provides an additional water source of high quality that could improve: • Agricultural water supply reliability (CVP water contractors, SWP water contractors, and local agricultural water districts) • M&I water supply reliability (CVP water contractors, SWP water contractors, and local agencies)

CVP = Central Valley Project
M&I = municipal and industrial
NODOS = north-of-the-Delta offstream storage
SWP = State Water Project

Incremental Level 4 Refuge Water Supply

Section 3406 (d) of the CVPIA requires the Secretary of the Interior to provide firm water supplies of suitable quality to maintain and improve 19 identified wetland habitat areas in the Central Valley of California. The fourteen refuges in the San Joaquin Valley named in the CVPIA are managed by USFWS, CDFW, and the landowners of privately owned/managed wetlands in the Grassland Resource Conservation District, which are represented by the Grassland Water District. The refuges are the San Luis, West Bear Creek, East Bear Creek, Kesterson, and Freitas Units of the San Luis National Wildlife Refuge, the Los Banos Wildlife Area, Volta Wildlife Area, Kern National Wildlife Refuge, China Island and Salt Slough Units of the North Grassland Wildlife Area, Grassland Resource Conservation District, Merced National Wildlife Refuge, Mendota Wildlife Area, and Pixley National Wildlife Refuge. Another five wildlife refuges identified in the CVPIA are located north of the Delta in the Sacramento Valley. The refuges are identified in Figure 2-2. Prior to the enactment of the CVPIA, most of these wildlife refuges relied on surplus water, agricultural return flows, junior water rights, and groundwater for water supply; these sources were all either unreliable or of marginal water quality, or both.

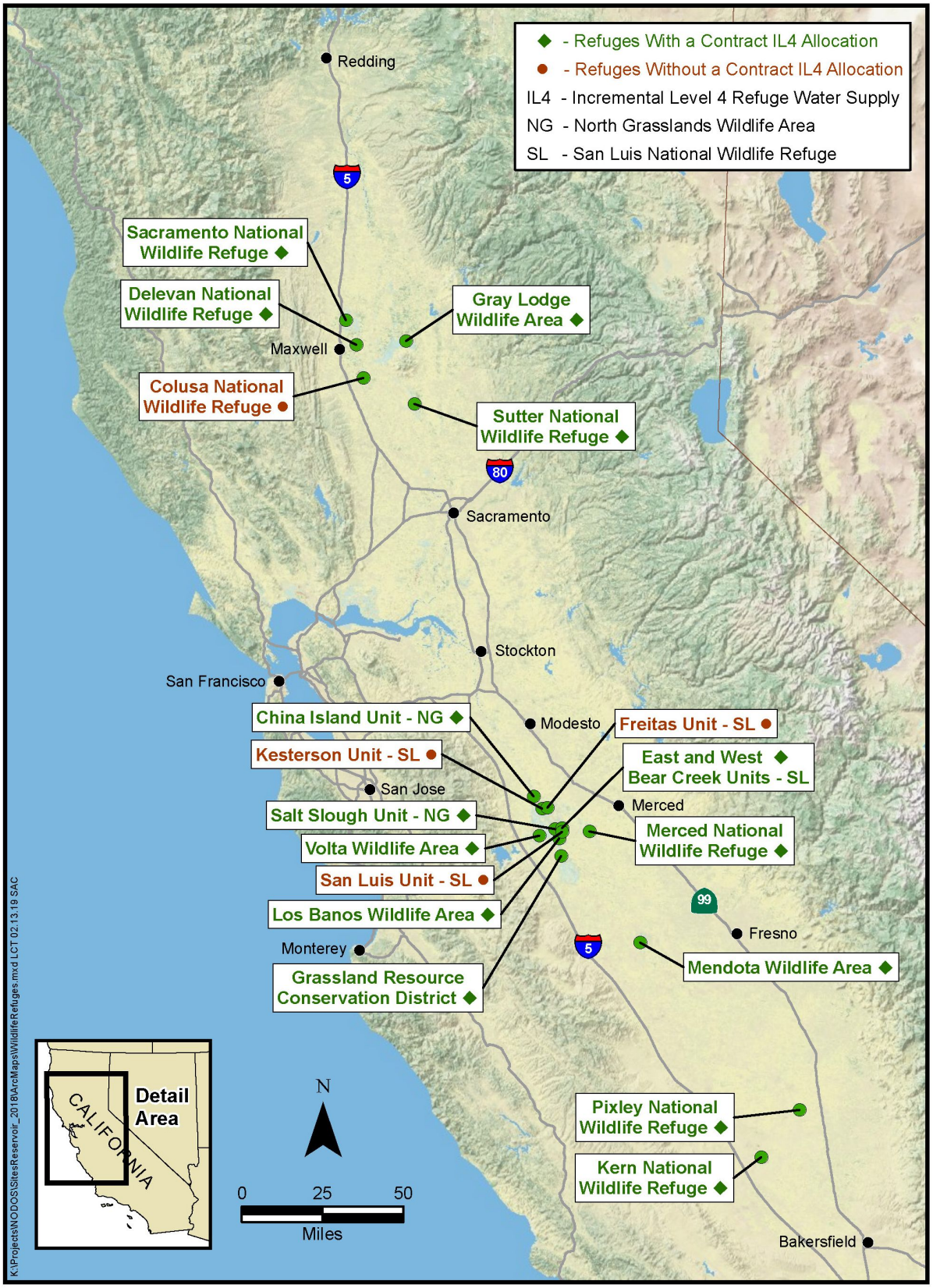


Figure 2-2. Refuges Served by Reclamation's Refuge Water Supply Program

The CVPIA specifies two refuge water types, Level 2 and Incremental Level 4 (IL4), for delivery to the CVPIA refuges. Sections 3406 (d)(1) through 3406 (d)(4) of the CVPIA define requirements for refuge water supplies, as follows:

- **Level 2** – Represents the historical average amount of water received by those CVPIA refuges identified in the Report on Refuge Water Supply Investigations (3/1989) prior to CVPIA enactment in 1992; and represents two-thirds of the water supplies identified for full habitat development for those refuges identified in the San Joaquin Basin Action Plan/Kesterson Mitigation Report (12/1989). The total Level 2 contract allocation is 422,251 acre-feet annually and is considered the baseline water required for wildlife habitat management. Level 2 water is provided primarily from CVP yield.
- **Level 4** – The total amount of water identified for optimum wetlands and wildlife habitat development and management. The CVPIA defines these supplies as the quantities in Level 4 of the "Dependable Water Supply Needs" table for those habitat areas as set forth in the in the *Report on Refuge Water Supply Investigations* (Reclamation 1989) and the full water supply needed for full habitat development for those habitat areas identified in the *San Joaquin Basin Action Plan/Kesterson Mitigation Action Plan Report* (Reclamation et al. 1989). IL4 water is the difference between full Level 4 and Level 2 volumes. CVPIA section 3406 (d)(2) specifies that IL4to be acquired in cooperation with the State of California through "activities which do not require involuntary reallocations of project yield" (e.g., acquired from willing sellers, water conservation, and/or conjunctive use). CVPIA authorizes CVP water transfers and exchanges that benefit the acquisition of IL4 supplies. For SOD refuges, IL4 water supply contract allocations total about 105,500 acre-feet.

Section 3406 (d)(2) directs Reclamation to supplement Level 2 water supplies to the full Level 4, which would provide for optimum habitat management to support a broad range of species including targeted threatened and endangered species.

Table 2-4 shows CVPIA wildlife refuge water allocations, including Level 2, IL4, and Level 4 volumes.

The Reclamation Refuge Water Supply Program (RWSP), created to implement Section 3604 (d) of the CVPIA, is administered by Reclamation and includes a U.S. Fish and Wildlife representative. The RWSP is tasked with delivering refuge Level 2 and acquiring and delivering IL4 water supplies, including the construction of conveyance facilities to provide the capacity to deliver full Level 4 supplies to the refuges. The RWSP coordinates closely with CDFW, GWD, and the Central Valley Joint Venture (a self-directed coalition consisting of state and Federal agencies, private conservation organizations and a corporation working toward the common goal of providing for the habitat needs of migrating and resident birds in the Central Valley of California) to provide and manage CVPIA water supplies for wetland habitat on those CVPIA Federal, state, and privately managed wetlands in the Central Valley. USFWS, CDFW, and GWD each have a long-term water contract or memorandum of understanding with Reclamation for water supplies for all CVPIA-designated refuges (Reclamation and USFWS 2001; Reclamation and CDFW 2001; and Reclamation and GWD 2001).

Table 2-4. Level 2 and Level 4 Refuge Water Supply Contract Allocations

Refuge	Level 2 (acre-feet)	Incremental Level 4 (acre-feet) [1]	Full Level 4 (acre-feet) [1]
North of Delta Refuges			
Sacramento NWR	46,400	3,600	50,000
Delevan NWR	20,950	9,050	30,000
Colusa NWR	25,000	0	25,000
Sutter NWR [2]	23,500	6,500	30,000
Gray Lodge WA [2]	35,400	8,600	44,000
Subtotal	***151,250***	***27,750***	***179,000***
South of Delta Refuges			
San Luis NWR			
San Luis Unit	19,000	0	19,000
West Bear Creek Unit	7,207	3,603	10,810
East Bear Creek Unit	8,863	4,432	13,295
Kesterson Unit	10,000	0	10,000
Freitas Unit	5,290	0	5,290
Merced NWR	13,500	2,500	16,000
Los Banos WA	16,670	8,330	25,000
North Grasslands WA			
Salt Slough Unit	6,680	3,340	10,020
China Island Unit	6,967	3,483	10,450
Mendota WA 2	27,594	2,056	29,650
Volta WA	13,000	3,000	16,000
Grassland RCD	125,000	55,000	180,000
Kern NWR	9,950	15,050	25,000
Pixley NWR2	1,280	4,720	6,000
Subtotal	***271,001***	***105,514***	***376,515***
Total North and South of the Delta	**422,251**	**133,264**	**555,515**

Source: Reclamation Refuge Water Supply Contracts (5 contracts: 01-WC-20-1754, 01-WC-20-1755, 01-WC-20-1756, 01-WC-20-1757 and 01-WC-20-1758).

Notes:

[1] Without conveyance losses, which can range from 0% to over 35% of the IL4 volume for deliveries to Refuges located south of the Delta. IL4 conveyance losses must be acquired in addition to the IL4 quantities delivered to the refuge boundaries. Losses for Level 2 are covered by project yield.

[2] Conveyance constrained.

Key:
NWR = National Wildlife Refuge
RCD = Resource Conservation District
WA = Wildlife Area

The overarching goal of the RWSP is to ensure that all wetland habitat areas identified in the CVPIA annually receive water of a specified quantity and suitable quality, meeting needed flow rate and timing, for optimal habitat management. The CVPIA mandates under Section 3406 (d) are to provide the water supply necessary to meet each individual wildlife refuge's annual contract water allocation, convey this water to the wildlife refuge boundaries, and upgrade conveyance facilities or build new facilities to provide the necessary conveyance capacity to meet the CVPIA wildlife

refuges' scheduled contract water needs. The CVPIA specifies that 75 percent of costs associated with implementation of Section 3406 (d)(2) will be deemed a nonreimbursable Federal expenditure, and 25 percent shall be allocated to the State of California. These costs associated with IL4 supplies include water acquisition and conveyance.

The RWSP acquires IL4 supplies primarily through short-term (annual) and medium-term (multi-year) purchases, donations, or exchanges from willing sellers of both surface water and groundwater supplies, with preference for long-term purchases and permanent water rights acquisition. Funding for the RWSP is provided primarily from the CVPIA Restoration Fund through annual Congressional appropriations, with some funding from other sources. The Restoration Fund is coordinated with Reclamation's broader budget such that CVPIA-related activities use multiple funding sources. Available funding for water acquisitions varies annually based on the level of appropriation, and the other competing CVPIA and the RWSP needs (e.g., other CVPIA program activities or refuge conveyance improvements).

Historical water purchases to meet IL4 demands are shown in Table 2-5. The annual volumes of these acquisitions have varied historically, reflecting funding levels, hydrologic conditions, conveyance capacity to the refuges, and availability of conveyance capacity through the Delta. A key goal of the RWSP has been to acquire water on a long-term basis to provide greater reliability of water supplies and to reduce the administrative costs involved in conducting water acquisitions on an annual basis. However, the RWSP has relied primarily on short-term water purchases and exchanges, and a few medium and long-term contracts, to meet IL4 requirements; limited amounts of long-term water have been secured due to diminishing supplies and escalating costs.

IL4 refuge water supply obligations established by the CVPIA are not being fully met at all refuges. From 1994 to 2016, average annual IL4 Refuge water supply deliveries were less than 50 percent of the total IL4 contract allocations. As shown in Table 2-5, during the peak of California's historically unprecedented drought in 2014 and 2015, the RWSP was extremely limited in its ability to acquire water supplies on the spot market because of scarcity and high prices. Since passage of the CVPIA, delivery of full Level 4 refuge supplies to all of the nineteen designated refuges has never been achieved.

The RWSP is not able to meet the full IL4 contract allocations for the following key reasons:

- Funding constraints limit the annual volume of water the RWSP acquires as well as the program's ability to cover the high costs of more reliable, long-term acquisitions and weakening the program's position as a potential buyer on the competitive water market.
- Increased competition for surface water supplies south of the Delta further limits the availability of willing sellers and increases the price for water acquisitions. This is due to hydrological conditions (drought), regulatory constraints (Biological Opinions governing Delta operations), and the willingness of M&I and agricultural water users to pay higher prices to secure available supplies in all year types.
- Limited Delta conveyance restricts the RWSP's ability to acquire NOD supplies and deliver them to refuges south of the Delta. RWSP IL4 supplies have a lower priority at the CVP and SWP pumping facilities in the south Delta.

Table 2-5. South-of-Delta IL4 Water Acquisitions from 1994 to 2016

Contract Water Year	Year Type	Acquisition Amounts (acre-feet) [1,2]	Estimated Deliveries (acre-feet) [3]	Percent of SOD IL4 Obligation (105,514 acre-feet)
2016	Below Normal	24,397	21,225	20%
2015	Critical	8,519	7,412	7%
2014	Critical	7,980	6,943	7%
2013	Dry	33,925	29,515	28%
2012	Below Normal	46,759	40,680	39%
2011	Wet	81,810	71,175	67%
2010	Below Normal	62,238	54,147	51%
2009	Dry	31,726	27,602	26%
2008	Critical	30,308	26,368	25%
2007	Dry	41,111	35,767	34%
2006	Wet	83,822	72,925	69%
2005	Above Normal	70,962	61,737	59%
2004	Below Normal	67,710	58,908	56%
2003	Above Normal	70,000	60,900	58%
2002	Dry	85,390	74,289	70%
2001	Dry	63,005	54,814	52%
2000	Above Normal	67,748	58,941	56%
1999	Wet	43,618	37,948	36%
1998	Wet	6,300	5,481	5%
1997	Wet	69,800	60,726	58%
1996	Wet	36,395	31,664	30%
1995	Wet	88,009	76,568	73%
1994	Critical	29,415	25,591	24%
Average		**51,207**	**43,536**	**41%**

Notes:

[1] Based on individual contract information provided by the Refuge Water Supply Program, October 20,2017

[2] These amounts do not include amounts from North-of-Delta permanent acquisitions, which have a maximum contract amount of 6,300 AF as of 1998, with an additional maximum contract amount of 3,000 AF as of 2005.

[3] Estimated deliveries adjust the acquisition amounts by an estimated conveyance loss percentage of 13 percent based on Investigation modeling assumptions.

Key:

SOD = south-of-Delta

- Lack of dedicated storage for refuge water supplies limits the RWSP's ability to carry-over IL4 water from one year to the next.
- Conveyance limitations at some refuges prevent delivery of full Level 4 supplies. These limitations will continue until the RWSP completes remaining conveyance facility improvement projects for those specific refuges.

Challenges are likely to increase into the future due to forecasted increases in competition for the finite water resources in California, underscoring continued complications for Reclamation in meeting its obligation to provide reliable, long-term Refuge water supplies. The NODOS project

can provide an additional source for the IL4 water delivered to the refuges through the RWSP on a consistent basis.

Summary of Problems, Needs, and Opportunities for IL4 Water Supply for Refuges

Table 2-6 summarizes the problems, needs, and opportunities associated with IL4 water supply for wildlife refuges. With increasing demand for water in California, and limited available supply, it is likely going to be more difficult to meet the IL4 demands required under the CVPIA.

Table 2-6. Problems, Needs, and Opportunities: IL4 Water Supply for Refuges

Problem	Need	Opportunity
Providing full IL4 water supplies as required under the CVPIA.	Need reliable water supplies to provide for optimum habitat on the refuges.	The NODOS project provides an additional water source that can be used for consistent delivery of IL4 water to the refuges.

CVP = Central Valley Project
CVPIA = Central Valley Project Improvement Act
NODOS = north-of-the-Delta offstream storage
SWP = State Water Project

Coldwater Availability for Anadromous Fish

Anadromous fish hatch and develop in freshwater and migrate to spend a large part of their life cycle in brackish water or saltwater. Anadromous fish eventually return to freshwater to spawn at their location of origin. Sacramento River system anadromous fish include native species (e.g., steelhead, North American green sturgeon, four runs of Chinook salmon, and introduced species such as American shad). Loss of riparian habitat, introduction of non-native predatory

fish, the operation of dams and pumping facilities, polluted runoff, and changes in stream geomorphology have negatively affected the populations of anadromous fish in the Sacramento River hydrologic region. The following Federal- or State-listed endangered and threatened fish species are among those affected by water supply operations in the Sacramento River:

- Chinook salmon: Sacramento River winter-run (Federal and California Endangered Species)
- Chinook salmon: Central Valley spring-run (Federal and California Threatened Species)
- Steelhead: Central Valley (evolutionarily significant unit [ESU]) (Federal Threatened Species)
- North American green sturgeon – Southern Distinct Population Segment (DPS): (Federal Threatened Species)

In addition, the following non-listed fish species may also be affected by water operations:

- Chinook salmon: Sacramento River fall-run
- Chinook salmon: Sacramento River late fall-run
- Sacramento splittail
- River lamprey
- Pacific lamprey
- White sturgeon
- American shad

Coldwater Pool

Anadromous fish in the Sacramento River watershed are sensitive to water temperature. When California reservoirs are relatively full, the cold water released from the hypolimnion (the cold, non-circulating layer of water that lies below the thermocline in a thermally stratified lake) provides cooler water in the summer to downstream reaches. Since the early 1980s, reservoirs have been drawn down because of increased water demands, resulting in warmer-water releases and higher egg mortality rates. The warmer water temperatures have especially harmed winter-run Chinook salmon, which spawn in spring and summer. To address this problem, a temperature control device was added to Shasta Dam to allow for the release of cooler water from the hypolimnion, even when water levels in the reservoir are drawn down.

The CALFED Ecosystem Restoration Program (ERP) included evaluating new sources of water to improve conditions for the spawning, rearing, and migration of myriad fish species in the Sacramento River and the Delta. Further needs exist to provide cooler water for fish spawning habitat.

Temperatures in the Sacramento River for spawning areas below Keswick Dam must be kept near 56 degrees Fahrenheit (°F) to allow salmon and steelhead incubation and smolt survival. Experts disagree on the range of temperatures that various ESUs of salmon need for survival in different life stages. These requirements are further complicated by the number of different species inhabiting the spawning area, and the life stage of each of these species. As an example, the Central Valley steelhead has different freshwater incubation and rearing requirements than do several salmon species, because steelhead require longer periods in freshwater. Therefore, juvenile steelhead may be present in the Sacramento River spawning grounds when fall-run Chinook salmon are beginning to spawn, and each may have independent water supply and water quality needs. Four seasonal runs of Chinook salmon occur in the Sacramento River drainage area, with each run being defined by a combination of adult migration timing and spawning, juvenile residency, and smolt migration periods.

Similar issues exist in the Trinity, American, and Feather River watersheds. Systemwide integration of a NODOS project could potentially provide temperature-related benefits in these watersheds as well, but the greatest opportunity that could be addressed by a NODOS project is in the reach of the Sacramento River between Keswick Dam and Red Bluff Pumping Plant.

Stabilization of Fall Flows

In addition to a need for better temperature management, there is also a need to improve flows for anadromous fish migration. In 2009, NMFS released a proposed Central Valley Salmon and Steelhead Recovery Plan (NMFS 2014). The proposed recovery strategy has many components, including the need to restore ecological flows throughout the Sacramento River Basin. There is a particular need to stabilize fall flows in the reach of the Sacramento River between Keswick Dam and RBPP to minimize dewatering of fall-run Chinook salmon redds, particularly during fall months. By exchanging water in a NODOS project for water in Lake Shasta, fall flows could be augmented in the portion of the Sacramento River downstream from Keswick Dam.

A similar need exists for stabilizing flows in the lower American River to minimize the dewatering of fall-run Chinook salmon and steelhead redds, and to reduce isolation events for juvenile anadromous salmonids.

Summary of Problems, Needs, and Opportunities to Provide Coldwater for Anadromous Fish

Table 2-7 summarizes the problems, needs, and opportunities associated with anadromous fish and other aquatic species. The need for additional cold water increases as temperature rises under climate change scenarios and the coldwater pool becomes more difficult to maintain.

Table 2-7. Problems, Needs, and Opportunities: Coldwater for Anadromous Fish

Problem	Need	Opportunity
Populations of anadromous and endemic fish species in the Sacramento Valley river system and the Bay-Delta are declining due to warmer water temperatures and low flows.	Need additional cold water and increased flows for anadromous fish migration, spawning, and rearing.	The NODOS project provides an additional water source that could be cooperatively operated with the CVP and SWP systems to provide water to help stabilize river flows in the fall, and facilitate the release of additional cold water (from Shasta and Oroville Reservoirs) to benefit anadromous fish in the Sacramento River watershed.

CVP = Central Valley Project
NODOS = north-of-the-Delta offstream storage
SWP = State Water Project

Water Quality

Improved water quality in the Delta is needed for drinking water, agriculture, and environmental restoration. *Our Vision for the California Delta* (Delta Vision Blue Ribbon Task Force 2008) emphasized the need for California to encourage equitable access to higher-quality water sources, and to reduce conflict among water users for diversion from the highest-water-quality locations. It also emphasized the importance of meeting water quality standards in both storage and conveyance systems. The NODOS Investigation considers the need to improve water quality by providing increased flows of high-quality water during periods when water quality is impaired.

Delta Environmental Water Quality

Achieving the co-equal goals of water supply and protection and restoration of the ecosystem for the Delta is one of the ten actions in the *California Water Action Plan 2016 Update* (NRA, CDFA, and CalEPA n.d.). Delta fisheries are sensitive to a variety of water quality constituents. For example, Delta smelt require a water source with a solution electrical conductivity (EC_w) of less than 12,000 EC_w to reproduce. In addition, there is strong opinion that the survival of Delta smelt increases as X2[1] moves west of Collinsville and downstream toward San Francisco Bay. State Water Resources Control Board (SWRCB) Decision 1641 (D-1641) requires X2 implementation from February to June to improve habitat protection for fish in the Delta. The intent of the X2 requirement is to maintain adequate transport flows to move Delta smelt away from the influence of the CVP/SWP water diversions and into low-salinity rearing habitat in Suisun Bay and the lower Sacramento River. In addition to electrical conductivity (EC) and salinity requirements, the ideal water temperature for Delta smelt is 71.6°F, but they cannot survive if water temperatures exceed 77°F. Accordingly, there is a need to provide freshwater of sufficient quality and temperature to meet the biological needs of Delta smelt and other Delta species.

[1] X2 is a Delta management tool that is defined as the distance in kilometers from the Golden Gate Bridge to the location where the tidally averaged near-bottom salinity in the Delta measures 2 parts per thousand.

Urban and Agricultural Water Quality Improvements

The Delta system is the diversion point for drinking water for millions of Californians, and it is critical to California's agricultural sector.

Typically, the months of April through July are most favorable with respect to the Delta as a source of drinking water. Outflow from natural runoff is usually high enough during this period to push seawater out of the Delta toward San Francisco Bay. This period is also outside of the peak loading time related to agricultural drainage. Addressing the USFWS Biological Opinion (BiOp) and NMFS BiOp (USFWS 2008; NMFS 2009) requirements for flow and temperature has resulted in a shift in exports from the higher-quality spring months to the typically lower-quality fall months, with the corresponding degradation in delivered water quality. Improving water quality in these months can reduce treatment costs for water used by CVP and SWP contractors for M&I purposes.

Reduced water quality in exports for San Joaquin Valley agricultural use exacerbates the problems caused by high salinity in agricultural drainage. Using higher-quality water, with less salt, for irrigation reduces the amount of water that needs to be applied to crops, and reduces the pollutant load in agricultural runoff throughout the San Joaquin River watershed.

Summary of Problems, Needs, and Opportunities for Water Quality

Table 2-8 summarizes the problems, needs, and opportunities associated with water quality. Water quality in the Delta would degrade severely with sea level rise. Water quality problems could overwhelm the capacity of existing or future storage to respond to system needs if the sea level rises significantly.

Table 2-8. Problems, Needs, and Opportunities: Water Quality

Problem	Need	Opportunity
Delta water quality concerns associated with flows, salinity, water temperature, and toxins negatively affect Delta fisheries and water supplies for urban and agricultural needs.	Need additional water of sufficient quantity, quality, temperature, and timing to meet drinking water, agricultural, and environmental needs.	The NODOS project provides an additional water source that could be cooperatively operated with the CVP and SWP systems to facilitate several ecosystem restoration and enhancement actions to improve conditions in the Delta and Sacramento River watershed.

CVP = Central Valley Project
NODOS = north-of-the-Delta offstream storage
SWP = State Water Project

Sustainable Hydropower Generation

Pumped-storage hydropower generation is a well-established technology that is an attractive alternative to the fossil-fuel-powered electrical-generating facilities that are widely used as peaking or load-following resources. The intermittent nature of renewable energy from solar, wind, and some other green technologies means that renewable energy often lacks responsiveness to meet peak demand and follow loads. Therefore, there is an opportunity to add pumped storage hydropower to support the firming of solar and wind resources to provide stable grid operation and reliable supply for customers. The environmental benefits from hydroelectric power primarily arise from the replacement (offset) of fossil fuel generation and the corresponding reduction of its associated

greenhouse gas (GHG) emissions. Hydropower can play an important role in developing more sustainable energy supplies with reduced GHG emissions when paired with solar and wind energy.

Pumped storage produces electricity to supply high peak demands by moving water between reservoirs at different elevations. At times of low electrical demand, excess capacity in the grid is used to pump water into the higher reservoir. When the demand increases, the pump is reversed and water is released back into the lower reservoir through a turbine to generate electricity. Pumped storage schemes currently provide the most commercially important means of large-scale grid energy storage and improve the daily capacity factor of the generation system. Pumped storage offers the benefits of:

- Capacity value: Reliability
- Ancillary services value: Ability to quickly shift power output or demand
- Avoided carbon costs: Reduced GHG emissions
- Clean peak power: Renewable generation (wind and solar power) easily integrated

Hydropower generation associated with the operation of the offstream storage reservoir could be used to support the development of renewable energy (i.e., solar and wind). Federal and State policy initiatives promoting renewable energy include:

- An MOU for hydropower development and integration between the Department of Energy, U.S. Department of the Interior (DOI), and the Department of the Army: signed in March 2010 and extended in March 2015 for another 5 years of continued collaboration between the agencies. This MOU helps meet the nation's needs for reliable, affordable, and environmentally sustainable hydropower development by supporting the goals of doubling renewable energy generation by 2020, and improving the Federal permitting processes for clean energy, as established in the President's Climate Action Plan (Executive Office of the President 2013).
- California Executive Order S-3-05: Signed in June 2005, it established the following GHG emission reduction targets for California:
  - By 2010, reduce GHG emissions to 2000 levels
  - By 2020, reduce GHG emissions to 1990 levels
  - By 2050, reduce GHG emissions to 80 percent below 1990 levels.
- Assembly Bill (AB) 32, California Global Warming Solutions Act of 2006: AB 32 requires reductions in GHG emissions to 1990 levels by 2020 (a reduction of approximately 15 percent).
- California Senate Bill (SB) X1-2: Signed in April 2011, SB X1-2 directs the California Public Utilities Commission's Renewable Energy Resources Program to increase the amount of electricity generated from eligible renewable energy resources per year by 33 percent by December 31, 2020.
- California Executive Order B-30-15: Signed in April 2015, this order added the intermediate target to reduce GHG emissions to 40 percent below 1990 levels by 2030.

- California Senate Bill 32: Signed into California state law in September 2016, SB 32 requires reductions in GHG emissions to 1990 levels by 2030 (a reduction of approximately 80 percent).

Summary of Problems, Needs, and Opportunities for Sustainable Hydropower Generation

Table 2-9 summarizes the problems, needs, and opportunities associated with sustainable hydropower generation. Hydropower generation at Sites Reservoir is likely to be unchanged to slightly improved with future climate variability.

Table 2-9. Problems, Needs, and Opportunities: Sustainable Hydropower Generation

Problem	Need	Opportunity
Demands for power in the state are expected to increase as population, industry, and associated infrastructure growth occurs in the future.	Need new power sources that can meet California's stringent GHG regulations.	The NODOS project provides new pumped storage hydropower to meet the state's need for additional sustainable energy supplies with reduced GHG emissions.

GHG = greenhouse gas
NODOS = north-of-the-Delta offstream storage

Recreation

In Colusa and Glenn Counties, there are existing recreational opportunities for the public at East Park Reservoir in western Colusa County, and Stony Gorge Reservoir in western Glenn County. These reservoirs are relatively remote, and have a combined surface area smaller than the proposed Sites Reservoir. As population increases in the Sacramento Valley, demands for flat water and land-based recreation are expected to increase. Reservoirs provide an opportunity to develop new recreational facilities. Recreation in the immediate vicinity of a new reservoir could include hiking, fishing, camping, boating, and mountain biking. The NODOS Investigation considers various recreational opportunities, including multiple recreation area locations and day-use facilities.

Summary of Problems, Needs, and Opportunities for Recreation

Table 2-10 summarizes the problems, needs, and opportunities associated with recreation.

Table 2-10. Problems, Needs, and Opportunities: Recreation

Problem	Need	Opportunity
Demands for flat-water, river, and land-based recreation are expected to increase as population increases in the region.	Need additional recreation areas to meet the region's increased demands.	The NODOS project provides a new reservoir with recreation areas that could help meet current and future demands.

NODOS = north-of-the-Delta offstream storage

Flood-Damage Reduction

Flooding in the Colusa Basin watershed typically takes place between October and April. The primary cause of flooding is inadequate conveyance capacities in the Colusa Basin Drain and in the many ephemeral streams throughout the watershed. Flood flows from the foothill streams are prone to sudden surges that flow swiftly into the Colusa Basin Drain.

Although the NODOS Investigation is evaluating offstream storage, the construction of any new reservoir provides an opportunity to capture and attenuate flood flows associated with ephemeral watersheds that can be important over a short period. Potential flood-damage reduction benefits in the Stone Corral Creek and Funks Creek watersheds and in downstream areas, such as the community of Maxwell and the Colusa Basin Drain, are being considered.

Summary of Problems, Needs, and Opportunities for Flood-Damage Reduction

Table 2-11 summarizes the problems, needs, and opportunities associated with flood-damage reduction. Flood damage reduction benefits resulting from the construction of dams on the east side of the Sacramento Valley should be resilient to the effects of climate change.

Table 2-11. Problems, Needs, and Opportunities: Flood-Damage Reduction

Problem	Need	Opportunity
Flooding occurs in the Colusa Basin watershed between October and April.	Need to capture or attenuate the sudden surges associated with flooding in the watershed.	The NODOS project provides a new reservoir that could capture and attenuate flood flows, thereby providing flood-damage reduction to the community of Maxwell and the Colusa Basin Drain.

NODOS = north-of-the-Delta offstream storage

Cooperative Operations to Achieve Project Objectives

Achieving the increases in water supply deliveries in the CVP and SWP service areas and providing benefits to anadromous fish will require cooperative operations for the NODOS facilities with the CVP and SWP facilities. The Authority has formed an Operations Work Group to develop an Operations Agreement for operations with Reclamation and DWR. Successfully completing this agreement is necessary to address the problems, needs, and opportunities and to deliver the project benefits. Completing this agreement is further discussed in Chapter 6, Alternative Development.

Existing Water Resources Facilities in Study Area

Central Valley Project

Reclamation owns the CVP, which delivers a total of about 7 MAF annually to 253 CVP contractors for agricultural use (6.2 MAF), urban use (0.5 MAF), and refuge use (0.4 MAF) (Reclamation 2008b, 2017a). Initial Federal authorization of the CVP was included in the 1935 Rivers and Harbors Act, and construction began in the late 1930s. When the Rivers and Harbors Act was reauthorized in 1937, Reclamation took over CVP construction and operation with three project purposes:

- To regulate rivers and improve flood control and navigation
- To provide water for irrigation and domestic use
- To generate power

Under later reauthorizations and through legislation for specific project additions, more project purposes were added, including recreation, fish and wildlife enhancement, and water quality improvements. The CVP supplies water for irrigation, M&I, and environmental purposes

throughout the Central Valley. The CVP comprises 20 dams and reservoirs, 39 pumping plants, 2 pumping-generating plants, 11 power plants, and 500 miles of major canals, conduits, and tunnels. The Jones Pumping Plant, a major CVP pumping plant in the south Delta, conveys water to the Delta-Mendota Canal. The CVP supplies water for one-third of the agricultural land in California (about 5 million acres), and delivers water to meet the needs of 1 million households in California annually. The pertinent features of the CVP relative to the NODOS Investigation are described in the rest of this section.

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) includes "amendments to Central Valley Project Authorizations Act of August 26, 1937." Specifically, these amendments include adding "fish and wildlife mitigation, protection, and restoration" as a priority equal to water supply and adding "fish and wildlife enhancement" as a priority equal to hydropower generation. CVPIA Section 3406(d) contains specific actions related to the Central Valley Refuges and Wildlife Habitat Areas. CVPIA Section 3406(d) states the following:

> Central Valley Refuges and Wildlife Habitat Areas.--In support of the objectives of the Central Valley Habitat Joint Venture and in furtherance of the purposes of this title, the Secretary shall provide, either directly or through contractual agreements with other appropriate parties, firm water supplies of suitable quality to maintain and improve wetland habitat areas on units of the National Wildlife Refuge System in the Central Valley of California; on the Gray Lodge, Los Banos, Volta, North Grasslands, and Mendota state wildlife management areas; and on the Grassland Resources Conservation District in the Central Valley of California.
>
> > *(1) Upon enactment of this title, the quantity and delivery schedules of water measured at the boundaries of each wetland habitat area described in this paragraph shall be in accordance with Level 2 of the "Dependable Water Supply Needs" table for those habitat areas as set forth in the Refuge Water Supply Report and two-thirds of the water supply needed for full habitat development for those habitat areas identified in the San Joaquin Basin Action Plan/Kesterson Mitigation Action Plan Report prepared by the Bureau of Reclamation. Such water shall be provided through long-term contractual agreements with appropriate parties and shall be supplemented by the increment of water provided for in paragraph (1) of this subsection; Provided, That the Secretary shall be obligated to provide such water whether or not such long-term contractual agreements are in effect. In implementing this paragraph, the Secretary shall endeavor to diversify sources of supply in order to minimize possible adverse effects upon Central Valley Project contractors.*
> >
> > *(2) Not later than ten years after enactment of this title, the quantity and delivery schedules of water measured at the boundaries of each wetland habitat area described in this paragraph shall be* in *accordance with Level 4 of the "Dependable Water Supply Needs" table for those habitat areas as set forth in the Refuge Water Supply Report and the full water supply needed for full habitat development for those habitat areas identified in the*

San Joaquin Basin Action Plan/Kesterson Mitigation Action Plan Report prepared by the Bureau of Reclamation. The quantities of water required to supplement the quantities provided under paragraph (1) of this subsection shall be acquired by the Secretary in cooperation with the State of California and in consultation with the Central Valley Habitat Joint Venture and other interests in cumulating increments of not less than ten percent per annum through voluntary measures which include water conservation, conjunctive use, purchase, lease, donations, or similar activities, or a combination of such activities which do not require involuntary reallocations of project yield.

(3) All costs associated with implementation of paragraph (1) of this subsection shall be reimbursable pursuant to existing law. Incremental costs associated with implementation of paragraph (2) of this subsection shall be fully allocated in accordance with the following formula: 75 percent shall be deemed a nonreimbursable Federal expenditure; and 25 percent shall be allocated to the State of California for recovery through direct reimbursements or through equivalent in-kind contributions.

(4) The Secretary may temporarily reduce deliveries of the quantity of water dedicated under paragraph (1) of this subsection up to 25 percent of such total whenever reductions due to hydrologic circumstances are imposed upon agricultural deliveries of Central Valley Project water; Provided, That such reductions shall not exceed in percentage terms the reductions imposed on agricultural service contractors. For the purpose of shortage allocation, the priority or priorities applicable to the increment of water provided under paragraph (2) of this subsection shall be the priority or priorities which applied to the water in question prior to its transfer to the purpose of providing such increment.

(5) The Secretary is authorized and directed to construct or to acquire from non-Federal entities such water conveyance facilities, conveyance capacity, and wells as are necessary to implement the requirements of this subsection; Provided, That such authorization shall not extend to conveyance facilities in or around the Sacramento-San Joaquin Delta Estuary. Associated construction or acquisition costs shall be reimbursable pursuant to existing law in accordance with the cost allocations set forth in paragraph (3) of this subsection.

The CVPIA also addresses the operational flexibility of the CVP and methods to expand the use of voluntary water transfers, improved water conservation, and initiated CVP yield studies (described below). The CVPIA dedicates 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 dry years, previously available to CVP contractors (Reclamation 2008a).

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 documented 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 was determined to be 516,000 acre-feet on average and 585,000 acre-feet in dry years, with impacts to SOD contractors much greater than impacts to North-of-Delta (NOD) contractors and impacts to agricultural contractors

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

Shasta Dam and Lake

Shasta Dam and Lake are Federally owned. Shasta Dam is a concrete gravity dam on the Sacramento River, about 12 miles northwest of Redding. It controls floodwaters and stores surplus winter runoff that is used for irrigation and M&I purposes; maintains navigation flows; provides instream flows for the conservation of fish in the Sacramento River; protects the Sacramento–San Joaquin Delta from the intrusion of saline ocean water; and generates hydroelectric power.

Shasta Dam is more than 600 feet high, and is the second-largest dam (by mass) in the U.S. Shasta Lake has a capacity of more than 4.5 MAF, and is the largest man-made reservoir in California. The Shasta Power Plant is below Shasta Dam on the Sacramento River and has the capacity to generate 710 megawatts. Shasta Reservoir delivers about 55 percent of the total annual water supply developed by the CVP.

Keswick Dam and Reservoir

Keswick Dam and Reservoir are Federally owned CVP features. Keswick Dam is on the Sacramento River, about 9 miles downstream from Shasta Dam. It is a concrete gravity structure that contains a 23.8-TAF afterbay for Shasta Lake. The dam stabilizes the uneven water releases from the power plants and has a facility to trap migratory fish that operates in conjunction with Livingston Stone National Fish Hatchery, just downstream from Shasta Dam; and Coleman National Fish Hatchery, which is 25 miles downstream on Battle Creek.

Tehama-Colusa Canal

The T-C Canal is Federally owned. The canal is 110 miles long and serves 14 water districts. Through an operation, maintenance, and replacement (OM&R) agreement with Reclamation, the Tehama-Colusa Canal Authority operates and maintains the T-C Canal (and the Corning Canal). The T-C Canal travels south from the RBPP through Tehama, Glenn, and Colusa Counties, and into Yolo County. It terminates about 2 miles south of Dunnigan in Yolo County. The initial capacity of the canal is 2,530 cfs, diminishing to 1,700 cfs at the terminus. Canal flows are re-regulated by Funks Reservoir, which is along the canal about 66 miles downstream from RBPP. The canal capacity at Funks Reservoir is 2,100 cfs. The RBPP currently has space for two additional pumps.

The T-C Canal diverts water from the Sacramento River through a modern fish screen and pumping plant at Red Bluff. The Red Bluff Diversion Dam Fish Passage Improvement Project was completed in 2012. It appreciably improved fish passage and the reliability of irrigation water deliveries. The new pumping plant and flat-plate fish screen deliver up to 2,000 cfs into the T-C and Corning Canals.

Funks Dam and Reservoir

Funks Dam and Reservoir are Federally owned CVP features. Funks Reservoir is formed by an earth-filled dam on Funks Creek in Colusa County, about 7 miles northwest of Maxwell. The reservoir can hold 2.25 TAF, with a surface area of 232 acres at a water surface elevation of 205 feet. A 40-foot-high compacted earthfill dam impounds the reservoir on the east. The dam forms the

downstream bank of the T-C Canal as it crosses Funks Creek; it is used to re-regulate canal demands or releases.

The T-C Canal runs through Funks Reservoir with an inlet at the northeastern end, adjacent to the dam spillway, and an outlet to the southeast. The spillway overflow discharge capacity is 25,000 cfs with all gates fully open. Because the watershed receives little runoff, Funks Reservoir serves as an offstream regulatory reservoir filled by diversions from the Sacramento River via the T-C Canal.

Colusa Basin Drain

Reclamation District 2047 and the Colusa Basin Drainage District operate the Colusa Basin Drain (CBD). The CBD provides water for agriculture and other beneficial uses, including wildlife habitat and warm-water fisheries. It collects water drained from more than 450,000 acres of agricultural land. Runoff from 11 streams draining the western foothill and valley floor watersheds contributes flow to the CBD. The CBD flows southward through Glenn, Colusa, and Yolo Counties and enters the Sacramento River at Knights Landing. The Sacramento River levee system serves to isolate the historic Colusa Basin drainage system, except when flood flows on the Sacramento River exceed 300,000 cfs near Ord Ferry. In general, the CBD conveys flood flows from November through March, and agricultural irrigation and drainage flows from April through October. The northern half of the CBD does not have levees. Beginning south of Colusa, left-bank levees extend southward to the CBD's confluence with the Sacramento River. Reclamation Districts 108 and 787 pump the drainage from interior lands that are surrounded by levees to either the Sacramento River or the CBD. The drainage area at State Route (SR) 20 is 973 square miles, and the average annual runoff is 497 TAF.

Glenn-Colusa Irrigation District Canal

GCID owns, operates, and maintains the GCID Canal, a 65-mile-long irrigation canal that supplies water from the Sacramento River. The water moves into a complex system of more than 900 miles of laterals and drains for delivery to more than 1,200 farms on about 141,000 acres of agricultural land. GCID's Hamilton City pump station is at the headworks of the GCID Canal, about 100 miles north of Sacramento. The pump station is on an oxbow off of the main stem of the Sacramento River.

GCID diverts a maximum of 3,000 cfs from the Sacramento River at the Hamilton City pump station, with the peak demand in the spring, often at the same time as the peak out-migration of juvenile salmon. GCID, in partnership with Reclamation, completed fish screens at its Hamilton City pump station in 2000. The United States Army Corps of Engineers (USACE) built a gradient facility on the main stem to restore and stabilize the river channel and surface water elevations at the fish screen to improve fish passage conditions and screen performance. Water passes through the fish screens, where a portion of it is pumped into GCID's main irrigation canal. The remaining flow in the oxbow passes by the screens and then back into the main stem of the Sacramento River.

State Water Project

DWR operates and maintains the SWP, which delivers water to 29 agricultural and urban contractors in the Central Valley, the San Francisco Bay Area, the Central Coast, and Southern California. The SWP delivers water for agricultural, municipal, and industrial uses, providing water to 20 million Californians and 660,000 acres of irrigated farmland. It comprises 20 pumping plants, 5 hydroelectric power plants, 33 storage facilities, and more than 660 miles of aqueducts and pipelines.

The SWP operates under long-term contracts with public water agencies from Sutter, Butte, and Plumas Counties in the north to Alameda, Santa Clara, and Napa Counties in the Bay Area, through the San Joaquin Valley, and finally to Southern California. These agencies, in turn, deliver water to wholesalers or retailers, or deliver it directly to agricultural and urban water users. The SWP was designed to deliver about 4.2 MAF of water per year. The maximum that has been supplied in one year is 3.71 MAF (DWR 2005).

The SWP includes Lake Oroville, the second largest reservoir in California (approximately 3.5 MAF of storage). Oroville Dam regulates releases from the Feather River to the Delta. Other SWP facilities include major diversion facilities and pumps (Clifton Court Forebay and Banks Pumping Plant) in the south Delta and the California Aqueduct, which extends from the south Delta to Southern California.

Chapter 3 Planning Objectives and Constraints and the Alternative Development Process

Planning Objectives and Constraints

The planning objectives for the NODOS Investigation are consistent with the Federal authorization for the Feasibility Study and national objectives to maximize sustainable economic development while protecting the environment and avoiding unwise use of floodplains. The planning objectives also consider the resource management objectives from the CALFED ROD: water supply reliability, water quality, and ecosystem quality. Primary and secondary objectives were used to support the development and evaluation of the NODOS Investigation alternatives. The primary objectives are considered essential to developing a viable project, and the alternatives must meet all of the primary objectives to advance in the evaluation process. Alternatives are developed to effectively and efficiently meet the primary objectives. The development of new storage also provides an opportunity to provide other, secondary benefits. After developing alternatives to meet the primary objectives, the resulting opportunities to achieve the secondary benefits were evaluated.

Planning Objectives

The primary and secondary planning objectives for the NODOS feasibility study are based on the identified problems, needs, and opportunities discussed in Chapter 2. These planning objectives incorporate national, state, and Study-specific goals.

The primary objectives for the NODOS feasibility studies are:

- Water Supply
- IL4 Water Supply to CVPIA Wildlife Refuges
- Anadromous Fish
- Delta Environmental and Export Water Quality

The NODOS alternatives are formulated to achieve these primary objectives, and evaluated to assess their effectiveness in achieving these objectives.

The secondary objectives are:

- Sustainable Hydropower Generation
- Recreation
- Flood-Damage Reduction

The NODOS alternatives are not formulated to maximize the secondary objectives, but opportunities to achieve them were included in the alternatives and evaluated to the extent that they are available. Problems, needs, and opportunities and the corresponding objectives are identified in Table 3-1.

National Goals

The Water Resources Development Act of 2007, Section 2031, Water Resources Principles and Guidelines, establishes National Water Resources Policy and specifies that Federal water resources investments shall reflect national priorities, encourage economic development, and protect the environment by:

- Seeking to maximize sustainable economic development
- Seeking to avoid the unwise use of floodplains and flood-prone areas, and minimizing adverse impacts and vulnerabilities in any case in which a floodplain or flood-prone area must be used
- Protecting and restoring the functions of natural systems and mitigating any unavoidable damage to natural systems

This document is grandfathered into the 1983 guidelines, and incorporates the 2007 congressional guidance when possible.

No hierarchal relationship can be specified for these goals. As a result, trade-offs among potential solutions need to be evaluated during the decision-making process. Federal investments in water resources as a whole should strive to maximize public benefits, with appropriate consideration of costs (WRC 2013). Public benefits include environmental, economic, and social goals. Both monetary and non-monetary effects may be considered.

California Goals

In addition to the national goals and requirements, California's objective for the feasibility studies is to provide technical and financial information to implementing agencies. Key factors that agencies must consider are whether the Sites Reservoir Project can be implemented to ensure public health and safety, and whether it can provide statewide benefits (e.g., water supply reliability, water quality, ecosystem restoration) at a reasonable cost. In the California process, an EIR is required for project environmental compliance under CEQA, and to identify permitting and mitigation requirements. Reclamation and the Authority are preparing a joint EIR/EIS in support of the NODOS Feasibility Study (Reclamation and Authority 2017).

Planning Constraints

The scope of the feasibility studies process is limited by basic constraints specific to the NODOS feasibility studies, which include the following:

CALFED ROD: The CALFED ROD is a general framework for addressing CALFED. It includes program goals, objectives, and projects intended primarily to benefit the Delta system, its tributaries, and areas that receive water supplies exported from the Delta. In addition to the NODOS feasibility studies, the Preferred Program Alternative in the CALFED ROD includes four other surface water

Table 3-1. Summary of Problems, Needs, Opportunities, and Planning Objectives

Problems	Needs	Opportunities	Planning Objectives
Water supply			
Water supply reliability for municipal and industrial, and agriculture has decreased appreciably, resulting in loss of system resiliency.	Need improved water supply reliability to meet current and future challenges associated with increasing population, agriculture production, environmental needs, and climate change.	The NODOS project provides an additional water source of high quality that could improve: • Agricultural water supply reliability (CVP water contractors, SWP water contractors, and local agricultural water districts) • M&I water supply reliability (CVP water contractors, SWP water contractors, and local agencies)	Improve water supply, and water supply reliability
IL4 Water Supply to CVPIA Wildlife Refuges			
Delivering reliable IL4 water supplies annually to refuges as required by the CVPIA.	Need reliable water supplies to provide for optimum habitat management on the refuges.	NODOS provides an additional water source that can be cooperatively operated with the CVP/SWP system and used for consistent delivery of IL4 water to the refuges.	Provide IL4 water supply for the refuges
Coldwater for Anadromous Fish			
Populations of anadromous and endemic fish species in the Sacramento Valley river system are declining due to warmer water temperatures and low flows.	Need additional cold water and increased flows for anadromous fish migration, spawning, and rearing.	NODOS provides an additional water source that could be cooperatively operated with the CVP and SWP systems to provide water to help stabilize river flows in the fall, and facilitate the release of additional cold water (from Shasta and Oroville Reservoirs) to benefit Sacramento River anadromous fish and other aquatic species.	Improve the survival of anadromous fish and other aquatic species
Water Quality			
Delta water quality concerns associated with flows, salinity, water temperature, and toxins negatively affect Delta fisheries and water supplies for urban and agricultural needs.	Need additional water of sufficient quantity, quality, temperature, and timing to meet drinking water, agriculture, and environmental restoration needs.	NODOS provides an additional water source that could be cooperatively operated with the CVP and SWP systems to facilitate several ecosystem restoration and enhancement actions to improve conditions in the Delta and Sacramento River watershed.	Improve water quality in the Delta environment and for Delta export

Problems	Needs	Opportunities	Planning Objectives
Sustainable hydropower generation			
Demands for power in the state are expected to increase as population, industry, and associated infrastructure growth occurs in the future.	Need new power sources that can meet California's stringent GHG regulations.	NODOS provides new pumped storage hydropower to meet the state's need for additional sustainable energy supplies with reduced GHG emissions.	Provide sustainable hydropower generation.
Recreation			
Demands for flat-water, river, and land-based recreation are expected to increase as population increases.	Need additional recreation areas to meet the region's increased demands.	NODOS provides a new reservoir with recreation areas that could help meet current and future demands.	Provide opportunities for recreation.
Flood Damage Reduction			
Flooding occurs in the Colusa Basin watershed between October and April.	Need to capture or attenuate the sudden surges associated with flooding in the watershed.	NODOS provides a new reservoir that could capture and attenuate flood flows, thereby providing flood-damage reduction to the community of Maxwell and the Colusa Basin Drain.	Provide flood-damage reduction

CVP = Central Valley Project
CVPIA = Central Valley Project Improvement Act
GHG = greenhouse gas
NODOS = north-of-the-Delta offstream storage
SWP = State Water Project

and various groundwater storage projects to help meet water supply needs, improve water quality, and improve the ecosystem functions of the Delta system. Although the CALFED ROD does not identify NODOS as a specific project to be pursued, the ROD does identify NODOS (the proposed Sites Reservoir) as a project requiring further investigation. Developed plans should, therefore, incorporate the goals, objectives, and programs or projects of the CALFED ROD.

Offstream Storage

By definition—and consistent with the CALFED ROD—the NODOS feasibility studies are focused on offstream storage locations. The creation of reservoirs that would interrupt major watercourses and impede the migration of fish is not the subject of this investigation.

Laws, Regulations, and Policies

Laws, regulations, and policies that must be considered include, but are not limited to, NEPA, the Fish and Wildlife Coordination Act, the Clean Air Act, the Clean Water Act (CWA), the National Historic Preservation Act (NHPA), the ESA, the California ESA, CEQA, and the CVPIA. The CVPIA of 1992 (P.L. 102-575) influences water supply deliveries, river flows, and related environmental conditions.

Public Outreach Plan

Efforts to engage the public, stakeholders, Federally recognized tribes, NGOs, and public agencies in decisions affecting the Sites Reservoir Project continue to play an important role in the investigation.

Consistent with NEPA, CEQA, and the P&Gs, Reclamation and the Authority have met directly with stakeholders, elected officials, NGOs, agencies, Federally recognized tribes, and the public (including affected landowners) throughout the NODOS Investigation. This interaction has included formal public meetings, focused meetings with specific stakeholder groups, briefings to elected officials, briefings to local public agencies, and tours of the reservoir footprint area. The purpose of this engagement has been, and continues to be, aimed at:

- Identifying and engaging the broadest number of stakeholders possible
- Creating and maintaining project transparency by providing project information in a timely and unbiased fashion
- Identifying and resolving issues and concerns within the parameters of the NEPA/CEQA process

Specific outreach activities to support the NODOS Investigation continue, with the goal of expanding awareness of the project, obtaining community support for the project, maintaining transparency and accountability to the public, reducing legal risk, and providing opportunities for public input at appropriate investigation milestones (see Table 3-2).

Table 3-2. Public Outreach

Outreach	Date	Purpose
Sites Authority board meetings	Held monthly	Project progress and issues
California Water Commission meetings	Held monthly	(State) WSIP funding
EIR/EIS tribal consultation led by the Authority	February 2017, April 2017	Compliance with AB52
Tribal coordination meeting with Colusa Indian Community Council	July 2018	Project awareness and progress; tribal feedback/ concerns
Landowner meetings	Variable	Project awareness and progress; tribal feedback/ concerns
Local Agency Briefings	Variable	Project awareness and coordination
Study Area tours	Variable	Project awareness and progress

WSIP = Water Storage Investment Program

CALFED Evaluation of Statewide Reservoir Locations

The 2000 CALFED PEIS/EIR Preferred Program Alternative and associated CALFED ROD (CALFED 2000a, 2000b) recommended that five surface water storage projects be pursued with project-specific studies. These five studies were Shasta Lake Enlargement, Los Vaqueros Reservoir Enlargement, Sites Reservoir, In-Delta Storage, and development of storage in the upper San Joaquin River Basin. As described in the CALFED 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 PEIS/R."

However, the CALFED ROD states that the Sites Reservoir Project would "require substantial technical work and further environmental review and development of cost-sharing agreements before decisions to pursue [it] as part of the CALFED Program." These studies were completed as part of the Draft EIR/EIS.

The preliminary studies in support of the CALFED PEIS/EIR considered more than 50 surface water storage sites (Figure 3-1) throughout California and recommended more detailed study of the five sites identified in the ROD (CALFED 2000a, 2000b, 2000c). Consistent with the above guidance in the CALFED ROD, the Draft EIR/EIS relies on evaluations and alternatives development and screening included in the CALFED PEIS/EIR and focuses on the subsequent action of evaluating the development of the Sites Reservoir Project. Accordingly, the Sites Reservoir Project is an action contained within the CALFED Preferred Program Alternative.

Specifically, CALFED looked for sites that could contribute substantially to its multiple-purpose objectives. These objectives included potential sites that could provide broad benefits for water supply, flood control, water quality, and the ecosystem. CALFED eliminated locations providing less than 0.2 MAF of storage and those that conflicted with CALFED solution principles, objectives, or policies.

Source: Adapted from CALFED 2000c.

Figure 3-1. Locations of 52 Potential Reservoir Sites in Initial Evaluation

This page intentionally left blank.

Of the 52 surface storage sites considered, 40 were removed from CALFED's list during the initial evaluation process (Figure 3-2) detailed in the *Initial Surface Water Storage Screening Report* (CALFED 2000c).

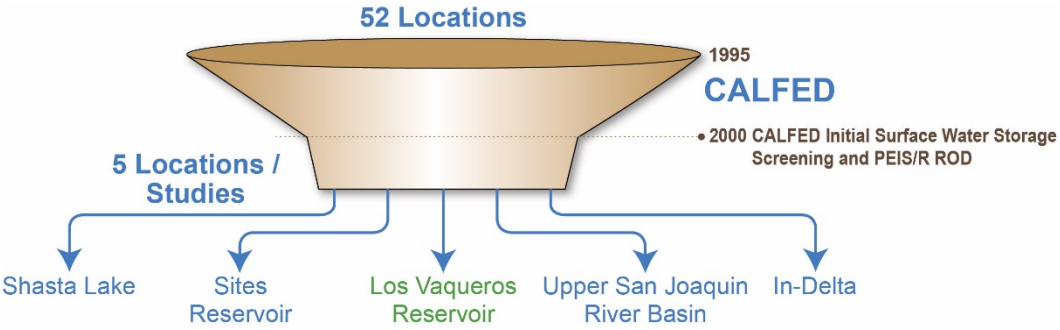


Figure 3-2. CALFED Surface Water Storage Investigations Screening

Alternative Development Process

As discussed in Chapter 1, Introduction, the development of alternatives for the NODOS feasibility studies has been an iterative process that was initiated with the CALFED ROD (see Figure 1-2). The planning process for the NODOS Feasibility Study includes four major phases with their respective milestone products: the NODOS Initial Alternatives Information Report (i.e., the IAIR) (Reclamation and DWR 2006b); the PFR (Reclamation and DWR 2008); status reports, including the 2013 Progress Report (Reclamation and DWR 2013); and the documentation of the Feasibility Study. A Draft Feasibility Report (Reclamation and Authority 2017) was released for public review.

The IAIR documented the first stage in the planning process, and identified several features and activities (structural and non-structural)—called management measures—that met the planning objectives. The IAIR summarized the preliminary screening for the management measures that focused on the evaluation of potential reservoir locations. During the IAIR stage, the Red Bank Project offstream storage alternative was not recommended for further inclusion in the development of measures because of its considerable fishery and environmental impacts. Recognizing the limited scope of the IAIR and the iterative nature of the planning process, the PFR developed a more complete evaluation of management measures and the evaluation of a series of initial alternatives.

Further evaluation of the NODOS alternative reservoir locations and refined alternatives is presented in this Report.

Table 3-3 shows the complete process for developing the initial alternative plans and the final selection of the recommended plan.

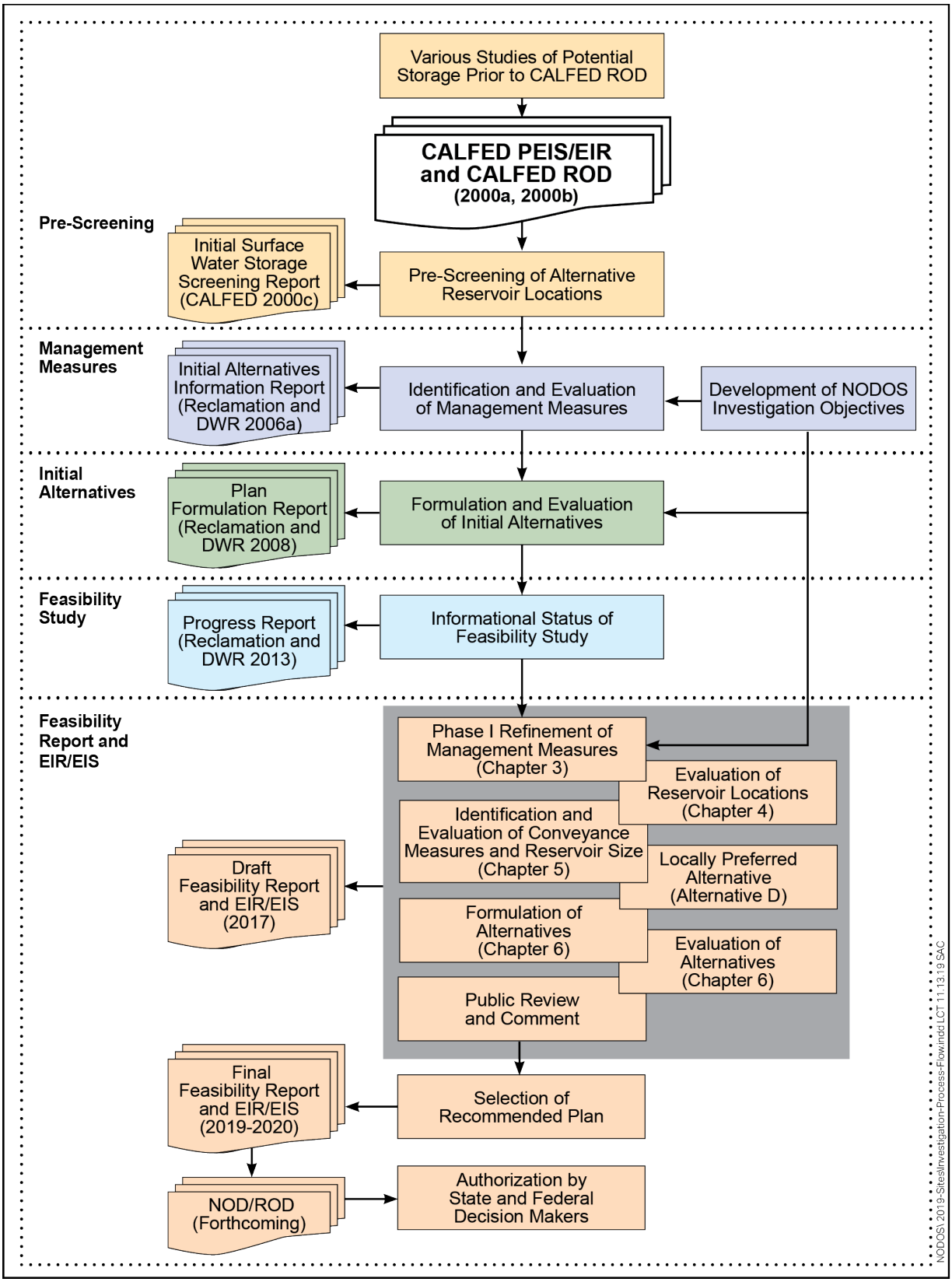


Figure 3-3. NODOS Feasibility Study Process

Identification and Evaluation of Measures to Address Primary Planning Objectives

Numerous management measures have been identified to address each of the primary planning objectives. The development of measures has been an iterative process. Measures were initially identified in the IAIR, and subsequently refined in the PFR and the subsequent feasibility studies process.

Table 3-3 identifies the measures that best address the primary and secondary planning objectives. Measures carried forward best address the objectives for the NODOS feasibility studies, given the consideration of planning constraints and criteria.

Table 3-3. Retained Management Measures to Address Primary Planning Objectives

Objectives	Management Measures
Water supply	Develop NODOS measures for offstream storage
	Incorporate water-use efficiency methods
	Incorporate additional recycling
	Transfer water between water users and source shift (i.e., use groundwater in lieu of surface water and vice versa to better manage water resources)
	Improve flows by integrating a new offstream storage facility into system operations
IL4 water supply for CVPIA wildlife refuges	Reduce year-to-year variability in acquired water supply from willing sellers by developing NODOS measures
Improve the survival of anadromous fish	Improve water quality (temperature) by conserving water at existing reservoirs upstream of critical fish habitat and provide additional flows to support fish migration
Delta environmental and export water quality	Improve water quality by increasing flows to the Delta from new offstream surface storage (NODOS measures)
Sustainable hydropower generation	Incorporate pumped storage into the project
Flood-damage reduction	Provide local flood-damage reduction benefits
Recreation	Provide flat-water recreation benefits

NODOS = north-of-the-Delta offstream storage

The evaluation of NODOS measures included modeling the ability of the system to meet demands under extended dry conditions. Under these conditions, three of the water supply measures (water use efficiency, additional recycling, and water transfers) were found to play a necessary and important role—in combination with the NODOS measures—in improving water supply reliability.

The management measures and further details regarding their evaluation are provided in Appendix A, Plan Formulation. These three measures were evaluated through the use of the Least-Cost Planning Simulation Model (LCPSIM) to assess water supply benefits, rather than by building specific targets for these actions into the No Project Alternative hydrodynamic modeling effort.

This page intentionally left blank.

Chapter 4 Potential Offstream Storage Locations

This chapter describes the evaluation of the offstream storage projects north of the Delta. These proposed sites would provide a range of potential water supply reliability benefits and would also serve similar project purposes. Four of the locations—Red Bank Project, Thomes-Newville (Newville) Reservoir, Colusa Reservoir Complex, and Sites Reservoir—were identified in the CALFED ROD as the preferred locations for north-of-the-Delta offstream storage.

Through the public scoping process, two additional sites,—Cottonwood Reservoir Complex and Veteran's Lake—were recommended for further evaluation.

Reservoir Location Descriptions

Locations for offstream storage evaluated during the NODOS Feasibility Study are described below and shown on Figure 4-1.

- **Colusa Reservoir Complex:** The Colusa Reservoir Complex is in north-central Colusa County and south-central Glenn County, approximately 12 miles southwest of the community of Willows and 10 miles west of Maxwell. Colusa Reservoir Complex would include the area of the proposed Sites Reservoir and the Colusa Cell. The Colusa Cell would be due north of Sites Reservoir, and could be constructed with the Sites Reservoir facilities to form a single 28,000-acre reservoir. The inundation area of the Colusa Cell is in the Logan Creek and Hunter Creek watersheds (35,000 acres), with the associated United States Geological Survey (USGS) subbasins. A mean full pool elevation of 520 feet[1] would inundate approximately 14,000 acres in the Colusa Cell, and could store an additional 1.2 MAF. The maximum storage of the Colusa Reservoir Complex would be 3.0 MAF. The Colusa Cell would require a total of 16 dams (all dams for Sites Reservoir and four additional major dams along Logan ridge: one for Logan Creek, and three for Hunter Creek and its tributaries). The Colusa Reservoir Complex requires seven saddle dams, compared to the nine required for Sites Reservoir. The Colusa Reservoir Complex would provide greater total storage capacity (up to 64 percent greater storage capacity than Sites Reservoir).
- **Cottonwood Reservoir Complex:** Cottonwood Reservoir is in northwestern Tehama County, approximately 21 miles southwest of Anderson. The Cottonwood Reservoir Complex could be designed as a 0.4 MAF reservoir (Cottonwood South Reservoir), or as a 1 MAF reservoir (Cottonwood South Reservoir and Cottonwood North Reservoir). At 0.4 MAF, the reservoir (Cottonwood South Reservoir) would cover 3,400 acres. If expanded

[1] Elevations in this document are based on the National Geodetic Vertical Datum.

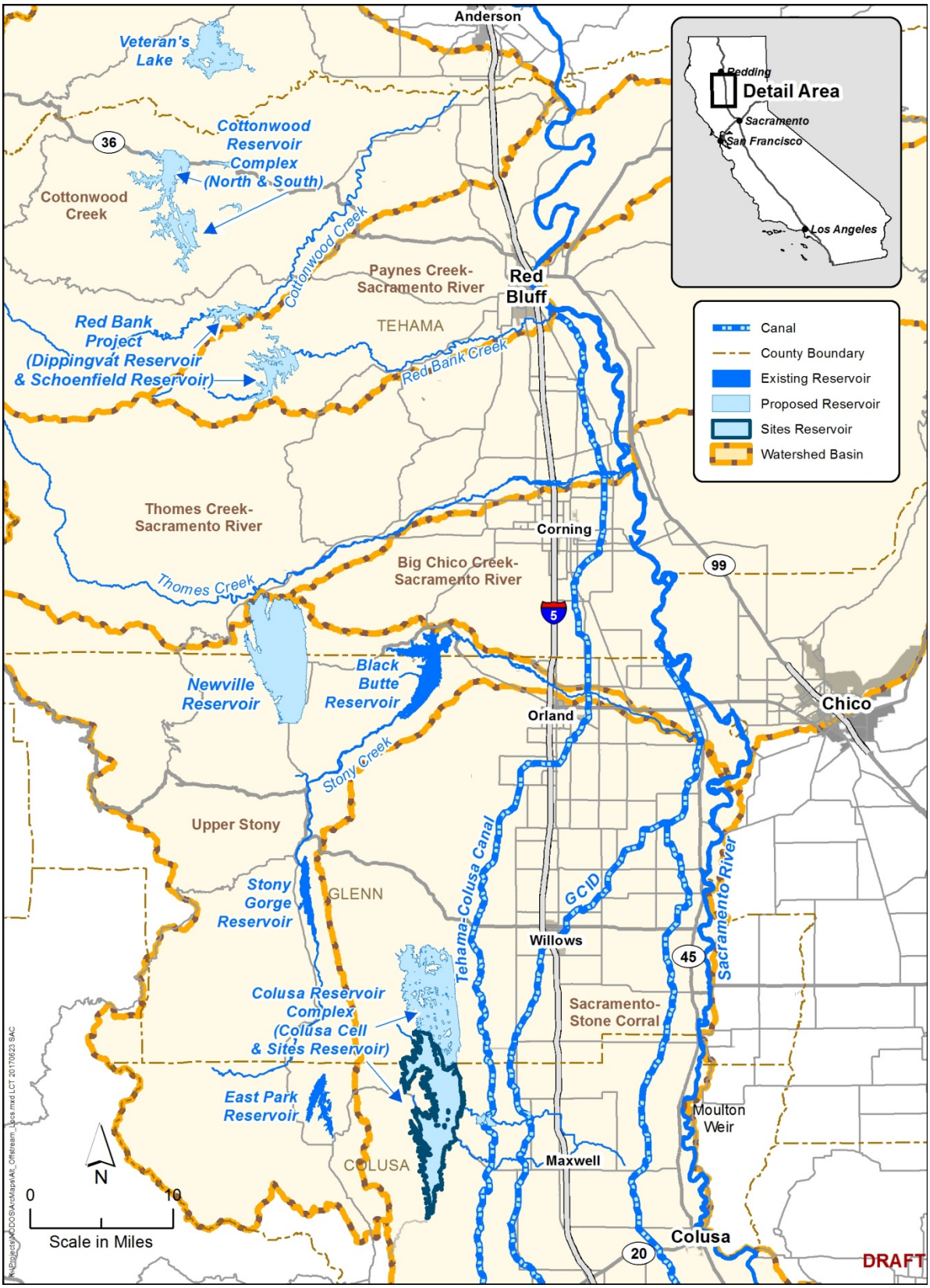


Figure 4-1. Alternative Offstream Locations for NODOS/Sites Reservoir Project

to 1 MAF, the reservoir would cover 7,100 acres at a mean pool elevation of 1,300 feet. The Cottonwood South Reservoir would be filled by runoff from 179,500 acres in the South Fork of the Cottonwood Creek, Salt Creek, and Hensley Creek watersheds. The Cottonwood North Reservoir would be filled by runoff from 84,000 acres from the Beegum Creek and Dry Creek watershed. Cottonwood South Reservoir would be formed by a dam on Salt Creek just upstream from Dexter Gulch, 4 miles south of State Route (SR) 36. Cottonwood North Reservoir would be formed by a dam on Dry Creek just downstream from the confluence with Pentacola Gulch, on Route 36.

- **Newville Reservoir:** Newville Reservoir would be situated in north-central Glenn County and south-central Tehama County, approximately 18 miles west of the city of Orland and 23 miles west-southwest of the city of Corning. This proposed reservoir project would be in portions of the North Fork Stony Creek watershed (51,200 acres) and the Thomes Creek watershed (123,500 acres) and the associated USGS subbasins. A small diversion along Thomes Creek would transfer water to Newville Reservoir in the North Fork Stony Creek watershed. Alternative reservoir sizes of 1.9 and 3.0 MAF were evaluated, with associated normal water surface elevations (WSEs) of 905 and 980 feet, and corresponding reservoir surface areas of 14,500 and 17,000 acres, respectively. Newville Reservoir would be upstream from Black Butte Lake. Constructing a dam on North Fork Stony Creek and a small saddle dam at Burrows Gap would form the smaller proposed reservoir. Up to five additional saddle dams and a dike would be required for the 3.0 MAF reservoir alternative. Multiple conveyance options are possible using existing infrastructure, such as canals, new infrastructure, tunnels, and/or pipelines, or a combination of new and existing mechanisms to provide increased flexibility and reliability in the operation of existing and new infrastructure.
- **Red Bank Project:** The Red Bank Project would be in northwestern Tehama County, approximately 17 miles west of the city of Red Bluff. This reservoir complex would include a diversion on South Fork Cottonwood Creek at Dippingvat Reservoir; two small reservoirs in the headwaters of North Fork Red Bank Creek (Blue Door and Lanyan Reservoirs); and a larger storage reservoir on Red Bank Creek (Schoenfield Reservoir). The South Fork Cottonwood Creek watershed is relatively large (81,900 acres), and the Red Bank Creek watershed is relatively small (27,300 acres). Dippingvat Reservoir would have a normal pool elevation of 1,205 feet and an inundation area of 1,800 acres. Schoenfield Reservoir, with a normal pool elevation of 1,017 feet, would inundate 2,770 acres and have a storage capacity of 0.25 MAF. Both Dippingvat Reservoir and Schoenfield Reservoir would be constructed on perennial streams, and be considered onstream facilities.
- **Sites Reservoir:** Sites Reservoir would be in northern-central Colusa County and southern-central Glenn County, approximately 10 miles west of the community of Maxwell. Water would be diverted from the Sacramento River to fill the reservoir. The proposed reservoir inundation area includes most of Antelope Valley and the small community of Sites. The reservoir is in the Funks Creek and Stone Corral Creek watersheds (59,700 acres), with the associated USGS subbasins. A mean full pool elevation of 520 feet would inundate 14,000 acres, and could store a maximum of 1.8 MAF. Potential reservoir sizes of 1.3 to 1.8 MAF are under consideration. At 1.3 MAF, six saddle dams and two major dams (Sites and Golden Gate Dams) would be required. At 1.8 MAF, Sites Reservoir would require the construction of two major dams (Sites and Golden Gate Dams) and nine saddle dams along the southern edge of the Hunter Creek watershed. Diversions from the CBD, the

Sacramento River, Stony Creek, and local tributaries would provide potential sources of water supply for the Sites Reservoir Project.

- **Veteran's Lake:** Veteran's Lake would be in southwestern Shasta County near Ono, approximately 17 miles west of Anderson; the lake would inundate 5,100 acres and store up to 0.6 MAF at a mean pool elevation of 1,050 feet. Veteran's Lake would be filled from the North Fork Cottonwood Creek, Middle Fork Cottonwood Creek, and Jerusalem Creek watersheds covering 109,500 acres. Veteran's Lake would be formed by Roaring Dam on Roaring Creek and by Crow Dam on Crow Creek and six small saddle dams along the ridge between Roaring Creek and Bee Creek. Roaring Creek Dam would be approximately 3 miles downstream from Bland Road, off of Platina Road.

Summary of Evaluation of Potential Locations

The IAIR (Reclamation and DWR 2006b) evaluated the Colusa Complex, the Newville Reservoir, the Red Bank Project, and the Sites Reservoir. The 2013 Progress Report (Reclamation and DWR 2013) subsequently evaluated the Cottonwood Reservoir Complex and Veteran's Lake. These investigations are described in Appendix A, Plan Formulation.

The primary findings of the evaluation of potential reservoir locations are summarized in Table 4-1. The Colusa Reservoir Complex and Sites Reservoir score highest across the most categories, have appreciably lower environmental impacts, and can leverage existing conveyance systems for diversion and release of water (this leverage notably reduces cost and environmental impacts). The initial cost analysis in the PFR (Reclamation and DWR 2008) found the cost per acre-foot of supply was $64 for Sites Reservoir, compared to $235 for the Colusa Reservoir Complex. Because Sites Reservoir is smaller, it would also have fewer environmental impacts than the Colusa Complex. Therefore, Sites Reservoir was selected as the preferred reservoir location.

Table 4-1. Summary of Evaluation of Offstream Storage Locations

Evaluation Category	Colusa Reservoir Complex	Cottonwood Reservoir Complex	Thomes-Newville Reservoir	Red Bank Project	Sites Reservoir	Veteran's Lake
Storage	3.3 MAF **Score: HIGH**	0.4 to 1.0 MAF **Score: HIGH**	1.8 to 3.0 MAF **Score: HIGH**	0.2 to 0.4 MAF **Score: LOW**	1.2 to 1.9 MAF **Score: HIGH**	0.6 to 1.0 MAF **Score: HIGH**
Potential water sources	Colusa Basin Drain Grindstone Creek Little Stony Creek Sacramento River Stony Creek Thomes Creek Logan Creek Hunter Creek Funks Creek Stone Corral Creek **Score: HIGH**	Beegum Creek Cold Fork Creek Clear Creek South Fork Cottonwood Creek Cottonwood Creek Dry Creek Hensley Creek Sacramento River Salt Creek Weemasoul Creek **Score: HIGH**	Sacramento River Stony Creek Thomes Creek North Fork Stony Creek **Score: HIGH**	South Fork Cottonwood Creek North Fork Red Bank Creek Red Bank Creek **Score: LOW**	Colusa Basin Drain Grindstone Creek Little Stony Creek Sacramento River Stony Creek Thomes Creek Funks Creek Stone Corral Creek **Score: HIGH**	Clear Creek Cottonwood Creek Crow Creek Duncan Creek Jerusalem Creek Roaring Creek Sacramento River Wilson Creek North Fork Cottonwood Creek Middle Fork Cottonwood Creek **Score: HIGH**
Conveyance facilities	Existing Tehama-Colusa and Glenn-Colusa Canals with supplemental intake **Score: HIGH**	No existing facilities **Score: LOW**	No existing facilities **Score: LOW**	No existing facilities **Score: LOW**	Existing Tehama-Colusa and Glenn-Colusa Canals with supplemental intake **Score: HIGH**	No existing facilities **Score: LOW**
Distance for conveyance to the Sacramento River for statewide benefit	14 miles **Score: HIGH**	25 miles **Score: LOW**	23 miles **Score: LOW**	16 miles **Score: HIGH**	14 miles **Score: HIGH**	15 miles **Score: HIGH**
Avoidance of Impacts to fisheries	New diversion south of Hamilton City **Score: HIGH**	Impact to Cottonwood Creek **Score: LOW**	Impact to Thomes Creek **Score: LOW**	Impact to Cottonwood Creek **Score: LOW**	New diversion south of Hamilton City **Score: HIGH**	Impact to Cottonwood Creek **Score: LOW**
Avoidance of Environmental impacts in inundated area	Annual grasslands **Score: MEDIUM**	Blue oak woodland **Score: LOW**	Annual grasslands More oak woodland **Score: LOW**	Foothill pine woodland **Score: LOW**	Rangeland **Score: MEDIUM**	Blue oak woodland and valley oak woodland **Score: LOW**

MAF = million acre-feet

This page intentionally left blank.

Chapter 5 Evaluation of Conveyance and Reservoir Size

The next step in the development of measures for NODOS facilities was to evaluate the many different ways of diverting water into the reservoir and releasing water to the project beneficiaries. The size of the reservoir was also evaluated. A more detailed discussion of the conveyance measures and reservoir size selection is provided in Appendix A, Plan Formulation.

Development of Conveyance Measures

Water must be delivered both to and from the offstream reservoir. As a result, the conveyance measures identified include diversion and delivery facilities (including some measures that can serve both purposes). Diversions would need to provide adequate flows into the reservoir. Deliveries of water from Sites Reservoir would need to reach the service areas and locations with water resource needs and uses. Table 5-1 provides a list of potential conveyance measures.

Table 5-1. Conveyance Measures Considered

Conveyance Facility	Source	Capacity Description
T-C Canal	Sacramento River at Red Bluff	Existing 2,100 cfs capacity Modify to 2,700 cfs capacity Expand to 4,000 cfs capacity Expand to 5,000 cfs capacity
GCID Canal	Sacramento River at Hamilton City	Existing 1,800 cfs capacity Expand to 3,000 cfs capacity Expand to 4,000 cfs capacity Expand to 5,000 cfs capacity
Stony Creek Pipeline Diversion	Stony Creek at existing Black Butte Reservoir Afterbay	1,000 cfs capacity 2,100 cfs capacity
Delevan Pipeline	Sacramento River opposite Moulton Weir	1,500 cfs capacity 2,000 cfs capacity 3,000 cfs capacity 4,000 cfs capacity 5,000 cfs capacity
Colusa Basin Pipeline	Colusa Basin Drain	1,000 cfs pipeline capacity 3,000 cfs pipeline capacity

cfs = cubic feet per second
GCID = Glenn-Colusa Irrigation District
T-C = Tehama-Colusa

The conveyance measures considered are shown on Figure 5-1.

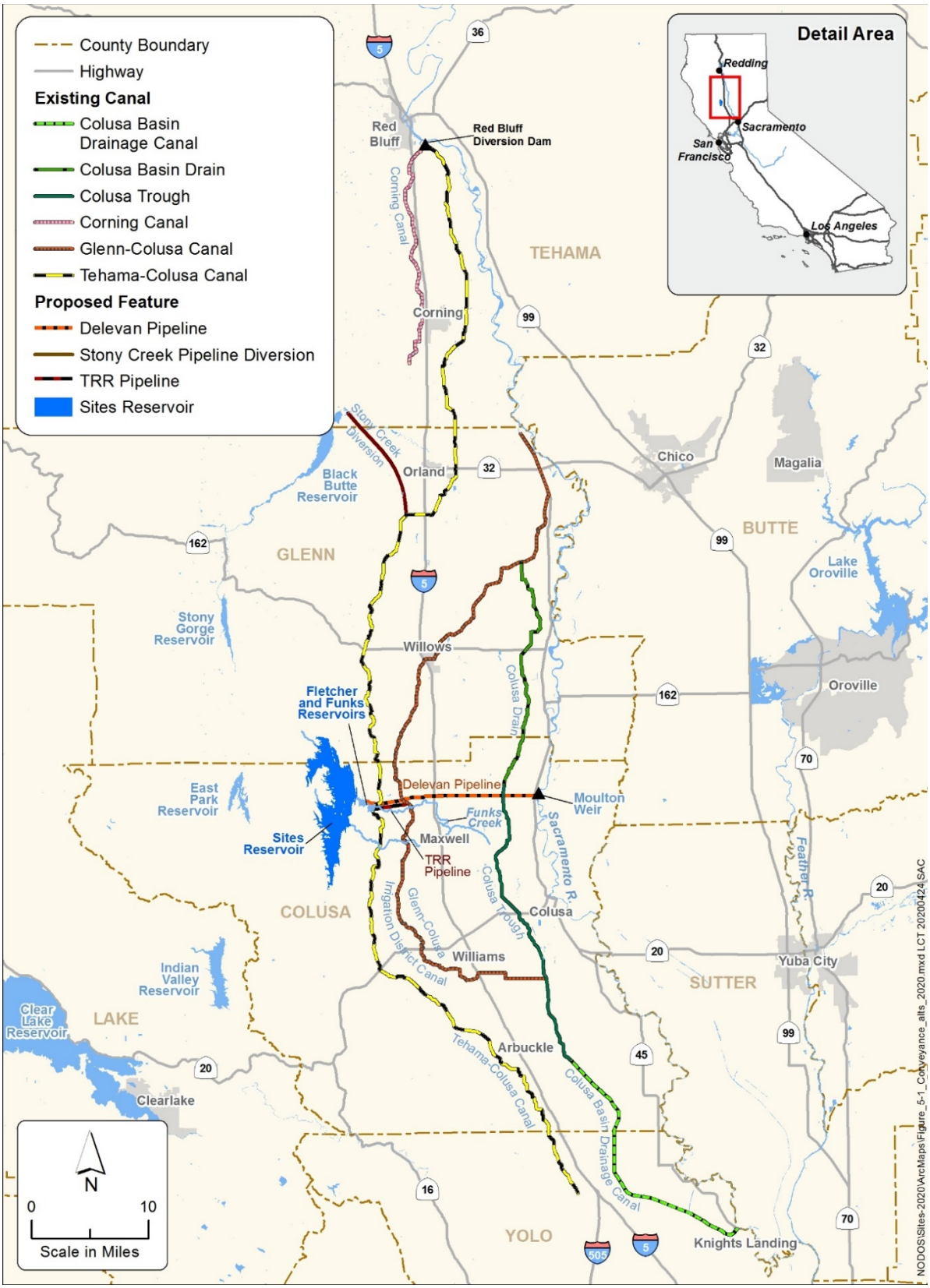


Figure 5-1. NODOS Conveyance Measures

One of the primary advantages of the Sites Reservoir location is that it provides the ability to use and incorporate the existing GCID and T-C Canals into the project. Leveraging existing infrastructure for conveyance markedly reduces both the construction costs and the construction-related environmental impacts. Preliminary operation simulations indicate that 3,000 to 6,000 cfs of total inflow capacity to the proposed Fletcher Reservoir (an expansion of the existing Funks Reservoir) on the T-C Canal is needed to fill Sites Reservoir reliably. The larger T-C Canal measures and Stony Creek Pipeline Diversion require increasing the capacity of the lower portion of the T-C Canal from Orland to the proposed Fletcher Reservoir. This increase in capacity appreciably increases the project costs and environmental impacts.

Figure 5-2 shows a conceptual flow diagram for the array of conveyance measures.

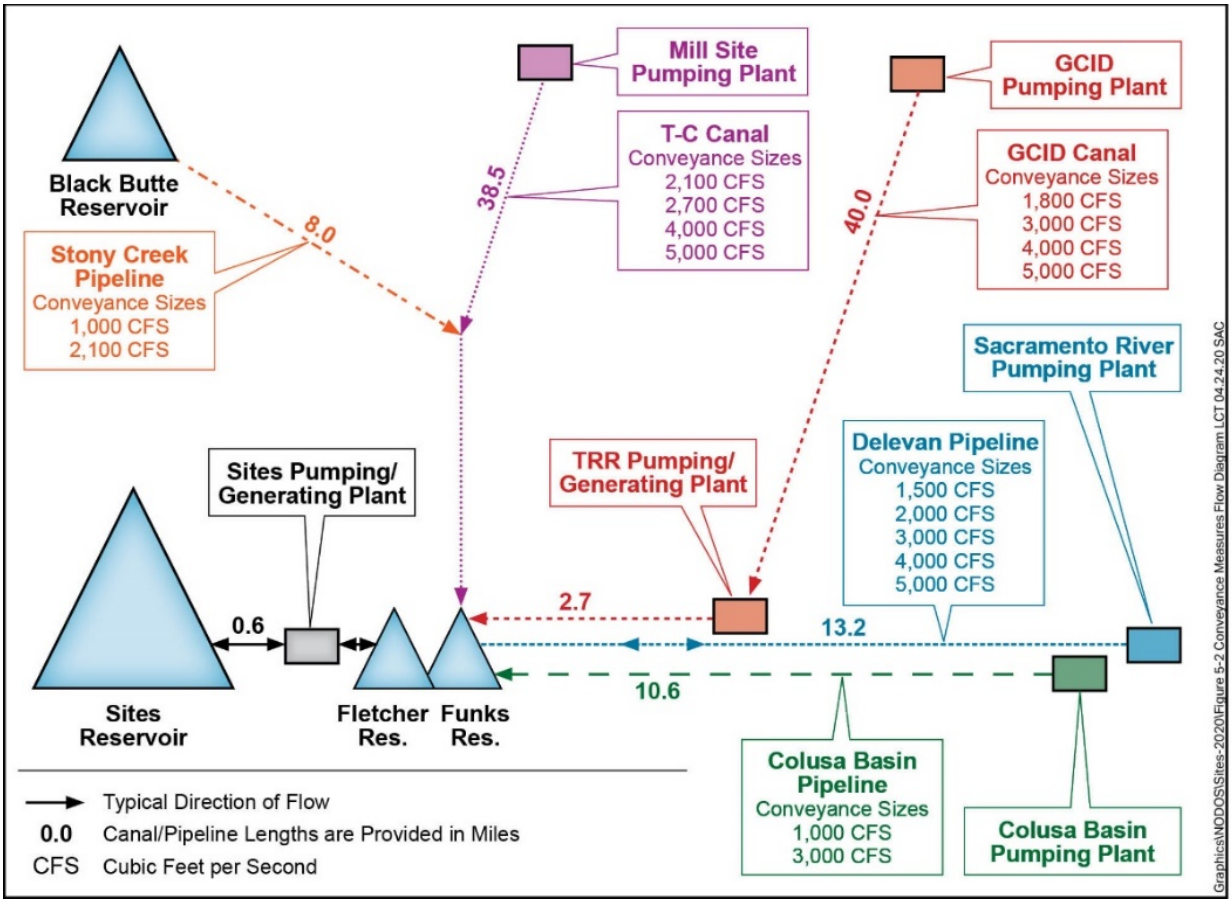


Figure 5-2. Flow Diagram for Conveyance Measures

All measures convey water to the proposed Fletcher Reservoir. Consequently, they can be compared directly to determine their relative performance in conveying water to storage. By contrast, each measure's ability to convey water from Sites Reservoir to areas of need or use, or directly to the Sacramento River, varies. Any conveyance system would facilitate delivery of water to a portion of the T-C service area, because Sites Reservoir uses Fletcher Reservoir on the canal as an afterbay. However, the Stony Creek Pipeline and T-C Canal measures alone do not provide conveyance to additional areas of need or use.

Conveyance from Reservoir to Service Areas or Locations with Various Water Resource Needs and Uses

Three general methods can be used to facilitate the delivery of water to areas of need and use from the proposed Sites Reservoir:

- Water can be delivered directly from Sites Reservoir to meet local needs in the vicinity of the existing GCID and T-C Canals. Needs are defined as currently unmet uses for water.
- Sites Reservoir can deliver water locally in a cooperative way (i.e., using water supply exchanges) with CVP operations, thereby facilitating an ability to meet additional needs throughout the Bay-Delta system. Any Sites Reservoir configuration would be connected to Fletcher Reservoir, and therefore, to the T-C Canal. This connection would facilitate cooperative operations with the CVP, independent of the conveyance measures selected. Additional opportunities for cooperative operations with the CVP would be facilitated by the GCID Canal measures. The benefits resulting from this type of exchange operation relate directly to the amount of water served to the local area by Sites Reservoir that was previously served by the CVP's other facilities. For example, delivering water to CVP contractors in the Sacramento River Valley from Sites Reservoir in lieu of delivering water from Shasta provides additional coldwater pool storage in Shasta. This additional storage would enable the CVP to serve one of the primary objectives of this project without affecting current uses.
- The Delevan Pipeline offers the ability to release water into the Sacramento River directly from Sites Reservoir. Water released from the Delevan Pipeline could provide downstream benefits for Delta water quality and water supply reliability for CVP, SWP, and IL4 water supply to CVPIA wildlife refuges.
- Locations other than the Delevan Pipeline with connectivity to the Sacramento River would provide similar downstream benefits for Delta water quality and water supply reliability for CVP, SWP, and IL4 water supply to CVPIA wildlife refuges, but were not specifically studied for this report.

Initial Evaluation of Environmental Considerations of the Conveyance Measures

The following environmental considerations are also noted for evaluating the various conveyance measures:

- **Water quality:** The CBD is the single largest source of agricultural return flows to the Sacramento River. The water from the CBD is considered to be of relatively poor quality outside of the wet season when compared to Sacramento River water, and therefore CBD water is less desirable as a primary source for diversions. Diversions would need to be restricted to periods when the CBD is primarily conveying natural runoff of higher-quality water to avoid water quality impacts to Sites Reservoir users. The CBD could be used as a means to convey Sites water back to the Sacramento River and depending on the time of year this is accomplished, such additions could improve water quality.
- **Agricultural land:** California's desire to preserve agricultural land is reflected in the California Land Conservation Act, also known as the Williamson Act. The effectiveness of the Williamson Act is often measured by the amount of prime agricultural land (as defined in

the Act) in the program. Expansion of the GCID Canal would require the acquisition of temporary and permanent rights-of-way. Similar impacts to agricultural land are associated with the expansion of the T-C Canal or construction of the Delevan Pipeline.

- **Environmental effects.** Measures that expand the existing canals would affect large land areas temporarily and permanently.

Table 5-2 summarizes the detailed screening of the conveyance measures. Some of the measures that are screened out as not suitable for primary diversions or releases may still be beneficial as supplemental facilities, and could be added at some point in the future. Additional details regarding the screening evaluation are provided in Appendix A, Plan Formulation. Based on the screening of conveyance measures, the most favorable measures were considered to be the existing T-C and GCID Canals, and the Delevan Pipeline with a capacity of less than 3,000 cfs. Inclusion of a conveyance facility with the ability to release water directly to the Sacramento River was considered essential to achieving the objectives of the Feasibility Study.

Evaluation of Various Reservoir Sizes

Four sizes of Sites Reservoir have been considered: 800 TAF, 1.27 MAF, 1.81 MAF, and 2.1 MAF. The reservoir sizes studied were chosen to reflect a range of storage values that would allow for a useful comparison of the developed cost and quantity estimates, and provide for reasonably reliable interpolation for other reservoir sizes not specifically addressed by the four selected reservoir sizes.

Table 5-3 presents a summary of each reservoir storage alternative. The table lists the total number of dams required to impound Sites Reservoir, and the total embankment volume (i.e., amount of material required to construct the dams) for each of the reservoir measures.

After a review of the reservoir rim topography, the site geology, the presence of geologic features trending through the reservoir rim, and a cursory evaluation of the relationship between embankment volume and reservoir storage, it was determined that a 2.1 MAF reservoir may be infeasible. A review of the reservoir rim indicated that reservoir elevations at or above 540 feet would likely require more extensive grouting of the saddle areas along the relatively steep ridges of the eastern rim to ensure the structural integrity of the project. This treatment, combined with the increasing proportion of required embankment material volume and higher reservoir surface elevations, would result in larger unit costs (reservoir cost/AF of storage) for reservoir elevations above 540 feet. Therefore, the reservoir measures below elevation 540 feet were found to be more economical on a unit-cost basis. In addition, detailed geologic and geotechnical evaluations have not been performed on lower-elevation areas of the eastern rim. Therefore, a maximum elevation of 520 feet was selected to ensure that the proposed size of Sites Reservoir would be technically feasible. The maximum reservoir elevation was limited to 520 feet due to questionable conditions on the relatively steeper slopes of the eastern reservoir rim that could result in large increases in project costs during the later stages of design.

Therefore, reservoir sizes of 0.8 MAF, 1.27 MAF, and 1.81 MAF were considered further for alternative development. The larger reservoirs were prioritized for initial evaluation and preferred if the economics were favorable.

Table 5-2. Summary of Conveyance Measures Screening for Primary Intakes

Option	Water Quality	Williamson Act (Impacts to Farm Land)	Biological Impacts	Release to Sacramento River	Cost-Effectiveness	Retained for Further Consideration
T-C Canal Existing	**Score: HIGH**	**Score: HIGH**	**Score: HIGH**	**Score: LOW**	**Score: HIGH**	Yes
T-C Canal Expansion	**Score: HIGH**	Significant construction impact **Score: LOW**	**Score: LOW**	**Score: LOW**	**Score: MEDIUM**	No
GCID Canal Existing	**Score: HIGH**	**Score: HIGH**	**Score: HIGH**	**Score: LOW**	**Score: HIGH**	Yes
GCID Canal Expansion	**Score: HIGH**	Significant construction impact **Score: LOW**	**Score: LOW**	**Score: LOW**	**Score: MEDIUM**	No
Delevan Pipeline < 3,000 cfs	**Score: HIGH**	Significant construction impact **Score: LOW**	**Score: LOW**	**Score: HIGH**	**Score: MEDIUM**	Yes
Delevan Pipeline > 3,000 cfs	**Score: HIGH**	Significant construction impact **Score: LOW**	**Score: LOW**	**Score: HIGH**	**Score: LOW**	No
Stony Creek Pipeline	**Score: HIGH**	Significant construction impact **Score: LOW**	**Score: LOW**	**Score: LOW**	**Score: HIGH**	No
Colusa Basin Drain	Occasionally high EC, TDS, and nutrient levels **Score: LOW**	Significant construction impact **Score: LOW**	**Score: LOW**	**Score: MEDIUM**	**Score: HIGH**	No

cfs = cubic feet per second
EC= electrical conductivity
GCID = Glenn-Colusa Irrigation District
T-C = Tehama-Colusa
TDS = total dissolved solids

Table 5-3. Sites Reservoir Alternative Reservoir Size Summary

Reservoir Storage (MAF)	Maximum Water Surface Elevation (feet)	Reservoir Surface Area (acres)	Total Number of Dams (main + saddle) [a]	Total Embankment Volume (CY)
0.8	440	10,200	2 + 3	6,900,000
1.27	480	12,400	2 + 6	11,600,000
1.81	520	14,200	2 + 9	22,300,000
2.1	540	15,100	2 + 7 [b]	33,800,000

[a] Total number of dams includes the main dams, Sites Dam and Golden Gate Dam, and the saddle dams.
[b] Saddle dams 7, 8, and 9 become one continuous embankment in the 2.1 MAF reservoir alternative.
CY = cubic yards
MAF = million acre-feet

Conveyance and Reservoir Measures Considered for Further Evaluation

From the results of the initial screening of the conveyance measures and reservoir sizes described above, the following measures were further evaluated:

- Sites Reservoir size:
  - 1.27 MAF
  - 1.81 MAF
- Conveyance measures:
  - Existing T-C Canal (2,100 cfs)
  - Existing GCID Canal (1,800 cfs)
  - Delevan Pipeline
    - 1,500 cfs
    - 2,000 cfs
    - 3,000 cfs

Subsequent analysis (see Appendix A) suggested that a 2,000 cfs diversion with the Delevan Pipeline was adequate to fill the reservoir. This allows for releases to the Sacramento River of 1,500 to 2,500 cfs, depending on the design of the energy dissipation system.

This page intentionally left blank

Chapter 6 Alternative Development

This chapter describes the development of the Sites Reservoir Project alternatives.

Previous Facility and Alternative Evaluations

The Sites Reservoir Project alternatives combine numerous facilities and cooperative operations with the existing CVP and SWP facilities. The facilities and operations have been iteratively evaluated. Previous studies that informed the development of the alternatives presented in this chapter are described in Appendix A, Plan Formulation.

Sites Reservoir Alternatives

In addition to the No Action Alternative, four action alternatives were identified for detailed evaluation. These alternatives consider a range of potential facilities and operations. The alternatives vary in reservoir size, number of intakes, regulating reservoir location and size, recreational facilities, road locations, transmission line locations, and operations (Table 6-1). The No Action Alternative and the four action alternatives are listed below.

- **No Action Alternative** – The No Action Alternative considers the future conditions of the Study Area and the future level of demand for water in 2025 if an action alternative is not implemented.
- **Alternative A** – Alternative A is a 1.3 MAF reservoir with a new intake (2,000 cfs) on the Sacramento River (Delevan Intake). Alternative A operations would deliver water for agricultural and M&I supply (with approximately 90 percent export), IL4 water supply for CVPIA refuges, and to convey biomass through the Yolo Bypass into the Delta for Delta species. The alternative would be operated cooperatively with the CVP and SWP to provide benefits to anadromous fish.
- **Alternative B** – Alternative B is a 1.8 MAF reservoir with a release-only structure in place of a new intake on the Sacramento River. Alternative B operations would deliver water for agricultural and M&I supply (with approximately 90 percent export), IL4 water supply for CVPIA refuges, and to convey biomass through the Yolo Bypass into the Delta for Delta species. The alternative would be operated cooperatively with the CVP and SWP to provide benefits to anadromous fish.
- **Alternative C** – Alternative C is a 1.8 MAF reservoir with a new intake (2,000 cfs) on the Sacramento River (Delevan Intake). Alternative C operations would deliver water for agricultural and M&I supply (with approximately 90 percent export), IL4 water supply for CVPIA refuges, and to convey biomass through the Yolo Bypass into the Delta for Delta species. The alternative would be operated cooperatively with the CVP and SWP to provide benefits to anadromous fish.

Table 6-1. Summary of Alternatives for Detailed Evaluation

	Alternative A	Alternative B	Alternative C	Alternative D
Storage Capacity				
Sites Reservoir	1.3 MAF	1.8 MAF	1.8 MAF	1.8 MAF
Terminal Regulating Reservoir	2,000 TAF	2,000 TAF	2,000 TAF	1,200 TAF
Conveyance Capacity (to Sites Reservoir) [a]				
Tehama-Colusa Canal	2,100 cfs	2,100 cfs	2,100 cfs	2,100 cfs
Glenn-Colusa Canal	1,800 cfs	1,800 cfs	1,800 cfs	1,800 cfs
Delevan Pipeline – Diversion [b]	2,000 cfs	Not applicable [c]	2,000 cfs	2,000 cfs
Delevan Pipeline – Release [b]	1,500 cfs	1,500 cfs	1,500 cfs	1,500 cfs
Sites Pumping/ Generating Plant and TRR				
Transmission and Generation	Lines from new substation to either the existing PG&E or the existing WAPA lines near Funks Reservoir	Lines from new substation to either the existing PG&E or the existing WAPA lines near Funks Reservoir	Lines from new substation to either the existing PG&E or the existing WAPA lines near Funks Reservoir	Lines from new substation to either the existing PG&E or the existing WAPA lines near Funks Reservoir. Some penstock refinements.
Transmission Line to Delevan Intake				
Transmission lines	East-west from Fletcher Reservoir to Delevan Intake (shortest distance)	None required (no new intake)	East-west from Fletcher Reservoir to Delevan Intake (shortest distance)	North-south from Colusa to Delevan Intake (reduced impact to landowners and birds)
Roads				
Roads and Bridge	Roads and Bridge	Roads and Bridge	Roads and Bridge	Roads and Bridge

	Alternative A	Alternative B	Alternative C	Alternative D
Operations				
Summary of operations (see Table 6-3 for a detailed description of operations)	New facilities would be operated by the non-Federal sponsor. Deliveries to South Coast M&I would be high. Deliveries would also be provided for IL4 water supply for CVPIA refuges and Delta ecosystem enhancement. Cooperative operations would be needed to secure coldwater benefits for anadromous fish at Trinity, Shasta, Oroville, and Folsom.	New facilities would be operated by the non-Federal sponsor. Deliveries to South Coast M&I would be high. Deliveries would also be provided for IL4 water supply for CVPIA refuges and Delta ecosystem enhancement. Cooperative operations would be needed to secure coldwater benefits for anadromous fish at Trinity, Shasta, Oroville, and Folsom.	New facilities would be operated by the non-Federal sponsor. Deliveries to South Coast M&I would be high. Deliveries would also be provided for IL4 water supply for CVPIA refuges and Delta ecosystem enhancement. Cooperative operations would be needed to secure coldwater benefits for anadromous fish at Trinity, Shasta, Oroville, and Folsom.	New facilities would be operated by the non-Federal sponsor, which would release water for water supply (export would require agreements with Reclamation and DWR for conveyance). Deliveries to the Sacramento Valley would be high. Deliveries would also be provided for IL4 water supply for CVPIA refuges and Delta ecosystem enhancement. Cooperative operations would be needed to secure coldwater benefits for anadromous fish at Trinity, Shasta, Oroville, and Folsom.
Recreation				
Recreation areas	Stone Corral Lurline Headwaters Antelope Island	Stone Corral Lurline Headwaters Antelope Island	Stone Corral Lurline Headwaters Antelope Island	Stone Corral Peninsula Hills

[a] Primary season for filling Sites Reservoir is November through March; winter fill operations are constrained to diversion operating criteria.

[b] Delevan Pipeline can be operated June through March (April and May are reserved for maintenance).

[c] A pump station, intake, and fish screens are not included for the Delevan Pipeline for Alternative B. For this alternative, the Delevan Pipeline would only be operated for year-round releases from Sites Reservoir to the Sacramento River.

cfs = cubic feet per second
M&I = municipal and industrial
MAF = million acre-feet
PG&E = Pacific Gas and Electric Company
TAF = thousand acre-feet
TRR = Terminal Regulating Reservoir
WAPA = Western Area Power Administration

- **Alternative D** – Alternative D has been developed by the Authority. This alternative includes a 1.8 MAF reservoir with a new intake (2,000 cfs) on the Sacramento River (Delevan Intake). Alternative D operations would deliver water for agricultural and M&I supply (with approximately 45 percent of the deliveries to agriculture in the Sacramento Valley and the remainder exported), IL4 water supply for CVPIA refuges, and to convey biomass through the Yolo Bypass into the Delta for Delta species. The alternative would be operated cooperatively with the CVP and SWP to provide benefits to anadromous fish.

All of the action alternatives must be operated in a mutually beneficial and cooperative manner with the CVP and SWP to achieve the project objectives. Project operations and water rights are discussed at the end of this chapter. The Authority has formed an Operations Work Group, including representatives from Reclamation and DWR, to develop an Operations Agreement and an Operations Framework. The operations presented in this chapter can only be achieved if the Operations Agreement is finalized and accepted by all involved parties as a basis for cooperatively operating the CVP, SWP, and Sites Reservoir.

Potential for Phased Implementation

The lead agencies would need to determine the project implementation strategy prior to developing the applications for permits and before beginning project construction. Implementation of the project may be phased to meet the current needs of the participating agencies who are investing in the project; however, there is no phased implementation plan at this time. This may initially alter the magnitude of the benefits and effects of the project. In general, if the project were to be constructed in phases the initial benefits would be realized over time. This Report does not consider the benefits and costs associated with potential phases of implementation.

Alternative Modeling Assumptions

Several modifications to the California water system have been proposed and the regulatory requirements are undergoing ongoing changes simultaneous with the modeling performed to evaluate the Sites Reservoir alternatives. The modeling details are provided in Appendix G. Chapter 10 considers the effects of proposed storage projects (including enlarging Shasta Lake and Los Vaqueros Reservoir). Both USFWS and NMFS issued a new BiOp in 2019. The initial modeling results described within Chapter 7 are not specifically consistent with the amended COA (2019 January) or the 2019 BiOps (USFWS and NMFS, 2019 October); however, the modeling was updated for the refined alternatives in Chapter 8 to consider both the amended COA and 2019 BiOps.

No Action Alternative (NEPA)/No Project Alternative (CEQA)

The terms "No Action Alternative" (as described by NEPA), "No Project Alternative" (as described by CEQA), and "Without Project Future Conditions" are considered synonymous throughout this Report. The No Action Alternative is used as the basis for comparison of the potential benefits and effects of the action alternatives, consistent with the Federal P&Gs (WRC 1983) and NEPA

Guidelines. Under the No Action Alternative, no actions would be taken to provide storage north of the Delta to achieve the project objectives.

For the surface storage investigations, the planning horizon for the future conditions is assumed to be 100 years. Future conditions include facilities, policies, regulations, programs, and operational assumptions included in the existing conditions, plus future actions, projects, and programs that can reasonably be expected to take place. Climate variability was subsequently evaluated through sensitivity analysis (see Chapter 7).

The modeling effort to evaluate the Sites Reservoir Project alternative plans began in 2010, and relied on assumptions that were finalized on July 5, 2010. The assumptions for the No Action Alternative include reasonably foreseeable projects, including projects under construction, and continuation of existing policy and management decisions. Altering these assumptions would change the conclusions in this Report.

Key assumptions regarding the No Action Alternative include the following:

- Operations of the CVP and SWP by Reclamation and DWR, respectively, are described in the *Long-Term Coordinated Operation of the CVP and SWP: Biological Assessment*, published in October 2019 (Reclamation 2019). These operations include operations of the CVP under the Central Valley Project Improvement Act (P.L. 102-575), including fish and wildlife restoration activities in accordance with Section 3406(b)(2); coordinated operations of the CVP and SWP under SWRCB Decision-1641 (D-1641)[1] and the SWRCB Water Quality Control Plan adopted in 2006; and use of Joint Points of Diversion (which allows Reclamation and DWR to use both the CVP and SWP diversion capacity capabilities in accordance with D-1641).
- CVP and SWP operational assumptions also include continued operations under the COA, which was approved by the United States Congress and the California State Legislature in 1986 and amended in 2019, to share responsibilities between the CVP and SWP for providing water for in-basin uses in the Delta watershed, sharing of responsibilities to meet water quality criteria established by the SWRCB, and sharing of surplus water flows in the Delta. The modeling results described in Chapter 7 are not specifically consistent with the amended COA (2019 January). These requirements are included in the modeling of refined alternatives presented in Chapter 8.
- For Chapter 7 of this document, operations of the CVP and SWP are in accordance with the 2008 USFWS Biological Opinion (BiOp) (USFWS 2008a) and the 2009 NMFS BiOp (NMFS 2009). The sensitivity modeling in Chapter 8 incorporates the 2019 BiOps (USFWS and NMFS, 2019 October).
- Operations at the diversion from the Sacramento River into the T-C Canal and the Corning Canal were modified under the No Action Alternative to improve fish passage. Under the Existing Conditions, the radial gates were lowered into the Sacramento River to create Lake Red Bluff between June 15 and August 31, based on the 2009 NMFS (BiOp) Action I.3.2. However, under the No Action Alternative, the radial gate operations were replaced with a new 2,000 cfs intake and pumping plant along the bank of the Sacramento River with a flat-

[1] Water Rights Decision 1641 Revised (State Water Resources Control Board, March 2000).

plate fish screen to divert water from the Sacramento River into the T-C and Corning Canals.

- Operations of the Freeport Regional Water Authority pumping plant along the Sacramento River serve Sacramento County and the East Bay Municipal Utility District and are included in the No Action Alternative assumptions.
- The final operational criteria for the interim operations of the San Joaquin River Restoration were undergoing NEPA evaluation at the time of model development; therefore, the criteria were not available for inclusion in the No Action Alternative assumptions.
- Enlargement of Los Vaqueros Reservoir from 100 TAF to 160 TAF is included in the No Action Alternative assumptions. The reservoir expansion to 260 TAF is not included in the No Action Alternative assumptions.
- The SWP Banks Pumping Plant capacity is assumed to be 10,300 cfs. However, diversions from Old River into Clifton Court Forebay are assumed to be limited by USACE agreement to generally 6,680 cfs, except during high-flow events (Section 10 of the Rivers and Harbors Appropriation Act of 1899 [33 U.S.C. 403]).
- The No Action Alternative includes water-use efficiency to conserve and recycle water throughout California.
- The assumptions in the 2009 Memorandum of Understanding between Reclamation, DWR, and SWRCB for implementing the CALFED Water Transfer Program are included.
- All hydropower facilities of the CVP, SWP, and other waters tributary to the Sacramento River and the Delta are assumed to be operated in accordance with existing agreements and other regulatory operating agreements. Operations of these facilities are dependent on the hydrology and water supply allocations. It is assumed that these facilities operate in the same manner they have historically.
- The No Action Alternative does not include modifications to Folsom Dam to increase releases during lower pool stages, or to revise the surcharge storage space in the reservoir. These projects were under evaluation at the time of development of the modeling assumptions.
- The No Action Alternative does not include potential enlargement of Shasta Lake or construction of Temperance Flat Reservoir because these projects were under evaluation at the time of development of the modeling assumptions.
- The No Action Alternative and Future Conditions do not include assumptions for climate variability related to sea level rise and changes in precipitation patterns, including changes in ratios between snow and rainfall. The analysis supporting the estimation of benefits does not include the effects of climate variability; however, sensitivity analysis to evaluate the potential effects of climate variability on the benefits was performed, and the results are provided in Chapter 10, Risk and Uncertainty. Additional information regarding the effects of climate variability is provided in Chapter 25 of the Draft EIR/EIS (Authority and Reclamation, 2017).

- The No Action Alternative does not assume new Delta conveyance facilities to be in place, including proposed construction of intakes in the North Delta to convey CVP and SWP water supplies.

The bulleted assumptions were also included in the future with-project conditions.

Action Alternatives

Alternatives A, B, C, and D are described in this section. Each alternative is described, and then the individual facilities that constitute each alternative are described. This discussion of alternatives and individual facilities is followed by a description of the operations associated with the alternatives. More detailed descriptions of the facilities are provided in Appendix B, Engineering. Alternative C1 was evaluated in the EIR/EIS to assess the impacts that would result from Alternative C without hydropower generation; however, that alternative was not considered in this Feasibility Report because it does not meet the secondary objective for hydropower generation.

Alternative A (1.3 MAF Sites Reservoir, 2,000 cfs Delevan Pipeline for Intake and Release)

Under Alternative A, Sites Reservoir would have a 1.3 MAF storage capacity (it is the smallest of the four action alternatives). The Sites Pumping/Generating Plant has a reduced capacity due to the shorter dams that would be needed for the smaller reservoir. Under this alternative, water released from Sites Reservoir would generate up to 100 megawatts (MW), as compared to 125 MW under Alternatives B, C, and D. The facilities for Alternative A are depicted on Figure 6-1.

On the eastern side of the project, Alternative A includes the Delevan Intake Pumping/ Generating Plant and adjoining fish screen structure at the Sacramento River. The new intake would have a 2,000 cfs capacity, and this flow would be conveyed across the valley by the Delevan Pipeline to Fletcher Reservoir. Releases could also be made from the Sites Reservoir to the Sacramento River through the Delevan Pipeline through the fish screen at the Delevan Intake Pumping/Generating Plant. The power transmission lines would run from the vicinity of Fletcher Reservoir to the Delevan Intake Pumping/Generating Plant parallel to the Delevan Pipeline.

In addition to the Delevan Pipeline, water would be conveyed into the reservoir by the T-C and GCID Canals. Water intended for providing public benefits and supplying the CVP and SWP service areas would be stored in Sites Reservoir for future delivery. The following releases would be possible:

- Releases from Fletcher Reservoir to the southern portion of the TCCA service area
- Releases from the Terminal Regulating Reservoir (TRR) to the southern portion of the GCID service area
- Releases from the Delevan Pipeline to the Sacramento River for downstream water users, IL4 water supply for CVPIA refuges, and Delta ecosystem enhancement

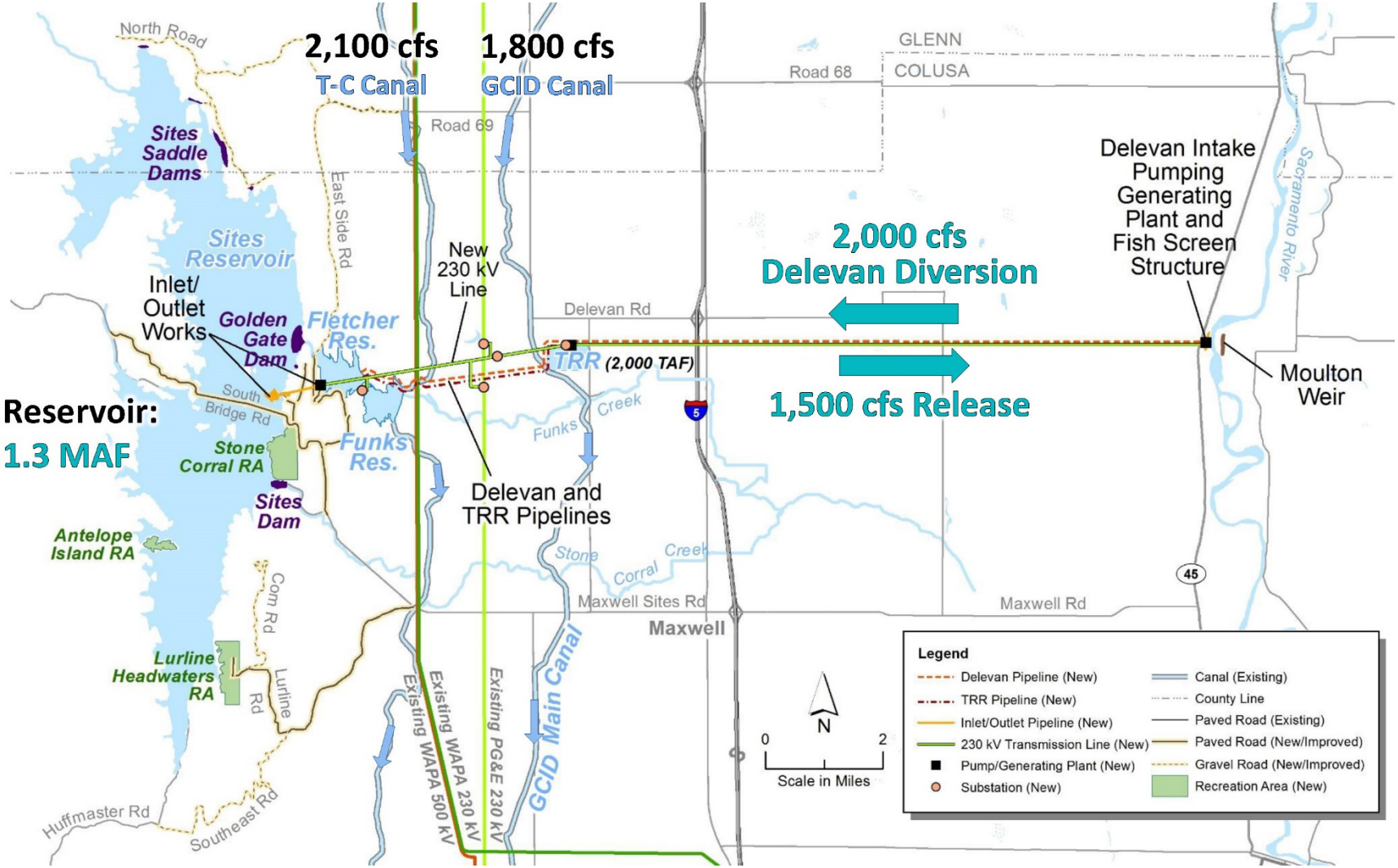


Figure 6-1. Features of Sites Reservoir Project Alternative A

Reclamation and DWR may execute contracts for conveyance (i.e., export) using CVP or SWP facilities at the contractor's request. Conveyance contracts would be required for all non-CVP water moved through Federal facilities (e.g., the T-C Canal for diversions from Red Bluff of non-CVP water into Sites, and releases of Sites Project water to the T-C Canal service area). Potential contractual arrangements are described in more detail in Chapter 11, Findings. Releases made from the Fletcher Reservoir Forebay/Afterbay would generate power at the TRR and Delevan Intake Pumping/Generating Plants.

Alternative A has three recreation areas (Stone Corral, Lurline Headwaters, and Antelope Island).

Alternative B (1.8 MAF Sites Reservoir, 1,500 cfs Delevan Pipeline for Release Only)

Under Alternative B, Sites Reservoir would have a 1.8 MAF storage capacity. Under this alternative, water released from Sites Reservoir would generate up to 125 MW. The facilities for Alternative B are depicted on Figure 6-2.

On the eastern side of the project, Alternative B does not include the Delevan Intake Pumping/Generating Plant or adjoining fish screen structure at the Sacramento River. Instead, this alternative includes a reinforced-concrete structure housing a flow meter and cone valve to dissipate releases of up to 1,500 cfs into the Sacramento River. There would be no pumping at this location. The Delevan Pipeline would only be used to release water from Fletcher Reservoir to the Sacramento River through the dissipating structure. As a result, there would be no new power transmission lines running from Fletcher Reservoir to the Delevan Release Structure across the valley.

For Alternative B, water would be conveyed to the reservoir solely by the T-C and GCID Canals. Water intended for providing public benefits and supplying the CVP and SWP service areas would be stored in Sites Reservoir for future delivery. The following releases would be possible:

- Releases from Fletcher Reservoir to the southern portion of the TCCA service area
- Releases from the TRR to the southern portion of the GCID service area
- Releases from the Delevan Pipeline to the Sacramento River for downstream water users, IL4 water supply for CVPIA refuges, and Delta ecosystem enhancement

Reclamation and DWR may execute contracts for conveyance (i.e., export) using CVP or SWP facilities at the contractor's request. Conveyance contracts would be required for all non-CVP water moved through Federal facilities (e.g., the T-C Canal for diversions from Red Bluff of non-CVP water into Sites, and releases of Sites Project water to the T-C Canal service area). Potential contractual arrangements are described in more detail in Chapter 11, Findings.

Releases made from the Fletcher Reservoir Forebay/Afterbay would generate power at the TRR Pumping/Generating Plant.

Alternative B has three recreation areas (Stone Corral, Lurline Headwaters, and Antelope Island).

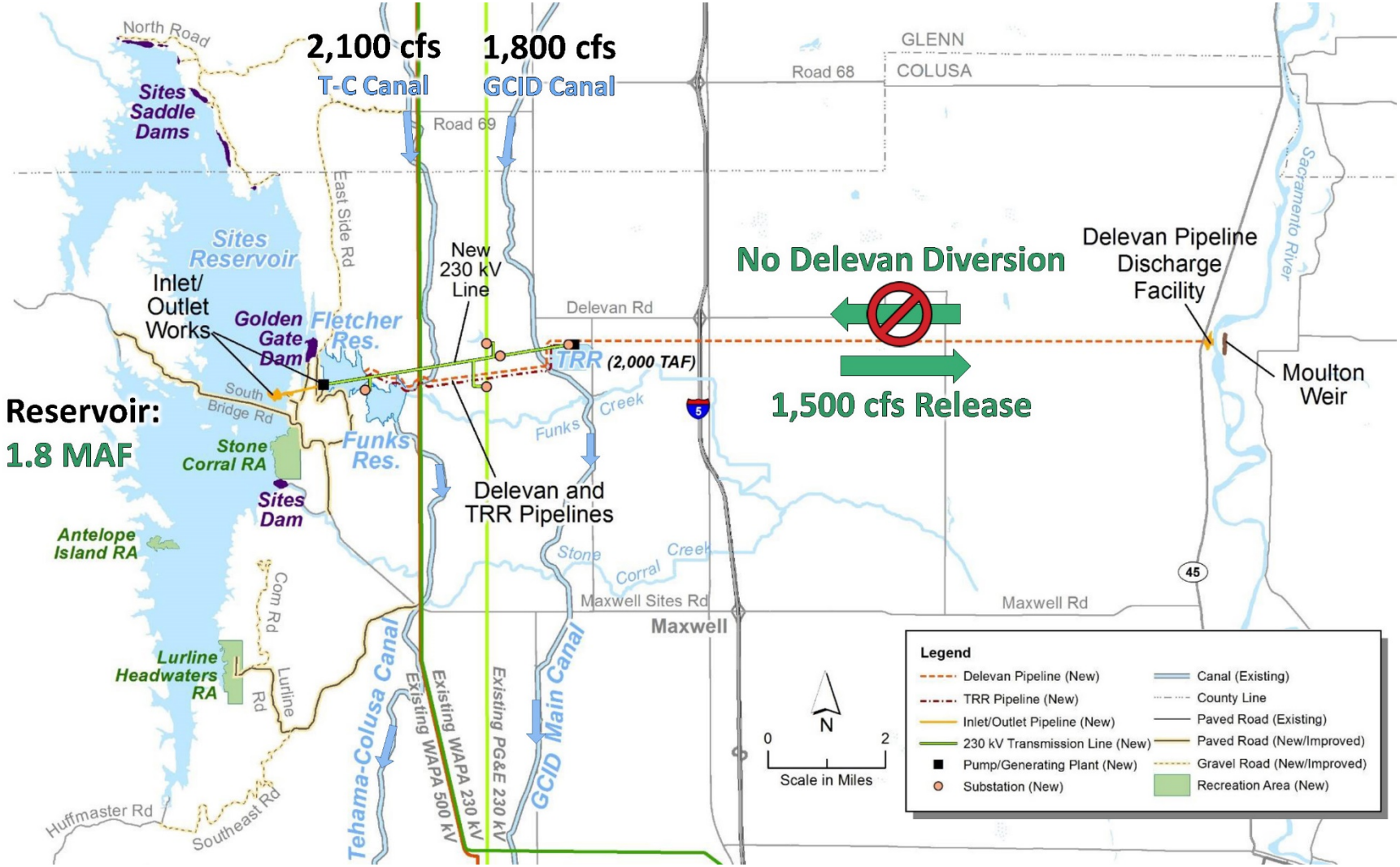


Figure 6-2. Features of Sites Reservoir Project Alternative B

Alternative C (1.8 MAF Sites Reservoir, 2,000 cfs Delevan Pipeline for Intake and Release)

Under Alternative C, Sites Reservoir would have a 1.8 MAF storage capacity. The Sites Pumping/Generating Plant would have a 125 MW capacity. The facilities for Alternative C are depicted on Figure 6-3.

On the eastern side of the project, Alternative C includes the Delevan Intake Pumping/ Generating Plant and adjoining fish screen structure at the Sacramento River. The new intake would have a 2,000 cfs capacity, and this flow would be conveyed across the valley by the Delevan Pipeline to Fletcher Reservoir. Releases could also be made from Sites Reservoir to the Sacramento River through the Delevan Pipeline through the fish screen at the Delevan Intake. The power transmission lines would run from the vicinity of Fletcher Reservoir to the Delevan Intake Pumping/Generating Plant parallel to the Delevan Pipeline.

In addition to the Delevan Pipeline, water would be conveyed to the reservoir by the T-C and GCID Canals. Water intended for providing public benefits and supplying the CVP and SWP service areas would be stored in Sites Reservoir for future delivery. The following releases would be possible:

- Releases from Fletcher Reservoir to the southern portion of the TCCA service area
- Releases from the TRR to the southern portion of the GCID service area
- Releases from the Delevan Pipeline to the Sacramento River for downstream water users, IL4 water supply for CVPIA refuges, and Delta ecosystem enhancement

Reclamation and DWR may execute contracts for conveyance (i.e., export) using CVP or SWP facilities at the contractor's request. Conveyance contracts would be required for all non-CVP water moved through Federal facilities (e.g., the T-C Canal for diversions from Red Bluff of non-CVP water into Sites, and releases of Sites Project water to the T-C Canal service area). Potential contractual arrangements are described in more detail in Chapter 11, Findings.

Releases made from the Fletcher Reservoir Forebay/Afterbay would generate power at the TRR and Delevan Intake Pumping/Generating Plants.

Alternative C has three recreation areas (Stone Corral, Lurline Headwaters, and Antelope Island).

Alternative D (1.8 MAF Sites Reservoir, 2,000 cfs Delevan Pipeline for Intake and Release, Local Considerations)

Under Alternative D, Sites Reservoir would have a 1.8 MAF storage capacity. The Sites Pumping/Generating Plant would have a 125 MW capacity. The facilities for Alternative D are depicted on Figure 6-4.

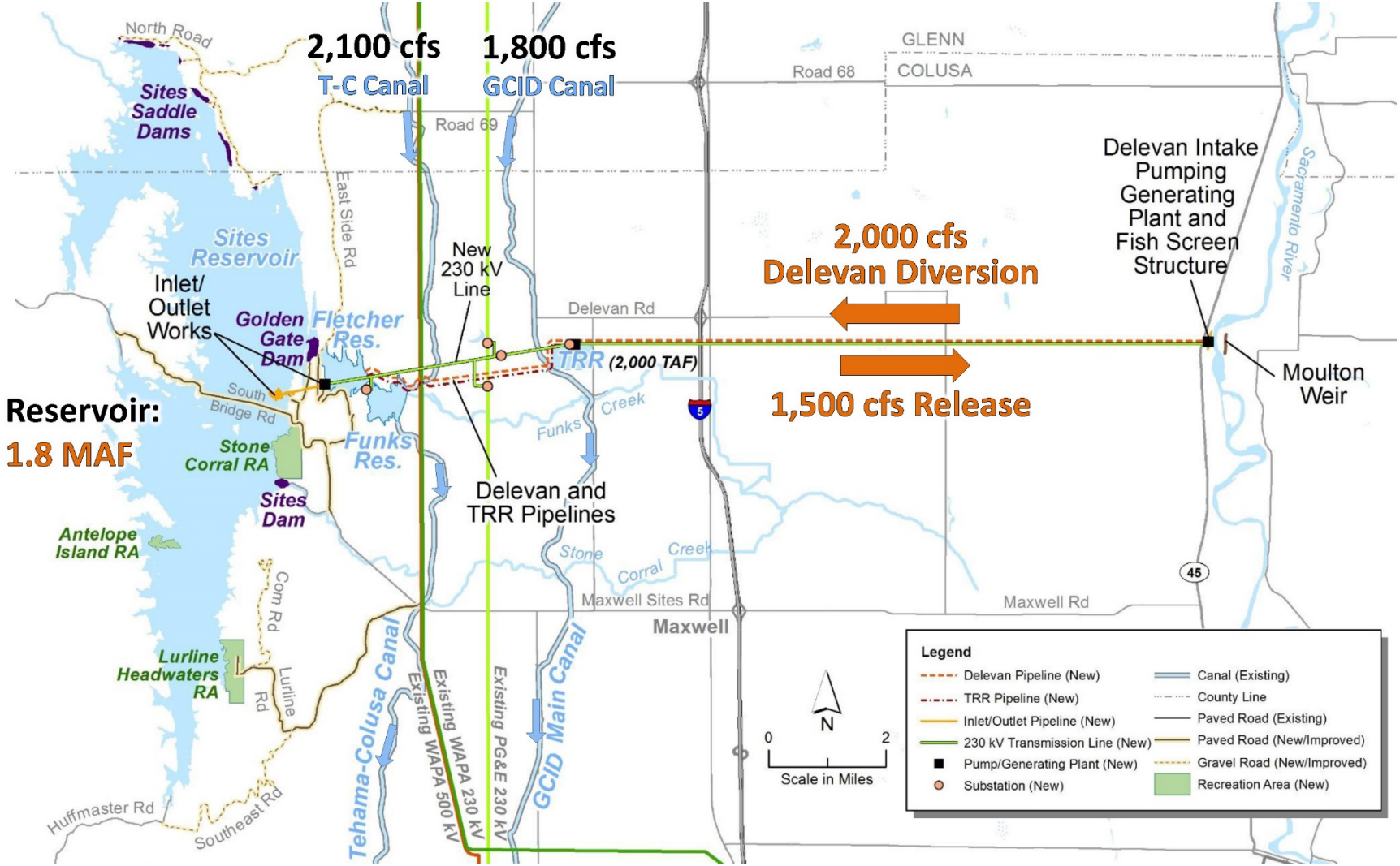


Figure 6-3. Features of Sites Reservoir Project Alternative C

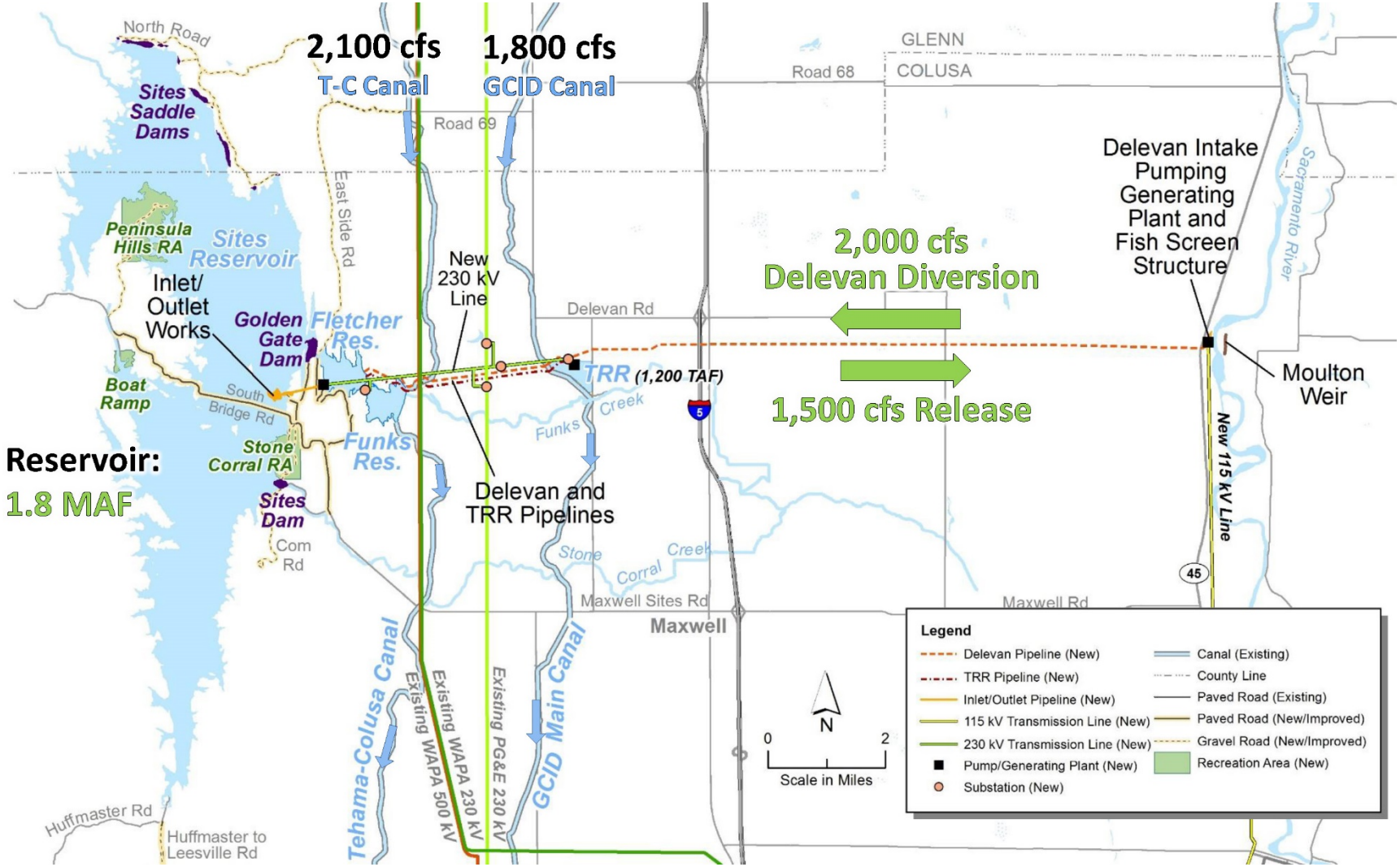


Figure 6-4. Features of Sites Reservoir Project Alternative D

On the eastern side of the project, Alternative D includes the Delevan Intake Pumping/Generating Plant and adjoining fish screen structure at the Sacramento River. The new intake would have a 2,000 cfs capacity, and this flow would be conveyed across the valley by the Delevan Pipeline to Fletcher Reservoir. The power transmission lines for the Delevan Intake would run north from a new substation in Colusa rather than across the valley from the west.

In addition to the Delevan Pipeline, water would be conveyed to the reservoir by the T-C and GCID Canals. Water intended to provide public benefits and to supply the GCID and TCCA service areas would be stored in Sites Reservoir for future delivery. The following releases would be possible:

- Releases from Fletcher Reservoir to the southern portion of the TCCA service area
- Releases from the TRR to the southern portion of the GCID service area
- Releases from the Delevan Pipeline to the Sacramento River for downstream water users, IL4 water supply for CVPIA refuges, and Delta ecosystem enhancement
- Releases from Fletcher Reservoir to Funks Creek and the Colusa Basin Drain

Reclamation and DWR may execute contracts for conveyance (i.e., export) using CVP or SWP facilities at the contractor's request. Conveyance contracts would be required for all non-CVP water moved through Federal facilities (e.g., the T-C Canal for diversions from Red Bluff of non-CVP water into Sites, and releases of Sites Project water to the T-C Canal service area). Potential contractual arrangements are described in more detail in Chapter 11, Findings.

Releases made from the Fletcher Reservoir Forebay/Afterbay would generate power at the TRR and Delevan Intake Pumping/Generating Plants.

Alternative D has two recreation areas (Stone Corral and Peninsula Hills).

Facility Descriptions

Detailed information on all project facilities is provided in the section titled "Design Considerations" in Appendix B, Engineering.

Sites Reservoir

Two reservoir storage capacity options are under consideration for the action alternative plans:

- 1.3 MAF for Alternative A
- 1.8 MAF for each of Alternative B, Alternative C, and Alternative D

1.3 MAF Storage Capacity (Alternative A)

For the 1.3 MAF storage reservoir, the maximum WSE of the reservoir would be 480 feet above mean sea level (msl), with an inundation area of approximately 12,400 acres. The minimum operating water surface would be at elevation 340 feet. The reservoir would require construction of the Golden Gate Dam on Funks Creek, Sites Dam on Stone Corral Creek, and six saddle dams on

the northern end of the reservoir (see Figure 6-1). All of these dams would be zoned earth rockfill embankment-type dams, which previous investigations indicate would be the most economical. However, a study of dam types would be conducted in the preliminary design phase to ensure the selection of the most economical and technically feasible dam types for all of the Sites Reservoir dams.

The embankment for Golden Gate Dam would have a crest elevation of 500 feet, a crest length of 1,450 feet, a maximum height of 266 feet above the streambed, and a total embankment volume of 6.0 million cubic yards. Sites Dam would be constructed on Stone Corral Creek. The dam embankment would have a crest elevation of 500 feet, a crest length of 725 feet, a maximum height of 250 feet above the streambed, and a total embankment volume of 2.9 million cubic yards.

Six saddle dams would be required at the northern end of Sites Reservoir, between the Funks Creek and the Hunter Creek watersheds, roughly along the Glenn-Colusa County line. Total embankment volume of the saddle dams would be 2.2 million cubic yards.

Total embankment volume required for the Golden Gate Dam, Sites Dam, and the six saddle dams would be approximately 11.0 million cubic yards.

1.8 MAF Storage Capacity (Alternatives B, C, and D)

For the 1.8 MAF storage capacity reservoir, the maximum WSE of the reservoir would be 520 feet above msl, with an inundation area of approximately 14,000 acres. The minimum operating water surface would be at elevation 340 feet. The reservoir would require construction of Golden Gate Dam on Funks Creek, Sites Dam on Stone Corral Creek, and nine saddle dams on the northern end of the reservoir, between the Funks Creek and the Hunter Creek watersheds (see Figure 6-2, Figure 6-3, and Figure 6-4). The current design for the larger reservoir also uses zoned earth rockfill embankment-type dams.

Golden Gate Dam would be constructed on Funks Creek, approximately 1 mile west of Fletcher Reservoir. The proposed dam embankment would have a crest elevation of 540 feet, a crest length of 2,250 feet, a maximum height of 310 feet above the streambed, and a total embankment volume of 10.6 million cubic yards. Sites Dam would be constructed on Stone Corral Creek, approximately 0.25 mile east of the town of Sites and 8 miles west of the town of Maxwell. The dam embankment would have a crest elevation of 540 feet, a crest length of 850 feet, a maximum height of 290 feet above the streambed, and a total embankment volume of 3.8 million cubic yards.

Nine saddle dams would be required at the northern end of Sites Reservoir, between the Funks Creek and the Hunter Creek watersheds, roughly along the Glenn-Colusa County line.

The total embankment volume required for the Golden Gate Dam, Sites Dam, and the nine saddle dams is approximately 21.0 million cubic yards.

Sites Reservoir Inlet/Outlet Structure (All Alternatives)

Water would be diverted into and released from Sites Reservoir to Fletcher Reservoir, which would serve as a forebay/afterbay. Water would be pumped out of Fletcher Reservoir at the Sites Pumping/Generating Plant through a connecting tunnel and then passed into the reservoir through a vertical inlet/outlet structure standing in the reservoir. Releases would be made using these same facilities.

The purpose of the reservoir inlet/outlet structures would be to regulate reservoir releases through the connecting tunnel to the Sites Pumping/Generating Plant. The reservoir inlet/outlet structure would be at the western end of the tunnel and southwest of the proposed Golden Gate Dam. The reservoir inlet/outlet structure would consist of a low-level inlet/outlet structure for emergency drawdown releases.

For the 1.8 MAF reservoir, the tower would be approximately 260 feet high and have nine tiers of port valves. For the 1.3 MAF reservoir, the tower would be approximately 220 feet high and have seven tiers of port valves. The main tower shaft would have an inner diameter of 32 feet and an outer diameter of 39 feet.

Tunnel Connecting Inlet/Outlet Structure to Sites Pumping/Generating Plant (All Alternatives)

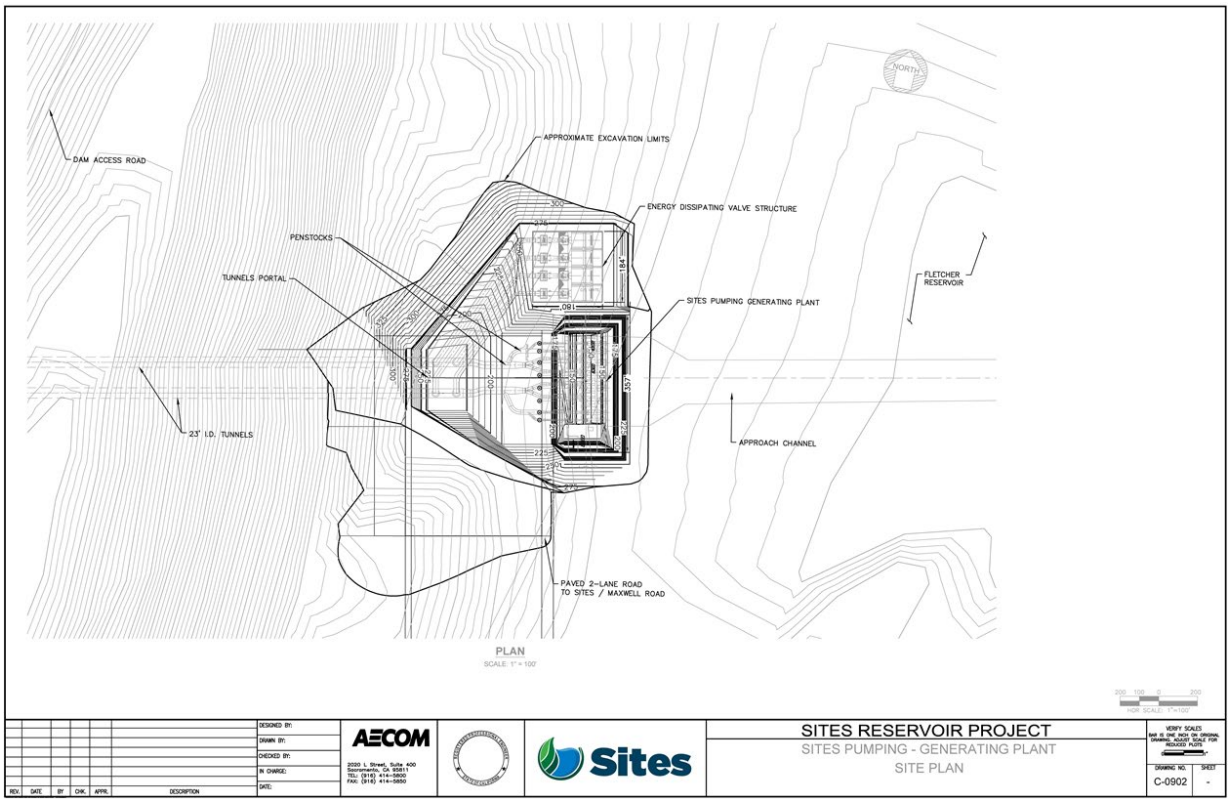
The purpose of the connecting tunnel is to convey water between Sites Reservoir and the Sites Pumping/Generating Plant. The tunnel would be approximately 4,500 feet long. The proposed 30-foot-diameter finished tunnel size was developed to meet DWR's Division of Safety of Dams emergency drawdown release criteria. The proposed tunnel has a design capacity of approximately 23,000 cfs.

Sites Pumping/Generating Plant (All Alternatives)

Hydroelectric generating capability has been incorporated into the Sites Pumping/ Generating Plant (see graphic below). In general, the addition of ancillary hydroelectric power generation to the grid would help mitigate some of the power consumption costs associated with this offstream water storage facility. Water would be pumped into Sites Reservoir primarily in the winter and spring months during off-peak periods, and water would be released primarily during the summer and fall, thereby producing hydropower when power demands and costs are typically higher. Although every alternative includes the Sites Pumping/Generating Plant, the sizing of the plant varies based on the release capacity and maximum water surface elevation in Sites Reservoir.

The design capacity of the Sites Pumping/Generating Plant would be approximately 5,900 cfs for Alternatives A, C, and D; and 3,900 cfs for Alternative B.

The Sites Pumping/Generating Plant would be connected to Fletcher Reservoir by an unlined approach channel approximately 8,300 feet long. An electrical switchyard would be required adjacent to the Sites Pumping/Generating Plant to provide power to and from the plant. The switchyard would step down the electrical voltage from the high-voltage lines used to transmit electricity over long distances to a lower voltage that can be used by the pumps and other machinery in the plant in pump mode. Power could be provided to the switchyard from the nearby Pacific Gas and Electric Company (PG&E) or WAPA 230-kVa transmission lines.



Sites Pumping/Generating Plant

Fletcher Reservoir (All Alternatives)

It would be necessary to supplement Funks Reservoir to provide the storage capacity to operate the conveyance systems supplying water; to regulate flows for the proposed Sites Pumping/Generating Plant; and to store water for on-call power generation for up to 6 hours per day. Funks Reservoir is an existing reservoir on Funks Creek, approximately 7 miles northwest of Maxwell, in Colusa County. It was constructed in 1975 by Reclamation, and has a design capacity of 2,250 AF, with a surface area of 232 acres. An earthfill dam with a crest elevation of 214 feet impounds the reservoir on the east. The spillway overflow discharge capacity is 25,000 cfs with all gates fully open. Funks Reservoir would continue to be owned by the Federal government and used as a regulating reservoir for the T-C Canal, with no negative impacts to the operation of the T-C Canal.

Funks Reservoir would be supplemented with Fletcher Reservoir by excavating the adjacent area to the west to create a new reservoir for pumpback storage. Preliminary studies indicate that the combined active storage for Fletcher and Funks Reservoirs should be approximately 6,500 AF to satisfy seasonal water balance needs and simultaneously permit pumpback power generation for up to 6 hours per day on a daily basis.

Fletcher Reservoir would regulate inflows and releases to minimize power usage and maximize power generation; it would also serve as a regulatory reservoir for the T-C Canal.

Pump Installation at the Red Bluff Pumping Plant (All Alternatives)

Water entering Fletcher Reservoir from the T-C Canal would be diverted into the canal from the Sacramento River at Red Bluff. Facilities associated with the Red Bluff Pumping Plant were

extensively upgraded as part of the RBDD Fish Passage Improvement Project, completed by Reclamation in 2012. Additional capacity would be needed at the pumping plant to provide diversions into Sites Reservoir. The plant has two empty bays where additional pumps can be added and sufficient fish screen capacity to accommodate the additional flow. Two additional pumps would be installed as part of the Sites Reservoir Project.

Terminal Regulating Reservoir (All Alternatives)

Water conveyed down the GCID Canal would flow into a future TRR. The TRR would be required to provide operational storage to balance normal and emergency flow variations between the upstream GCID Canal Pump Station, a new TRR Pumping/Generating Plant, and the downstream canal. The TRR Pumping/Generating Plant would convey water from the TRR up to Fletcher Reservoir via a new pipeline.

The TRR would be created on the valley floor next to the GCID Canal by a combination of excavation and embankment. The reservoir would be composed of an earth embankment dam. The reservoir would be approximately 16 feet deep, with a maximum water depth of 12 feet, leaving 4 feet of freeboard. Two configurations were considered for the TRR. Alternatives A, B, and C use a larger, 2,000 AF reservoir. Alternative D proposes a smaller 1,200 AF reservoir to reduce impacts to landowners.

The TRR Pumping/Generating Plant would pump 1,800 cfs of water from the TRR to Fletcher Reservoir. The TRR Pumping/Generating Plant would generate power from flows released through the TRR Pumping/Generating Plant, with a maximum return flow of 900 cfs (the return flow is constrained by the downstream capacity of the GCID Canal).

TRR Pipeline (All Alternatives)

The 3.5mile-long TRR Pipeline would convey water from the TRR to Fletcher Reservoir. The TRR Pipeline would be bi-directional, allowing water to be pumped from the TRR to Fletcher Reservoir for storage, and allowing water to flow by gravity from Fletcher Reservoir for release to the TRR/GCID Canal. The TRR Pipeline would consist of two 12foot-diameter reinforced-concrete pipes with capacity to convey 1,800 cfs from the TRR to Fletcher Reservoir, and 900 cfs from Fletcher Reservoir to the TRR. The pipeline would be buried a minimum of 8 feet (to top of pipe) below ground surface.

Delevan Pipeline (All Alternatives)

The Delevan Pipeline would consist of two buried 12foot-diameter reinforced-concrete pipes that would provide water conveyance capability between the Sacramento River and Fletcher Reservoir. The pipeline would be about 13.5 miles in length, with an elevation difference of approximately 150 feet. Under Alternatives A, C, and D, the Delevan Pipeline would be used to both convey water to Fletcher Reservoir using the pumps at the Delevan Intake Pumping/ Generating Plant, and to release water back to the river under gravity conditions. Under Alternative B, the Delevan Pipeline would only release water by gravity from Fletcher Reservoir to the Sacramento River through a new outlet structure. To construct pipelines under major infrastructure facilities, bore/jack construction methods would be used at road crossings (Interstate [I]-5, SR-99, and SR 45); railroad crossings, the crossing under the Colusa Basin Drain, gas transmission line crossings, and the crossing under the GCID Canal.

The alignment for the pipeline is the same under Alternatives A, B, and C, but it is slightly farther south under Alternative D to take advantage of an existing easement held by the Maxwell Irrigation District.

Delevan Intake Pumping/Generating Plant (Alternatives A, C, and D)

The Delevan Intake Pumping/Generating Plant would pump 2,000 cfs of water from the Sacramento River to Fletcher Reservoir and the design return flow is 1,500 cfs.

The Delevan Intake Pumping/Generating Plant would be on the right bank of the Sacramento River opposite the Moulton Weir. The proposed pumping/generating plant would involve the construction of:

- A pumping/generating plant
- Forebay/afterbay pond
- Two air chambers
- Manifold piping to connect the pumping and generating units to the Delevan Pipeline
- A control building
- An electrical switchyard
- Fish-screening facilities on the Sacramento River

The fish-screening facilities would be on the western side of the Sacramento River, slightly downstream of River Mile 158.5, and on the eastern side of SR 45. Based on the fish screen design and constructability, the proposed location of the plant is considered the best for hydraulics for fish-screening operations.

Delevan Pipeline Discharge Facility (Alternative B)

Alternative B would not include the Delevan Intake Pumping/Generating Plant. It would instead include the Delevan Pipeline Discharge Facility. This facility would control releases from Fletcher Reservoir to the Sacramento River through the Delevan Pipeline. This structure would be on the waterside bank of the Sacramento River and would have a flowmeter and cone-valves for each of the two pipes of the Delevan Pipeline. A concrete-lined discharge channel would carry the released flows from the valves into a concrete spillway to the Sacramento River. A positive barrier bar rack would cover the spillway at expected operating river levels to prevent fish from entering the structure.

Road Relocations and South Bridge (All Alternatives)

Sites Reservoir would inundate portions of Maxwell-Sites Road and Sites-Lodoga Road (paved roads), and would therefore block travel between the towns of Maxwell and Lodoga. These roads are in Colusa County's jurisdiction. Approximately 6 miles of Huffmaster Road and Peterson Road (gravel roads) would be inundated. Therefore, this project would reroute existing roads or provide alternate access.

The proposed public roads and South Bridge would provide vehicle access to allow for travel between Maxwell and areas west of the proposed reservoir, including the town of Lodoga and East

Park Reservoir. The proposed primary route from Maxwell to Lodoga would be a paved two-lane road, and would use portions of the existing Maxwell-Sites Road and Sites-Lodoga Road alignments. This route would also provide access to the proposed Stone Corral Recreation Area. The proposed South Bridge would be a two-lane concrete bridge. The bridge would be 35.5 feet wide and approximately 1.6 miles long.

Gravel roads would provide access to the dams and operations facilities in the vicinity of Sites Reservoir. Alternatives A, B, and C include more extensive roads to allow access to the southern end of the reservoir. Alternative D includes a new road that would connect property at the southern end of the reservoir to Leesville Road.

Transmission Lines, Electrical Substations, and Switchyards (All Alternatives)

Proposed dedicated transmission lines would carry electricity from an existing power source (grid) to the individual pumping/generating plants. The substation and transmission lines would also allow the pumping/generating plants to reverse the flow of electricity, and feed electricity back into the electrical grid for use by other customers during generation activities.

The Sites and TRR Pumping/Generating Plants would be connected to the existing electrical grid by a new 230-kilovolt (kV) or 115 kV overhead transmission line in the vicinity of Fletcher Reservoir. Near the Sites Pumping/Generating Plant, the existing WAPA and PG&E 230-kV lines are the most probable power sources large enough for project use (see Figure 6-1 through Figure 6-4). To reach the Sites Pumping/Generating Plant, a short transmission line (length of 1 to 4 miles) may be required from the substation to the pumping plant. A similar transmission line from the same substation would be required for the TRR Pumping/Generating Plant.

In Alternatives A and C, new transmission lines would parallel the proposed route of the Delevan Pipeline from the Sacramento River to the Delevan Intake Pumping/Generating Plant, and would be constructed primarily within a 150foot-wide permanent transmission line easement. Alternative B does not include the Delevan Intake Pumping/Generating Plant, and no new transmission line would be required. Under Alternative D, the transmission lines would be routed north-south along SR 45 instead of across the valley. Under this alternative, power would be supplied from a new substation west of the city of Colusa.

Power transmission costs for the Sites Reservoir Project will be affected by whether transmission is through WAPA or the California Independent System Operator (CAISO).

Recreation Facilities (All Alternatives)

New recreational facilities adjacent to Sites Reservoir are included in each of the project alternatives (see Appendix E, Recreation). Alternatives A, B, and C have three recreation areas, and two are proposed under Alternative D.

- **Stone Corral Recreation Area (All Alternatives)** – The Stone Corral Recreation Area would be on the eastern side of the reservoir, north of the existing Maxwell-Sites Road and the proposed Sites Dam. The maximum proposed size of the Stone Corral Recreation Area is 235 acres.

- **Antelope Island Recreation Area (Alternatives A, B, and C)** – The Antelope Island Recreation Area would be in the southwestern portion of the reservoir. The maximum proposed size of the Antelope Island Recreation Area is 49 acres.
- **Lurline Headwaters Recreation Area (Alternatives A, B, and C)** – The proposed Lurline Headwaters Recreation Area is a 219acre site on the southeastern end of Sites Reservoir in an open meadow surrounded by oak grassland along steep mountains with excellent views.
- **Peninsula Hills Recreation Area (Alternative D)** –Peninsula Hills Recreation Area, proposed by Colusa County, would occupy approximately 516 acres on the northwestern side of Sites Reservoir. The Authority is considering the installation of a separate boat launch facility approximately 2 miles south of this recreation area, with access to the reservoir south of Sites-Lodoga Road.

These recreation areas could potentially be developed and commissioned in a phased approach to match recreation interest at Sites Reservoir. Under Alternatives A, B, and C, the Stone Corral Recreation Area would be the first to be developed, followed by the Lurline Headwaters Recreation Area, and then the Antelope Island Recreation Area. Should recreational use remain low, only the Stone Corral Recreation Area would be constructed. For Alternative D, the Stone Corral Recreation Area and the west-side Boat Ramp would be constructed initially, followed by the remainder of Peninsula Hills Recreation Area, if warranted. The facilities for each recreation area are summarized in Table 6-2.

Table 6-2. Summary of Recreation Facilities

Feature	Lurline Headwaters	Stone Corral	Antelope Island	Peninsula Hills
Alternative	A, B, and C	A, B, C, and D	A, B, and C	D
Size	219 acres	235 acres	49 acres	516 acres
Access	Sulphur Gap Road to Lurline Road	New Stone Corral Road	Boat-in only	Existing Sites-Lodoga Road and new bridge and new Peninsula Road
Camp sites	50 (car and recreational vehicle) and 3 group camp area (each group camp area can accommodate up to 24 people)	50 (car and recreational vehicle)	12 (boat-in)	100 (car and recreational vehicle) and 1 group camp area (group camp area can accommodate up to 24 people)
Picnic sites	10 (with parking at each site)	10 (with parking at each site)	None	10 (with parking at each site)
Hiking trails	Yes	Yes	Yes	Yes
Vault toilets	8	10	1	10
Kiosk	1	1	None	1
Boat launch	None	Two-lane ramp and parking area	Off-shore	Nearby two-lane ramp and parking area approximately 2 miles from recreation area
Utilities	None	Electricity and water	None	Electricity and water
Other	Fishing access parking (10 stalls); vista point/ sightseeing; additional parking areas	35-acre overlook/ interpretive (sightseeing) and additional parking areas	None	Equestrian trails and horse trailer parking area; vista point/sightseeing; additional parking areas

Proposed Operations

An Operations Agreement will be developed to address the long-term planning and integration processes, and how to improve water supply performance with the addition of Sites Reservoir and associated infrastructure. Parties that will have the rights to divert water into Sites Reservoir (Reclamation, DWR, and the Authority) will partner to develop the agreement. The Operations Agreement would determine how to integrate the Sites Reservoir Project into the existing California water system in a way that benefits the system and improves the utility of the CVP in a beneficial way. The agreement will include, but is not limited to, tools and procedures on making changes to coordinated operations, new facilities, changes in permit conditions, meeting the goals of the projects, and options to be considered and analyzed from a water rights basis and hearing context. Existing CVP and SWP contractors will be purchasing water from the Sites Reservoir Project. To use State or Federal facilities to convey the Sites Reservoir Project water, new agreements/contracts with DWR and the United States will be required (see Chapter 11 for details).

The proposed reservoir would be filled by diversions from the Sacramento River. Sites Reservoir would be operated in cooperation with CVP and SWP facilities to maximize the potential benefits and to comply with existing operations requirements (e.g., COA, CVPIA, BiOps, and D-1641).

The operations for all of the action alternatives are designed to provide water for the following purposes:

- Improve the water supply and water supply reliability
- Increase IL4 water supply for CVPIA refuges for optimum habitat management on CVPIA refuges in the Central Valley
- Improve Sacramento and American River water temperatures and flow conditions for salmon and other native fish
- Improve Delta outflows
- Provide better conditions for Delta smelt and other aquatic species in the Delta

Cooperative operations of Sites Reservoir with the existing CVP and SWP reservoirs would increase the benefits of the project. Additional water could be stored in the existing reservoirs (Shasta, Trinity, Oroville, and Folsom) through the following operations:

- Releasing water from Sites Reservoir to meet existing Sacramento Valley CVP contract requirements, instead of taking this water out of Shasta (including exchange of Sites Reservoir Project water between Sites Project Contractors for needs upstream of Sites Reservoir)
- Releasing water from Sites Reservoir to meet CVP and SWP south-of-the-Delta needs, instead of releasing water from the CVP and SWP reservoirs
- Releasing water from Sites Reservoir instead of from the CVP and SWP reservoirs to meet a portion of the CVP commitment for Delta outflow to maintain the position of X2

The Sites Reservoir alternatives would be adaptively managed to provide water for the highest beneficial use, consistent with the objectives of this Report.

Sites Reservoir would provide water through the following mechanisms.

- Water stored in Sites Reservoir could be released to the T-C Canal for distribution to water users south of Fletcher Reservoir.
- Water could be released from Fletcher Reservoir to the TRR, where it could be released to either the GCID Canal or Funks Creek to meet local water supply needs.
- Water could be released through the Delevan Pipeline to the Sacramento River, where it could be picked up by downstream users or used for Delta export. Releases would also be provided for IL4 water supply for CVPIA refuges and for Delta ecosystem enhancement.
- Water stored in Sites Reservoir could be used in lieu of water stored in Shasta Lake or other CVP system reservoirs. This mechanism would appreciably increase upstream storage to support multiple water supply and ecosystem benefits.
- Implementation considerations associated with project operations are discussed in Chapter 9, National Economic Development.

All operations of the Sites Reservoir Project would be provided by the non-Federal Sponsor (the Authority). The Authority and its cost-share partners would be responsible for managing releases for all deliveries of water north of the Delta, and releases of water intended for export. For the conveyance of water for export, water users participating in the Authority would need contracts (CVP or SWP) for the conveyance of Sites water across the Delta to their place of use. Contracts would be required for all water wheeled through the T-C Canal. The Authority would also need to obtain wheeling agreements with GCID to move water through the GCID Canal.

Water Rights

Water rights would need to be obtained from the SWRCB for diversions, storage, and regulation of Sites Reservoir, and delivery of that water for beneficial use (see Chapter 9, National Economic Development for discussion of implementation requirements). Implementation of the Sites Reservoir Project would include:

- Assignment of the State Filing (A025517), as it will be updated, as necessary
- Possible additional water right filings as may be needed for the operation of Sites Reservoir
- Obtaining a water right permit from the SWRCB for the operation of Sites Reservoir
- Other water rights water

This will be expanded on in the draft Water Rights Strategy.

Department of Water Resources Application for Water Rights for "Colusa Reservoir": In February 1975, DWR, Northern District, published *Major Surface Water Development Opportunities in the Sacramento Valley: A Progress Report (DWR 1975)*. This Report considered the results of previous Reclamation and DWR reports, and provided in-depth analyses of four reservoir locations in the Sacramento Valley, including the "Colusa Reservoir Complex" (which included the currently

proposed Sites Reservoir) and the "Glenn Reservoir Complex" (which included a potential Newville Reservoir). The analysis considered the timing and volume of available surplus water in the Sacramento River with respect to riparian and senior appropriative water rights. For the Colusa Reservoir proposal, the report acknowledged that water from local water rights would be included in the operation of the originally proposed Colusa Reservoir; however, the study focused primarily on using surplus Sacramento River and associated tributary water supplies to provide up to 3,164,000 AF of stored water.

Subsequently, on September 30, 1977, the Department of Water Resources submitted a water right application under Water Code 10500 for diversions that would provide water to the Colusa and Glenn Reservoir Complexes. Water Right Application A025517 was filed for the Colusa Reservoir Complex; it included the following five diversion locations, with a collective direct diversion rate to use of 4,200 cfs:

- Sacramento River at Red Bluff Diversion Dam (adjacent to the current Red Bluff Pumping Plant) (Latitude N40°15'21.5240" / Longitude W122°20'30.4725")
- Sacramento River at the existing GCID Pumping Plant (Latitude N39°78'95.7266" / Longitude W122°05'01.9941")
- Middle South Fork of Willow Creek along Road 302 (Latitude N39°54'24.0015" / Longitude W122°39'04.4006")
- Funks Creek to the northwest of Funks Reservoir in 1977 (Latitude N39°34'27.3539" / Longitude W122°32'07.3568")
- Stone Corral Creek along Maxwell-Sites Road east of Huffmaster Road (Latitude N39°30'75.6840" / Longitude W122°32'90.5778")

This resulted in a State filing, which is now held by the SWRCB. The Face Value Amount[2] was for 3,164,000 acre-feet/year. The stated water uses included irrigation, municipal, domestic, industrial, recreational, fish and wildlife, water quality control, incidental power, and other without any seasonal restrictions (i.e., proposed application requested diversion from January 1 through December 31). The water right application will need to be updated to reflect the details of the Sites Reservoir Project, including all of the points of diversion, service areas, and reduction of the storage amount down to 1.81 MAF.

The State filing did not include the proposed Delevan Pipeline intake diversion from Sacramento River near the existing Maxwell Irrigation District diversion. This diversion would need to be added as a point of diversion under the State filing or require a new water right.

[2] SWRCB defines Face Value Amount as the maximum amount of water that can be appropriated for water rights issued after 1914 (Title 23 California Code of Regulations Section 731). The Face Value Amount, as shown on each water right application and permit, includes the total amount of water to be diverted for consumptive uses plus water not consumed by the water rights holder that may be used by other users (e.g., conveyance losses to percolation or surface runoff) (SWRCB 2016). For appropriative water rights, the total Face Value Amount is only available after flows are provided to senior water rights, instream flow criteria, and other senior water regulatory requirements as specified in the actual water right permit.

Diversions into Sites Reservoir

The proposed Sites Reservoir would be filled through the diversion of water from the Sacramento River pursuant to State issued water rights. Water would be diverted at two (Alternative B) to three (Alternatives A, C, and D) locations on the river. Diversions would only occur during periods when flow is in excess of the following:

- Existing CVP and SWP and other water rights diversions, including SWP Article 21 (interruptible supply) and other more senior flow priorities (diversions associated with Freeport Regional Water Project and the existing Los Vaqueros Reservoir)
- Existing regulatory requirements, including SWRCB D-1641, CVPIA 3406(b)(2) (Reclamation and USFWS 2003), the 2008 USFWS BiOp (USFWS 2008), the 2009 NMFS BiOp (NMFS 2009), and other instream flow requirements
- Future regulatory or other requirements that may be placed on the United States or the State of California

The Authority is committed to the concept of only diverting water when the system is declared to be in "true" Excess Conditions under the COA. Excess water conditions exist when it is agreed that releases from upstream reservoirs plus unregulated flows exceed Sacramento Valley in-basin uses plus exports. Reclamation's Central Valley Operations Office and DWR's SWP Operations Control Office jointly decide when balanced or excess water conditions exist. Operating Sites Reservoir in this manner avoids adverse effects on SWP and CVP operations. If the water right conditions or the BiOp provisions on the SWP and CVP become more restrictive on CVP/SWP operations, then this will likely decrease the times that the system is in Excess Conditions, and this will therefore limit the times that Sites will be able to divert water, and will decrease the water delivery capability of Sites.

The original priority date of Application 25517 (September 30, 1977) may be retained. Any new or revised application for a water right would have a present-day priority date as of date of filing. State Water Board Decision 1594 states that Standard Permit Term 91 has been placed in permits issued on applications for diversions within the Delta watershed filed after August 16, 1978. The operations modeling performed in support of this Feasibility Report was more restrictive than Term 91 limitations on diversions. The studies used "balanced conditions" to control diversions that protect stored water releases of the CVP and SWP, and also maximize CVP and SWP diversions prior to allowing diversions for Sites Reservoir. The Authority intends to demonstrate to the State Water Board that for every application involved, whether State filed or new, there is a reasonable likelihood that unappropriated water is available for the proposed appropriations.

Developing Cooperative Operations with Reclamation and DWR

The Authority, Reclamation, and DWR are discussing operational principles for Sites Reservoir. As the Federal Feasibility Investigation proceeds, these principles will be refined and eventually used to develop an Operations Agreement that outlines the cooperative operations of the Sites Reservoir and the Federal and State facilities.

One key principle is that the operation of the Sites Reservoir Project will cause no negative impacts to the CVP, SWP, or their contractors. Avoiding these impacts includes, but is not limited to, no net negative operational, financial, or environmental compliance impacts to the CVP or SWP. The filling of Sites Reservoir will be restricted to periods when the regulatory-required bypass requirements at

the diversion points and other key locations are met and the Delta is declared to be in "excess conditions."

Potential Cooperative Operations with Central Valley Project and State Water Project

There are several ways that Sites Reservoir could be operated in cooperation with CVP and SWP operations. Releases from Sites Reservoir could be made in lieu of and consistent with the annual planned releases for the CVP. The Operations Agreement with the Authority will specify how releases from other reservoirs could be reduced while still meeting requirements for minimum instream flow objectives, Sacramento River temperature requirements, and Delta salinity control. Through this reduction in releases, storage could be conserved in Shasta Lake and Folsom Lake to improve fish survival (including water temperature and flow stabilization), and other ecological benefits.

The following are examples of potential operational scenarios that would require cooperation between agencies, including Reclamation, DWR, the Authority, TCCA, and GCID, and would be pursuant to new cooperative agreements and a water right permit and eventual license related to Water Right Application A025517;

- Sites Reservoir Project water would be diverted from the Sacramento River at the RBPP and conveyed through the T-C Canal through a new agreement with the United States. This water would be stored in Sites Reservoir. Funks Reservoir would be expanded and re-configured into Fletcher Reservoir without losing current functions, and remain under ownership of the Federal government.
- Sites Reservoir Project water would be diverted from the Sacramento River at the GCID pumping plant in Hamilton City under a new agreement between the Authority and GCID. This water would be conveyed to the TRR, pumped into Fletcher Reservoir, and then stored in Sites Reservoir.
- Sites Reservoir Project water, pursuant to a modification to Water Right Application A025517, would be diverted from the Sacramento River at the Delevan Intake Pumping/Generating Plant; pumped into Fletcher Reservoir; and then stored in Sites Reservoir.
- Reclamation's Sites Reservoir Project Water, as cooperatively operated with the CVP, could be used by Reclamation for Congressionally authorized purposes, including, but not limited to, coldwater pool, instream flows or other public benefit.
- If there are conflicting requests for deliveries, operations will balance all deliveries based on a proportionate share of water.
- Sites Reservoir Project water (i.e., supplemental water acquired by CVP and SWP contractors in the Sacramento Valley from the Authority) could be released from Sites Reservoir via the T-C Canal and GCID Canal to provide an additional water supply.
- The State's Sites Reservoir Project water stored in Sites Reservoir for ecosystem benefits could be released as pulse flows to Cache Slough via the Colusa Basin Drain and Toe Drain in the Yolo Bypass to provide food for Delta smelt. This water would be funded and managed by the State.

- Sites Reservoir Project water (i.e., supplemental water purchased by the Authority's cost-share partners south of the Delta) could be released from Sites Reservoir via the new Delevan Pipeline to provide additional water supply in the CVP and SWP service areas. This water would be acquired by the Authority's cost-share partners, but the agencies receiving this water would have to execute new contracts with the Federal government or agreements with the State for use of Federal or State facilities to pump and convey the Sites Reservoir Project water to the Authority's cost-share partners south of the Delta. Water released from Sites may be temporarily held in downstream storage and conveyance systems. Arrangements for storage and conveyance once water has left the Sites Reservoir is the responsibility of the end user.

Operations for Anadromous Fish and Delta Ecosystem Enhancement

Operations to benefit anadromous fish and Delta ecosystem enhancement were informed by prior CALFED studies and recommendations. As part of CALFED, several systemwide operational strategies were considered for reversing the fundamental causes of decline in fish and wildlife populations. CALFED recommended a series of actions to improve ecological processes and increase the amount and quality of habitat.

The CALFED Environmental Restoration Program identified more than 600 programmatic actions to improve ecological health. Eight of these (EI-1 through EI-8) were identified by the NODOS planning team, with input from the Sacramento River Flow Regime Technical Advisory Group (which included environmental advocacy groups, academics, and representatives from Federal and State water resource and fish and wildlife agencies), and incorporated into the Sites Reservoir Project alternatives. These actions are described in Table 6-3. CALFED advocated an adaptive management implementation strategy that supports the flexible use of environmental water. This adaptive approach has been accommodated by dedicating a storage allocation to benefit anadromous fish and Delta ecosystem enhancement.

Proposed operations, including the proposed actions for fish enhancement, are summarized in Table 6-3. This table shows the types of beneficiary operations under drought and other hydrologic conditions and the priorities assumed for various seasonal operations. The proposed actions for fish enhancement are described below.

Shasta Lake Coldwater Pool and Sacramento River Temperature Control

The benefits from Sites Reservoir would be appreciably enhanced through cooperative operations with Shasta Lake to increase the volume of cold water stored in Shasta Lake, and improve the ability to maintain appropriate water temperatures in the Sacramento River during summer months, especially in drought years. This would be accomplished by the in-lieu use of water dedicated to public benefits stored in Sites Reservoir to conserve water in Lake Shasta for the benefit of anadromous fish. The water from Sites Reservoir would then be released to meet CVP obligations (e.g., CVP water deliveries to CVP contractors in accordance with existing CVP contracts). This would allow the coldwater pool at Shasta Lake to be maintained at higher levels than are currently achievable. Shasta Lake release patterns could be shifted in-season and between adjacent years to improve coldwater storage and flow management for salmon that use the Sacramento River between Keswick Dam and Red Bluff as habitat.

Folsom Lake Coldwater Pool Improvement and Supply Reliability

Coordinated operations between Sites Reservoir and Folsom Lake would improve the reliability of coldwater carryover storage at Folsom Lake, stabilize flows in the American River, and help maintain suitable water temperatures in the lower American River. Additional summer releases from Sites Reservoir could reduce the need for releases from Folsom Lake, resulting in increased carryover storage. Sites Reservoir releases could also provide additional Delta outflow to reduce the reliance on Folsom Lake for releases to maintain Delta water quality.

Delta Ecosystem Enhancement

Sites Reservoir releases into the Yolo Bypass toe drain could convey biomass into the Delta. This operation would increase Delta smelt spawning habitat and improve food availability. The primary objectives and triggers would be the phytoplankton/zooplankton populations and the Delta smelt population response. Results in the August through October time period should be highly reproducible.

The Authority would rely on existing Delta smelt monitoring programs to track smelt population, including actions consistent with Delta Smelt Resiliency Strategy (California Natural Resources Agency 2016), as well as adaptive measures, would include changes in the timing of releases, the duration and magnitude of the pulse, and the magnitude of the pulse (in cfs).

Lake Oroville Coldwater Pool Improvement

Sites Reservoir releases could increase the reliability of coldwater pool storage in Oroville Reservoir to reduce water temperatures in the lower Feather River for the benefit of juvenile steelhead and spring-run Chinook salmon over-summer rearing and fall-run Chinook salmon.

Table 6-3. Description of Proposed Seasonal Schedule for Project Operations

Measure	Detail of Operation	Alternative(s)	Priority of Operation [a]	Year-Type Suitable [b]	Suitable Months for Operation [c]
					Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
General Operation					The darker shading indicates months where there is heavy use of operations to attain the stated objective. Lighter shading indicates months where operations for the objective are light to moderate (i.e., operations occur when supplies are available and conditions favor the operation). No shading indicates no use to light use for the indicated objective.
Diversions	Conduct diversions to T-C Canal, GCID Canal, and the proposed Delevan Pipeline (diversions could occur in any month). Diversions would only occur once the D-1641, CVPIA 3406(b)(2), 2008 and 2019 USFWS BiOps, and 2009 and 2019 NMFS BiOps requirements have been met and existing authorized Delta diversions have been satisfied. Diversions to Sites Reservoir would be restricted by Sacramento River bypass criteria at Red Bluff, Hamilton City, Wilkins Slough, and Freeport, and the restrictions for protecting fish outmigration-related pulse flows (7 to 10 days once a month when flow conditions provide). Shading indicates the period in which diversion operations would occur, with the highest diversions during November through March. Diversions could also be limited by future regulatory requirements which may be imposed.	A, B, C, and D	N/A	N/A	
Seasonal Reservoir Operations	Fill Sites Reservoir by pumping water diverted and stored throughout the winter and spring and drawdown during peak release periods throughout the summer and fall.	A, B, C, and D	N/A	N/A	Fill Cycle; Drawdown Cycle; Fill Cycle
Water Supply Operations (modeled results are provided in Chapter 7)					
Authority	Provide average annual deliveries of 225 TAF for agricultural and municipal water supply. Approximately 98 TAF would be delivered to the Sacramento River Valley, and the remainder would be exported. Export would require new contracts for conveyance with Reclamation and DWR.	D	SPA-1	AN, BN, D, C	
SWP Contractors	Increase water supply reliability up to SWP Table A contract amounts in years when SWP delivery allocation is below 85 percent. Shading highlights period in which Delta exports would be increased. Table A represents the maximum annual contract amount of water delivery that SWP contractors can receive.	A, B, C	DP-1	BN, D, C	
CVP Contractors	Increase CVP water supply reliability up to Contract Total[3] (total increase up to 55 TAF in Dry and Critical years) in any Year[4] when water supply availability limits water made available by the CVP. There would be little effect if Delta export capacity is limiting water made available by the CVP. Reliability increase would mostly affect agricultural water service contractors. Shading indicates the typical agricultural diversion pattern.	A, B, C	AVG-4	AN, BN, D	
IL4 Water Supply to Refuges					
IL4 water supply for wildlife refuges	Provide 3.35 TAF per year maximum for refuges north of the Delta and up to a maximum of 101.09 TAF per year for refuges south of the Delta to supplement refuges' supplies up to the full Level 4 water supplies (CVPIA). Deliveries are modeled as occurring in the fall. Water may occasionally be moved at other times if the opportunity exists.	All	AVG-3	AN, BN, D	
Delta Environmental and Export Water Quality					
Release to enhance water quality	Augment Delta outflow above base D-1641 operations for up to 6 months with monthly rates varying within 750 cfs, 1,000 cfs, and 1,500 cfs tiers (maximum augmentation of 450 TAF per period)	All	AVG-1	AN, BN, D	
Sustainable Hydropower Operation					
Dispatchable hydropower generation	Provide more than 30 hours per week of uninterrupted operation, with dedicated afterbay/forebay (Fletcher Reservoir) with 6,500–acre-foot capacity.	All	N/A	ALL	
Ecosystem Improvements					
EI-1: Shasta Lake Coldwater Pool	Conserve water in Shasta Lake to provide additional coldwater pool storage. This action would have particular emphasis in summer months for Below Normal, Dry, and Critical water-year types. This benefit would be achieved by (1) in lieu use of water from Sites Reservoir to conserve storage in Shasta for later release to provide benefits to anadromous fish; (2) releasing water from Sites Reservoir to meet CVP south-of-the-Delta needs instead of releasing water from Shasta; and (3) releasing water from Sites Reservoir to meet a portion of the CVP commitment for Delta outflow.	All	DP-1	BN, D, C	

[3] Contract Total is defined in Reclamation's water service contract as the maximum amount of water to which the Contractor is entitled under subdivision (a) of Article 3 of this [water service] Contract. Contract Total is defined in the Sacramento River Settlement Contracts as the sum of the Base Supply and Project Water available for diversion by the Contractor for the period April 1 through October 31.
[4] Year is defined in Reclamation's water service contract as the period from and including March 1 of each Calendar Year through the last day of February of the following Calendar Year.

Table 6-3. Description of Proposed Seasonal Schedule for Project Operations

Measure	Detail of Operation	Alternative(s)	Priority of Operation [a]	Year-Type Suitable [b]	Suitable Months for Operation [c]											
					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
EI-2: Sacramento River Flows for Temperature Control	Maintain water temperatures year-round at levels suitable for all species and life stages of anadromous salmonids in the Sacramento River between Keswick Dam and Red Bluff Pumping Plant, and during the July through November period for Below Normal, Dry, and Critical water-year types. This objective would be achieved by using additional water stored in Shasta Lake as a result of the in lieu use of water from Sites Reservoir (see EI-1).	All	DP-2	BN, D, C												
EI-3: Folsom Lake Coldwater Pool	Conserve water in Folsom Lake to provide additional coldwater pool to achieve temperatures that are more suitable for juvenile steelhead summer rearing and fall-run Chinook salmon spawning in the lower American River from May through November during all water-year types. The additional water retained in storage (see EI-1) would be achieved by relying on Sites Reservoir to respond to some of the Delta objectives that are currently met through releases from Folsom Lake, particularly from January through August.	All	DP-2	D, C												
EI-6: Lake Oroville Coldwater Pool	Improve the reliability of coldwater pool storage in Lake Oroville to improve water temperature suitability for juvenile steelhead and spring-run Chinook salmon over-summer rearing and fall-run Chinook salmon spawning in the lower Feather River from May through November during all water-year types. Additional water retained in storage would be accomplished through releases from Sites Reservoir to meet Lake Oroville compliance obligations. (1) Provide releases from Oroville Dam to maintain mean daily water temperatures at levels suitable for juvenile steelhead and spring-run Chinook salmon over-summer rearing and fall-run Chinook salmon spawning in the lower Feather River. (2) Stabilize flows in the lower Feather River to minimize redd dewatering, juvenile stranding, and isolation of anadromous salmonids.	All	DP-2	BN, D, C												

[a] Priority of operation: "DP" indicates that the operational priority has a driest period's emphasis, and "AVG" indicates an average-to-wet hydrologic emphasis. The numbers 1-4 indicate priority within the associated hydrologic emphasis; "N/A" indicates that operations are not or cannot be easily defined within the priority structure of the scenario.

[b] Year-type most suitable for operation is the D-1641 40-30-30 year-types that are reflected in operations studies; operations in these year-types occur when supplies would be available in Sites Reservoir to support the operation, when the operations criteria in the scenario allow for prioritization of the operations, and when conditions are suitable for developing the benefit associated with the operation.

[c] The heavier shaded parts of each bar highlight the months in which conditions would be most suitable to the operations; the lighter shaded parts of each bar highlight the months that would be less suitable to the operations; operations in these months would occur when supplies are available in Sites Reservoir to support the operation, when the operations criteria in the scenario allow for prioritization of the operations, and when conditions are suitable for developing the benefit associated with the operation.

AN = Above Normal
Authority = Sites Project Authority
AVG = Average
BiOp = Biological Opinion
BN = Below Normal
C = Critical
cfs = cubic feet per second
CVP = Central Valley Project
CVPIA = Central Valley Project Improvement Act
D = Dry
D-1641 = Water Rights Decision 1641 Revised (SWRCB 2000)
Delta = Sacramento–San Joaquin River Delta
DP = driest periods
GCID = Glenn-Colusa Irrigation District
km = kilometers
N/A = not applicable
NMFS = National Marine Fisheries Service
SWP = State Water Project
T-C Canal = Tehama-Colusa Canal
TAF = thousand acre-feet
TCCA = Tehama-Colusa Canal Authority
USFWS = United States Fish and Wildlife Service

[3] Contract Total is defined in Reclamation's water service contract as the maximum amount of water to which the Contractor is entitled under subdivision (a) of Article 3 of this [water service] Contract. Contract Total is defined in the Sacramento River Settlement Contracts as the sum of the Base Supply and Project Water available for diversion by the Contractor for the period April 1 through October 31.
[4] Year is defined in Reclamation's water service contract as the period from and including March 1 of each Calendar Year through the last day of February of the following Calendar Year.

Chapter 7 Initial Evaluation of Alternatives

This chapter describes the initial evaluation of physical improvements, economics, and the four P&G accounts (National Economic Development, Regional Economic Development, Environmental Quality, and Other Social Effects) for the Sites Reservoir Project alternatives. The project purposes and operations are subsequently refined in Chapter 9.

Evaluation of Physical Accomplishments

This section discusses the predicted physical accomplishments of each alternative and evaluates the relative strengths and weaknesses of each plan. All alternatives were modeled using CALSIM II and a variety of supporting models (see Figure 7-1 and Figure 7-2) to evaluate their performance.

Table 7-1 summarizes the increases in water deliveries associated with the project objectives for each of the alternatives. As the table indicates, the ability to increase deliveries varies for each alternative. These variances arise from the following project features:

- The size of the reservoir (More water deliveries are possible with a larger reservoir.)
- The addition of a new intake (Delevan Intake) (The increased ability to divert water results in an increased ability to deliver water.)

Dry and Critical years are as defined in SWRCB D-1641 40-30-30 Dry and Critical years for the period October 1921 through September 2003. The long-term average annual amounts also cover the period from October 1921 through September 2003.

Water Supply (Primary Objective)

All alternatives include water supply for M&I and agricultural purposes. Increases in water supply for agricultural and M&I use over the long-term Average for all water year types, as well as Dry and Critical years, were used to evaluate the alternatives with respect to water supply and water supply reliability (see Table 7-1). The water supply objective is measured as a long-term Average change and a Dry/Critical year change in water deliveries.

Deliveries of Sites Reservoir Project water to north-of-Delta users is highest in Alternative D, followed by Alternative C. Much of this water would be delivered in the CVP service area. Alternative C has a much greater emphasis on moving Sites Reservoir Project water south of the Delta, and there are higher deliveries in the SWP service area for M&I purposes under both Alternatives B and C.

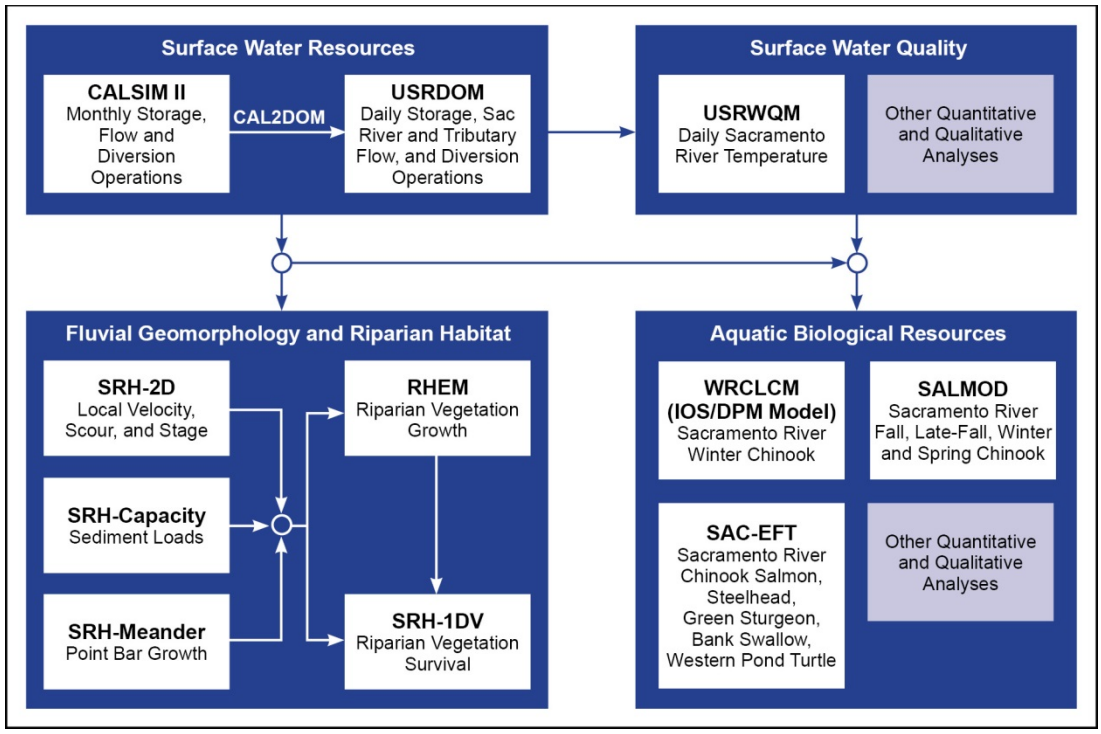


Figure 7-1. Modeling Framework for Alternative Evaluation – System Level

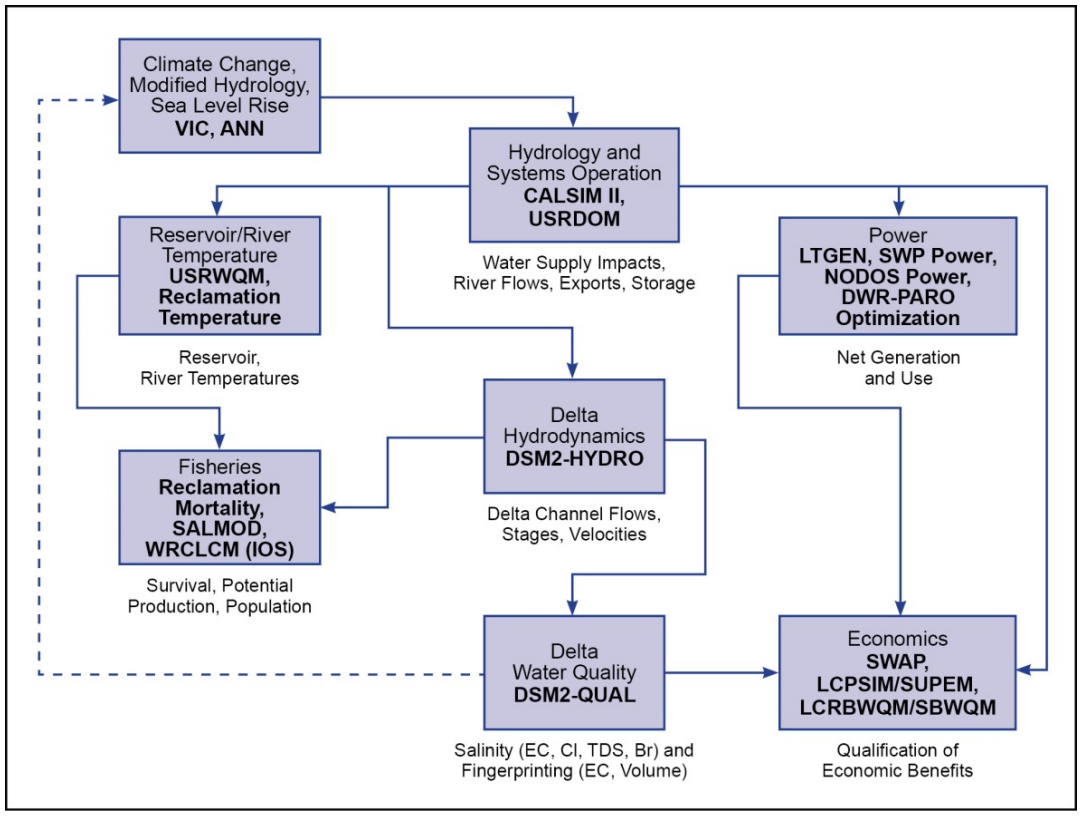


Figure 7-2. Modeling Framework for Alternative Evaluation – Watershed Level

Table 7-1. Increased Long-Term and Dry/Critical Year Annual Deliveries

Objectives and Accomplishments (above No Project Alternative conditions) [a]	Alternative A		Alternative B		Alternative C		Alternative D	
	Average (TAF)	Dry and Critical (TAF)	Average (TAF)	Dry and Critical (TAF)	Average (TAF)	Dry and Critical (TAF)	Average (TAF)	Dry and Critical (TAF)
Alternative Facilities	1.3-MAF Reservoir New Intake		1.8-MAF Reservoir No New Intake		1.8-MAF Reservoir New Intake		1.8-MAF Reservoir New Intake	
Alternative Operation	Export Focus		Export Focus		Export Focus		Sac Valley Focus	
Supplemental Deliveries in SWP Service Area	**122**	**267**	**130**	**248**	**134**	**291**	**116**	**228**
NOD Ag	0	2	0	1	-1	-3	1	4
NOD M&I	1	2	1	2	1	3	1	2
SOD Ag	30	57	34	55	36	67	28	51
SOD M&I	91	206	95	190	98	224	86	171
Supplemental Deliveries in CVP Service Area	**47**	**67**	**11**	**22**	**38**	**55**	**109**	**190**
NOD Ag	19	28	12	14	25	30	95	169
NOD M&I	2	1	0	0	2	1	1	0
SOD Ag	0	0	-1	8	10	22	13	21
SOD M&I	1	1	0	0	1	1	0	0
Sub-Total Supplemental Deliveries for Water Supply	**169**	**334**	**141**	**270**	**172**	**346**	**225**	**418**
IL4 Water Supply for CVPIA Wildlife	44	22	72	37	74	37	48	23
Water supply for Delta environmental water quality/salmonid improvement	212	208	216	217	243	255	174	162
Total Deliveries	**425**	**564**	**429**	**524**	**489**	**637**	**446**	**604**
Additional end-of-September storage in Shasta (TAF)	101	139	106	180	108	175	132	198

Note: Totals may not sum exactly due to rounding.

[a] Increases in deliveries above the No Project Alternative, including supplies for agriculture, M&I, and environmental purposes. Dry and Critical period average is the average quantity for the combination of the SWRCB's D-1641 40-30-30 Dry and Critical years for the period October 1921 to September 2003. The "Average (TAF)" is for this period.

[b] Releases from Sites Reservoir to the Delta solely for environmental benefit. This quantity excludes any water released for export or carriage water requirements.

Ag = agriculture
CVP = Central Valley Project
D-1641 = Water Rights Decision 1641 Revised (SWRCB 2000)
M&I = municipal and industrial
MAF = million acre-feet
SWP = State Water Project
SWRCB = State Water Resources Control Board
TAF = thousand acre-feet

The ability of Sites Reservoir to provide Sites Reservoir Project water to SWP contractors in years with less than an 85 percent allocation of contract amounts was evaluated, with an emphasis on years below 65 percent allocation. On average, the increases are modest; however, during Dry and Critical years (approximately 22 percent of years are Dry and 15 percent are in the Critical-year category), increases in supplemental water supply available for delivery range from 171 to 288 TAF/year. Alternative C provides the greatest increases in supplemental water supply in Dry and Critical years available for delivery to SWP contractors, followed by Alternatives D, B, and A, in that order.

Increasing Table A deliveries in the action alternatives might take pumping priority over Article 21 exports. SWP contractors could therefore experience a small reduction in Article 21 deliveries. (CALSIM II results show a decrease of 1 to 2 TAF in average Article 21 deliveries from the No Action Alternative for Alternatives A, B, C, and D.)

Alternative D would provide non-CVP water to CVP contractors in the Sacramento Valley who are participating agencies in the Authority. This new supply of 95 TAF on average, and up to 169 TAF in Critical years, is unique to Alternative D.

Key findings regarding water supply and water supply reliability include the following:

- Alternative D provides the highest average long-term annual increases in the total amount of available supplemental water (273 TAF) and Dry and Critical year increases (455 TAF).

Alternative C provides the second-largest average long-term annual and Dry/Critical year increases in the total amount of available supplemental water due to the larger reservoir size. The amount of total stored water also characterizes the ability of each alternative to provide water supply reliability over a variety of hydrologic conditions. Table 7-2 lists the amount of stored water that would be maintained at Sites Reservoir.

Table 7-2. Water Stored in Sites Reservoir

Parameter	Alternative A (1.3 MAF)	Alternative B (1.8 MAF)	Alternative C (1.8 MAF)	Alternative D (1.8 MAF)
End-of-May Storage (TAF)				
Average Annual	985	1,235	1,441	1,447
Dry and Critical	680	803	1,031	1,051

MAF = million acre-feet
TAF = thousand acre-feet

Figure 7-3 provides a summary of the systemwide increases in storage for the four alternatives. Both the long-term average and the driest periods' average end-of-May storage are provided. This additional storage (816 to 1,1,584 TAF) appreciably increases the flexibility of system operations to respond to CVP system needs. Alternatives C and D provide the greatest increase in storage throughout the system.

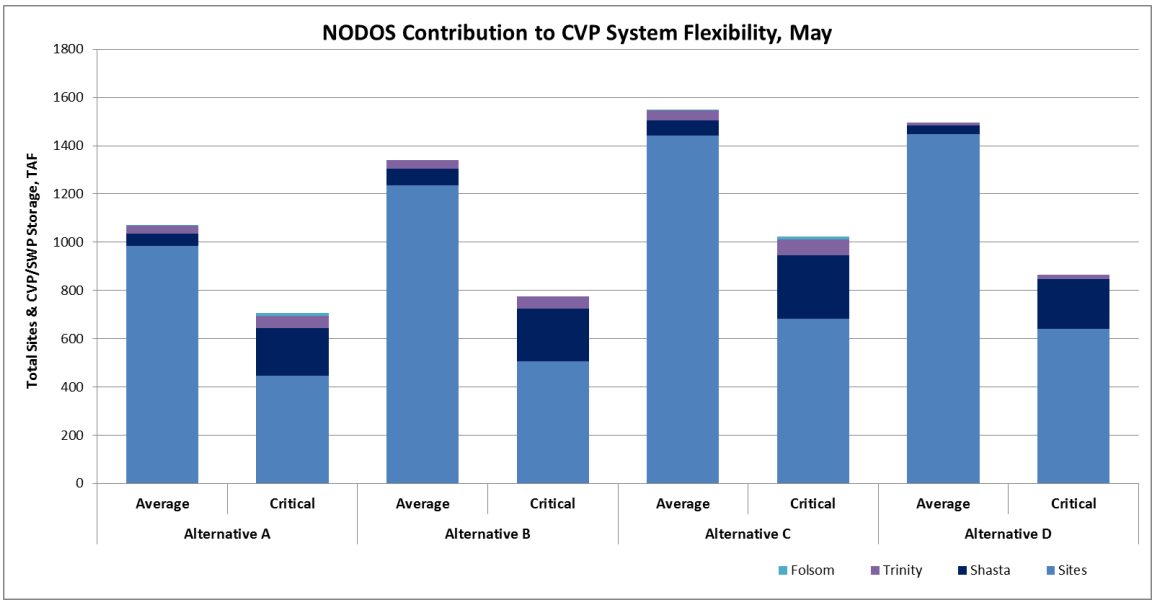


Figure 7-3. Increases in Average End-of-May Storage in Sites and CVP Reservoirs

IL4 Water Supply for CVPIA Wildlife Refuges (Primary Objective)

IL4Sites Reservoir would provide supplemental Sites Reservoir Project water for IL4 refuge water supply under the action alternatives. For each of the action alternatives, most of the Sites Reservoir Project water was modeled as south of Delta deliveries (over 95 percent). A minimal amount of water was included in the modeled deliveries to the Colusa Basin (Sacramento National Wildlife Refuge, Delevan National Wildlife Refuge, Sutter National Wildlife Refuge, and Gray Lodge Wildlife Area); nearly 80 percent of the water was delivered to Mendota Pool (West Bear Creek Unit, East Bear Creek Unit, Los Banos Wildlife Area, China Island Unit and Salt Slough Unit of North Grasslands Wildlife Area Complex, Mendota Wildlife Area, Volta Wildlife Area, and Grassland Resource Conservation District), and the remainder was delivered to the Tulare Basin (Kern National Wildlife Refuge and Pixley National Wildlife Refuge). Historically, it has been difficult for the refuge program to move IL4 refuge water south of the Delta. All modeled deliveries used the Banks pumping facilities with most deliveries in the fall, when there should be more export capacity to move the water south. Additional work is needed to better match the distribution with refuge needs.

The water source for these increased deliveries of IL4 is excess Delta water supplies available during Delta surplus conditions. The RWSP conveys water from San Luis Reservoir to most of the Refuges via the Delta-Mendota Canal. C.W. Jones Pumping Plant and the Delta-Mendota Canal are operated by San Luis Delta Mendota Water Agency (SLDMWA); the operations and maintenance agreement between Reclamation and SLDMWA identifies water deliveries to Refuges. The majority of Refuges receive water deliveries either diverted directly from the Delta-Mendota Canal or taken from the Mendota Pool through conveyance agreements between Reclamation and three local water and irrigation districts: Central California Irrigation District, GWD, and Henry Miller Reclamation District.

The ability of the alternatives to provide water to meet the IL4 criteria was modeled as part of the alternative evaluation. Modeled deliveries may vary from real-time operations due to differences in

modeling prioritization and real-time availability. The model evaluated 2030 conditions where conveyance improvements were included for some refuges that currently lack a conveyance system.

The alternatives would provide a reliable source of IL4 water supply for CVPIA wildlife refuges from storage in Sites Reservoir. The Sites Reservoir alternatives would provide increased long-term water supplies, ranging from 44 TAF under Alternative A to 74 TAF under Alternative C. The ability to provide IL4 refuge water supply is reduced in Dry and Critical years (22 to 37 TAF would be delivered in Dry and Critical years).

Anadromous Fish (Primary Objective)

Several operational actions were included in the CALSIM operations model for the alternatives to improve conditions in ways that would support anadromous fish (Figure 7-4). Most of the improvements for salmonids would occur in the Sacramento River between Keswick Dam and Red Bluff. Actions to benefit fish in this portion of the river include:

- Improve Shasta Lake coldwater pool
- Augment Sacramento River flows for temperature control
- Augment Sacramento River fall flows to support migration and reduce dewatering of redds

Water temperature is one of the principal drivers for salmonid production. Evidence suggests a strong correlation between daytime migratory activity and water temperature. There are optimum temperatures for survival and growth that minimize mortality. However, as temperatures reach maximum threshold values, fish stress levels and fish mortality increase. Each of the Sites Reservoir Project action alternatives increases the coldwater pool at Shasta Lake, providing an opportunity to reduce temperatures in the portion of the Sacramento River immediately downstream (Table 7-3). Augmenting flows in the Sacramento River would also reduce stranding events, which would support the migration of fish. Water flow and net river discharge have been shown to be highly influential in the rates at which young salmon migrate.

Improvements in habitat conditions for anadromous fish in the Sacramento River were directly evaluated through the use of SALMOD. SALMOD evaluates the linkage between habitat dynamics (i.e., flow and temperature) and smolt growth, movement, and survival between Keswick Dam and Red Bluff (Figure 7-5). SALMOD also was used to quantify the effects of flow and temperature regimes for the alternatives on annual production potential. SALMOD is habitat-based, and only examines the juvenile (freshwater) life history phase, but it provides output for all four Sacramento Chinook stocks (winter, spring, fall, and late-fall run).

SALMOD results indicated that water temperature changes had a greater effect on mortality than river flow changes. Sites Reservoir would have beneficial temperature effects for all four Chinook salmon stocks (Table 7-4). Figure 7-6 shows the simulated percentage increase in production of juvenile Chinook salmon, based on SALMOD results.

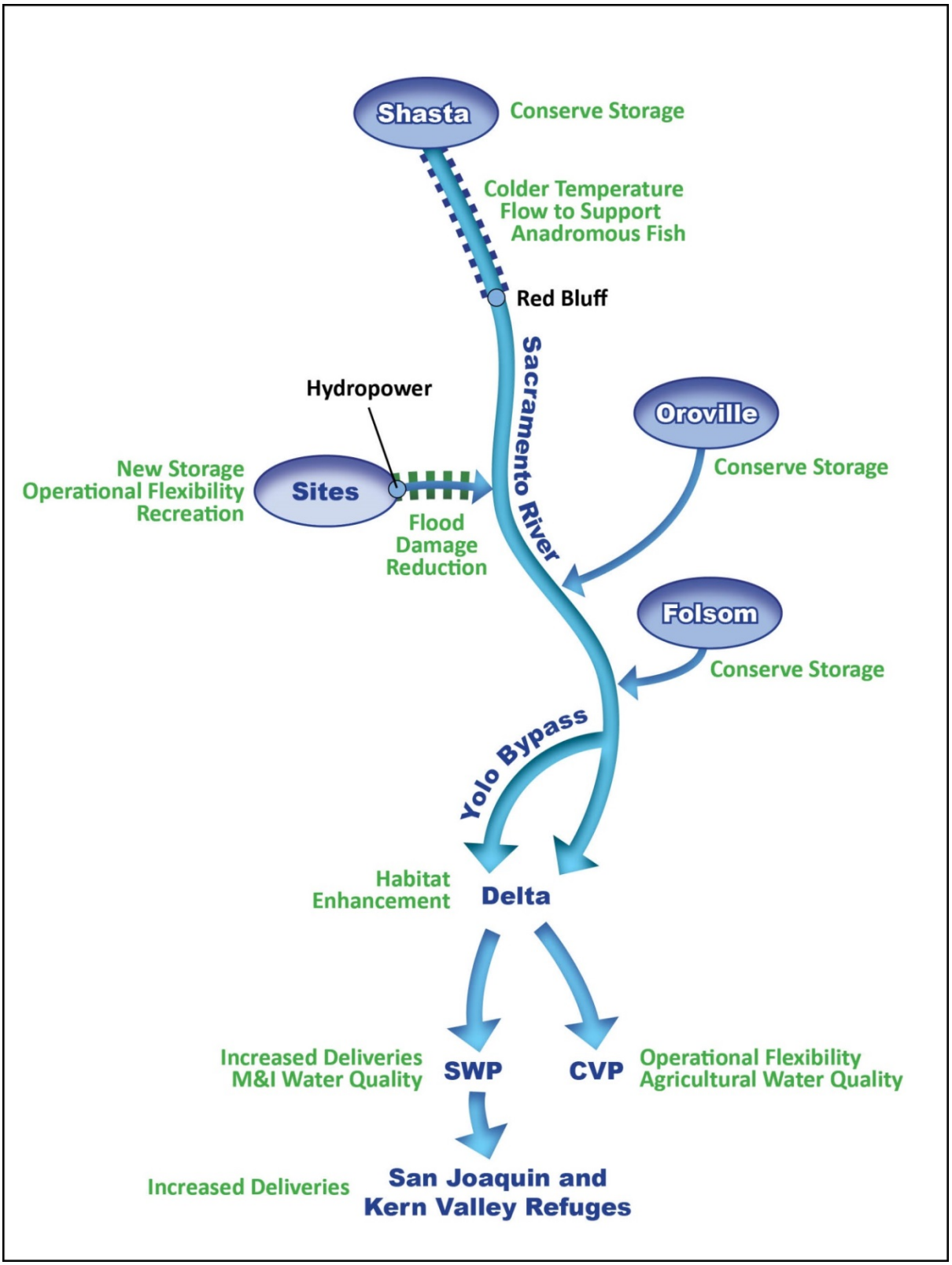


Figure 7-4. Conceptual Model Including Benefits to Anadromous Fish

Table 7-3. NODOS Alternatives Temperature Model Results for Keswick and Balls Ferry

	Sacramento River below Keswick (August to September Average Temperature)								
	No Action Alternative	Alternative A		Alternative B		Alternative C		Alternative D	
	Temp (°F)	Temp (°F)	Change from NAA	Temp (°F)	Change from NAA	Temp (°F)	Change from NAA	Temp (°F)	Change from NAA
Full Simulation Average	54.2	53.7	-0.5	53.7	-0.5	53.6	-0.6	53.4	-0.7
Wet Year Average	52.8	52.7	-0.1	52.8	0.0	52.7	-0.1	52.7	-0.1
Above Normal Year Average	53.2	53.0	-0.2	53.0	-0.1	53.1	-0.1	52.9	-0.3
Below Normal Year Average	53.0	52.7	-0.3	52.6	-0.3	52.7	-0.2	52.6	-0.3
Dry Year Average	54.3	53.6	-0.7	53.6	-0.7	53.5	-0.8	53.3	-1.0
Critical Year Average	59.3	57.5	-1.8	57.9	-1.4	57.3	-2.0	56.8	-2.5
	Sacramento River at Balls Ferry (August to September Average Temperature)								
	No Action Alternative	Alternative A		Alternative B		Alternative C		Alternative D	
	Temp (°F)	Temp (°F)	Change from NAA	Temp (°F)	Change from NAA	Temp (°F)	Change from NAA	Temp (°F)	Change from NAA
Full Simulation Average	56.0	55.6	-0.4	55.7	-0.4	55.6	-0.4	55.5	-0.6
Wet Year Average	54.6	54.6	0.0	54.6	0.0	54.6	-0.1	54.6	-0.1
Above Normal Year Average	55.1	55.1	0.0	55.1	-0.1	55.1	0.0	55.0	-0.2
Below Normal Year Average	55.2	54.9	-0.3	54.9	-0.3	55.0	-0.2	54.9	-0.3
Dry Year Average	56.4	55.8	-0.5	55.8	-0.6	55.7	-0.7	55.6	-0.8
Critical Year Average	60.4	58.9	-1.5	59.2	-1.1	58.7	-1.7	58.3	-2.1

Notes:
°F = degrees Fahrenheit

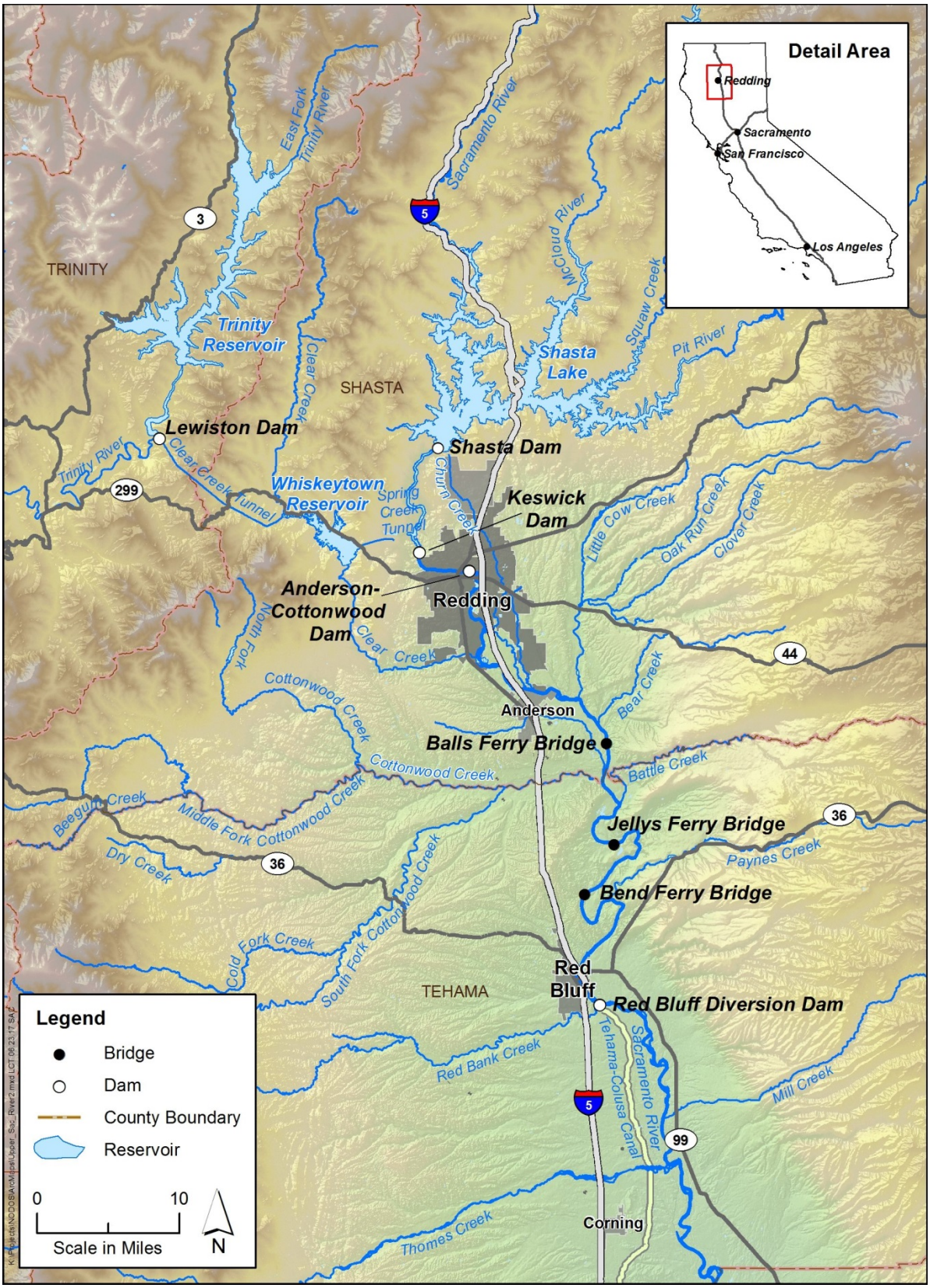


Figure 7-5. Area of Salmon Habitat Improvement Evaluated by SALMOD Model

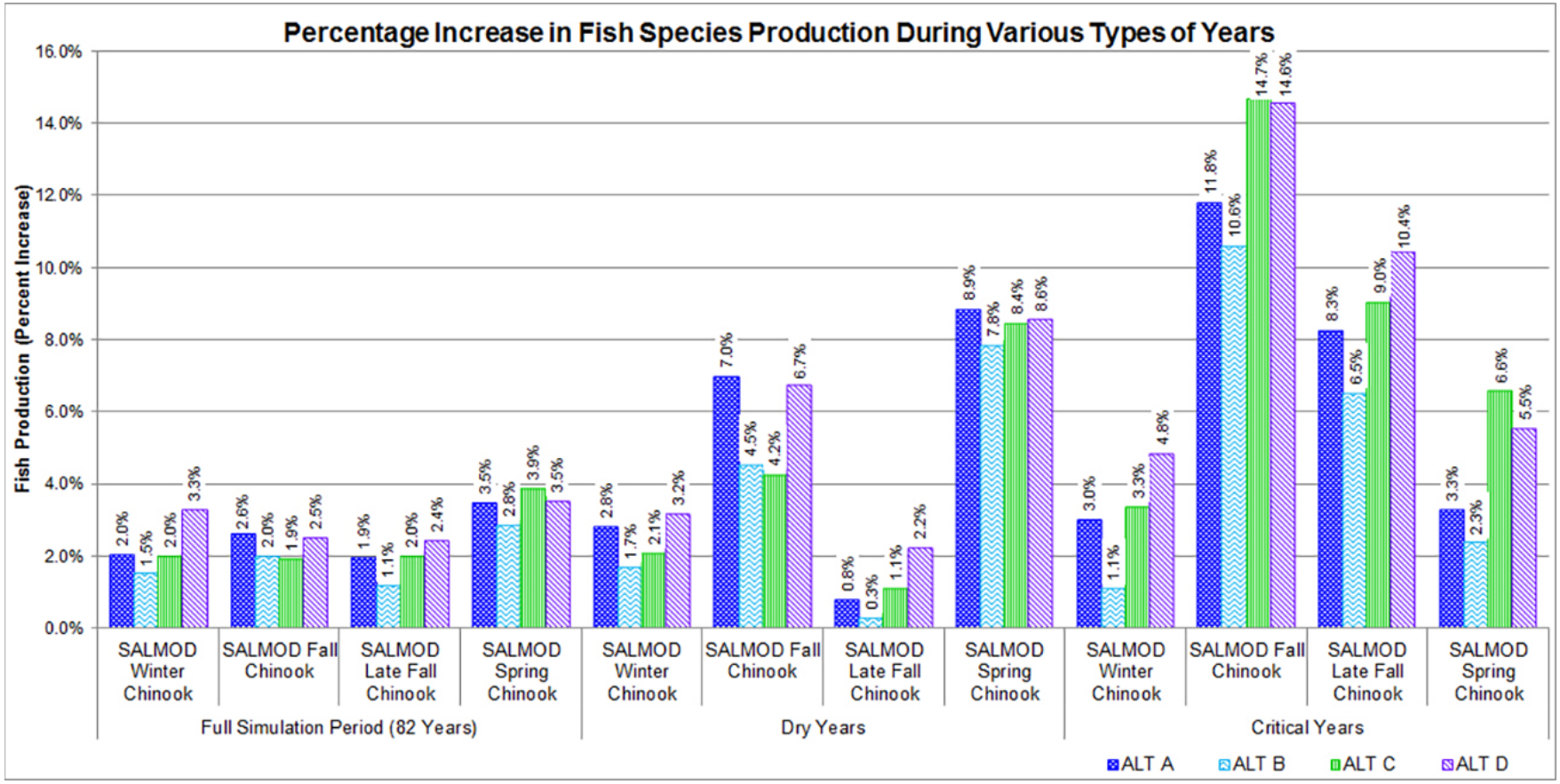


Figure 7-6. Anticipated Effects of Alternatives A, B, C, and D Compared to No Project Alternative on Sacramento River Chinook Salmon Juvenile Production (SALMOD Model)

Table 7-4. SALMOD Modeling Results for Sacramento River Winter Run Chinook Salmon

Percent Increase Compared to Without Project				
Parameter	**Alternative A**	**Alternative B**	**Alternative C**	**Alternative D**
Egg to Fry Survival				
Average	2.8%	3.1%	3.8%	3.8%
Dry Year	4.8%	6.3%	6.9%	6.1%
Critical Year	26.1%	21.2%	33.1%	33.8%
Returning Female Spawners				
Average	8.1%	8.1%	8.3%	11.2%
Dry Year	7.1%	6.4%	5.7%	7.2%
Critical Year	10.2%	11.2%	8.5%	10.0%

All alternatives would improve the survival of anadromous fish populations (all Chinook stocks) in the Sacramento River. Modeling results suggest that Alternative D would be the most beneficial to anadromous fish, followed closely by Alternative A. Alternative B provides the least benefit to anadromous fish.

Delta Environmental and Export Water Quality (Primary Objective)

All alternatives improve environmental water quality in the Delta and water quality of Delta exports. This section evaluates the ability of the alternatives to provide these benefits.

Delta Environmental Water Quality

Increased flows through the Delta and through San Francisco Bay provide a wide range of environmental benefits. These flows increase estuarine habitat, reduce entrainment, and improve food availability for anadromous fish and other estuarine-dependent species (e.g., Delta smelt, longfin smelt, Sacramento splittail, starry flounder, and California bay shrimp). The SWRCB has concluded that the best available science suggests that current Delta flows are insufficient to protect public trust resources, including fish populations (SWRCB 2010).

The potential for water quality improvements in the Delta was evaluated in terms of the position of X2 and the resulting Delta outflows. Shifting X2 downstream improves the habitat for Delta smelt and reduces water quality stress for other species, including salmonids. X2 is a Delta management tool; and is defined as the distance in kilometers from the Golden Gate Bridge to the location where the tidally averaged near-bottom salinity in the Delta measures 2 parts per thousand (ppt). East of X2, water becomes progressively fresher, and west of X2 the water becomes more saline, until it reaches the ocean, which has a salinity of approximately 35 ppt.

Habitat quality in the Delta is degraded when the salinity in the Delta increases. The highest salinities occur during the fall and early winter, when Delta outflow is at its lowest. Water quality degradation is most pronounced in Dry and Critical years. Figure 7-7 shows the change in the average X2 positions during September and October in Dry and Critical years for each of the alternatives. Alternative C performs best in terms of the shift in the location of X2 by 0.3 to 1.0 kilometer (km) seaward, followed by Alternative B and then Alternative A. Alternative D provides the least water quality benefit, with an average shift of 1 km to the east in July through August, and a 0.3 km shift to the east in September through November. Shifting X2 requires a.

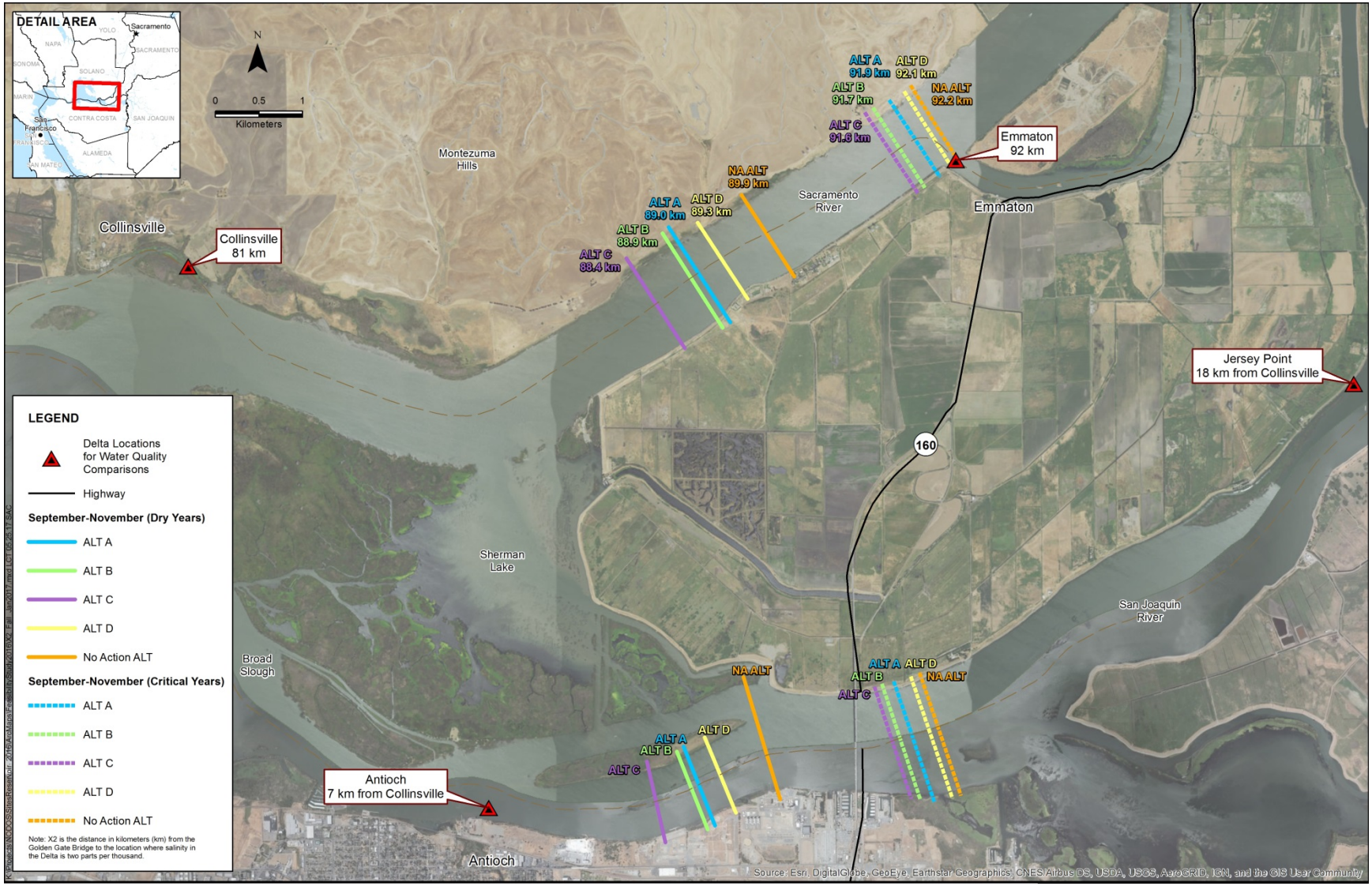


Figure 7-7. Position of X2 During September – November in Dry and Critical Years

significant quantity of water. Releases from Sites Reservoir to improve Delta environmental water quality range from 174 TAF/yr under Alternative D, up to 242 TAF/yr under Alternative C. The modeled benefits assume that all water is released from the Delevan Pipeline to the Sacramento River. It is also possible to release water via the Colusa Basin Drain to the Yolo Bypass and into the Delta. Releasing water in this way may provide additional benefits to salmonids and Delta smelt.

Water Quality for Agricultural and M&I Water Uses

Improved water quality in the Delta would benefit the Delta export water quality. Exporters using water for M&I purposes would experience a reduction in water treatment costs. Agricultural users, particularly in the San Joaquin River Basin, would benefit from reduced salt loads.

Water quality improvements that would result from the Sites Reservoir Project alternatives for agricultural and M&I water uses were evaluated using salinity concentrations for the four action alternatives. Figure 7-8 shows the improvements in salinity concentrations at the CVP, SWP, and Contra Costa Water District pumps under long-term average conditions and for dry/critical years. Alternative C provides the greatest improvements, followed by Alternatives A, B, and D in decreasing order

Sustainable Hydropower Generation (Secondary Objective)

All Sites Reservoir Project alternatives are net users of energy. There is nevertheless a potential hydropower benefit to the grid that can be derived from the timing of pumping and hydropower generation operations. The intent is to integrate the operation of the Sites hydropower facilities with the operation of renewable energy sources (i.e., wind and solar). This integration is maximized when the hydropower generated is fully dispatchable. The capability for pumpback storage with Fletcher Reservoir as a forebay/afterbay supports hydropower generation when it is beneficial to the grid, not just when Sites Reservoir is making water releases for customers.

Pumpback generation will be constrained when the reservoir is filling, but there will be no conflicts during the summer and early fall period, when diversions are not taking place. Even during the winter months when the reservoir is filled, there will be periods where pumpback operations will be under way when water is not available to divert; due either to a lack of rainfall or permit conditions

The Sites Reservoir Project alternatives may also have a negative impact on CVP power customers, depending on permits for implementation. The Sites Reservoir Project proposal of conserving Shasta's and Folsom's coldwater pool would alter the timing of releases from "summer peak" months to fall release months. This may positively or negatively impact revenues associated with CVP power generation. The fact that CVP water will be stored longer in Shasta or Folsom may cause the latent CVP stored water to enter into the Flood Control operations season, forcing some or all of that water to be spilled to satisfy mandated Flood Control curves, thereby not allowing CVP to generate with that quantity of spilled water.

Neither Reclamation nor the Western Area Power Association (WAPA) will receive any benefits from Sites pumpback operations unless the agencies enter into an agreement with the Authority. However, WAPA currently has restrictions on entering into agreements with non-customers.

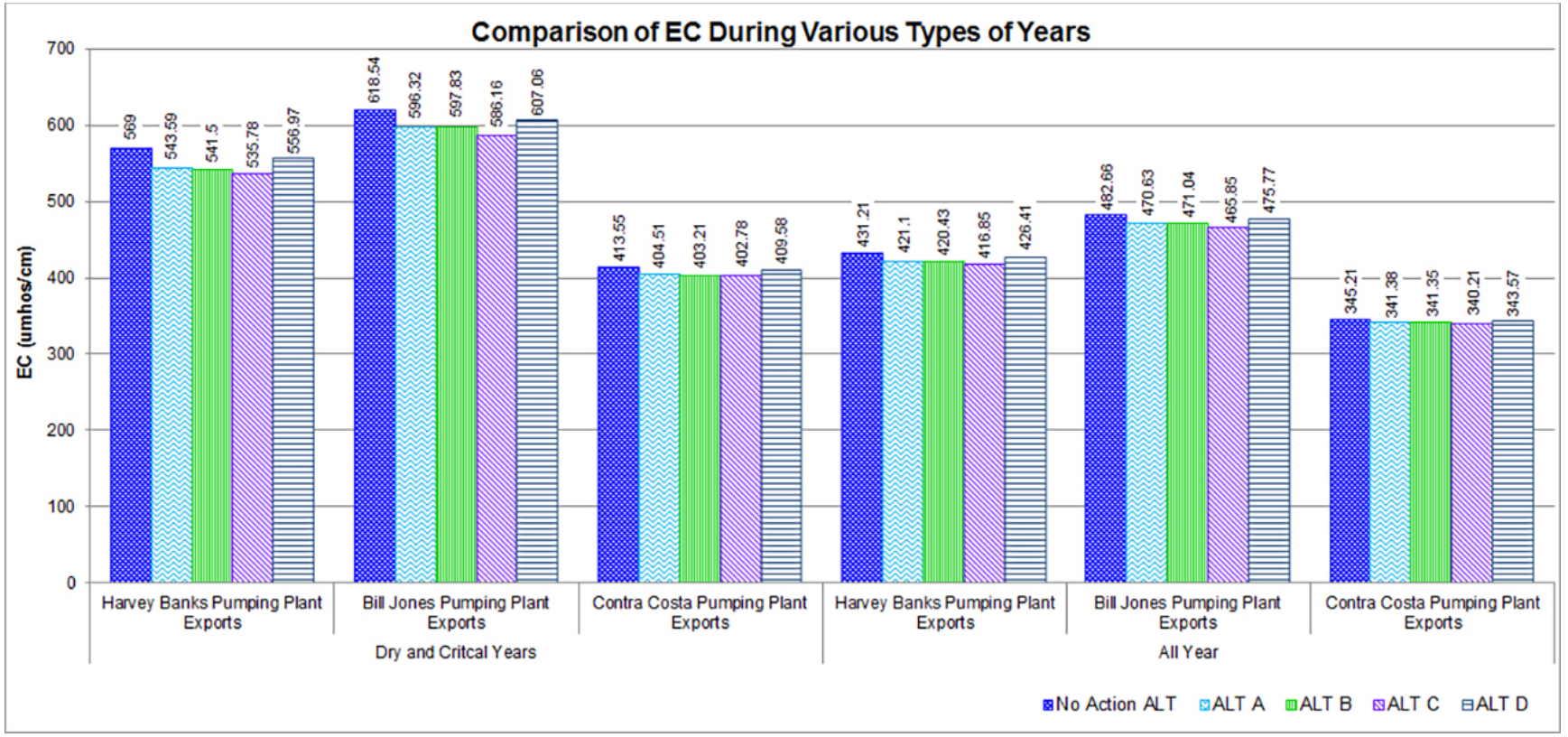


Figure 7-8. Improvements in Electrical Conductivity

Table 7-5 presents the dispatchable power generated and rated generating capacity for each of the facilities under each alternative; and the range of hydropower generation (not accounting for the energy consumed in the system by pumping) over the 30year analysis period in the Sites Reservoir Power Optimization Scheme.

Table 7-5. Sustainable Hydropower Generation

Generation Capacity	Alternative A	Alternative B	Alternative C	Alternative D
Sites-rated generation capacity (MW)	96.3	109.7	109.7	109.7
Terminal Regulating Reservoir–rated generation capacity (MW)	4.9	4.9	4.9	4.9
Sacramento River–rated generation capacity (MW)	12	N/A	12	12
Long-term average dispatchable power generated through pumpback operation (MWh)	144	143	136	98

MWh = megawatt-hours
MW = megawatt
N/A = not applicable

Alternative A has less power head (shorter dams) than the other three alternatives; and as a result, the Sites Pumping/Generating Plant for Alternative A has a lesser generation on release. The opportunity for generating dispatchable power with Alternative A is high, because it would maintain a more constant water surface elevation. Alternatives B, C, and D have the same dam heights, but Alternatives C and D generate more energy on release due to the inclusion of the Delevan Intake Pumping/Generating Plant. The TRR Pumping/Generating Plant is identical for all four alternatives.

Power generation is typically greatest in the spring and early summer. Under all alternatives, the reservoir is maintained at a higher level throughout all seasons in wet and average years. Under these conditions, power generation at the Sites Pumping/Generating Plant can occur deeper into the summer. Releases occur in summer and fall that result in power generation at the TRR and Sacramento River facilities, as well.

Hydropower generation is also affected by the water-year type. Under extended drought conditions, there may not be sufficient water in the reservoir for pumpback operation, and releases, which contribute to power generation, would be diminished. As a result, there is a notable range of power generation over the 30year analysis period corresponding to year-type.

As discussed in Chapter 2, Problems, Needs, and Opportunities, there is an opportunity for pumped-storage hydropower to firm renewable energy sources (solar and wind) resources to provide stable grid operation and reliable supplies for energy customers. Environmental benefits from reductions in GHG emissions are provided through the replacement of fossil fuel with hydropower generation to follow loads. The economics for these ancillary benefits are difficult to monetize but are generally discussed in the section titled "Benefits," below.

Recreation (Secondary Objective)

The action alternatives would provide new opportunities at Sites Reservoir for surface-water recreation, such as boating and fishing. New facilities would be developed on the shore of the

reservoir to support other recreational activities, such as camping, hiking, picnicking, and sightseeing.

Alternatives A, B, and C would develop three new recreation areas in a phased approach to meet the local demand for recreation. It is assumed that each project alternative would provide recreational development and types of recreational opportunities comparable to those available at Black Butte Reservoir. The three new recreation areas would be at Stone Corral, Lurline Headwaters, and Antelope Island. Future facilities would include boat launch sites, picnic areas and tables, developed campsites, restrooms, trails, and parking. Up to 112 overnight campsites would be added at each recreation area if it were fully developed.

Alternative D includes two recreation areas (Stone Corral and Peninsula Hills). The design for these areas was developed with input from Colusa County. Although this alternative has fewer recreation areas, the sites selected provide superior public access from the eastern and western ends of the new bridge. The facilities in these areas may also be phased in over time.

Overall usage of the recreational facilities is not expected to vary appreciably between the different alternatives.

As discussed previously, the Sites Reservoir Project alternatives would provide important benefits to anadromous fish, including game fish. The benefits to Sacramento River and Delta fisheries may result in higher catch rates and greater fish sizes. These benefits were not quantified.

Flood-Damage Reduction (Secondary Objective)

Under current No Project conditions, Stone Corral Creek can be overwhelmed with runoff and send peak flows downstream, causing flooding in the town of Maxwell and impacting nearby infrastructure. The construction of Golden Gate and Sites Dams would essentially eliminate the potential for flooding in Funks Creek, Stone Corral Creek, and various other unnamed streams.

All alternatives would provide a similar reduction in flood damages. Of the 22,200 acres of land prone to flooding in these watersheds, approximately 43 percent (9,570 acres) would experience a reduction in flood-related damages under a 100-year flood event. This area includes the northern portion of the town of Maxwell, Interstate 5 adjacent to Maxwell, and State Highway 20 to the east. These areas are subject to frequent flooding. In addition to increasing the level of protection in the Funks Creek and Stone Corral Creek watersheds, a 100-year level of protection would be achieved for approximately 4,025 acres in the Colusa Basin. Additional flood damage benefits are likely from the diversions off of the Sacramento River that would occur during major storm events. The greatest benefits would be in the vicinity of the Red Bluff and Hamilton City diversions.

Benefits

Project benefits were evaluated in accordance with the basic guidelines for water development projects at the Federal level, as specified in the P&Gs (WRC 1983). This Study was initiated before the release of the Principles, Requirements, and Guidelines (PR&Gs) (WRC 2015). Under the P&Gs, the Federal objective for water contributions is to maximize the contribution to NED, consistent with protection of the environment.

Accurate representation and comparison of the project alternatives' future benefits and costs requires that all future benefits and costs are discounted to current dollars to reflect the time value of money. Benefits are provided in 2019 dollars so that the benefits are more comparable with the benefits under WSIP and the feasibility reports for other CALFED storage projects. However, it should be noted that benefits for the State of California WSIP application differ from the NED benefits presented in this Report. Benefits in the WSIP application were estimated with climate variability assumptions and methodologies specific to the WSIP requirements; and as a result, vary from the benefits presented in this Report. Although the results from the two independent analyses (NED analysis using Federal guidelines and WSIP analysis using State guidelines) varied, both processes concluded the benefit-cost ratio (BCR) was greater than 1, and identified significant environmental benefits. Table 7-6 shows the methodologies that were used in the analysis of benefits.

Table 7-6. Economic Benefit Methodology

Benefit Type	Primary Method	Sensitivity Method	Rationale for Selection of Primary Method
Water Supply M&I	Water Transfer Pricing	LCPSIM, OMWEM	Transfer model reviewed by Reclamation for recent feasibility reports
Water Supply Agriculture	SWAP model	WSIP unit values for water supply	SWAP model used for other feasibility reports, more conservative
IL4 Water Supply to CVPIA Wildlife Refuges	Water Transfer Pricing	WSIP unit values for water supply	Long-term dedicated water supply
Anadromous Fish	Alternative Project Cost – Shasta Raise	WSIP unit values	Uses SALMOD model to produce equivalent number of habitat units
Delta Environmental and Export Water Quality	SWAP Model	Alternative Project Cost – Auburn Dam	More conservative approach
Sustainable Hydropower	PARO and PLEXOS Modeling	N/A	Availability
Recreation	Visitation	N/A	Availability
Flood Damage Reduction	Expected annual damages	N/A	Availability

LCPSIM = Least Cost Planning Simulation Model
M&I = municipal and industrial
OMWEM = Other Municipal Water Economics Model
PARO = Power and Risk Office
PLEXOS = Plexos Integrated Energy Model – a registered trademark of Energy Exemplar
SWAP = Statewide Agricultural Production
WSIP = Water Storage Investment Program
N/A = not available

Federal regulations require use of the Federal discount rate as specified by the DOI. In accordance with agency regulations, the Federal discount rate of 2.75 percent was used for fiscal year 2019 to calculate the present value of the project's future benefits and costs for this Study (Federal Register 2016). Table 7-7 provides a summary of the potential features and benefits of the alternatives.

Table 7-7. Summary of Potential Features and Benefits of Alternatives (Compared to No Action Alternative)

Item	Alternative A 1.3 MAF Reservoir New Intake	Alternative B 1.8 MAF Reservoir No New Intake	Alternative C 1.8 MAF Reservoir New Intake	Alternative D 1.8 MAF Reservoir New Intake
Water Supply				
Long-term average dedicated water supply increases (TAF/yr) [a]	169	141	172	224
Dry and Critical year dedicated water supply increases (TAF/yr) [b]	333	271	346	419
IL4 Water Supply to CVPIA Wildlife Refuges				
IL4 dedicated water supply increases (TAF/yr)	44	72	74	48
Anadromous Fish				
Additional End-of-September Storage in Shasta (TAF)	101	106	108	115
Winter-run Chinook fish production increase (thousand fish – SALMOD) [c]	936	683	756	986
Delta Environmental and Export Water Quality				
Eastward shift in X2 position July to August (km)	1.2	1.2	1.3	1.0
Sustainable Hydropower (in GWh)				
Long-term dispatchable power generation (Mwh)	144	143	136	98
Recreation (Reservoir)				
Maximum # recreation areas	3	3	3	2
Flood Damage Reduction				
Reduction on Stone Corral Creek Watershed	Yes	Yes	Yes	Yes

[a] Water supply increases are above the No Project Alternative and show total supplies for agriculture and M&I.

[b] Dry and Critical period is the average quantity for the combination of the SWRCB D-1641 40-30-30 Dry and Critical years for the period October 1921 to September 2003. Average annual is for that same period.

[c] 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 Red Bluff Pumping Plant.

D-1641 = Water Rights Decision 1641 Revised (SWRCB 2000)
MWh = megawatt-hours
km = kilometer(s)
M&I = municipal and industrial
MAF = million acre-feet
SALMOD = a computer model that simulates the dynamics of freshwater salmonid populations
SWRCB = State Water Resources Control Board
TAF/yr = thousand acre-feet per year

The project benefits and costs have been analyzed over a 100-year planning horizon based on the expected project completion and project operations beginning in 2030. Consequently, the end of the Federal planning horizon is 2130. Annualized benefits for each beneficiary are presented in Climate variability was not included in these analyses; however, climate variability is qualitatively addressed in Chapter 10, Risk and Uncertainty. Additional analysis with climate variability scenarios for 2030 and 2070 was performed in support of the WSIP application process (Authority 2017).

Table 7-8 (note that the corresponding quantities of water associated with these benefits are shown in Table 7-1).

Table 7-8. Summary of Estimated NED Annual Benefits for Sites Reservoir Action Alternatives ($ millions, 2019)

Beneficiary	Alternative A	Alternative B	Alternative C	Alternative D
Water Supply	$130.1	$125.3	$139.3	$129.2
Agricultural Supply	*$15.2*	*$8.6*	*$14.2*	*$22.7*
M&I Supply	*$114.9*	*$116.7*	*$125.0*	*$106.5*
IL4 Water Supply to CVPIA Wildlife Refuges	$25.3	$40.2	$42.3	$26.9
Anadromous Fish	$45.8	$33.5	$37.0	$48.3
Delta Environmental and Export Water Quality	$65.5	$70.5	$80.7	$45.3
Sustainable Hydropower	$20.3	$14.5	$23.5	$21.5
Recreation	$2.4	$2.4	$2.5	$2.5
Flood Damage Reduction	$4.6	$4.6	$4.6	$4.6
Total	**$294.1**	**$290.9**	**$330.0**	**$278.4**

Totals may not sum exactly due to rounding.
M&I = municipal and industrial
NED = National Economic Development

Appendix C, Economics, provides details about the estimation of benefits and the results of the sensitivity analysis. Annual benefit estimates varied considerably depending on the estimating methodology that was applied. Annual benefits ranged from $294 million to $552 million for Alternative A; from $291 million to $548 million for Alternative B; from $330 million to $609 million for Alternative C; and from $278 million to $470 million for Alternative D. The preferred method conservatively used the opportunity cost to shift water from agriculture for other project purposes. The sensitivity analysis applied other modeling approaches for valuation of the project's future M&I supply benefits, as well as use of WSIP unit values and future water transfer prices for the other flow-related purposes.

Climate variability was not included in these analyses; however, climate variability is qualitatively addressed in Chapter 10, Risk and Uncertainty. Additional analysis with climate variability scenarios for 2030 and 2070 was performed in support of the WSIP application process (Authority 2017).

Water Supply Benefits (Primary Objective)

CALSIM II operational studies were used to estimate the additional water provided by the Sites Reservoir Project alternatives for agricultural and M&I uses. For agricultural benefits, these CALSIM II water deliveries were applied to the Statewide Agricultural Production (SWAP) model. The model was then run with demands based on 2025 and 2060 level of development for the future No Action and action alternatives.

Climate variability was not included in these analyses; however, climate variability is qualitatively addressed in Chapter 10, Risk and Uncertainty. Additional analysis with climate variability scenarios for 2030 and 2070 was performed in support of the WSIP application process (Authority 2017).

Table 7-8 shows the estimated annual benefits for agricultural water supplies provided by each alternative. Alternative B would provide lesser benefits to agricultural users as a result of reduced diversions without the Delevan intake. Alternative D has the highest agricultural benefits due to its increased emphasis on water supply for the Sacramento Valley.

M&I water uses include municipal, domestic, commercial, educational, and public safety applications. The M&I benefits derived from the Sites Reservoir Project alternatives were estimated based on the assumption that the next increment of water supply to M&I users would likely be obtained through water transfers. This analysis relies on a water transfer pricing model developed for the Shasta Lake Water Resources Investigation (Reclamation 2015). This method is consistent with the "cost of the most likely alternative" method recommended by the P&Gs.

The action alternatives would increase water supplies to M&I water users across the state, especially during Dry/Critical years. The M&I water supply benefits would largely accrue to SWP contract holders south of the Delta. M&I water supply increases would generate economic benefits in the form of avoided water supply costs and reductions in shortage-related costs and losses.

Table 7-8 shows the estimated annual benefits for M&I water supplies provided by each alternative. Alternative C generates the greatest benefits to M&I users, followed by Alternative B, and then Alternatives A and D, in decreasing order.

IL4 Water Supply for CVPIA Wildlife Refuge Benefits (Primary Objective)

IL4 refuge water supply benefits (Table 7-8) were estimated based on the least-cost alternative of obtaining supplies from water transfer purchases. The results show the highest benefits for Alternative C, followed by Alternatives B, D, and A, in decreasing order.

Anadromous Fish Benefits (Primary Objective)

The greatest benefits to anadromous fish Table 7-8) would occur in the Sacramento River watershed between Keswick Dam and Red Bluff, where the potential to store additional water in Shasta Lake provides lower water temperatures and improved flows that benefit anadromous fish, including Chinook salmon and steelhead.

The economic benefits derived from changes in anadromous fish populations were estimated through an alternative project cost approach (benefits are estimated using the cost of an alternative project that would provide the same physical accomplishment). SALMOD results for the Sites Reservoir alternatives were correlated with SALMOD results for a single-purpose raise of Shasta Dam that would result in the same increase in the production of anadromous fish.

Alternative D provides the greatest benefit associated with anadromous fish. This alternative emphasized improving Coldwater Pool conditions in Shasta Lake to a greater extent than the other alternatives. It is followed by Alternative A, then Alternative C, and finally Alternative B in terms of the estimated anadromous fish benefits.

Delta Environmental and Export Water Quality Benefits (Primary Objective)

Three types of benefits associated with water quality improvements were considered to estimate the alternative benefits.

- Agricultural benefits that result from using less saline irrigation water

- M&I benefits resulting from reductions in M&I water supply treatment costs and avoided damages to equipment and distribution systems
- Environmental benefits resulting from improved water quality conditions in the Delta, including improved X2 conditions and improved habitat for Delta smelt

Agricultural Water Quality Benefits: Improvements in the quality of irrigation water diverted by exporters would affect crop production in both the short term and the long term. Reduced salinity in irrigation water improves production by reducing crop root zone salinity. Potential benefits of improved quality of irrigation water for agriculture can be categorized according to specific crop and/or irrigation management effects, such as:

- Increased yield of existing crops
- Ability to increase the yield for crops that are currently impacted by high salt concentrations
- Reduced leaching requirements and other irrigation management costs
- Reduced drainage and disposal costs
- Avoided losses in crop acreage

Growers can take advantage of some or all of these benefits, depending on their irrigation and cropping decisions. The SWAP model was used to estimate the unit value (or marginal value) of an additional unit of water available for irrigation for each alternative. In addition, the Lower Colorado River Basin Water Quality Model was used to estimate the agricultural water quality benefits for the South Coast region. Alternative C offers the highest agricultural water quality benefits, followed by Alternative B, Alternative A, and then Alternative D.

M&I Water Quality Benefits: Improvements in Delta water quality are also important for urban exporters using the water for M&I purposes. Two models were used to assess the economic benefits of M&I water supplies. Each model represents a different geographic region. The Lower Colorado River Basin Water Quality Model covers water users in the service area of the Metropolitan Water District of Southern California, and the Bay Area Water Quality Economics Model covers Southern Bay Area water users. Both models estimate the benefits of salinity reduction resulting from water quality improvements in terms of avoided costs and damages.

Alternative C offers the greatest water quality benefits to exporters diverting water for M&I purposes, followed by Alternative B and then Alternative A. Alternative D provides the lowest water quality benefits to exporters because it provides less water to M&I use.

Delta Environmental Water Quality Benefits: The economic benefits derived from Delta water quality improvements were estimated using the SWAP model to approximate the opportunity cost of shifting water from agriculture to Delta water quality (see Appendix C, Economics).

Sensitivity analysis was performed through an alternative project cost approach. The alternative project considered was the construction of Auburn Dam as a water supply project without hydropower generation. The previously studied water deliveries from Auburn Dam are similar to the amount of water released from Sites Reservoir to improve water quality in the Delta (this amount

excludes releases for export). Securing a long-term improvement in Delta water quality without a new water supply like Auburn Dam is unlikely to occur.

Alternative C provides the greatest environmental water quality benefit, followed by Alternatives B and A. Alternative D provides the least Delta water quality benefit due to its greater emphasis on anadromous fish benefits in the Sacramento watershed north of the Delta and increased use of its water in the Sacramento Valley.

There are questions regarding whether the operations proposed to obtain this benefit would be fully realized with CVP and SWP operations. This prompted the sensitivity analysis evaluation of alternative project objectives in Chapter 8.

Sustainable Hydropower Benefits (Secondary Objective)

The DWR Power and Risk Office (PARO) developed an optimization scheme for Sites Reservoir Project operations to take advantage of the opportunities and price differentials that the energy market offers to estimate the hydropower generation benefits. PARO used CALSIM II model results to identify a median-case 30-year time-series for project operations. Daily pumpback operations were superimposed (where and when possible) to better use excess capacities of project facilities, and to capture energy market opportunities. Pumpback operations would enhance the project's economics by capturing opportunities offered by the energy market (energy price differentials between peak and off-peak hours) and providing opportunities to support and integrate renewable energy production (e.g., wind, solar).

The Electric Power Research Institute's Energy Portfolio Model was used to monetize the probabilistic value of the Sites Reservoir Project power portfolio for each of the project alternatives under both incidental and optimized operational scenarios. Overall, modeling results show that if Sites Reservoir Project pumping and generation operations are managed to address peak demand and energy pricing considerations, the increased revenues from the optimized operations would have an important beneficial impact on the project's economics. Additional hydropower analysis was performed (Toolson and Zhang 2013) to estimate annual ancillary service benefits and systemwide capacity benefits.

It should be noted that market conditions for dispatchable hydropower have changed significantly over the last decade. Future market conditions are difficult to predict. As a result, there is a degree of uncertainty in the estimated hydropower benefits. Furthermore, it has not yet been determined if transmission capacity is available, and if power agreements would be through WAPA/CVP or through CAISO. The estimated benefits assume CAISO oversight. Due to this uncertainty in the magnitude of the estimated hydropower benefits, the total benefits have been analyzed with and without hydropower included. In the case where hydropower benefits have been removed, the potential for O&M cost savings is still included in the determination of the net NED benefits.

Recreation Benefits (Secondary Objective)

Alternatives A, B, and C include three potential recreation areas (Stone Corral, Lurline Headwaters, and Antelope Island). Alternative D has two recreation areas (Stone Corral and modified Peninsula Hills), which collectively provide recreational capacity and opportunity at a level similar to or exceeding that of the three combined recreation areas for Alternatives A, B, and C. Boat ramps, trails, day use, and overnight facilities (see Table 6-2) would be constructed to support the recreational activities. The economic values (as measured by consumer surplus) of the different

recreational activities anticipated at Sites Reservoir were developed using a benefits-transfer approach. The values for outdoor recreational activities are derived from published estimates for specific outdoor activities across distinct regions of the U.S. The recreation activity values used for the analysis are average values derived from individual studies conducted between 1967 and 2003, updated to 2019 dollars (Loomis 2005).

Based on the previous recreational activity studies for other regions of the country, the weighted-average value per activity expected at Sites Reservoir is estimated to be $54.26 per day. Based on a maximum of 200,000 visitor-days per year across a range of activities, the maximum annual value of the future recreational use at a Sites Reservoir Project is estimated to be approximately $10.9 million for Alternatives A, B C, and D (Table 7-8).

Due to expected fluctuations in the reservoir's surface area resulting from Dry year conditions, recreational activity at Sites Reservoir might be expected to be slightly reduced, and average between 179,000 and 186,850 annual visitor-days for Alternatives A, B, C, and D. However, a large share of Sites Reservoir's future recreational use may be expected to result from visitors relocating their recreational activity from other locations in the region. Furthermore, it is likely that the recreation areas would be phased in over time, rather than all constructed initially. Stone Corral Recreation Area is the most accessible and is included in all alternatives. It would likely be constructed first. Therefore, it is conservatively estimated that only 25 percent of the recreational use would represent net new recreation benefits. Consequently, Alternatives C and D are projected to result in the greatest recreation benefits ($2.5 million). Alternatives A and B would have similar, but slightly lower, benefits of approximately $2.4 million.

Flood-Damage Reduction Benefits (Secondary Objective)

The area along Funks Creek downstream of the existing Funks Reservoir is subject to flooding. Funks Reservoir is not a flood control reservoir. Constructing Sites Reservoir would appreciably reduce the risk of flooding at Funks Creek, Stone Corral Creek, and various other unnamed streams. Additional reductions in flooding would be realized in some portions of the downstream Colusa Basin. The reduction in flood damages can be estimated by comparing the estimated average annual cost of flooding under the No Action Alternative with the predicted average annual flooding costs following the construction of Sites Reservoir.

For the land parcels within the 100-year floodplain for Funks and Stone Corral Creeks, rice production is the primary crop, followed by dryland pasture. Irrigated production in the area is predominantly tomatoes (for processing), wheat, and alfalfa. Crop budget data were used to calculate a weighted average annual flood damage estimate, based on income, variable costs not expended, probability of flooding in each month, and percent of damages that would occur if there was a flood. Land cleanup and rehabilitation costs were added as a fixed cost to each estimate. Under the Sites Reservoir Project alternatives, up to 9,570 acres of farmland would experience a reduction in flood-related damages during a 100-year flood event.[1] Apart from irrigated production in the floodplain, most of the land uses would not be substantially affected by the short-term flooding that the area periodically experiences.

[1] The specific locations and related agricultural production in the floodplain that would be less affected by flood events are not known.

In addition, the Sites Reservoir Project would also potentially reduce the likelihood of flood damage to some of the homes at the northern end of Maxwell. Approximately a quarter of the town of Maxwell is in the 100-year floodplain area of Funks Creek, although no businesses are within the 100-year floodplain area. The total potential flood control benefit of Alternatives A, B, C, and D are estimated to be approximately $4.6 million per year (Table 7-9).

Alternative Costs

Table 7-9 provides the construction, OM&R, and total costs for each of the project alternatives. Costs are based on 2019 price levels. Annualized costs are based on a 100-year period of analysis with a 2.75 percent interest discount rate. Construction costs were escalated to a NOP date in mid-2022. An escalation of 15 percent over 7 years was also applied for each alternative for the purpose of estimating the potential necessary budgetary approval request.

Table 7-9. Estimated Construction and Annual Costs of Sites Reservoir Project Alternatives

Item	Alternative A	Alternative B	Alternative C	Alternative D
Construction Cost ($ millions)				
With Escalation to Midpoint of Construction	$6,310	$6,504	$7,000	$7,070
With Escalation to Notice to Proceed (2022) to Mid-Point of Construction (2026)	$6,801	$7,010	$7,544	$7,626
Investment Cost ($ millions)				
Interest During Construction (2019 price level)	$783	$807	$868	$877
Total Investment Cost (2019 price level) (Construction Cost + Interest During Construction)	**$7,093**	**$7,311**	**$7,868**	**$7,947**
Annual Cost ($ millions – 2019)				
Interest and Amortization	$203	$210	$226	$228
Operation, Maintenance, and Replacement[a]	$62	$63	$66	$59
Total Annual Cost	**$275**	**$273**	**$291**	**$287**

[a] Energy use conveyance costs for M&I, agricultural, operational flexibility and IL4 refuge water supply are included in OM&R costs and BCR analyses, and as separable costs for the cost allocation and cost assignment analyses.

Totals may not sum exactly due to rounding.

Costs for OM&R for the delivery of IL4 Refuge water supply to CVPIA wildlife refuges includes the following:

1. Any costs for storing Federal refuge water in a non-federal reservoir (not including the proposed Sites Reservoir) which would be an annual cost if water is stored over more than one year (these costs were not estimated).
2. Energy costs of pumping/conveying water through the non-federal entities system for introduction to the Federal system.
3. Energy costs of pumping/conveying water from Federal facilities to get water to the refuge boundary as required by law.

Feasibility Analysis

The evaluation of feasibility for the Sites Reservoir Project alternatives is presented through four accounts established by the P&Gs (WRC 1983). Specifically, the NED, Regional Economic Development (RED), Environmental Quality (EQ), and Other Social Effects (OSE) accounts are used to consider beneficial and adverse effects of the alternatives.

National Economic Development Account

The P&Gs (WRC 1983) define the NED plan as the alternative that reasonably maximizes the net NED benefits. Table 7-10 summarizes the annualized benefits and costs and presents the net NED benefits for each alternative.

As shown in Table 7-10, Alternative C has the highest annual net NED benefit, and is therefore the NED Plan. The annual net NED benefit for Alternative C is approximately $39 million, based on a projected annual total cost of $291 million, of which $225.5 million would be required for capital amortization. Alternatives A, B and C all have a BCR greater than one both with and without the hydropower benefits included. Alternative D has a BCR less than one both with and without the hydropower power benefits included.

Table 7-10. Summary of Annual Benefits, Annual Costs, and NED Benefits ($ millions, 2019)

Annualized Costs/Benefits	Alternative A	Alternative B	Alternative C	Alternative D
Total NED Benefits	**$294.1**	**$290.9**	**$330.0**	**$278.4**
Capital Amortization (100 yr, 2.75%)[a]	$203.3	$209.5	$225.5	$227.8
Operation, Maintenance and Replacement[b]	$62.2	$63.4	$85.5	$58.7
Total Cost	$265.5	$273.0	$291.0	$286.5
BCR	1.11	1.07	1.13	0.97
Annual Net NED Benefits	$28.5	$17.9	$39.0	($8.2)
Total Net Benefit (NPV)	**$995**	**$626**	**$1,362**	**($285)**

[a] Amortization period is from 2030 to 2129.

[b] Energy use conveyance costs for M&I, agricultural, operational flexibility and IL4 refuge water supply are included in OM&R costs and BCR analyses, and as separable costs for the cost allocation and cost assignment analyses.

BCR = benefit-cost ratio
NED = National Economic Development
NPV = net present value
yr ~ = year(s)

Regional Economic Development Account

The RED account tracks changes in regional economic activity that result from each alternative. In accordance with the P&Gs, regional income and regional employment were considered as measures of regional or local effects that would result from implementing one of the alternatives.

For Sites Reservoir, two regions were considered in the RED analysis. The first region covers Colusa and Glenn Counties, the two counties in which most construction and maintenance activities associated with the project would be located. Statewide effects were also considered as a second region to capture the large geographic extent of benefits anticipated under the Sites Reservoir Project.

For this analysis, the following drivers of regional economic effects are evaluated:

- Construction expenditures
- OM&R expenditures
- Recreation spending
- Agricultural production

Development of the Sites Reservoir Project would require substantial capital investment, including land acquisition, construction, and mitigation-related costs. The total construction cost of the project is estimated at approximately $6.3 billion to $7.1 billion (depending on the project alternative) over the 8-year construction period (2022 to 2030). Project costs include payments for construction labor and the procurement of construction-related goods and services. To the extent that construction spending occurs locally, the project would generate regional economic benefits in the Local Study Area (i.e., Colusa and Glenn Counties). However, based on the small size of the local economy, it is anticipated that substantial expenditures would include labor and commodities imported into the region. These regional economic benefits associated with construction of the Sites Reservoir Project would be temporary, coinciding with the estimated 8-year construction period.

The annual workforce serving the project is estimated to range between 30 and 330 workers annually, with an average of approximately 143 to 159 jobs (see Table 7-11 for Direct Jobs: Construction) supported over the construction period. The corresponding construction payroll is estimated at $47.1 million to $52.4 million annually.

Table 7-11. Summary of Annual Employment Impacts to the Local Region for RED Account

Employment	Alternative A	Alternative B	Alternative C	Alternative D
Short-Term Employment[a]				
Direct Jobs: Agriculture	-44	-44	-44	-44
Direct Jobs: Construction	143	144	156	159
Indirect and Induced Jobs: Agriculture	-18	-18	-18	-18
Indirect and Induced Jobs: Construction	367	371	402	406
Total Direct, Indirect, and Induced Employment	448	453	496	503
Long-Term Employment: Direct Jobs				
Operations and Maintenance	35	30	35	35
Agriculture	-5	-5	-5	-5
Recreation	15	15	16	16
Total Direct Jobs	45	40	46	46
Long-Term Employment: Indirect and Induced Jobs				
Operations and Maintenance	13	12	13	15
Agriculture	-5	-5	-5	-5
Recreation	2	2	2	2
Total Long-Term Indirect and Induced Jobs	10	9	10	12
Long-Term Total Direct, Indirect and Induced Employment	56	49	56	57

[a] Approximately 14.5 direct jobs would also be created locally by project-related land acquisition during the 1-year period before project construction begins. In addition, land acquisition would create approximately 3 indirect and induced jobs locally.

Totals may not add up exactly due to rounding.

RED = Regional Economic Development

Other expenditures consist primarily of purchases of construction materials (e.g., concrete and steel) and construction equipment required to develop project facilities. In addition, large capital equipment, such as power generating turbines, would need to be purchased and installed at the site. Estimated non-labor construction expenditures would total $5.2 billion to $6.0 billion, of which $760 million to $988 million are allocated to capital equipment assumed to be imported into the region. RED effects associated with land acquisition were assumed to be one-time effects occurring in a single year at the commencement of project development.

Table 7-11 summarizes the expected increase in employment throughout the region that would result from the Sites Reservoir Project alternatives.

Table 7-12 shows the increases in income that are expected to accompany the regional increase in employment during construction. Because economic benefits are typically reported in annual terms, costs were converted to average annual expenditures for the duration of the construction period.

Table 7-12. Summary of Average Annual Income Effects to the Local Region for RED Account: During Construction ($ millions, 2019)

Income	Alternative A	Alternative B	Alternative C	Alternative D
Direct	$46.9	$47.3	$51.3	$52.4
Indirect and induced jobs	$17.1	$17.6	$18.7	$18.8
Total income	**$63.9**	**$64.8**	**$70.0**	**$71.3**

Totals may not add up exactly due to rounding.
RED = Regional Economic Development

Table 7-13 shows the income increases that would result from long-term operation of a new reservoir. It is assumed that all employees would reside in the local area. Project operations would incur wheeling and pumping costs to fill the reservoir. It would also require ongoing OM&R expenditures on miscellaneous goods and services to primarily support hydropower operations, but also maintenance of recreational facilities at the reservoir. The average annual OM&R spending associated with the project operations is estimated to be approximately $29 million annually. Additional OM&R expenditures will also be made for energy use conveyance costs outside of the local region.

Table 7-13. Summary of Average Annual Income Effects to the Local Region for RED Account: Long Term ($ millions, 2019)

Income	Alternative A	Alternative B	Alternative C	Alternative D
Direct	$2.3	$2.0	$2.3	$2.3
Indirect and induced jobs	$0.3	$0.3	$0.3	$0.3
Total Income	**$2.6**	**$2.3**	**$2.6**	**$2.6**

Long-term RED income effects include project operations and maintenance and recreation.
Totals may not add up exactly due to rounding.
RED = Regional Economic Development

Table 7-14 presents the results of the RED analysis associated with changes in agricultural production and prices with the Sites Reservoir Project. The direct effects represent impacts in the agricultural sector, and total effects account for changes across all industries with economic linkages to agricultural production. Future agricultural output statewide is expected to increase between $6.5 million and $16.4 million per year as a result of the project.

Table 7-14. Average Annual RED Effects to the State: Agricultural Production and Price Effects ($ millions, 2019)

Alternative	Labor Income			Employment (FTEs)	
	Direct	Indirect	Total	Direct	Total
Alternative A	$4.4	$1.0	$5.4	44.7	72.1
Alternative B	$3.5	$0.9	$4.4	36.6	59.6
Alternative C	$4.9	$1.1	$6.0	47.3	77.3
Alternative D	$5.0	$1.1	$6.1	47.3	77.3

Average annual effect based on average water-year conditions.
Results represent change relative to future No Project conditions.
Based on changes in agricultural production (irrigated acreage) and agricultural commodity prices. Does not fully represent potential benefits to the agricultural sector of improved water supply reliability.
FTE = full-time equivalent
RED = Regional Economic Development

Environmental Quality Account

The EQ account provides an analytical framework to integrate environmental review, coordination, and consultation requirements into the planning process. The EQ account displays both positive and negative non-monetary effects on ecological, cultural, and aesthetic resources. The monetary impacts of a project on environmental resources are included in the NED account, but are also included in the descriptions in this section to provide a comprehensive overview of the environmental impacts and benefits of the alternatives.

Table 7-15 summarizes the potential environmental effects for all resource categories. Environmental effects are comprehensively evaluated in the EIR/EIS for the Sites Reservoir Project (Reclamation and Authority 2017). All alternatives would be similar in terms of their potential environmental effects, although some effects would be increased by the construction of higher dams or the construction of a new Delevan Intake.

Table 7-15. Summary of Potential Environmental Effects

Resource Area and Potential Effects	No Action	Alt A	Alt B	Alt C	Alt D
Surface Water Resources: Beneficial effect of increasing water supply in Dry and Critical years. No negative impacts.	▲	●	●	●	♦
Surface Water Quality: Less-than-significant impact on water temperatures. Potentially beneficial effect on temperature in the Sacramento River between Keswick Dam and Red Bluff. No impact to mercury, nutrients, salinity, or dissolved oxygen. Potentially beneficial effect of reducing salinity in the Delta. Less than significant impact on the Yolo Bypass. Less-than-significant impact from construction activities.	▲	♦	♦	♦	●
Fluvial Geomorphology and Riparian Habitat: Less-than-significant impact in the Primary and Secondary Study Areas to riverine processes, river meander, bank erosion, alteration of riparian vegetation, and aquatic habitat. No impact in the Extended Study Area.	■	■	■	■	■
Flood control: No impact in the Secondary or Extended Study Areas. Less-than-significant impact in the Primary Study Area. Potentially beneficial effect of reducing flooding in the Stone Corral and Funks Creeks watersheds, including downstream benefit in Colusa Basin Drain.	■	●	●	●	●
Groundwater Resources: Potential benefits in the Extended and Secondary Study Areas, including improvements to the quantity and quality of riparian and floodplain habitats for aquatic and terrestrial species. Potentially beneficial effects of providing water supply for groundwater banking and in-lieu recharge. Less-than-significant impacts in the Primary Study Area from construction activities.	▲	●	●	●	♦

Resource Area and Potential Effects	No Action	Alt A	Alt B	Alt C	Alt D
Groundwater Quality: Potential benefits in the Extended Study Areas. Less-than-significant impacts in the Primary and Secondary Study Areas.	▲	●	●	●	♦
Aquatic Biological Resources: Less-than-significant impacts in the Extended and Secondary Study Areas. Potentially beneficial effects from providing cold water at times and locations to increase the survival of salmonid eggs and fry, and improve conditions for the migration of juveniles. Helps maintain flows to minimize dewatering of salmonid redds and reduce stranding. Potential to increase upstream attraction flows. Potential to provide lower-salinity habitat for Delta smelt, longfin smelt, and other estuarine fishes. Significant impacts in the Primary Study Area to the Stone Corral and Funks Creek watershed can be mitigated to less-than-significant levels. Significant impacts from the Delevan Pipeline Intake/Discharge Facility can be mitigated to less-than-significant levels.	▲	●	●	●	♦
Botanical Resources: Less-than-significant impacts in the Extended Study Area. Potentially beneficial effects in the Secondary Study Area. Significant impact to vegetation communities in the inundation, recreation, and buffer areas can be mitigated to less-than-significant levels. Significant impact to freshwater marsh and riparian vegetation along the Delevan Pipeline can be mitigated to less-than-significant levels. Significant impacts to Fremont cottonwood forest at the Delevan Intake can be mitigated to less-than-significant levels. Potential impacts from construction to special-status plants can be mitigated to less-than-significant levels. Significant impacts from invasive or noxious species can be mitigated to less-than-significant levels. Indirect impacts from human disturbance can be mitigated to less-than-significant levels.	■	■	■	■	■
Terrestrial Biological Resources: Impacts are less than significant in the Extended and Secondary Study Areas. In the Primary Study Area, adverse effects, including alteration of habitat suitability and mortality, on any wildlife habitat identified in local or regional plans, policies, and regulations or identified by CDFW or USFWS can be mitigated to less-than-significant levels, with the exception of golden eagle. Significant and unavoidable impact to golden eagle habitat. Significant impacts to the movement of wildlife species can be mitigated to less-than-significant levels. Less-than-significant impact to common wildlife from human disturbance. No impacts from conflicts with conservation plans, local policies, or ordinances.	■	▲	▲	▲	▲
Wetlands and Other Waters of the U.S.: Less-than-significant effects in the Extended and Secondary Study Areas. In the Primary Study Area, significant impacts to the use or quality of waters could be reduced to less-than-significant levels with mitigation. Adverse effects to Federally protected wetlands can be reduced to less-than-significant levels with mitigation.	■	■	■	■	■
Geology, Minerals, Soils, and Paleontology: No impact in the Extended or Secondary Study Areas. Within the Primary Study Area, adverse impacts to paleontological resources could be reduced to less-than-significant levels with mitigation.	■	■	■	■	■
Faults and Seismicity: No impacts in the extended or secondary study areas. Impacts in the Primary Study Area are less than significant.	■	■	■	■	■
Cultural Resources: Less-than-significant impact in the Extended and Secondary Study Areas. In the Primary Study Area, significant impact to archaeological resources can be mitigated to less-than-significant levels. If possible, historic resources will be avoided, but there is a potential for significant and unavoidable impact to historical properties. Disturbance of cultural properties and tribal resources can be mitigated to less-than-significant levels. Significant and unavoidable impact from disturbance of human remains.	■	▲	▲	▲	▲

Resource Area and Potential Effects	No Action	Alt A	Alt B	Alt C	Alt D
Indian Trust Assets: Less-than-significant impact to Indian Trust assets.	■	■	■	■	■
Land Use: No impacts in the Extended or Secondary Study Areas. In the Primary Study Area, significant and unavoidable impact from physical division of an established community. Construction would result in significant and unavoidable conflicts or incompatibilities with designated land uses, existing zoning, and conversion of land with Williamson Act contracts.	■	▲	▲	▲	▲
Recreation: No impacts to recreation in the Extended and Secondary Study Areas. Impacts in the Primary Study Area are less than significant. Potential benefit from newly constructed recreation areas. Potential benefit to water levels in existing reservoirs (Shasta, Folsom, Oroville).	■	●	●	●	●
Socioeconomics: All impacts are considered to be less than significant. Beneficial effect to recreation economics and reduced groundwater pumping	■	●	●	●	●
Environmental Justice: No impacts.	■	■	■	■	■
Air Quality: No impacts in the Extended or Secondary Study Areas. Significant and unavoidable impacts from particulate and vehicle exhaust emissions (NOx and ROG) during construction in the Primary Study Area.	■	▲	▲	▲	▲
Climate Change and Greenhouse Gas Emissions: Significant and unavoidable impact from generation of cumulative GHG emissions.	■	▲	▲	▲	▲
Navigation, Transportation, and Traffic: All impacts are at less-than-significant levels.	■	■	■	■	■
Noise: No impact in the Extended or Secondary Study Areas. All impacts in the Primary Study Area are at less-than-significant levels.	■	■	■	■	■
Public Health and Environmental Hazards: All impacts are at less-than-significant levels.	■	■	■	■	■
Public Services and Utilities: Impacts in the Primary Study Area are at less-than-significant levels. Potentially beneficial effects with less pumping of groundwater	■	●	●	●	●
Visual Resources: Significant and unavoidable impacts from the proposed TRR facilities. All other impacts are less than significant.	■	▲	▲	▲	▲
Power Production and Energy: Potential benefit from hydropower generation that could support the development of renewable wind and solar energy. Potential impacts could be mitigated to less-than-significant levels.	■	●	●	●	●

CVP = Central Valley Project
NOx = nitrous oxides
ROG = reactive organic gases
TRR = Terminal Regulating Reservoir
▲ = negative impact
■ = neutral to mitigated impact
● = beneficial effect
♦ = highly beneficial effect

Table 7-16 summarizes the environmental accomplishments of the four alternatives.

In support of WSIP, CDFW has recently developed priorities for ecosystem improvement to "improve California's ecosystem resources for the benefit of people, fish and wildlife, and plants" (CWC 2016). The CDFW ecosystem priorities for the WSIP are based on existing environmental laws and regulations, species recovery plans and strategies, initiatives, and conservation plans. The Sites Reservoir Project alternatives address several of these priorities by providing benefits to anadromous fish in the Sacramento River watershed and ecological benefits in the Delta.

Table 7-16. Summary of Environmental Accomplishments Considered in EQ Account

	Alternative A Average/Dry and Critical	Alternative B Average/Dry and Critical	Alternative C Average/Dry and Critical	Alternative D Average/Dry and Critical
IL4 Water Supply to CVPIA Wildlife Refuges				
IL4 Deliveries (TAF/yr)	44/22	72/37	74/37	48/23
Anadromous Fish: Increase in Storage Associated with Coldwater Pool Improvement				
Shasta, End of September (TAF)	101/139	106/180	108/175	132/198
Anadromous Fish: Chinook (all runs)				
Average Increase (habitat units/yr): SALMOD results for winter-run, spring-run, fall-run, and late-fall-run Chinook [a]	936	683	756	986
Anadromous Fish: Sacramento River Flows Below Keswick				
Monthly Flow (% Increase December–February)	6.8%/17.1%	6.8%/17.2%	6.4%/15.9%	7.6%/16%
Delta Environmental Water Quality				
July through August Improvement in X2 (km)	-1.2/-0.9	-1.2/-1.1	-1.3/-1.3	-1.0/-0.7
September through November Improvement in X2 (km)	-0.5/-0.6	-0.6/-0.9	-0.8/-1.1	-0.3/-0.4

[a] 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 Red Bluff Pumping Plant.

EQ = Environmental Quality
km = kilometer(s)
SALMOD = a computer model that simulates the dynamics of freshwater salmonid populations
TAF = thousand acre-feet
TAF/yr = thousand acre-feet per year

The CDFW ecosystem improvement priorities that would be addressed by the Sites Reservoir Project alternatives are described below.

- **Provide cold water at times and locations to increase the survival of salmonid eggs and fry:** All alternatives would result in improvement in egg-to-fry survival for endangered winter-run Chinook salmon. For Sacramento River winter-run Chinook salmon, modeling results indicate reductions in annual early-life-stage mortality of approximately over 50 percent, when compared to the No Action Alternative over the entire cumulative frequency distribution. Model results also indicate lower probabilities of exceeding specified water temperature index values, and therefore, more suitable water temperatures—particularly during months with relatively warm water temperature conditions (i.e., July and August). Other salmon runs and steelhead would also benefit from more favorable water temperatures, especially at important spawning habitat between Keswick Dam and Bend Bridge. In addition, salmonids would benefit from improvements in coldwater pool conditions in Lake Oroville, and Folsom Lake.
- **Enhance flows to improve habitat conditions for in-river rearing and downstream migration of juvenile salmonids:** Improvements in flow and flow patterns for both the American River and the Sacramento River would benefit juvenile salmonids in the Sacramento River. Juvenile fish would benefit from the extended opportunity to exit inundated rearing habitats, which would contribute to increased survival of smolts during out migration periods.
- **Maintain flows and appropriate ramping rates at times and locations that would minimize dewatering of salmonid redds and prevent stranding of juvenile salmonids in side channel habitat:** Connectivity between main and side channels is an important parameter to reduce stranding risk, and at the same time, increase habitat and food availability for rearing juvenile fish. Also, appropriate ramping rates would help trigger and contribute to the success of downstream movement of juvenile fish by preventing fish from being stranded when flow decreases. All alternatives would result in increased flows in Average, Dry, and Critically Dry water-year types, which would benefit early life stages of salmon. Seasonal schedules for the Sites Reservoir Project operations would stabilize flows in the lower American River to minimize the dewatering of salmon and steelhead spawning habitats, which would in turn reduce isolation events for juvenile fish.
- **Increase flows to improve ecosystem conditions:** Releases of conserved water in Shasta Lake would increase flows during times when flows are generally low, and ambient temperatures are unsuitably high for fish (i.e., July and August). Increased summer flows would help improve ecosystem conditions by preventing extreme water temperatures, which impede fish migration for both juvenile downstream movement and adult upstream migration to spawning grounds. Such flows would have an ecosystem-wide benefit because the water from this reservoir is typically cooler than the existing water temperature in the Sacramento River.
- **Increase flows to support anadromous fish passage by providing adequate dissolved oxygen and lower water temperatures:** Although dissolved oxygen conditions would not be appreciably affected by the Sites Reservoir Project alternatives, increased flows from the end of May to the end of September, when flows are generally low and temperatures are generally high under current conditions, may support fish passage.

- **Increase attraction flows during the upstream migration period to reduce the straying of anadromous species into non-natal tributaries:** Increased flows could function as attraction flows for a number of Chinook spawners. Although straying may be less likely to occur by fish in the Sacramento River compared to the San Joaquin River Basin, release of flow from coldwater pools upstream would contribute to an increase in the number of Chinook salmon spawners reaching their natal spawning grounds.
- **Maintain groundwater and surface water interconnections to support instream benefits and groundwater-dependent ecosystems:** Increasing flows during summer months would benefit interconnection between groundwater and surface water. Although there are no quantitative data available, groundwater would most likely be recharged from water released to either the Sacramento River, or possibly, to Funks Creek.
- **Enhance flow regimes to improve the quantity and quality of riparian and floodplain habitats for aquatic and terrestrial species:** Increased flow and improvements of flow patterns for both the American River and the Sacramento River would improve a variety of habitats bordering the Sacramento and American Rivers.
- **Enhance floodplains by increasing the frequency, magnitude, and duration of floodplain inundation to enhance primary and secondary productivity and the growth and survival of fish:** Suitable aquatic edge habitats (fish territories with cover features that act as current breaks to provide safety from predators) in close proximity to food sources are important to the growth and survival of juvenile fish. Slower velocities in shallow floodplain areas would result in increased food availability for fish in edge habitats. All alternatives would be expected to provide these types of habitats in the Sacramento River.
- **Enhance the temporal and spatial distribution and diversity of habitats to support all life stages of fish and wildlife species:** Juvenile fish would benefit from extended access to inundated rearing habitats, contributing to increased survival of smolts during emigration periods. Wildlife species that would be supported by the enhanced and diversified habitats (i.e., inundated rice fields north of the Delta) include giant garter snake (*Thamnophis gigas*), greater sandhill crane (*Grus Canadensis*), long-billed curlew (*Numenius americanus*), western pond turtle (*Actinemys marmorata*), purple martin (*Progne subis*), tricolored blackbird (*Agelaius tricolor*), and yellow-headed blackbird (*Xanthocephalus xanthocephalus*).
- **Enhance access to fish spawning, rearing, and holding habitat by eliminating barriers to migration:** Reduced water temperatures could better support migrating salmon in reaching their historical spawning grounds (i.e., eliminate thermal barriers).
- **Provide water to enhance seasonal wetlands, permanent wetlands, and riparian habitat for aquatic and terrestrial species on Federal and State wildlife refuges and on other public and private lands managed for ecosystem values:** The seasonal schedule of Sites Reservoir Project operations would increase water supply, which would help riparian habitats in the Sacramento River watershed. Increasing water supply during Dry and Critically Dry water-year types would benefit willows and aesthetics. All alternatives provide IL4 water supply to south-of-the-Delta National Wildlife Refuges, State Wildlife Areas, and privately managed wetlands in the San Joaquin River Valley.
- **Develop and implement non-native invasive species management plans using proven methods to enhance habitat and increase the survival of native species:** Mitigation

activities include the development and implementation of non-native species management, primarily the removal of yellow starthistle (*Centaurea solstitialis*) on mitigation property with conversion to a native plant conservation easement.

- **Enhance habitat for native species that have commercial, recreational, scientific, and educational value:** All alternatives would enhance habitat for native species that are Federal- and/or State-listed, State species of concern, and species with commercial value. The alternatives can be adaptively managed to benefit a wide variety of species, but especially anadromous fish, Delta species, and waterfowl.

In accordance with Water Code Section 79754, the SWRCB has identified water quality priorities that could be realized by water storage projects. The Sites Reservoir Project alternatives would address the following priorities.

- **Improve water temperature conditions in surface water bodies that are not meeting water quality standards for temperature:** Temperature issues in the Sacramento River vary by season and river reach. Basin Plan Water Quality Objectives (RWQCB 2016) require that the Keswick Dam to Hamilton City reach of the Sacramento River have a temperature of 56°F or colder, and that the reach of the Sacramento River from Hamilton City to the I Street Bridge have a temperature of 68°F or colder. Temperature modeling results show improvements in the temperature in the Sacramento River at Bend Bridge (Appendix A, Plan Formulation).
- **Protect, clean up, or restore groundwater resources in high- and medium-priority basins designated by DWR.** Sites Reservoir is in the Sacramento Valley Groundwater Basin, Colusa Sub-Basin, which is classified as a medium-priority basin. Groundwater basin reports describe high EC, total dissolved solids (TDS), nitrate, and manganese groundwater impairments near Colusa; high TDS and boron levels near Knights Landing; and high nitrate concentrations near Arbuckle, Knights Landing, and Willows. In preliminary planning efforts, Colusa County has identified in-lieu recharge efforts as one of the potential management practices to improve groundwater quality and groundwater supplies.

EQ Account Summary: Alternative D would produce the most benefits for anadromous fish, followed by Alternative A. Alternative D provides the greatest end-of-September coldwater pool increase in Shasta Reservoir, provides the most water on average to stabilize Sacramento River fall flows, and has the highest increase in Chinook salmon production between Keswick Dam and Red Bluff, as estimated by SALMOD. Alternative C is considered to be slightly superior to Alternative B.

Alternative C would release the most water for Delta ecosystem enhancement benefits. Alternatives B, A, and D have the same releases for this purpose. Impacts from construction are somewhat higher for Alternatives C and D, but these specific impacts could be mitigated and do not change the overall ranking of EQ account benefits.

Overall, Alternatives C (better for Delta ecosystem enhancement) and D (better for anadromous fish in the Sacramento River) are expected to result in the most EQ account benefits.

Other Social Effects Account

The OSE account collects effects that are not reflected in the other accounts, including community impacts, public safety, population displacement, long-term productivity, and energy conservation.

Drought Preparedness: The vulnerability of California's water system to drought is one of the primary challenges identified in the *California Water Action Plan 2016 Update* (NRA, CDFA, and Cal EPA n.d.). Climate change increases the likelihood and severity of future droughts. An improvement is needed in the ability of the State to manage scarce surface water supplies and over-stressed groundwater basins for both economic and environmental sustainability.

Sites Reservoir would improve both water supply reliability and water system flexibility to achieve a greater level of drought preparedness for the statewide water system. Water supply reliability can be characterized by increases in water deliveries for agriculture, M&I, and environmental purposes in Dry and Critical water-years. The flexibility of the water system is a function of the water that is available in storage for delivery. Improvements associated with the Sites Reservoir alternatives are presented in Table 7-17. Alternative D provides the greatest improvement in water supply reliability, and Alternative C provides the greatest long-term improvement in storage.

Table 7-17. Water System Improvements

Improvements	Alternative A	Alternative B	Alternative C	Alternative D
Water Supply Reliability				
Average increase in Dry and Critical year water supply (TAF/yr)	333	271	346	419
Increased average end-of-September Storage in Sites, CVP, and SWP reservoirs (TAF)	867	1,127	1,304	1,278

TAF = thousand acre-feet
TAF/yr = thousand acre-feet per year

Water Supply for Disadvantaged Communities: Water provided from Sites Reservoir for M&I purposes would supply basic human needs, including drinking, cooking, and bathing, in disadvantaged communities where those needs are not adequately being met. California Water Code (Division 1, Section 106.3) establishes the right of every human being to safe, clean, affordable, and accessible water for human consumption, cooking, and sanitary purposes.

Sustainable Groundwater Management: The Sites Reservoir alternatives were also evaluated to assess their ability to support the implementation of the Sustainable Groundwater Management Act. Groundwater accounts for more than one-third of California's water supply on average, and groundwater approaches two-thirds of the water supply in Dry years when surface water supplies are reduced. The lack of flexibility in the statewide water system contributes to groundwater basin overdraft, seawater intrusion, land subsidence, and water quality degradation. Pumping more groundwater than is recharged lowers groundwater levels and increases energy costs.

Water supplied by Sites Reservoir could support both in-lieu recharge and provide a dedicated supply for conjunctive use. Specific opportunities that could be supported by Sites Reservoir include the following:

- Support conjunctive use efforts to manage groundwater by the Orland-Artois Water District in Glenn County (Davids Engineering and Orland-Artois Water District 2002)
- Support in-lieu groundwater recharge in Colusa County to address subsidence in the vicinity of Arbuckle, California

- Provide water for Delta environmental commitments to facilitate the success of the American River Basin Regional Conjunctive Water Project (the Placer County Water Agency and the City of Roseville are Authority Board members supporting the development of this project)
- Provide approximately 26 TAF for groundwater replenishment to the Coachella Valley Water District (a member of the Sites Reservoir Committee)
- Provide approximately 6.5 TAF for groundwater replenishment to the Desert Water Agency

Capacity for Emergency Response: The in-lieu use of water from Sites Reservoir would conserve water in CVP reservoirs, in addition to new storage at Sites Reservoir, to respond to a levee failure in the Delta. This additional capacity would improve the ability of the system to temporarily increase Delta outflow to reduce the impact of seawater intrusion on water operations because Sites Reservoir is well south of Shasta Lake, and would be able to release a block of water in response to an emergency. Releases from Sites would be able to travel to the Delta in less time than releases from Shasta Lake. Table 7-18 shows the increase in emergency response capacity for each alternative under different year-types. Water supplied directly from Sites Reservoir could also be used for fighting forest fires in the general vicinity of Sites Reservoir.

Table 7-18. Emergency Water Supply Storage

Storage	Alternative A	Alternative B	Alternative C	Alternative D
May (TAF)				
Average annual	1,100	1,376	1,584	1,546
Dry	1,037	1,236	1,505	1,461
Critical	817	851	1,101	960
September (TAF)				
Average annual	867	1,127	1,304	1,278
Dry	753	932	1,113	1,113
Critical	537	575	814	611

Combined end-of-month storage for Shasta Lake, Lake Oroville, Folsom Lake, and Sites Reservoir.
TAF = thousand acre-feet

OSE Account Summary: The ability of the alternatives to support drought preparedness, disadvantaged community water supply, and sustainable groundwater management is proportional to their improvements in water supply reliability and flexibility. Alternative C would provide a slightly greater benefit than Alternative D, and an appreciably greater benefit than Alternative B. Alternative A would provide the least OSE benefits.

Summary of Four Accounts

The results of the evaluation of the four accounts are as follows:

- **NED account**: Alternative D has the highest net NED benefits and is therefore the NED Plan.
- **RED account:** Alternative D has the highest RED.

- **EQ account:** Alternatives C and D provide the greatest net environmental benefits. Alternative C provides greater benefits to Delta ecosystem enhancement and IL4 water supply to CVPIA wildlife refuges; and Alternative D provides greater benefits to anadromous fish. This difference in benefits is due to how the alternatives are operated. Either alternative could be adaptively managed to emphasize benefits to the north (anadromous fish) or the Delta (Delta ecosystem enhancement).
- **OSE account:** Alternative C provides the greatest OSE benefits, followed by Alternative D.

Comparison of Alternatives

The P&Gs provide four criteria for consideration in evaluating alternatives: effectiveness, efficiency, acceptability, and completeness (WRC 1983).

Effectiveness

Effectiveness is the extent to which an alternative plan addresses the problems and needs and satisfies the planning objectives. The NODOS Investigation objectives and the effectiveness of each alternative in achieving the objectives are listed in Table 7-19. In developing a combined ranking, primary objectives were weighted twice as much as secondary objectives. A lower level of effectiveness does not mean an alternative would be infeasible or that is does not address the specified problems and opportunities.

Table 7-19. Ranked Effectiveness of Alternatives (1 = Highest, 5 = Lowest)

Objective	Rationale	No Action	Alternative A	Alternative B	Alternative C	Alternative D
Primary Objectives						
Water supply	Ranked by increase in deliveries	5	4	3	2	1
IL4 Water Supply to CVPIA Wildlife Refuges	Ranked by increase in deliveries	5	4	2	1	3
Coldwater for Anadromous Fish	Ranked based on SALMOD results	5	2	4	3	1
Delta Environmental Water Quality	Ranked based on shift in X2	5	2	2	1	4
Combined Primary Ranking		5	4	3	1	2
Secondary Objectives						
Hydropower Generation	Ranked based on pumpback generation	5	1	2	3	4
Recreation	Ranked based on visitor-days	Lowest	Equal	Equal	Equal	Equal
Flood Damage Reduction	Ranked based on acreage	Lowest	Equal	Equal	Equal	Equal

SALMOD = a computer model that simulates the dynamics of freshwater salmonid populations

As shown in Table 7-19, Alternative C has the highest effectiveness in meeting all project objectives. It is followed by Alternative D, then Alternatives A and B, and finally the No Action Alternative.

Efficiency

Efficiency is an evaluation of the cost-effectiveness of each alternative's ability to address the specified problems and opportunities, consistent with protecting the environment. The most efficient measures address the objectives with the least cost. The ranking is consistent with the BCRs presented in Table 7-10. In descending order, the alternatives' efficiency in meeting the project objectives are ranked as follows:

- Alternatives A and C (highest)
- Alternative B
- Alternative D
- No Action

Acceptability

Acceptability considers the acceptability of an alternative to Federal, State, and local entities and the public, as well as its compatibility with existing laws, regulations, and public policies. A measure with less support is not infeasible, but it is less preferred. All alternative plans are compatible with existing laws, regulations, and public policies. No harm to the CVP or SWP, either operationally, financially, or environmentally; and no harm to any other legal user of water is a requirement for acceptability. There is a local preference for Alternative D, including significant input from Colusa County—a member of the Authority—into the alignment and facilities for Alternative D. No comments reflecting a preference or objection to a specific alternative were received during circulation of the Draft Feasibility Report and EIR/EIS. There is ongoing opportunity for public input throughout the Final EIR/EIS and NOD/ROD process. In addition, acceptability is contingent on a cooperative operating agreement between the Authority, Reclamation, and DWR, with an approved water right from the SWRCB. Moreover, the non-Federal cost share of 75 percent, as proposed in this document, is required for Federal participation.

Completeness

Completeness is a determination of whether an alternative accounts for all necessary investments or other actions to ensure the realization of the planned benefits.

Table 7-20 provides an evaluation of the completeness of each alternative. One measure of completeness is the ability of the alternative to respond to drought and climate change without requiring actions by others to maintain the level of benefits. Alternatives C and D are the most complete, reflecting the flexibility of these alternatives to adapt to changing conditions. Alternative D has more resilience for water supply and anadromous fish.

Table 7-20. Relative Completeness of Alternatives (1 = Highest, 5 = Lowest)

Objective	Rationale	No Action	Alternative A	Alternative B	Alternative C	Alternative D
Primary Objectives						
Dry and Critical year water supply	Ranking based on deliveries	5	3	4	2	1
Dry and Critical year anadromous fish benefits	Ranking based on SALMOD results	5	3	4	2	1
Dry and Critical year water quality benefits	Based on X2 results	5	3	2	1	4
Resilience to climate change	Ranking based on increase in storage	5	2	3	1	1
Combined ranking		5	3	4	1	2

SALMOD = a computer model that simulates the dynamics of freshwater salmonid populations

The alternatives were evaluated and ranked with regard to the four criteria. Table 7-21 provides a summary comparison of the No Action Alternative and the action alternatives.

Table 7-21. Summary Comparison of No Action Alternative and Action Alternatives

Alternative	Effectiveness	Efficiency	Completeness	Acceptability	Combined
No Action	5	5	5	4	19
A	3	2	3	3	11
B	4	3	4	3	14
C	1	1	1	3	6
D	2	4	2	1	9

Alternatives are ranked from 1 to 5, with the best performer receiving a 1.
NED = National Economic Development

Alternative D, the NED Plan, has the best (lowest) combined score. Alternative C has the next-best score. It is anticipated that Sites Reservoir would be adaptively managed to provide the greatest benefit to the environment.

This page intentionally left blank

Chapter 8 Refined Alternative Analysis with Operational Flexibility and Delta Ecosystem Enhancement

Following the review of the initial alternatives, the operations of the alternatives were further refined. Several issues and opportunities for improvement were identified in the evaluation of the initial alternatives.

- No WSIP funds were awarded for the Delta environmental and export water quality purpose. As a result, no beneficiary has been identified to take on the cost assignment for this benefit.
- Modeled water quality improvements would be difficult to achieve without implementing additional operational constraints that are outside of the scope of the proposed project. Otherwise, some of the water delivered for this purpose could potentially be diverted by other Delta users and not serve its intended purpose.
- Delta Ecosystem Enhancement objective was added during WSIP application. The State has expressed an interest in releases to the Yolo Bypass for ecosystem enhancement to benefit Delta smelt.
- Regulatory environment changed significantly with adoption of the Amended Coordinated Operations Agreement and the 2019 Biological Opinions.
- Reclamation identified an opportunity to provide operational flexibility to improve CVP operations.

The water quality objective that was not funded by WSIP was replaced with two new objectives: CVP operational flexibility and Delta ecosystem enhancement. Each of these objectives could be readily assigned to a beneficiary.

The operations were remodeled using the updated project purposes for Alternatives A and D (refined modeling results are subsequently presented for Alternatives A1 and D1). These alternatives were selected to evaluate the range of potential project costs. The updated modeling includes both the updated COA and 2019 BiOps. Alternatives A1 and D1 were evaluated as the lowest and highest cost alternatives and represent the range of project sizes and benefits.

Refined Project Objectives

CVP Operational Flexibility (Primary Objective)

The CVP is operated to meet a variety of project purposes, including providing water for irrigation and domestic uses; fish and wildlife mitigation; fish and wildlife enhancement; and water quality. The

CVP has the potential to deliver about 7 MAF annually to agricultural and M&I customers, and for environmental purposes. California's Federal and state water systems have limited flexibility in timing, location, and capacity to meet the multiple purposes of the projects due to operational and demand constraints. The annual delivery capability of 7 MAF exists; however, actual deliveries have been much lower in recent years. For example, approximately 4.8 MAF were delivered for agricultural and M&I users on average between 2009 and 2014, with a high of 6.1 MAF in 2011 and a low of 2.9 MAF in 2014. There are several factors that have significantly affected the availability of the CVP to store and provide water for contract delivery: Delta pumping constraints; the establishment of three major regulations – the CVPIA, the State Water Resources Control Board Decision 1641, and the Reasonable and Prudent Alternatives from the 2008/2009 Biological Opinions on Long-Term Operation of the CVP and SWP; and natural variations in water supply based on annual precipitation. These factors diminished CVP deliveries to meet project purposes. Constraints vary annually based on governing conditions that would result in water available for authorized purposes tied to beneficial use in any year being restricted for that purpose but potentially being available to serve an alternate CVP purpose.

The operational flexibility purpose is defined as the benefit accruing to the Federal government from an increased ability to allocate additional water supplies through an investment by the United States in a water supply project. The water supply project would be functionally integrated with the CVP from a water rights and/or contractual basis. The investment would enable the Federal Government to deliver water for beneficial use and better meet authorized project purposes by increasing the efficiency, reuse, or multiple use of existing supplies or by reducing impacts of regulatory or capacity constraints on an existing Reclamation project.

Investigation Contributions to Operational Flexibility

As described above, operational flexibility facilitates delivery of CVP water supplies that would otherwise be undeliverable due to operational and demand constraints. For the Investigation, an example of an operational constraint is the inability of a water user to physically take delivery of their CVP contract supply during a certain time of year because of the availability of other supplies or a lack of storage capacity. For the Investigation, CVP operational flexibility can be accomplished by providing new storage and changing the timing of the CVP water delivery such that the operational constraint is no longer a factor.

Summary of Problems, Needs, and Opportunities for CVP Operational Flexibility

Table 8-1 summarizes the problems, needs, and opportunities associated with the operational flexibility of the CVP.

Table 8-1. Problems, Needs, and Opportunities: CVP Operational Flexibility

Problem	Need	Opportunity
There is an overall average delivery gap of about one-quarter of the Contract Total in all years. This increases to 40% in Dry and Critical years.	Need for increased flexibility so Central Valley Operations can respond to diverse needs and replace CVP yield.	The NODOS project provides an additional water source that could allow: • Higher allocations in accordance with CVP contracts • Releases for environmental restoration, CVPIA refuges, or anadromous fish water quality, as dictated by current conditions

CVP = Central Valley Project
M&I = municipal and industrial
NODOS = North-of-the-Delta Offstream Storage

Delta Ecosystem Enhancement

Since 2004, monitoring programs in the Delta have documented a decline of several pelagic (open-water) fishes (Delta smelt, longfin smelt, juvenile striped bass, and threadfin shad) in the freshwater portion of the estuary. The decline may have several causes, but reduced food availability is a contributing factor. Additional food resources are needed in the lower Cache Slough and lower Sacramento River areas to sustain Delta smelt and other estuarine-dependent species (e.g., Delta smelt, longfin smelt, Sacramento splittail, starry flounder, and California bay shrimp).

DWR and CDFW performed a pilot study in collaboration with other agencies and farmers in the summer of 2016 that released water into the Delta through a wetland and tidal slough corridor. Monitoring showed that the nutrient-rich "pulse flow" resulted in a phytoplankton bloom and enhanced zooplankton growth and egg production. DWR continues to work with Sacramento Valley water districts and others to study how these flows can enhance Delta food production (California Natural Resources Agency 2017).

There is an opportunity with NODOS to provide a dedicated source of water to convey water through the wetland and tidal slough corridor to provide a sustainable source of food for Delta species.

Summary of Problems, Needs, and Opportunities for Delta Ecosystem Enhancement

Table 8-2 summarizes the problems, needs, and opportunities associated with augmenting the food web for Delta species.

Table 8-2. Problems, Needs, and Opportunities: Delta Ecosystem Enhancement

Problem	Need	Opportunity
There is insufficient food to sustain Delta smelt, even in years with high precipitation and runoff.	Water is needed to convey biomass for food production from the toe drain of the Yolo Bypass into the Delta.	The NODOS project provides a dedicated source of water to transport biomass for food to portions of the Delta frequented by Delta smelt.

NODOS = North-of-the-Delta Offstream Storage

Facilities

The facilities for Alternatives A1 and D1 are generally the same as they were for Alternatives A and D, respectively. In reviewing the results for the initial alternatives, it was noted that the benefits received for hydropower generation through pumpback operations (ranging from $20 million to $22 million annually) were insufficient to cover the separable cost of the required facilities (Fletcher Reservoir and the Funks Pumping Plant have a combined cost of $518 million). This analysis is sensitive to energy prices (which have historically fluctuated) and regulatory requirements. This conclusion should be reevaluated as the project progresses; however, it was deemed appropriate to remove pumpback capability from Alternatives A1 and D1. Both alternatives retain turbines to allow for generation when water is being released from Sites Reservoir.

Operations

Operations were revised during the sensitivity modeling effort to incorporate the two new project objectives. Proposed operations, including the proposed actions for fish enhancement, are summarized in Table 8-3. This table shows the types of beneficiary operations under drought and other hydrologic conditions and the priorities assumed for various seasonal operations.

Operational flexibility facilitates delivery of CVP water supplies that would otherwise be undeliverable due to operational and demand constraints. For the Investigation, operational flexibility can be accomplished by providing storage that enables changes in the timing of CVP water delivery, such that the operational constraint is no longer a factor. The Sites Reservoir Project would use in lieu releases of water to conserve water stored in CVP reservoirs (i.e., Shasta and Folsom). This water could be used later, when deliveries are not constrained, for a variety of purposes. These purposes may be non-reimbursable or reimbursable purposes. In many instances, releases of the conserved water could serve multiple purposes as it flows downstream. These purposes include the following:

- Restoring CVP yield
- Enhancing flows to improve habitat conditions and in-river rearing for juvenile salmonids
- Maintaining flows and ramping rates to minimize dewatering of redds and prevent stranding of juveniles
- Increasing attraction flows during upstream migration to reduce straying
- Maintaining groundwater and surface water interconnections to support groundwater-dependent ecosystems
- Enhancing flow to improve the quantity and quality of riparian and floodplain habitats
- Providing water for seasonal wetlands for the benefit of wildlife
- Enhancing access to fish spawning, rearing, and holding habitat (e.g., improving access to habitat in the bypasses)

Refined Alternative Evaluation

Sensitivity results for the refined alternative operations are presented as Alternative A1 (corresponds to Alternative A) and Alternative D1 (corresponds to Alternative D). The facilities for these alternatives are unchanged. Operations have been modified to include CVP operational flexibility and Delta ecosystem enhancement.

Table 8-3. Description of Proposed Seasonal Schedule for Project Operations

Measure	Detail of Operation	Alternative(s)	Priority of Operation [a]	Year-Type Suitable [b]	Suitable Months for Operation [c] Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
General Operations					**The darker shading indicates months in which there is heavy use of operations to attain the stated objective. Lighter shading indicates months where operations for the objective are light to moderate (i.e., operations occur when supplies are available and conditions favor the operation). No shading indicates no use to light use for the indicated objective.**											
Diversions to fill Sites Reservoir	Conduct diversions to T-C Canal, GCID Canal, and the proposed Delevan Pipeline (diversions could occur in any month). Diversions would only occur once the D-1641, CVPIA 3406(b)(2) and 2019 USFWS BiOp requirements have been met and existing authorized Delta diversions have been satisfied. Diversions to Sites Reservoir would be restricted by Sacramento River bypass criteria at Red Bluff, Hamilton City, Wilkins Slough, and Freeport, and the restrictions for protecting fish outmigration-related pulse flows (7 to 10 days once a month when flow conditions allow). Diversions could also be limited by future regulatory requirements, which may be imposed.	A1, D1	N/A	N/A												
Seasonal Reservoir Operations	Fill Sites Reservoir by pumping water diverted and stored throughout the winter and spring, and drawdown during peak release periods throughout the summer and fall.	A1, D1	N/A	N/A	Fill Cycle			Release/Drawdown Cycle							Fill Cycle	
CVP Operational Flexibility	Operational scenario allowing a shift in timing to increase CVP flexibility. Provide additional storage to allow the CVP to shift the timing of operations, and also provide additional water to respond to operational needs.	A1, D1	N/A	AN, BN, D, C												
Water Supply Improvements due to Authority and Federal Participation																
Authority	Provide average annual deliveries of 131 TAF (Dry and Critical average of 289 TAF) for agricultural and municipal water supply. Approximately 28 TAF (Dry and Critical average of 60 TAF) would be delivered to the Sacramento River Valley Participants, and an average of 103 TAF (Dry and Critical average of 229 TAF) would be exported and delivered to Delta Participants. Exports would require new contracts for conveyance with DWR.	A1, D1	SPA-1	AN, BN, D, C												
CVP Contractors	Through CVP Operational Flexibility, increase CVP water supply reliability up to Contract Total[1] in any Year[2] when water supply availability is limited. Provide an average of 73 TAF (Dry and Critical average of 114 TAF). There would be little effect if Delta export capacity is limiting water made available by the CVP. Reliability increase would mostly affect agricultural water service contractors.	A1, D1	CVP-1	AN, BN, D, C												
Ecosystem Improvements due to State Participation																
Provide releases into the Yolo Bypass	Provide an average annual supply of 51 TAF to convey biomass from the Yolo Bypass toe drain into the Delta to promote a more robust food web for Delta species, including Delta smelt	A1, D1	CWC-1	ALL												
Incremental Level 4 water supply for wildlife refuges	Provide an average annual supply of 10 TAF (Dry and Critical average of 13 TAF) for refuges north of the Delta and an average annual supply of 24 TAF (Dry and Critical average of 35 TAF) for refuges south of the Delta to supplement the refuges' supplies up to the full Level 4 amounts (CVPIA). South of Delta supply is primarily conveyed through Banks Pumping Plant deliveries, which are modeled as occurring in the fall. Water may occasionally be moved at other times if the opportunity exists.	A1, D1	CWC-2	AN, BN, D, C												
Ecosystem Improvements due to Federal Participation																
Shasta Lake Coldwater Pool	Through CVP Operational Flexibility, conserve water in Shasta Lake to provide an additional average of 248 TAF coldwater pool storage in September of Dry and Critical years. This action would have particular emphasis in summer months for Below Normal, Dry, and Critical water-year types. This benefit would be achieved by (1) in lieu use of water from Sites Reservoir to conserve storage in Shasta Lake for later release to provide benefits to anadromous fish; (2) releasing water from Sites Reservoir to meet CVP south-of-the-Delta needs instead of releasing water from Shasta Lake; and (3) releasing water from Sites Reservoir to meet a portion of the CVP commitment for Delta outflow.	A1, D1	CVP-DP-1	BN, D, C												
Sacramento River Flows for Temperature Control	Through CVP Operational Flexibility, maintain water temperatures year-round at levels suitable for all species and life stages of anadromous salmonids in the Sacramento River between Keswick Dam and Red Bluff Pumping Plant, and during the July through November period for Below Normal, Dry, and Critical water-year types. This objective would be achieved by using additional water stored in Shasta Lake as a result of the in lieu use of water from Sites Reservoir.	A1, D1	CVP-DP-1	BN, D, C												
Stabilize Sacramento River Fall Flows	Through CVP Operational Flexibility, stabilize flows in the Sacramento River between Keswick Dam and the Red Bluff Diversion Dam to minimize dewatering of fall-run Chinook salmon redds (for the spawning and embryo incubation life-stage periods extending from October through February), particularly during fall months. Avoid abrupt changes.	A1, D1	CVP-DP-2	AN, BN, D												

[1] Contract Total is defined in Reclamation's water service contract as the maximum amount of water to which the Contractor is entitled under subdivision (a) of Article 3 of this [water service] Contract. Contract Total is defined in the Sacramento River Settlement Contracts as the sum of the Base Supply and Project Water available for diversion by the Contractor for the period April 1 through October 31.

[2] Year is defined in Reclamation's water service contract as the period from and including March 1 of each Calendar Year through the last day of February of the following Calendar Year

[a] Priority of operation: "DP" indicates that the operational priority has a driest period's emphasis, and "AVG" indicates an average-to-wet hydrologic emphasis. The numbers 1-4 indicate priority within the associated hydrologic emphasis; "N/A" indicates that operations are not or cannot be easily defined within the priority structure of the scenario.

[b] Year-type most suitable for operation is the D-1641 40-30-30 year-types that are reflected in operations studies; operations in these year-types occur when supplies would be available in Sites Reservoir to support the operation, when the operations criteria in the scenario allow for prioritization of the operations, and when conditions are suitable for developing the benefit associated with the operation.

[c] The heavier shaded parts of each bar highlight the months in which conditions would be most suitable to the operations; the lighter shaded parts of each bar highlight the months that would be less suitable to the operations; operations in these months would occur when supplies are available in Sites Reservoir to support the operation, when the operations criteria in the scenario allow for prioritization of the operations, and when conditions are suitable for developing the benefit associated with the operation.

AN = Above Normal
Authority = Sites Project Authority
BiOp = Biological Opinion
BN = Below Normal
C = Critical
CVP = Central Valley Project
CVPIA = Central Valley Project Improvement Act
D = Dry
D-1641 = Water Rights Decision 1641 Revised (SWRCB 2000)
Delta = Sacramento–San Joaquin River Delta
DP = driest periods
DWR = California Department of Water Resources
GCID = Glenn-Colusa Irrigation District
N/A = not applicable
State = State of California
T-C Canal = Tehama-Colusa Canal
TAF = thousand acre-feet
USFWS = United States Fish and Wildlife Service

Water Supply (Primary Objective)

Improvements in water supply and water supply reliability were characterized in several different ways. The amount of water stored in Sites Reservoir itself is one measure of the available water supply, and this is shown in Table 8-4. With a larger reservoir, Alternative D1 provides a greater increase in storage. Figure 8-1 shows the systemwide increase in storage in CVP and SWP reservoirs. The additional storage throughout the system would result in greater flexibility for operators to respond to CVP and SWP system needs.

Table 8-4. Additional Water Conserved in Existing CVP and SWP Reservoirs with Sites Reservoir

Parameter	Alternative A1 (1.3 MAF)	Alternative D1 (1.8 MAF)
End-of-May Storage (TAF)		
Average Annual	217	255
Dry and Critical	296	356

MAF = million acre-feet
TAF = thousand acre-feet

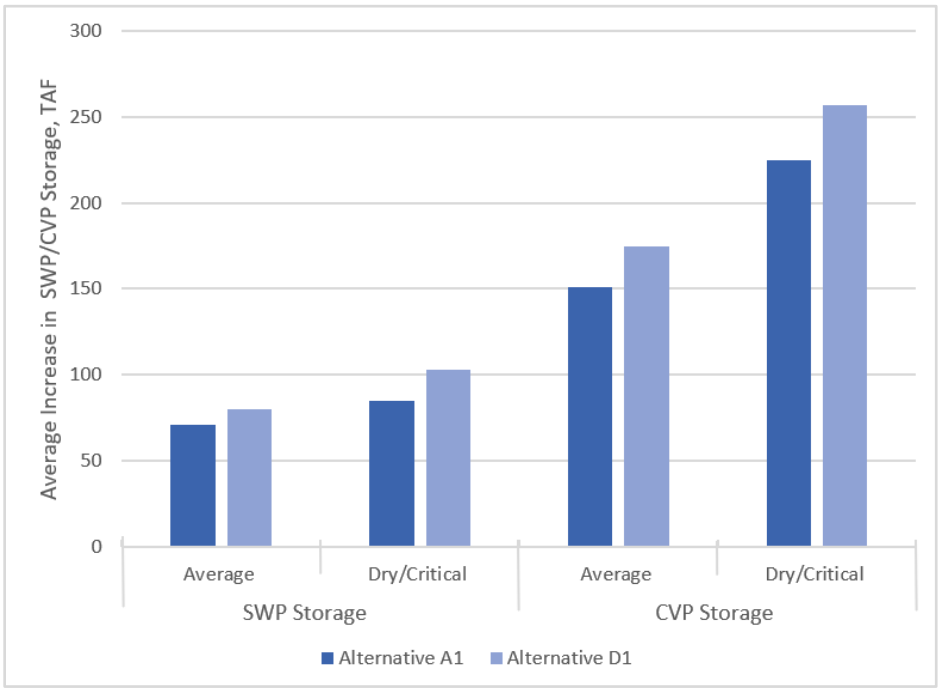


Figure 8-1. Increase in Average End-of-May Storage in Sites, CVP, and SWP Reservoirs

Authority Participant Water Supply: Water supply improvements were also evaluated in terms of Authority water supplies. Alternative D1 provides the highest average long-term annual increases in the total amount of available water for Authority participants (131 TAF) and Dry and Critical year increases (289 TAF). Table 8-5 summarizes deliveries for all project purposes.

Alternative D1 would provide non-CVP water to CVP contractors in the Sacramento Valley that are participating agencies in the Authority. This new supply is 28 TAF on average, and up to 60 TAF in Critical years. Alternative A1 provides similar deliveries in the Sacramento Valley.

Table 8-5. Increased Long-Term and Dry/Critical Year Annual Deliveries

Accomplishments (above No Project Alternative conditions)[a]	Alternative A1		Alternative D1	
	Average (TAF)	Dry and Critical (TAF)	Average (TAF)	Dry and Critical (TAF)
Alternative Facilities	1.3-MAF Reservoir New Intake		1.8-MAF Reservoir New Intake	
Authority Deliveries in SWP Service Area	**88**	**190**	**103**	**229**
SOD Ag	2	4	2	5
SOD M&I	86	185	101	224
Authority Deliveries in CVP Service Area	**28**	**58**	**28**	**60**
NOD Ag	28	58	28	60
Sub-Total Authority Deliveries for Water Supply	**116**	**248**	**131**	**289**
CVP Operational Flexibility Deliveries	**69**	**87**	**73**	**114**
NOD Ag	11	22	17	34
NOD M&I	3	6	5	9
SOD Ag	54	59	52	71
SOD M&I	0	0	0	0
IL4 Water Supply to CVPIA Refuges	**32**	**44**	**34**	**48**
NOD	9	12	10	13
SOD	23	32	24	35
Delta Ecosystem Enhancement[b]	**57**	**44**	**51**	**33**
Total Deliveries	**274**	**423**	**289**	**484**
Additional end-of-September storage in Shasta Lake (TAF)	138	207	164	248

Note: Totals may not sum exactly due to rounding.

[a] Increases in deliveries above the No Project Alternative, including supplies for agriculture, M&I, and environmental purposes. Dry and Critical period average is the average quantity for the combination of the SWRCB's D-1641 40-30-30 Dry and Critical years for the period from October 1921 to September 2003. The "Average (TAF)" is for this period.

[b] Releases from Sites Reservoir to the Delta solely for environmental benefit. This quantity excludes any water released for export or carriage water requirements.

Ag = agriculture
CVP = Central Valley Project
D-1641 = Water Rights Decision 1641 Revised (SWRCB 2000)
IL4 = Incremental Level 4
M&I = municipal and industrial
MAF = million acre-feet
NOD = North-of-the-Delta
SOD = South-of-the-Delta
SWP = State Water Project
SWRCB = State Water Resources Control Board
TAF = thousand acre-feet

CVP Operational Flexibility (Primary Objective)

CVP operational flexibility is one of the two additional refined project objectives considered through refined modeling. As described earlier in this chapter, water conserved in existing CVP reservoirs (Shasta and Folsom) by making in lieu CVP deliveries from Sites Reservoir would increase the flexibility of CVP operations. Reclamation would receive an assigned storage account within Sites Reservoir to support this operation. Table 8-5 shows the increases in deliveries with Alternative A1 and D1. This water could be used for any CVP purpose, including CVP water supply to meeting existing contract obligations, mitigation, or environmental enhancement. Alternative D1 provides the greatest increase in Average and Dry/Critical year water supply.

IL4 Water Supply for CVPIA Wildlife Refuges (Primary Objective)

Sites Reservoir would provide water for IL4 refuge water supply. Over 70 percent of the Sites Reservoir Project water released for IL4 refuge water supply was modeled as south of Delta deliveries. All modeled IL4 deliveries prioritized using the Banks pumping facilities with additional deliveries through the Jones Pumping Plant. Most modeled deliveries occur in the fall, when there should be more export capacity to move the water south. Additional work is needed to better match the distribution with refuge needs.

Modeled deliveries may vary from real-time operations due to differences in modeling prioritization and real-time availability. The model evaluated 2030 conditions where conveyance improvements were included for some refuges that currently lack sufficient conveyance capacity for full Level 4 deliveries in existing a conveyance systems. Increases in long-term average water supplies ranged from 32 TAF under Alternative A1 to 34 TAF under Alternative D1. The ability to provide IL4 refuge water supply is improved in Dry and Critical years (44 to 48 TAF could be delivered in Dry and Critical years). The performance of the two alternatives is essentially the same for IL4 refuge water supplies.

Anadromous Fish (Primary Objective)

Several operational actions were included in the CALSIM operations to improve conditions in ways that would support anadromous fish (see the conceptual model in Figure 7-4). Water temperature is one of the principal drivers for salmonid production. The Sites Reservoir Project action alternatives would increase the coldwater pool at Shasta Lake, providing an opportunity to reduce temperatures in the downstream portion of the Sacramento River. Table 8-5 shows the CALSIM-modeled increases in storage levels at Shasta Lake. It should be noted that the increase in end-of-September storage in Shasta Lake is greater in refined modeling results when compared to the initial alternatives (see Table 7-1). The refined alternative operations would provide for colder water in Shasta Lake.

Two egg mortality estimation methods (Martin and Anderson methods) were used to evaluate the results for Alternatives A1 and D1. Both start by modeling a redd's lifetime by counting the days required to cross a known cumulative degree-days threshold, and both estimate mortality as a linear, increasing function of temperature past a known temperature threshold. The Martin method estimates temperature-dependent egg mortality for Sacramento River Winter run Chinook population data collected between 1996 and 2015 (Martin et al., 2017). The Anderson method uses a short critical period just before hatching rather than the full life span of the redd (Anderson 2018). Both models showed a reduction in mortality for both alternatives, with the greatest reduction in Critical years. Alternative A1 showed a reduction in Critical year mortality of 9% with the Martin model and 8% with the Anderson model. Alternative D1 showed a reduction in Critical year mortality of 11% with the Martin model and 9% with the Anderson model.

The benefits to anadromous fish were also evaluated using SALMOD. The improvement in habitat units for all four runs (winter, fall, late fall, and spring) of Chinook salmon were evaluated. Alternative A1 showed an increase of 214 habitat units and Alternative D1 an increase of 268 habitat units when compared to the No Action Alternative.

Delta Ecosystem Enhancement (Primary Objective)

Approximately 57 TAF per year (TAF/year) (Alternative A1) to 51 TAF/year (Alternative D1) would be released from Sites Reservoir to help increase productivity in the lower Cache Slough and

lower Sacramento River areas to increase desirable food sources for Delta smelt and other estuarine-dependent species (e.g., Delta smelt, longfin smelt, Sacramento splittail, starry flounder, and California bay shrimp) in the late summer and early fall. This increase in desirable food sources would help improve Delta smelt growth and condition as the fish mature into adults, thereby increasing Delta smelt abundance over time. The key is to push the water high in phytoplankton and zooplankton directly into an area of Delta smelt habitat, where additional production may occur.

Determination of Benefits for Refined Alternatives

Determination of benefits for refined alternatives was generally consistent with the methodologies for the analysis of the initial alternatives. Climate variability was not included in that analysis; however, climate variability is qualitatively addressed in Chapter 10, Risk and Uncertainty. Additional analysis with climate variability scenarios for 2030 and 2070 was performed in support of the WSIP application process (Authority 2017).

The analysis of benefits for the refined alternatives differs as follows from the approach used for the initial alternatives.

- CVP operational flexibility water supply benefits were estimated based on the opportunity cost of obtaining the supplies from agricultural users using SWAP unit benefit values derived from the agricultural water supply benefit analysis.
- Delta ecosystem enhancement benefits were developed using unit values for water transfer prices to estimate the benefit value of the water quantity required to achieve the Delta ecosystem enhancement.

Table 8-6 shows the benefits estimated using the sensitivity modeling results for the refined alternatives.

Table 8-6. Summary of Estimated NED Annual Benefits for Sites Reservoir Action Alternatives ($ millions, 2019)

Beneficiary	**Alternative A1**	**Alternative D1**
Water Supply	$138.6	$161.7
Agricultural Supply	*$15.4*	*$16.2*
M&I Supply	*$123.2*	*$145.4*
CVP Operational Flexibility	$47.1	$48.4
Incremental Level 4 Refuge	$19.6	$20.7
Anadromous Fish	$14.4	$18.0
Delta Ecosystem Enhancement	$16.7	$14.5
Recreation	$2.4	$2.5
Flood Damage Reduction	$4.6	$4.6
Total	**$243.5**	**$270.4**

Totals may not sum exactly due to rounding.
M&I = municipal and industrial
NED = National Economic Development

The cost for construction for Alternatives A1 and D1 was adjusted for the removal of the pumpback facilities. The resulting construction cost when escalated to the midpoint of construction is $5,792 million for Alternative A1 and $6,552 million for Alternative D1.

The resulting net NED benefit for Alternative A1 is $539 million (present value) and for Alternative D1 is $524 million (present value). The BCR is 1.07 for Alternative A1 and 1.06 for Alternative D1.

Additional opportunities were identified that could reduce the costs and thereby improve the BCR. These opportunities have some trade-offs in increasing risks that may reduce the reliability of the benefits. Opportunities for reducing costs include:

- Reducing redundancy to maintain electrical power for pumping ($132 million)
- Eliminating turbines at the Delevan Pump Generating Plant ($85 million)
- Modifying the dam construction method for more efficient use of local materials ($34 million to $80 million)
- Adding a causeway to the bridge to reduce the span ($70 million)

It is also possible to eliminate the TRR pipeline and rely on the Delevan pipeline for diversions from the TRR. This would allow diversions from only two, instead of three, locations at one time and result in operations more like those modeled under Alternative B. The resulting cost savings is approximately $320 million. None of these potential savings has been applied in the costs or BCR calculations. They are noted here to indicate that there are further opportunities to optimize the facilities and improve the BCR.

This page intentionally left blank

Chapter 9 National Economic Development Plan

Determination of Feasibility

This chapter considers the feasibility of the refined alternatives addressed in Chapter 8. Alternative A1 has the highest net NED benefits, and is therefore the NED Plan. Alternatives A1 and D1 frame the lower and upper bounds for the size of Sites Reservoir. This chapter considers the feasibility of both alternatives (no alternative is selected as a preferred alternative in this report) and provides a cost allocation and cost assignment. The determination of feasibility considers the following elements:

- **Technical Feasibility:** The alternative is evaluated to ensure that it is technically possible to construct, operate, and maintain.
- **Environmental Feasibility:** The alternative is analyzed to verify that construction or operation would not result in unacceptable environmental consequences to endangered species, cultural resources, Indian trust assets, or other resources.
- **Economic Feasibility:** The investment to construct the alternative is analyzed with respect to the anticipated benefits to determine if constructing and operating the project would result in net NED benefits.
- **Financial Feasibility:** The alternative is analyzed to ensure that the alternative's beneficiaries have the ability to pay (ATP) or repay their assigned costs, including—but not limited to—any Federal investment over a period of time, consistent with applicable law.

Technical Feasibility

Technical feasibility considers both the feasibility of constructing the facilities and the operations for the project.

Facilities: Alternatives A1 and D1 have facilities that are considered to be constructible and can be operated and maintained. The engineering design has been developed to support a Class 3 level (feasibility). A summary of the estimates is provided in Appendix B.4, Engineering.

In early 2018, the Authority performed a QRA for the Sites Reservoir Project (attached as Appendix I to this Feasibility Report. The QRA's resulting report presented the results for both unmitigated and mitigated risk cases. An 80 percent confidence level has been used to provide a risk-adjusted cost estimate that is used for the estimation of NED net benefits and cost allocation in this Feasibility Report.

Operations: The ability of the alternative to achieve the level of benefits identified in this report depends on cooperative operation of Sites Reservoir by the CVP and SWP. A Water Rights Strategy and Operations Agreement between Reclamation, the Authority, and DWR (see Chapter 6, Alternative Development) are needed to support the determination of technical feasibility. The Authority is coordinating the formation of an Operations Work Group with Reclamation and DWR to develop the Water Rights Strategy and Operations Agreement, which is necessary to achieve the benefits presented in this Report. One important principle is that Sites Reservoir operations will not have negative impacts on the CVP, the SWP, or their contractors.

Environmental Feasibility

The environmental effects for Alternatives A and D are evaluated in the Sites Reservoir Draft EIR/EIS (Reclamation and Authority 2017). An environmentally preferred alternative that is consistent with NEPA requirements will be identified in the Final EIR/EIS. Constructing Sites Reservoir would affect environmental resources in the Primary, Secondary, and Extended Study Areas. Beneficial effects correspond to the following resource areas: water management, agricultural resources, fisheries and aquatic resources, socioeconomics, power and energy, and recreation. Temporary construction-related effects would be reduced to less-than-significant levels through mitigation. Significant and unavoidable effects include effects on seven resource areas (terrestrial biological resources, aquatic biological resources, paleontological resources, historical and tribal resources, land use, air quality, and climate change/greenhouse gas emissions). The Draft EIR/EIS is incorporated by reference in this document and a summary is provided in Appendix M. The Draft EIR/EIS evaluates the representative environmental effects, and the proposed mitigation measures are presented in Appendix 1A of the Draft EIR/EIS and are included in the alternative cost estimates.

As part of the project planning process, Reclamation and the Authority will incorporate environmental commitments and BMPs to avoid or minimize potential project impacts.

The evaluation of environmental feasibility is an ongoing process that will incorporate public comment on the Draft EIR/EIS into the Final EIR/EIS. The ROD will not be completed until pre-construction permits and approvals have been acquired.

Economic Feasibility

Based on evaluations, Alternatives A1 and D1 are economically feasible and would generate, on average, $243.5 million and $270.4 million in NED benefits per year, respectively. Alternative A1 offers net NED benefits of $15.5 million per year. Alternative D1 offers net NED benefits of $15.0 million per year. The BCRs for Alternatives A1 and D1 are 1.07 and 1.06, respectively. Total net benefits over the 100-year planning horizon are approximately $539 million and $524 million, respectively. The total capital cost (i.e., for both construction and IDC) is estimated to be $6.51 billion for Alternative A1 and $7.37 billion for Alternative D1. Ongoing analysis may modify both the benefits and costs, but the alternatives are expected to remain economically feasible.

The lead agencies may need to consider variations on these alternatives for permits and project construction. Should alternative facilities, operations, or alternatives be developed, a post-authorization report would be needed to confirm benefits and costs.

Financial Feasibility

The evaluation of financial feasibility includes: (1) an allocation of costs to project purposes; (2) identification of potential project beneficiaries; and (3) a cost assignment and financial capability analysis. These steps evaluate the ability of the beneficiaries to pay their assigned construction and long-term OM&R costs. This process informs the evaluation of the appropriateness of the investment in the project by Federal and State decision makers.

Allocation of Costs to Project Purposes

Reclamation law (53 Stat. 1187, Reclamation Project Act of 1939) and policy (Reclamation 1988) require an allocation of costs to components or project purposes to (1) test financial feasibility by comparing estimated project costs with anticipated revenues and (2) to establish and measure compliance with project financial requirements after construction and determine the final cost allocation. This Feasibility Report develops an application and evaluates financial feasibility consistent with item (1) above. Item (2) is evaluated post-construction.

This Feasibility Report includes a cost allocation to evaluate the financial feasibility. Estimated costs are allocated to the various project purposes and then assigned to beneficiaries.

Allocated costs include construction costs, other costs (sunk costs), land costs, interest during construction, mitigation costs, annual OM&R costs, net power costs, and replacement costs. Because the cost allocation is a financial evaluation, the presentation of project costs in the cost allocation may differ from the presentation of these costs in the economic evaluation.

Once identified, all estimated costs are allocated to the project purposes. To develop a preliminary cost allocation, the following project purposes were identified:

- Water Supply
- CVP Operational Flexibility
- IL4 Water Supply for CVPIA Refuges
- Anadromous Fish
- Delta Ecosystem Enhancement
- Recreation
- Flood Damage Reduction

Once allocated to appropriate purposes, costs are assigned to the Federal government and non-Federal partners based on specific project authorization, established Federal cost-sharing laws and regulations (see Table 9-1), and laws and objectives of non-Federal entities, including the State and local agencies.

The separable costs-remaining benefits analysis allocates costs to project purposes. Table 9-2 shows the estimated costs allocated to each project purpose for Alternative A1, and Table 9-3 shows the allocated costs for Alternative D1. The allocated construction cost for each project purpose is the total annual cost with OM&R costs and IDC removed.

Table 9-1. Authorities for Federal Financial Participation

Purpose	Pertinent Legislation	Description
Federal Cost Share for a State-Led Project	Water Infrastructure Improvements for the Nation Act, 2015-2016 (Public Law 114-322)	Provides authorization for Federal funding in surface storage projects led by public agencies organized pursuant to State law and limits Federal participation to not more than 25% of the total cost of a State-led storage project.[2]
Water Supply (M&I) [1]	Reclamation Act of 1939, as amended	Provides for up-front Federal financing of M&I water supply purposes, with 100% repayment of capital costs (including interest during construction and interest over the repayment period); 100% of OM&R costs are non-Federal.
Water Supply (Irrigation)	Reclamation Act of 1902, as amended	Provides for up-front Federal financing of irrigation water supply purposes, with 100% repayment of construction costs, without interest, and OM&R costs by beneficiaries. This could be altered with aid to irrigation for the repayment of construction costs.
CVP Operational Flexibility	Water Infrastructure Improvements for the Nation Act, 2015-2016 (Public Law 114-322)	Provides for Federal construction funding of CVP operational flexibility benefits consistent with Federal cost share for a State-led project.
IL4 Water Supply for CVPIA Refuges	Water Infrastructure Improvements for the Nation Act, 2015-2016 (Public Law 114-322)	Provides for Federal construction funding of Refuge water supply benefits.
	Central Valley Project Improvement Act (Public Law 102-575)	Provides Federal share of up to 75% and 25% non-Federal share (State of California) for voluntary acquisition of Incremental Level 4 supplies to meet full Level 4 obligations. This authority does not apply to capital costs for construction of facilities.
Delta Ecosystem Enhancement	Water Infrastructure Improvements for the Nation Act, 2015-2016 (Public Law 114-322)	Provides authorization for Federal funding of surface storage projects that yield Federal benefits, including water supplies dedicated to specific purposes such as environmental enhancement and wildlife refuges.
Anadromous Fish	Water Infrastructure Improvements for the Nation Act, 2015-2016 (Public Law 114-322)	Provides authorization for Federal funding of surface storage projects that yield Federal benefits, including water supplies dedicated to specific purposes such as environmental enhancement and wildlife refuges.
Flood Damage Reduction	Reclamation Project Act of 1939	Discussed in Section 9(b) of the act. "*In connection with any new project…there may be allocated to flood control or navigation the part of said total estimated cost which the Secretary may find proper.*"
Recreation [1]	Federal Water Project Recreation Act of 1965, as amended by the Reclamation Recreation Management Act (Public Law 102-575)	Public Law 102-575 provides Federal share of up to 50% for separable investment costs, and non-Federal share of 100% for OM&R.

Notes:

[1] The Investigation is not pursuing Federal funding for the M&I water supply, irrigation water supply, flood damage reduction and recreation project benefit categories. The Investigation is pursuing Federal funding for CVP Operational Flexibility and Anadromous Fish capital costs under the WIIN Act. The authorities listed for these project benefit categories were considered during initial determinations of Federal interest in the Investigation. Construction under these authorities would need to be authorized by a specific act of Congress.

[2] Total cost interpreted as total capital cost.

CVP = Central Valley Project
CVPIA = Central Valley Project Improvement Act
IDC = interest during construction
IL4 = Incremental Level 4
M&I = municipal and industrial
OM&R = operation, maintenance, and replacement
P.L. = Public Law
USC = United States Code
WIIN = Water Infrastructure Improvements for the Nation

Table 9-2. Estimated Cost Allocation Summary for Alternative A1 ($ millions)

Category	Water Supply	CVP Operational Flexibility	IL4 Water Supply for CVPIA Refuges	Anadromous Fish	Delta Ecosystem Enhance	Recreation	Flood Damage Reduction	Total
Total Costs								**$228.0**
Average Annual Benefits	$138.6	$47.1	$19.6	$14.4	$16.7	$2.4	$4.6	$243.5
Single-Purpose Projects	$149.3	$134.8	$24.7	$14.4	$23.7	$133.6	$2.8	-
Justifiable Expenditures	$138.6	$47.1	$19.6	$14.4	$16.7	$2.4	$2.8	$241.7
Separable Annual Costs	$10.0	$1.2	$0.4	$0	$0.0	$1.0	$0	$12.6
Remaining Benefits / Justifiable Expenditures	$128.6	$45.9	$19.2	$14.4	$16.7	$1.4	$2.8	$229.1
Percent of Remaining Benefits	56.1%	20.0%	8.4%	6.3%	7.3%	0.6%	1.2%	100%
Allocated Joint Costs	$120.9	$43.2	$18.0	$13.5	$15.7	$1.4	$2.7	$215.4
Total Allocated Costs (Separable Plus Allocated Joint Costs)	**$130.9**	**$44.4**	**$18.4**	**$13.5**	**$15.7**	**$2.4**	**$2.7**	**$228.0**
OM&R Annual Costs								
Separable OM&R	$10.0	$1.2	$0.4	$0	$0.0	$0.2	$0	$11.8
Percent Allocated OM&R	56.1%	20.0%	8.4%	6.3%	7.3%	0.6%	1.2%	100%
Allocated Joint OM&R	$16.6	$5.9	$2.5	$1.9	$2.2	$0.2	$0.4	$29.6
Total Allocated OM&R	$26.6	$7.8	$2.9	$1.9	$2.2	$0.4	$0.4	$41.4
Construction Annual Costs								
Separable Construction	$0.0	$0.0	$0.0	$0.0	$0.0	$0.8	$0.0	$0.8
Percent Allocated Construction	56.1%	20.0%	8.4%	6.3%	7.3%	0.6%	1.2%	100%
Allocated Joint Construction	$92.8	$33.1	$13.8	$10.4	$12.1	$1.0	$2.0	$165.3
Total Allocated Construction	$92.8	$33.1	$13.8	$10.4	$12.1	$1.8	$2.0	$166.1
IDC Annual Costs								
Separable IDC	$0.0	$0.0	$0.0	$0.0	$0.0	$0.02	$0.0	$0.02
Percent Allocated IDC	56.1%	20.0%	8.4%	6.3%	7.3%	0.6%	1.2%	100%
Allocated Joint IDC	$11.5	$4.1	$1.7	$1.3	$1.5	$0.1	$0.2	$20.5
Total Allocated IDC	$11.5	$4.1	$1.7	$1.3	$1.5	$0.1	$0.2	$20.5
Construction and IDC Costs (Nominal)								
Allocated Total Capital Cost	$3,639	$1,299	$543	$408	$473	$69	$80	$6,510
Allocated IDC	$402	$143	$60	$45	$52	$5	$9	$716
Allocated Construction Cost	$3,238	$1,156	$483	$363	$421	$64	$71	$5,794

Annual costs are based on a 2019 price levels and shown in 2019 dollar terms. Interest and amortization based on 2.75 percent Federal discount rate and 100-year period analysis. Totals may not sum exactly due to rounding.

% = percent
CVP = Central Valley Project
CVPIA = Central Valley Project Improvement Act
IDC = Interest During Construction
IL4 = Incremental Level 4
OM&R = operation, maintenance, and replacement

Table 9-3. Estimated Cost Allocation Summary for Alternative D1 ($ millions)

Category	Water Supply	CVP Operational Flexibility	IL4 Water Supply for CVPIA Refuges	Anadromous Fish	Delta Ecosystem Enhance	Recreation	Flood Damage Reduction	Total
Total Costs								**$255.4**
Average Annual Benefits	$161.7	$48.4	$20.7	$18.0	$14.5	$2.5	$4.6	$270.4
Single-Purpose Projects	$153.5	$135.0	$26.0	$18.0	$20.5	$133.6	$2.8	-
Justifiable Expenditures	$153.5	$48.4	$20.7	$18.0	$14.5	$2.5	$2.8	$260.4
Separable Annual Costs	$12.1	$1.0	$0.4	$0.0	$0.0	$1.0	$0.0	$14.5
Remaining Benefits / Justifiable Expenditures	$141.4	$47.4	$20.3	$18.0	$14.5	$1.5	$2.8	$245.9
Percent of Remaining Benefits	57.5%	19.3%	8.2%	7.3%	5.9%	0.6%	1.1%	100%
Allocated Joint Costs	$138.5	$46.4	$19.6	$17.7	$14.2	$1.5	$2.8	$240.9
Total Allocated Costs (Separable Plus Allocated Joint Costs)	**$150.6**	**$47.4**	**$20.3**	**$17.7**	**$14.2**	**$2.5**	**$2.8**	**$255.4**
OM&R Annual Costs								
Separable OM&R	$12.1	$1.0	$0.4	$0.0	$0.0	$0.2	$0.0	$13.7
Percent Allocated OM&R	57.5%	19.3%	8.2%	7.3%	5.9%	0.6%	1.1%	100%
Allocated Joint OM&R	$17.6	$5.9	$2.5	$2.2	$1.8	$0.2	$0.4	$30.6
Total Allocated OM&R	$29.7	$6.9	$2.9	$2.2	$1.8	$0.4	$0.4	$44.3
Construction Annual Costs								
Separable Construction	$0.0	$0.0	$0.0	$0.0	$0.0	$0.8	$0.0	$0.8
Percent Allocated Construction	57.5%	19.3%	8.2%	7.3%	5.9%	0.6%	1.1%	100%
Allocated Joint Construction	$107.5	$36.1	$15.4	$13.7	$11.0	$1.2	$2.1	$187.1
Total Allocated Construction	$107.5	$36.1	$15.4	$13.7	$11.0	$2.0	$2.1	$187.9
IDC Annual Costs								
Separable IDC	$0.0	$0.0	$0.0	$0.0	$0.0	$0.02	$0.0	$0.02
Percent Allocated IDC	57.5%	19.3%	8.2%	7.3%	5.9%	0.6%	1.1%	100%
Allocated Joint IDC	$13.3	$4.5	$1.9	$1.7	$1.4	$0.1	$0.3	$23.2
Total Allocated IDC	$13.3	$4.5	$1.9	$1.7	$1.4	$0.1	$0.3	$23.2
Construction and IDC Costs (Nominal)								
Allocated Total Capital Cost	$4,217	$1,414	$605	$538	$432	$74	$84	$7,365
Allocated IDC	$465	$156	$67	$59	$48	$8	$9	$813
Allocated Construction Cost	$3,752	$1,258	$538	$479	$385	$66	$75	$6,552

Annual costs are based on a 2019 price levels and shown in 2019 dollar terms. Interest and amortization based on 2.75 percent Federal discount rate and 100-year period analysis. Totals may not sum exactly due to rounding.

% = percent
CVP = Central Valley Project
CVPIA = Central Valley Project Improvement Act
IDC = Interest During Construction
IL4 = Incremental Level 4
OM&R = operation, maintenance, and replacement

Annual Cost – OM&R Cost – IDC Cost = Construction Cost – Project components that have a single purpose have specific costs associated with them; for example, Alternatives A1 and D1 include two recreation areas that serve a single project purpose. Separable costs are costs that are specifically necessary because a purpose is included in a multipurpose project. Specific costs are costs that are solely necessary for the purpose to be achieved. 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.

OM&R costs are then subtracted from the total cost to determine the capital cost allocated to each project purpose. A similar approach for developing the OM&R costs was used to subtract the separable costs and allocate the remaining OM&R costs, based on the percentage of the remaining OM&R costs. Subtracting the OM&R costs from the annual costs leaves the capital costs to be allocated to each project purpose.

Finally, the IDC is subtracted to determine the construction cost allocated to each project purpose. The IDC is calculated as the percentage of the total capital cost multiplied by the total IDC. Subtracting the IDC from the capital cost leaves the construction cost allocated to each project purpose.

As previously noted, realization of the benefits estimated for both alternatives depends on cooperative operations by the CVP and SWP. It would be necessary to develop a Water Rights Strategy and Operations Agreement between Reclamation, the Authority, and DWR to ensure these benefits are realized. The Authority is coordinating an Operations Work Group to develop such an agreement.

Identification of Potential Project Beneficiaries

Alternatives A1 and D1 have somewhat different beneficiaries. Alternative A1 assumes higher SWP deliveries and Alternative D1 beneficiaries match the Phase 1 Authority participants. The Authority participants have invested in the development of the WSIP application, permitting, and planning, but they are not currently under agreement to fund design, construction, or OM&R. The assumed geographical distribution for water supply increases per the model is shown in Table 9-4.

Table 9-5 shows the preliminary allocation of water among investors consistent with Alternative D1 (specific investors have not been identified for Alternative A1), but water could be allocated differently among these investors, or new investors could be added prior to construction.

The CALSIM model for Alternative D1 included an assumption that a water market would develop around the reservoir, whereby 30 percent of the water controlled by Sacramento Valley Water Agencies would be moved through water transfers to willing buyers in Southern California.

The following analysis assumes the beneficiaries would be associated with the purposes and geographies identified in Table 9-4. Beneficiaries for water supply in the various hydrologic regions would be water agencies in these locations. The beneficiary for Delta ecosystem enhancement would be the State of California (likely under the coordination of CDFW, SWRCB, and DWR).

Table 9-4. Modeled Increases in Deliveries of Water under Alternatives A1 and D1

Modeled Beneficiaries	Average Increase in Deliveries (TAF/yr)	Dry and Critical Increase in Deliveries (TAF/yr)	Average Increase in Deliveries (TAF/yr)	Dry and Critical Increase in Deliveries (TAF/yr)
Alternative	**Alternative A1**		**Alternative D1**	
Water Supply	115.3	248.1	131.5	289.4
SOD Ag	1.9	4.1	2.2	5.0
SOD M&I	85.6	185.5	101.1	224.0
NOD Ag	27.8	58.5	28.1	60.4
CVP Operational Flexibility	69.2	86.6	73.1	114.4
NOD Ag	11.4	21.6	16.6	34.3
NOD M&I	3.3	5.7	4.7	9.5
SOD Ag	54.4	59.3	51.7	70.5
Sub-Total Water Supply	**184.5**	**334.7**	**204.6**	**403.7**
IL4 Water Supply for CVPIA Refuges	32.5	44.2	33.8	47.7
NOD	9.2	11.8	9.9	12.9
SOD	23.3	32.4	23.9	34.8
Delta Ecosystem Enhancement	57.1	43.9	51.0	33.0
Total Deliveries	**274.1**	**422.8**	**289.4**	**484.4**

Ag = agriculture
CVP = Central Valley Project
CVPIA = Central Valley Project Improvement Act
IL4 = Incremental Level 4
M&I = municipal and industrial
NOD = North of the Delta
SOD = South of the Delta
SWP = State Water Project
TAF/yr = thousand acre-feet per year

Table 9-5. List of Alternative D1 Project Participants with Deliveries at Funks (not at Point of Use)

Agency	Contractor	Location	(TAF/yr)
Colusa County	CVP Water Service	NOD	10,000
Colusa County Water District	CVP Water Service	NOD	13,100
Cortina Water District	CVP Water Service	NOD	300
Davis Water District	CVP Water Service	NOD	2,000
Dunnigan Water District	CVP Water Service	NOD	2,717
LaGrande Water District	CVP Water Service	NOD	1,000
Glenn-Colusa Irrigation District	CVP SRS	NOD	20,000
Reclamation District 108	CVP SRS	NOD	4,000
Westside Water District	CVP Water Service	NOD	15,000
City of American Canyon		NOD	4,000
Santa Clara Valley Water District	CVP and SWP Water Service	NOD	24,000
Antelope Valley-East Kern Water Agency		SOD	500
Coachella Valley Water District		SOD	10,000
Desert Water Agency		SOD	6,500
Metropolitan Water District	SWP Water Service	SOD	50,000
San Gorgonio Pass Water Agency		SOD	14,000
San Bernardino Municipal Water District		SOD	21,400
Wheeler Ridge – Maricopa Water SD		SOD	3,050
Zone 7 Water Agency		NOD	10,000
Carter Mutual Water Company	CVP SRS	NOD	500
Pacific Resources Mutual Water Company		SOD	20,000
Santa Clarita Valley Water Agency	—	SOD	5,000
Total			**237,067**

CVP = Central Valley Project
NOD = North of the Delta
SD = Storage District
SOD = South of the Delta
SRS = Sacramento River Settlement
SWP = State Water Project
TAF/yr = thousand acre-feet per year
— = not applicable

Other beneficiaries for benefits that are not associated with increased water supply include the following:

- Reclamation would benefit from CVP Operational Flexibility and improved coldwater pool and flow augmentation to benefit anadromous fish.
- The State of California would benefit from IL4 refuge water supply, Delta ecosystem enhancement, flood damage reduction and new recreation opportunities.

Cost Assignment for Alternative A1

The cost assignment for the NED Plan assigns non-public benefits to the beneficiaries.

Ownership, operations, and funding scenarios were developed to support the evaluation of the NED Plan (Alternative A1). The costs for the NED Plan were assigned based on the following considerations:

- M&I and agricultural water supply benefits were assigned to the beneficiaries.
- State funding for construction is likely to be obtained for environmental purposes (consistent with the WSIP).

- Federal funding would be limited to, at most, 25 percent of the total project cost (consistent with the WIIN Act).

The Federal construction cost assignment includes the following:

- 100 percent funding to improve the operational flexibility of the CVP
- 80 percent funding for anadromous fish

Federal participation is at a threshold of 25 percent for total funding, consistent with the WIIN Act.

Operation of the Sites Reservoir Project can provide environmental benefits that, in accordance with the WIIN Act, are not reimbursable and are non-returnable. Specifically, WIIN Act Section 4007(c)(1) authorizes the Secretary to participate in up to 25 percent of the total cost of a State-led storage project.

Table 9-6 shows the cost assignment for the project's construction to the Federal government and the non-Federal partners. Table 9-6 also shows the cost assignment for the project's OM&R cost to the Federal government and the non-Federal partners. Table 9-6 shows the resulting cost assignment for the project's total annual cost (i.e., construction and OM&R) for Federal and non-Federal participants. The Federal government is assigned the full construction cost for the CVP Operational Flexibility purpose. The Federal government would partially fund the construction cost for the Anadromous Fish purpose (80.0 percent). All other construction costs would be paid by the non-Federal partners.

Table 9-6. Construction Cost Assignment for Federal and Non-Federal Partners: Alternative A1

			Cost Assignment ($ millions)			
			Federal		Non-Federal Partners[a]	
Purpose/Action	Total Percent	Total Cost	Percent	Cost	Percent	Cost
Alternative A1: Construction Cost Assignment – Nominal Value						
Anadromous Fish	6.3%	$363	80.0%	$290	20.0%	**$73**
CVP Operational Flexibility	19.9%	$1,156	100%	$1,156		
Water Supply	55.9%	$3,238			**100%**	$3,238
M&I Water Supply	*88.9%*	*$2,878*			***100%***	*$2,878*
Agricultural Water Supply	*11.1%*	*$360*			***100%***	*$360*
Delta Ecosystem Enhancement	7.3%	$421			**100%**	**$421**
IL4 Water Supply for CVPIA Refuges	8.3%	$483			**100%**	$483
Recreation	1.1%	$64			**100%**	**$64**
Flood Damage Reduction	1.2%	$71			**100%**	**$71**
Total	**100%**	**$5,794**	**25.0%**	**$1,446**	**75.0%**	**$4,348**

Notes:

[a] Includes State and Authority members paid funding.
Sub-allocations between M&I and agricultural use are based on relative benefits.
Totals may not sum exactly due to rounding.
CVP = Central Valley Project
CVPIA = Central Valley Project Improvement Act
IDC = interest during construction
IL4 = Incremental Level 4

M&I = municipal and industrial

Under Alternative A1, the Federal government's cost share for project construction is estimated at $1,446 million (25.0 percent of the total construction costs).

Table 9-7 shows the estimated OM&R cost assignments for Federal and non-Federal partners on an annual basis over the project's expected 100-year operating life. This project is being developed under the WIIN Act, which provides Federal funding for the capital costs of new storage. It is assumed that Federal funding sources for this project are otherwise limited. Table 9-8 shows the estimated total cost assignments (for construction and IDC) for Federal and non-Federal partners on an annual basis over the project's expected 100-year operating life.

Table 9-7. Annual OM&R Cost Assignment per WIIN for Non-Federal Partners: Alternative A1

Purpose/Action	Total Annual Percent	Total Annual Cost	Cost Assignment ($ millions per year)			
			Federal		Non-Federal Partners[a]	
			Percent	Cost	Percent	Cost
Alternative A1: OM&R Cost Assignment – Annual						
Anadromous Fish	4.5%	$1.9			100%	$1.9
CVP Operational Flexibility	17.3%	$7.1	100%	$7.1		
Water Supply	64.3%	$26.6			100%	$26.6
M&I Water Supply	*92.2%*	*$24.5*			*100%*	*$24.5*
Agricultural Water Supply	*7.8%*	*$2.1*			*100%*	*$2.1*
Delta Ecosystem Enhancement	5.2%	$2.2			100%	$2.2
IL4 Water Supply for CVPIA Refuges [b]	6.9%	$2.9	9.9%	$0.3	90.1%	$2.6
Joint		*$2.5*			*100%*	*$2.5*
Separable		*$0.4*	*75%*	*$0.3*	*25%*	*$0.1*
Recreation	0.9%	$0.4			100%	$0.4
Flood Damage Reduction	0.9%	$0.4			100%	$0.4
Total	**100%**	**$41.4**	**18.0%**	**$7.4**	**82.0%**	**$33.9**

Notes:

[a] Includes State and Authority members paid funding.

[b] OM&R costs associated with IL4 refuge water supplies can be broken down into two categories: (1) the cost of filling the reservoir, which is a joint cost that will be paid for by the Non-Federal partners, and (2) the cost of delivering water from the Delevan Pipeline Discharge to the Refuge, which a separable cost that is subject to the cost-share requirements of CVPIA. The annual OM&R cost for IL4 refuge water supply has two distinct components:

1 The cost to divert water to fill the reservoir and other reservoir O&M costs ($2.5 million for Alt A1)

2 The cost to deliver water from the reservoir (end of the Delevan Pipeline) to the refuge boundary ($0.4 million for Alt A1)

The first component is treated as a joint cost and allocated 100% to the JPA. The second component is a separable conveyance cost and subject to the 75/25 cost share requirement under CVPIA. Therefore, $0.3 million is allocated to the Federal government and $0.1 million is allocated to the non-Federal partners. The Federal government is allocated approximately 9.9% ($0.3 million) of the $2.9 million in total annual OM&R costs allocated to IL4 refuge water supply.

Sub-allocations between M&I and agricultural use are based on relative benefits and water delivery quantities.

Totals may not sum exactly due to rounding.

CVP = Central Valley Project
CVPIA = Central Valley Project Improvement Act
IL4 = Incremental Level 4
M&I = municipal and industrial
OM&R = operation, maintenance, and replacementWIIN = Water Infrastructure Improvements for the Nation

Water Supply for Alternative A1

No costs for M&I or agricultural water supply are assigned to the Federal government. Financial feasibility for the non-Federal cost-share partners will be demonstrated through upfront payment of the construction cost share for water supply by the non-Federal partners.

CVP Operational Flexibility for Alternative A1

Operational flexibility facilitates delivery of CVP water supplies that would otherwise be undeliverable due to operational and demand constraints. For the Investigation, operational flexibility can be accomplished by (1) changing the timing of the CVP water delivery, such that the operational constraint is no longer a factor, or (2) changing the method of delivery, using Sites Reservoir facilities to avoid or minimize an operational constraint.

Table 9-8. Total Annual Cost Assignment for Federal and Non-Federal Partners: Alternative A1

Purpose/Action	Total Annual Percent	Total Annual Cost	Cost Assignment ($ millions per year)			
			Federal[a]		Non-Federal Partners[b]	
			Percent	Cost	Percent	Cost
Alternative A1: Total Cost Assignment (Construction and OM&R) – Annualized						
Anadromous Fish	5.9%	$12.3	67.9%	$8.3	32.1%	$3.9
CVP Operational Flexibility	19.4%	$40.3	100%	$40.3		
Water Supply	57.6%	$119.4			100%	$119.4
M&I Water Supply	*89.7%*	*$107.0*			*100%*	*$107.0*
Agricultural Water Supply	*10.3%*	*$12.4*			*100%*	*$12.4*
Delta Ecosystem Enhancement	6.7%	$14.2			100%	$14.2
IL4 Water Supply for CVPIA Refuges	7.8%	$16.7	1.7%	$0.3	98.3%	$16.4
Recreation	1.1%	$2.2			100%	$2.2
Flood Damage Reduction	1.2%	$2.4			100%	$2.4
Total	**100%**	**$207.5**	**23.6%**	**$48.9**	**76.4%**	**$158.6**

Notes:

[a] Includes both Federal non-reimbursable and Federal reimbursable (for CVP Operational Flexibility supply OM&R expenses paid by beneficiaries).

[b] Includes State and Authority member paid funding.

[c] This percentage includes both OM&R and construction cost funding. Estimated Federal funding for project construction is projected to be 25.0 percent of the project's overall construction cost, and consistent with WIIN regulatory requirements.

Sub-allocations between M&I and agricultural use are based on relative benefits and water delivery quantities.

Totals may not sum exactly due to rounding.

CVP = Central Valley Project
CVPIA = Central Valley Project Improvement Act
IDC = interest during construction
IL4 = Incremental Level 4
M&I = municipal and industrial
OM&R = operation, maintenance, and replacement

Future operational flexibility water supplies are projected to average 69 TAF annually. During Dry and Critical years, an average of 87 TAF would be available.

Construction and OM&R Costs: The construction cost assigned for the CVP Operational Flexibility purpose is $1,279 million, which is equivalent to an annualized cost of $36.7 million.

The annual OM&R cost allocated to the CVP Operational Flexibility purpose is $7.1 million, of which an estimated $1.1 million would be conveyance energy expenses. As a result, the corresponding annualized total cost for the CVP Operational Flexibility purpose is estimated to be $40.3 million and is equivalent to a $584 per acre-foot annual unit cost

Assignment of CVP Operational Flexibility Costs: Based on its 100 percent construction cost share, the Federal contribution is equivalent to approximately a $33.1 million annualized cost. The Federal government's total assigned construction cost is $1,156 million. Should the ability to pay analysis determine beneficiaries do not have the capability to repay costs assigned to them, no water would be provided. Further, under the WIIN Act Section 4007, in the case of construction funding for agricultural water supply, no aid-to-irrigation would be incurred to hydropower, consistent with Reclamation Manual Temporary Release, *Irrigation Ability-to-Pay Analyses with Water Infrastructure Improvements for the Nation Act Actions* (PEC TRMR-122) (Reclamation, 2019b), and RM *Irrigation Ability-to-Pay Analyses* (PEC 11-01) (Reclamation, 2019c).

All OM&R costs under the CVP Operational Flexibility project purpose would be assigned to beneficiaries, as determined in the financial plans for these supplies, with non-reimbursable funding for water used for ecosystem and water quality enhancement and reimbursable funding for water delivered to CVP contractors or for mitigation. OM&R costs associated with deliveries for agricultural and M&I supply will be addressed using the existing Ratesetting Policies and cost pools and recovered through the existing Ratesetting process.

IL4 Water Supply for CVPIA Refuges for Alternative A1

IL4 water supply is currently acquired for CVPIA Refuges (National Wildlife Refuges, State Wildlife Areas, and privately managed wetlands) through both purchase and no-cost exchanges. Modeled increases in average deliveries of IL4 refuge water supply under Alternative A1 were 9 TAF per year north of the Delta and 23 TAF per year south of the Delta.

Construction and OM&R Costs: The total construction cost allocated for the IL4 Water Supply for CVPIA Refuges purpose is estimated to be approximately $483 million, which is equivalent to an annualized cost of $13.8 million. The total allocated annualized cost (including construction and OM&R costs) for the IL4 Water Supply for CVPIA Refuges purpose is estimated to be approximately $16.7 million, which is below the estimated annual benefit value of $19.6 million for IL4 refuge water supplies.

Assignment of IL4 Refuge Water Supply Costs: All construction costs ($483 million) for the IL4 Water Supply for CVPIA Refuges purpose would be paid by the non-Federal partners.

The project's non-Federal partners will pay 100 percent of the IL4 Water Supply for CVPIA Refuges purpose's OM&R expenses that are not attributable to conveyance (i.e., diversions and filling). Under the planned assignment of costs for the Recommended Plan, the cost to convey IL4 Water Supply for CVPIA Refuges from the Delevan pipeline discharge to the refuges would be consistent with CVPIA cost share requirements (75 percent Federal and 25 percent State). These costs would vary by year, depending on hydrology and the amount of water delivered from the project. Financial feasibility will be demonstrated through upfront payment of the construction cost.

Anadromous Fish for Alternative A1

Anadromous fish benefits would be provided through increases in the coldwater pool in existing reservoirs and increases in flows downstream from these reservoirs to support migrating fish. These improvements would be derived from cooperative operation of these existing facilities with Sites Reservoir. These operations would provide, on average, an additional 138 TAF of end-of-September storage in Shasta Lake.

Construction and OM&R Costs: As shown in Table 9-6, the total construction cost assigned to the Anadromous Fish purpose was estimated to be $363 million, which is equivalent to an annualized cost of $10.4 million. The corresponding annual total cost (i.e., including OM&R costs of approximately $1.9 million per year) for Anadromous Fish benefits is estimated to be $12.3 million (which is equivalent to $89 per acre-foot).

Assignment of Anadromous Fish Purpose Costs: The construction cost share assigned to the Federal government for the Anadromous Fish purpose is 80.0 percent and is estimated to be $290 million. The other $73 million (20.0 percent) of the construction cost for the Anadromous Fish purpose would be paid by the non-Federal partners.

All OM&R costs for the Anadromous Fish purpose would paid by the non-Federal partners.

Delta Ecosystem Enhancement for Alternative A1

Improvements in the Delta ecosystem would be achieved through the release of water from Sites Reservoir into the toe drain of the Yolo Bypass. On average, 57 TAF per year would be released from Sites Reservoir to the Delta for the Delta Ecosystem Enhancement purpose.

Construction and OM&R Costs: The total construction cost allocated to the Delta Ecosystem Enhancement purpose was $410 million, which is equivalent to an annualized cost of $12.1 million. The annual OM&R cost allocated to the Delta Ecosystem Enhancement purpose is $2.2 million. As shown in Table 9-8, the estimated corresponding annualized total cost for the Delta Ecosystem Enhancement purpose is $14.2 million, which is equivalent to $249 per acre-foot.

Assignment of Delta Ecosystem Enhancement Costs: No costs are assigned to the Federal government for the Delta Ecosystem Enhancement purpose. Consequently, the non-Federal partners would be required to meet the $14.2 million total annualized cost for both construction and annual OM&R costs.

The construction cost for Delta ecosystem enhancement is eligible for WSIP funding. Financial feasibility will be demonstrated through upfront payment of the construction cost. WSIP does not provide funding for future OM&R costs. The State (and/or other non-Federal entities) would need to cover the $2.2 million per year required for OM&R.

Recreation for Alternative A1

Construction and OM&R Costs: The allocated construction cost for the recreational facilities was estimated to be $64 million, which is equivalent to an annualized cost of $1.8 million. The future OM&R costs for the recreational facilities are estimated to be approximately $0.4 million per year. The total annual cost for the Recreation purpose is estimated to be approximately $2.2 million.

Assignment of Recreation Costs: All construction and future OM&R costs for the Recreation purpose would be paid by the non-Federal partners (e.g., State of California). Funds from WSIP may be used for recreation as a public benefit. Financial feasibility will be demonstrated through upfront payment of the construction costs. Future OM&R costs for recreational facilities could likely be at least partly funded by visitor fees.

Flood Damage Reduction for Alternative A1

Construction and OM&R Costs: The total allocated construction cost for the Flood Damage Reduction purpose is $71 million, with an equivalent annualized cost of approximately $2.0 million. The future OM&R cost is approximately $0.4 million per year. As shown in Table 9-8 the total annual cost for the Flood Damage Reduction purpose is approximately $2.4 million for construction and OM&R.

Assignment of Flood Damage Costs: All construction and future OM&R costs for flood damage reduction would be paid by the non-Federal partners. Flood damage reduction is recognized as a public benefit, so these costs could also receive WSIP funding. Several other State programs could potentially be used to cover the costs assigned to flood damage reduction. Financial feasibility would be demonstrated through upfront payment of the construction cost assigned to non-Federal partners.

Cost Assignment for Alternative D1

The cost assignment for Alternative D1 assigns non-public benefits to the beneficiaries. Ownership, operations, and funding scenarios were developed to support the evaluation of the Alternative D1.

The costs for the Alternative D1 were assigned based on the following considerations:

- M&I and agricultural water supply benefits were assigned to the beneficiaries.
- State funding for construction is likely to be obtained for environmental purposes (consistent with the WSIP).
- Federal funding would be limited to at most 25 percent of the total project construction cost (consistent with the WIIN Act).

The Federal construction cost assignment includes the following:

- 100 percent funding to improve the operational flexibility of the CVP
- 80.0 percent funding for anadromous fish

Table 9-9 shows the cost assignment for the project's construction cost to the Federal government and the non-Federal partners. Table 9-10 shows the cost assignment for the project's OM&R cost to the Federal government and the non-Federal partners. Table 9-11 shows the resulting cost assignment for the project's total annual cost (i.e., construction and OM&R) for Federal and non-Federal participants. The Federal government is assigned the full construction cost for the CVP Operational Flexibility purpose. The Federal government would partially fund the construction cost for the Anadromous Fish purpose (80.0 percent). All other construction costs would be paid by the non-Federal partners.

Table 9-9. Construction Cost Assignment for Federal and Non-Federal Partners: Alternative D1

Purpose/Action	Total Percent	Total Cost	Cost Assignment ($ millions)			
			Federal		Non-Federal Partners[a]	
			Percent	Cost	Percent	Cost
Alternative D1: Construction Cost Assignment – Nominal Value						
Anadromous Fish	7.3%	$479	80.0%	$383	20.0%	$96
CVP Operational Flexibility	19.2%	$1,258	100%	$1,258		
Water Supply	57.2%	$3,752			100%	$3,752
M&I Water Supply	*90.0%*	*$3,375*			*100%*	*$3,375*
Agricultural Water Supply	*10.0%*	*$376*			*100%*	*$376*
Delta Ecosystem Enhancement	5.9%	$385			100%	$385
IL4 Water Supply for CVPIA Refuges	8.2%	$538			100%	$538
Recreation	1.0%	$68			100%	$68
Flood Damage Reduction	1.1%	$75			100%	$75
Total	**100%**	**$6,554**	**25.0%**	**$1,641**	**75.0%**	**$4,913**

Notes:

[a] Includes State and Authority members paid funding.

Sub-allocations between M&I and agricultural use are based on relative benefits.

Totals may not sum exactly due to rounding.

CVP = Central Valley Project
CVPIA = Central Valley Project Improvement Act
IDC = interest during construction
IL4 = Incremental Level 4
M&I = municipal and industrial

Table 9-10. Annual OM&R Cost Assignment per WIIN for Non-Federal Partners: Alternative D1

Purpose/Action	Total Annual Percent	Total Annual Cost	Cost Assignment ($ millions per year)			
			Federal		Non-Federal Partners[a]	
			Percent	Cost	Percent	Cost
Alternative D1: OM&R Cost Assignment – Annual						
Coldwater for Anadromous Fish	5.1%	$2.2			100%	$2.2
CVP Operational Flexibility	15.6%	$6.9	100%	$6.9		
Water Supply	67.0%	$29.7			100%	$29.7
M&I Water Supply	*93.2%*	*$27.7*			*100%*	*$27.7*
Agricultural Water Supply	*6.8%*	*$2.0*			*100%*	*$2.0*
Delta Ecosystem Enhancement	4.1%	$1.8			100%	$1.8
IL4 Water Supply for CVPIA Refuges[b]	6.4%	$2.9	10.3%	$0.3	89.7%	$2.6
Joint		*$2.5*			*100%*	*$2.5*
Separable		*$0.4*	*75%*	*$0.3*	*25%*	*$0.1*
Recreation	0.9%	$0.4			100%	$0.4
Flood Damage Reduction	0.8%	$0.3			100%	$0.3
Total	**100%**	**$44.3**	**16.2%**	**$7.2**	**83.8%**	**$37.1**

Notes:

[a] Includes State and Authority member paid funding.

[b] OM&R costs associated with IL4 refuge water supplies can be broken down into two categories: (1) the cost of filling the reservoir, which is a joint cost that will be paid for by the Non-Federal partners, and (2) the cost of delivering water from the Delevan Pipeline Discharge to the Refuge, which a separable cost that is subject to the cost-share requirements of CVPIA. The annual OM&R cost for IL4 refuge water supply has two distinct components:

1 The cost to divert water to fill the reservoir and other reservoir O&M costs ($2.5 million for Alt D1)
2 The cost to deliver water from the reservoir (end of the Delevan Pipeline) to the refuge boundary ($0.4 million for Alt D1)

The first component is treated as a joint cost and allocated 100% to the JPA. The second component is a separable conveyance cost and subject to the 75/25 cost share requirement under CVPIA. Therefore, $0.3 million is allocated to the Federal government and $0.1 million is allocated to the non-Federal partners. The Federal government is allocated approximately 10.3% ($0.3 million) of the $2.9 million in total annual OM&R costs allocated to IL4 refuge water supply.

Sub-allocations between M&I and agricultural use are based on relative benefits and water delivery quantities.

Totals may not sum exactly due to rounding.

CVP = Central Valley Project
CVPIA = Central Valley Project Improvement
IDC = interest during construction
IL4 = Incremental Level 4
M&I = municipal and industrial
OM&R = operation, maintenance, and replacement
WIIN = Water Infrastructure Improvements for the Nation

Table 9-11. Total Annual Cost Assignment for Federal and Non-Federal Partners: Alternative D1

Purpose/Action	Total Annual Percent	Total Annual Cost	Cost Assignment ($ millions per year)			
			Federal[a]		Non-Federal Partners[b]	
			Percent	Cost	Percent	Cost
Alternative D1: Total Cost Assignment (Construction and OM&R) – Annualized						
Anadromous Fish	6.9%	$16.0	68.8%	$11.0	31.2%	$5.0
CVP Operational Flexibility	18.5%	$43.0	100%	$43.0		
Water Supply	**59.1%**	$137.2			100%	$137.2
M&I Water Supply	*90.7%*	*$124.4*			*100%*	*$124.4*
Agricultural Water Supply	*9.3%*	*$12.8*			*100%*	*$12.8*
Delta Ecosystem Enhancement	**5.5%**	$12.8			100%	$12.8
IL4 Water Supply for CVPIA Refuges	**7.9%**	$18.4	**1.6%**	**$0.3**	**98.4%**	$18.1
Recreation	1.0%	$2.3			100%	$2.3
Flood Damage Reduction	**1.1%**	$2.5			**100%**	$2.5
Total	**100%**	**$232.2**	**23.4%[c]**	**$54.2**	**76.6%**	**$177.9**

Notes:

[a] Includes both OM&R expenses paid by both Federal government and CVP beneficiaries.

[b] Includes State and Authority members paid funding.

[c] This percentage includes both OM&R and construction cost funding. Estimated Federal funding for project construction is projected to be 25.0 percent of the project's overall construction cost, which is consistent with WIIN regulatory requirements.

Sub-allocations between M&I and agricultural use are based on relative benefits and water delivery quantities.

Totals may not sum exactly due to rounding.

CVP = Central Valley Project
CVPIA = Central Valley Project Improvement
IDC = interest during construction
IL4 = Incremental Level 4
M&I = municipal and industrial
OM&R = operation, maintenance, and replacement

Under Alternative D1, the Federal government's cost share for project construction is estimated at $1,641 million (25.0 percent of the total construction cost).Table 9-10 shows the estimated OM&R cost assignments for Federal and non-Federal partners on an annual basis over the project's expected 100-year operating life. This project is being developed under the WIIN Act, which provides Federal funding for the capital costs of new storage. It is assumed that Federal funding sources for this project are otherwise limited.

Table 9-11 shows the estimated total cost assignments (for construction and OM&R) for Federal and non-Federal partners on an annual basis over the project's expected 100-year operating life.

Water Supply for Alternative D1

No costs for M&I or agricultural water supply are assigned to the Federal government. Financial feasibility for the non-Federal cost-share partners will be demonstrated through upfront payment of the construction cost share for water supply by the non-Federal partners.

CVP Operational Flexibility for Alternative D1

Operational flexibility facilitates delivery of CVP water supplies that would otherwise be undeliverable due to operational and demand constraints. For the Investigation, operational flexibility can be accomplished by (1) changing the timing of the CVP water delivery, such that the

operational constraint is no longer a factor, or (2) changing the method of delivery, using Sites Reservoir facilities to avoid or minimize an operational constraint.

Future operational flexibility water supplies are projected to average 73 TAF annually. During Dry and Critical years, an average of 114 TAF of water supplies would be available.

Construction and OM&R Costs: The total construction cost assigned for the CVP Operational Flexibility purpose is $1,258 million, which is equivalent to an annualized cost of $36.1 million.

The annual OM&R cost allocated to the CVP Operational Flexibility purpose is $6.9 million, of which an estimated $1.0 million would be conveyance energy expenses. As a result, the corresponding annualized total cost for the CVP Operational Flexibility purpose is estimated to be $43.0 million and is equivalent to a $589 per acre-foot annual unit cost.

Assignment of CVP Operational Flexibility Costs: Based on its 100 percent construction cost share, the Federal cost share is $1,258 million. Should the ability to pay analysis determine beneficiaries do not have the capability to repay costs assigned to them, no water would be provided. Further, under the WIIN Act Section 4007, in the case of construction funding for agricultural water supply, no aid-to-irrigation would be incurred to hydropower, consistent with Reclamation Manual Temporary Release, *Irrigation Ability-to-Pay Analyses with Water Infrastructure Improvements for the Nation Act Actions* (PEC TRMR-122) (Reclamation, 2019b), and RM *Irrigation Ability-to-Pay Analyses* (PEC 11-01) (Reclamation, 2109c).

All OM&R costs under the CVP Operational Flexibility project purpose would be assigned to beneficiaries, as determined in the financial plans for these supplies, with non-reimbursable funding for water used for ecosystem and water quality enhancement and reimbursable funding for water delivered to CVP contractors or for mitigation.. OM&R costs associated with deliveries for agricultural and M&I supply will be addressed using the existing Ratesetting Policies and cost pools and recovered through the existing Ratesetting process.

IL4 Water Supply for CVPIA Refuges for Alternative D1

IL4 water supply is currently acquired for CVPIA Refuges (National Wildlife Refuges, State Wildlife Areas, and privately managed wetlands) through both purchase and no-cost exchanges. Modeled increases in average deliveries of IL4 refuge water supply under Alternative D1 were 10 TAF per year north of the Delta, and 24 TAF per year south of the Delta.

Construction and OM&R Costs: The total constriction cost allocated for the IL4 Water Supply for CVPIA Refuges purpose is estimated to be approximately $538 million, which is equivalent to an annualized cost of $15.4 million. The total assigned annualized cost (including construction and OM&R costs) for IL4 refuge water supply is estimated to be approximately $18.4 million, which is below the estimated annual benefit value of $20.7 million for IL4 refuge water supplies.

Assignment of IL4 Water Supply for CVPIA Refuges: All construction costs for the IL4 Water Supply for CVPIA Refuges purpose would be paid by the non-Federal partners.

The project's non-Federal partners will pay 100 percent of the IL4 Water Supply for CVPIA Refuges purpose's OM&R expenses that are not attributable to conveyance (i.e., diversions and filling). Under the planned assignment of costs for the Recommended Plan, the cost to convey IL4

Water Supply for CVPIA Refuges from the Delevan pipeline discharge to the refuges would be consistent with CVPIA cost share requirements (75 percent Federal and 25 percent State). These costs would vary by year, depending on hydrology and the amount of water delivered from the project. Financial feasibility will be demonstrated through upfront payment of the construction cost.

Anadromous Fish for Alternative D1

Anadromous fish benefits would be provided through increases in the coldwater pool in existing reservoirs and increases in flows downstream from these reservoirs to support migrating fish. These improvements would be derived from cooperative operation of these existing facilities with Sites Reservoir. These operations would provide, on average, an additional 164 TAF of end-of-September storage in Shasta Lake.

Construction and OM&R Costs: As shown in Table 9-6, the total construction cost assigned to the Anadromous Fish purpose was estimated to be $479 million, which is equivalent to an annualized cost of $13.7 million. The corresponding annual total cost (i.e., including OM&R costs of approximately $2.2 million per year) for the Anadromous Fish purpose is estimated to be $16.0 million (which is equivalent to $98 per acre-foot for additional storage in Shasta Lake).

Assignment of Anadromous Fish Purpose Costs: The construction cost share assigned to the Federal government for the Anadromous Fish purpose is 80.0 percent and is estimated to be $383 million. The other $96 million (20.0 percent) of the construction cost for the Anadromous Fish purpose would be paid by the non-Federal partners.

All OM&R costs for the Anadromous Fish purpose would paid by the non-Federal partners.

Delta Ecosystem Enhancement for Alternative D1

Improvements in the Delta ecosystem would be achieved through the release of water from Sites Reservoir into the toe drain of the Yolo Bypass. On average, 51 TAF per year would be released from Sites Reservoir to the Delta for the Delta Ecosystem Enhancement purpose.

Construction and OM&R Costs: The construction cost allocated to the Delta Ecosystem Enhancement purpose was $385 million, which is equivalent to an annualized cost of $11.0 million. The annual OM&R cost allocated to the Delta Ecosystem Enhancement purpose is $1.8 million. As shown in Table 9-8, the estimated corresponding annualized total cost for the Delta Ecosystem Enhancement purpose is $12.8 million, which is equivalent to $251 per acre-foot.

Assignment of Delta Ecosystem Enhancement Costs: No costs are assigned to the Federal government for the Delta Ecosystem Enhancement purpose. Consequently, the non-Federal partners would be required to meet the $12.8 million total annualized cost for both construction and annual OM&R.

The construction cost for the Delta Ecosystem Enhancement purpose is eligible for WSIP funding. Financial feasibility will be demonstrated through upfront payment of the construction cost. WSIP does not provide funding for future OM&R costs. The State (and/or other non-Federal entities) would need to cover the $1.8 million per year required for OM&R.

Recreation for Alternative D1

Construction and OM&R Costs: The allocated construction cost for the recreational facilities was estimated to be $68 million, which is equivalent to an annualized cost of $1.9 million. The future OM&R costs for the recreational facilities are estimated to be approximately $0.4 million per year. The total annual cost for the Recreation purpose is estimated to be approximately $2.3 million.

Assignment of Recreation Costs: All construction and future OM&R costs for the Recreation purpose would be paid by the non-Federal partners (e.g., State of California). Funds from WSIP may be used for recreation as a public benefit. Financial feasibility will be demonstrated through upfront payment of the construction costs. Future OM&R costs for recreational facilities could likely be at least partly funded by visitor fees.

Flood Damage Reduction for Alternative D1

Construction and OM&R Costs: The total allocated construction cost for the Flood Damage Reduction purpose is $75 million, with an equivalent annualized cost of $2.1 million. The future OM&R cost is approximately $0.4 million per year. As shown in Table 9-8, the total annual cost for the Flood Damage Reduction purpose is approximately $2.5 million for construction and OM&R.

Assignment of Flood Damage Costs: All construction and future OM&R costs for the Flood Damage Reduction purpose would be paid by the non-Federal partners. Flood damage reduction is recognized as a public benefit, so these costs could also receive WSIP funding. Several other State programs could potentially be used to cover the costs assigned to the Flood Damage Reduction purpose. Financial feasibility would be demonstrated through upfront payment of the construction cost assigned to non-Federal partners.

Financing Approach

Reclamation law requires that investments be repaid by the beneficiaries, except for investments for the common welfare or defense. Financial feasibility depends on the ability of project beneficiaries to collectively pay the project costs. Where costs exceed an individual beneficiary's repayment ability, costs may be paid by other beneficiaries as Reclamation policy allows if resources are available. This ability-to-pay analysis evaluates the financial feasibility for Alternatives A1 and D1.

The non-Federal partner is the Authority, which would be responsible for all costs that are not allocated to the Federal government. The Authority is in the process of securing funding from California through WSIP for the State's cost share. The CWC has identified $1,008 million in Sites Reservoir public benefits that are eligible for funding under WSIP. The Authority funding amount from WSIP is $816 million. The WSIP investment would fund the Authority for the costs allocated by the State to project benefits that are considered public, including the IL4 Water Supply for CVPIA Refuges, Delta Ecosystem Enhancement, Recreation, and Flood Damage Reduction purposes.

Water Supply Benefits (Authority)

The costs for water supply benefits have been assigned to the Authority. The Authority is developing Phase 2 agreements for its cost-sharing partners to fund the Final EIR/EIS, WSIP

feasibility study, and permitting for the project. Phase 2 agreements for 2020 are scheduled to be executed in September 2020.

The Authority has developed an enterprise financial model to support projected revenues, expenses, and appropriate cash balances during the design and construction and through project operations, and is expected to finance construction of the project in 2022. An agreement from the Authority to provide upfront funding to pay the non-Federal share of the construction costs of the project must be secured before beginning construction of the project.

The financial model sets up two primary funds to transfer money for construction. The first is the Construction Fund. Inflows are (in order of priority based on lowest cost): WSIP funds, WIIN Act Funds (if available), cash from participants, interim loan draws, Water Infrastructure Finance and Innovation Act (WIFIA) loan draws, and finally, revenue bond draws. Transfers from the Construction Fund will fund the interim loan payoff for pre-construction costs and construction expenses. The model is programmed to maintain a minimum construction fund balance each month to reflect prudent cash flow management practices. When expenses would result in the monthly ending balance dropping below the minimum balance, draws would be initiated from the available sources in priority order. Each year in June from 2023 to 2029, revenue bonds would be issued to provide enough funds to cover expenses, and the Construction Fund would not be allowed to fall below the minimum balance before the next revenue bond issue is sold.

The other fund used during project construction is the Revenue Bond Fund. Starting in June 2023, a revenue bond would be issued to refinance the interim loan balance for the pre-construction phase and provide funds (along with the other sources of revenue) to pay for construction expenses until the next revenue bonds are issued. The initial revenue bond sale in 2023 would provide the initial deposit to the Revenue Bond Fund, and each month a draw would be made to transfer funds from the Revenue Bond Fund to the Construction Fund. Funds remaining in the Revenue Bond Fund would earn interest at a short-term rate. Additionally, with each revenue bond offering, a portion of the proceeds would be deposited in a Revenue Bond Fund subaccount, called the Debt Service Reserve Fund, where it would be held for the benefit of revenue bondholders if a shortfall in debt service payments on revenue bonds occurs. The Debt Service Reserve Fund balance would earn interest at a long-term rate. These interest earnings would add to the Revenue Bond Fund balance and would be used to pay construction costs.

Upfront cost sharing of costs assigned to non-Federal participants will be provided. The Department of the Interior would negotiate and enter into an agreement with non-Federal partners on behalf of the United States for planning, permitting, design, and construction costs up to 25 percent of the total project cost.

Operational Flexibility

No aid-to-irrigation is allowed for construction costs of CVP Operational Flexibility, and where ability to pay analysis determines the payment capacity is insufficient, the water will not go to that purpose. Assessments of the ability of agricultural beneficiaries to pay were performed.

The ATP for agricultural water users is based on a crop budget analysis for representative farm types to estimate farm-level payment capacity at the water district level and is adjusted to account for district operations and maintenance (O&M) costs and any additional financial capacity of the district.

Observable trends indicate the ATP increases for each type of beneficiary with the implementation of the project. These trends include increasing crop prices and yields; increased plantings of higher-value permanent crops; repayment of outstanding CVP facility capital costs by 2030; and increasing California populations. Costs included in irrigation ATP analyses include the cost of all water supplies, including the use of groundwater wells and sources of surface water, and existing CVP obligations. Because the majority of existing CVP capital obligations would be repaid by 2030, it is assumed that current CVP water contractors would continue to have the ATP at least equal to their currently allocated share of existing CVP capital obligations, less any aid to irrigation received. Accordingly, payment capacities for each type of beneficiary would increase over time as existing obligations are paid down.

Agricultural Water Supply Beneficiaries

Given that there are more than 250 current contracting entities within the CVP service area that supply water to farmers producing hundreds of commodities across a large geographic area in California (Shasta County to the north to Kern County to the south), detailed analyses for each contracting entity are not available. For this Feasibility Report, an initial ATP was performed for a representative irrigation contractor from four regions of the CVP. Reclamation project construction costs allocated to irrigation are eligible for adjustment based on the irrigation contractor's ATP. The ATP concept does not generally apply to OM&R costs payable by irrigation contractors. In the cases in which ATP does apply to OM&R costs, it is because project-specific legislation has made such costs eligible to receive irrigation assistance.

Participation in new storage at Sites Reservoir under WIIN is not expected to result in an increase in ATP relief for any CVP contractor. ATP analyses for irrigation contractors investing in storage projects consider the following (Reclamation 2019):

- The irrigation contractor's current status with additional investment in the storage project and the benefits to the irrigation contractor. An irrigation contractor shown to be able to pay their eligible obligations with the WIIN investment will not receive any aid to irrigation.
- If the irrigation contractor does not have the ATP as estimated with the additional WIIN investment, then the operation will be considered without the WIIN investment or the benefits from that investment. Any irrigation contractor without the ATP following analysis without the WIIN investment would be eligible for aid-to-irrigation, as the investment did not impact their criteria for aid-to-irrigation.
- Subsequent requests for ATP analyses will be based on a similar approach.

The estimation of a district's ATP begins with a payment capacity analysis. Payment capacity is the estimated residual net farm income available for payment of Federal and non-Federal assessed water costs, with the deduction of on-farm production and investment expenses and appropriate allowances for management, equity, and labor. Non-farm revenues are not included in the payment capacity assessment. The number of representative farms selected should be adequate to capture the different types of operations 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 this study, financial feasibility is determined by comparing the representative CVP agricultural contractor's ATP with the allocated construction costs and O&M costs for Alternatives A1 and D1 (Table 9-12).

Table 9-12. Allocated Irrigation Water Supply Costs ($ millions)

Cost Type	Alternative A1 ($ millions)	Alternative D1 ($ millions)
Allocated Construction Cost	**$1,156**	**$1,258**
Annualized Costs		
Irrigation Water Supply Repayment Cost (40-year repayment with no interest)	$28.9	$31.5
Operations and Maintenance	$6.0	$6.0
CVP Additional Pumping Costs	$0.9	$0.9
Total Annual Irrigation Water Supply Cost (40-year repayment with no interest)	**$35.8**	**$38.4**

Notes:
Project features and costs are described in detail in Appendix B. Costs are presented in millions and 2019 dollars.
CVP = Central Valley Project

New water service or repayment contracts may be needed to repay the cost for operational flexibility. At present, the existing contracts are scheduled to conclude in 2030 (construction for Sites Reservoir is scheduled to conclude in 2030). The increment of agricultural water supply from the selected alternative would be addressed through new repayment contracts with existing CVP contractors who are willing and able to pay the incremental costs.

The costs would be repaid over a 40-year period. At present, the specific agricultural contractors considered to be beneficiaries have not been identified. If new contracts were established, the $35.8 million (Alternative A1) and $38.4 million (Alternative D1) in allocated irrigation water supply costs would be distributed over the average annual estimated increase in agricultural deliveries. The results are summarized in Table 9-13.

Table 9-13. Scenario 2 Repayment through New Contracts for Irrigation Supply

	Alternative A1	Alternative D1
Allocated Irrigation Supply Cost ($ millions per year)	$35.8	$38.4
Average Increase in Irrigation Deliveries (TAF)	69	73
Cost per AF	$517	$525

Notes:
AF = acre-foot
TAF = thousand acre-feet

Analysis of the ATP for specific contractors 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.

CVP Irrigation Costs Repayment Status and ATP Trends

Relief from CVP capital repayment and CVPIA Restoration Fund charges is provided to contractors who are eligible for aid to irrigation, as demonstrated through an ATP study. Table 9-14 shows the status of CVP repayment of construction costs for existing facilities.

Historically, several contractors located north of the Delta that would benefit from improved operational flexibility have received "aid to irrigation" rate adjustments. However, the number of these districts 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 2014) due to improved financial circumstances. Similarly, of the 49 irrigation contractors receiving full relief that were reviewed, 24 are no longer eligible for the program and four are now receiving partial relief. This trend may be attributed to increased prices and yields for crops, such as rice and almonds. There has been a trend toward increased permanent crop plantings in Tehama and Colusa counties, which typically generate greater returns. For example, acres planted in almonds in Colusa County increased from 23,240 in 2003 to 46,806 in 2018 (U.S. Department of Agriculture 2018). Similarly, walnut acres have nearly doubled in the two counties over the same time period.

Table 9-14. CVP Irrigation Cost Construction Repayment Status at the End of FY 2018

CVP Construction Cost and Repayment	CVP Costs and Repayment ($ million)
Existing CVP Facility Construction Costs Allocated to Irrigation[1]	**$1,871**
Repayments of Irrigation Costs	
Irrigation Districts Repayment[2]	$895
Other Repayments Realized[3]	$118
Total Repayments of Irrigation Costs	**$1,012**
Anticipated Future Repayment of Irrigation Costs	
Repayment of Costs by Irrigation Districts	$641
Repayment of Costs by Irrigation Assistance[4]	$60
Other Anticipated Future Repayment[5]	$142
Total Anticipated Future Repayments of Irrigation Costs	**$842**
Credits[6]	**$17**

Source: Bureau of Reclamation, California-Great Basin Region, 2019. Statement of Project Construction Cost and Repayment (SPCCR)

Notes:

1 Total includes all CVP construction costs to date.

2 Estimated repayment includes matured repayment and water service contracts.

3 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.

4 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, when available.

5 Other anticipated future repayment includes repayment anticipated through future repayment contracts and contracts that have been deferred, among other things.

6 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 non-reimbursable.

CVP = Central Valley Project
FY = Fiscal Year

Assuming that CVP water contractors are on track with Public Law 99-546 requirements and repayment occurred over a 40-year period, the resulting annual repayment obligations (including conveyance costs) would be approximately $35.8 million (Alternative A1) and $38.4 million (Alternative D1).

Summary

Based on the initial ATP analysis performed, CVP irrigation contractors that would receive water supply benefits from CVP Operational Flexibility would likely be able to repay the allocated project costs. Increasing crop prices and yields and the transition to more valuable permanent crops suggest that the ATP is increasing with the potential to benefit from NODOS

Chapter 10 Risk and Uncertainty

During the NODOS Investigation, reasonable assumptions based on engineering, economic, and scientific judgment were made to support the evaluation and comparison of alternatives. Analyses were developed with advanced modeling and estimating tools using historical data and trends. Although this analysis supported the evaluation of project outcomes, many risks and uncertainties could affect the future performance of the project, as well as the estimated costs and benefits. These risks and uncertainties and their effects on costs and benefits are discussed in greater detail in this section, which is organized as follows:

- Implementation uncertainty
- Environmental impacts
- State water system operations
- Hydropower operations
- Cost estimates
- Environmental effects of project actions
- Benefit estimation
- Funding

Implementation Approach

The lead agencies are continuing to finalize the project implementation strategy. Implementation of the project may be phased to meet the current needs of the participating agencies who are investing in the project; however, there is no phased implementation plan at this time (see Appendix K). This may initially alter the magnitude of the benefits and effects of the project. In general, if the project were to be constructed in phases the initial benefits would be realized over time. This Report does not consider the benefits and costs associated with potential phases of implementation.

Modeling Assumptions

Several modifications to the California water system have been proposed and the regulatory requirements are undergoing ongoing changes. Modeling for the refined evaluation of alternatives (Chapter 8) included the updated COA and 2019 BiOps in the baseline. Subsequent sections in this chapter consider the effects of proposed storage projects (including enlarging Shasta Lake and Los Vaqueros Reservoir) that were not included in the model.

Environmental Impacts

A Draft EIR/EIS (Authority and Reclamation 2017) has been completed and circulated for public comment (see Chapter 1 for a summary of the public review comments). Completion of the Final Feasibility Report prior to the Final EIR/EIS requires a waiver of FAC 09-02. Should the conclusions of the Final EIR/EIS differ significantly from the conclusions of the Draft, it will be necessary to reevaluate the environmental feasibility and mitigation costs for the project.

State Water System Operations

The analysis of costs and benefits for the Sites Reservoir Project is dependent on the quality of the tools and analysis used to evaluate future water system operations that incorporate the project. This Feasibility Report has made reasonable assumptions regarding future operations of the State water system. Operations will be regulated by future permit conditions, impacted by any new storage projects that are developed in parallel, and affected by climate variability. Each of these factors is discussed in the following sections.

Regulatory Effects on Sites Reservoir Project Water System Operations

Planning and predicting the future long-term operations of the CVP, SWP, and other projects, while also predicting the future regulatory environment for the Sacramento River and Delta is challenging. Uncertainty regarding future operations of the State water system will need to be addressed in a framework for developing a cooperative operations agreement between Reclamation, the Authority, and DWR. Meetings to develop the framework are currently under way.

Both USFWS and NMFS issued a new BiOp in 2019. Modeling for the refined alternative evaluation (Chapter 8) described within this document is consistent with the amended COA (2019 January) or the 2019 biological opinions (USFWS and NMFS, 2019 October). However, they were not considered in the initial alternative modeling performed prior to 2019 (i.e., Chapter 7 results).

CalSim II is a monthly model developed for planning-level analyses. The model is run for an 82-year historical hydrologic period, at a projected level of hydrology and demands, and under an assumed framework of regulations. Therefore the 82-year simulation does not provide information about historical conditions, but it does provide information about variability of conditions that would occur at the assumed level of hydrology and demand with the assumed operations, under the same historical hydrologic sequence.

Despite detailed model inputs and assumptions, the CalSim II results differ from real-time operations under stressed water supply conditions. Such model results occur because the model is unable to make unique real-time policy decisions under extreme circumstances, as the actual (human) operators must do. Therefore, results that indicate severely low storage, or inability to meet flow requirements or senior water rights should only be considered an indicator of stressed water supply conditions under that alternative, and should not necessarily be understood to reflect literally what would occur in the future under that alternative. These conditions, in real-time operations, would be avoided by making policy decisions on other requirements in prior months. In actual future operations, as has always been the case in the past, the project operators would work in real

time to satisfy legal and contractual obligations given then current conditions and hydrologic constraints.

State Water Resources Control Board Water Rights Decision 1641 (D-1641) Revised (SWRCB 2000) defines water quality and flow standards for the San Francisco Bay/Sacramento–San Joaquin Delta Estuary. These standards are regulatory requirements on the operation of the CVP and SWP in the San-Francisco Bay/Delta Watershed. The Sites Reservoir Project will only appropriate water after the requirements of D-1641, the Biological Opinions on the CVP and SWP, and other conditions are met. Therefore, future changes to the flow requirements established in D-1641 reduce the allowable diversions into Sites Reservoir. The SWRCB is currently in the process of updating the Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary, and may change the water right decision that regulates the operations on the Central Valley Project and the State Water Project.

SWRCB July 2018 Framework for the Sacramento/Delta Update to the Bay-Delta Plan (SWRCB 2018) outlines the proposed flow levels and implementation requirements for updating the water quality control plan. The concept presented is to "maintain inflows from the Sacramento/Delta tributaries at 55% of unimpaired flow, within an allowed adaptive range between 45 and 65% of unimpaired flow." If implemented in this manner, it would substantially increase Delta outflows above the current regulatory minimum of 20 percent of average unimpaired flows. Actual flows are much higher due to the large amount of unregulated flows that pass through the Delta. Finalizing the inflows or other actions to provide ecological benefits is tied to the ongoing voluntary settlement agreement process.

The Authority is developing a Water Rights Strategy to comprehensibly identify water right requirements to operate Sites Reservoir. Water right terms and conditions for the Sites Reservoir Project will be developed through the completion of the Biological Opinion process for the Sites Reservoir and the Water Rights Strategy.

In summary, the modeled results are intended to represent a possible future condition based on known information. These results will vary from what actually happens, especially when regulations, operational requirements, and other factors change. Factors including meteorological conditions and changing regulations could result in improved or diminished project performance.

Effects of New Storage and New Conveyance Projects on Sites Reservoir Project Operations

Delta Conveyance and California EcoRestore: New Delta conveyance is being studied by Federal, State, and local agencies, environmental organizations, and other interested parties. This includes evaluating new conveyance facilities with capacities of up to 6,000 cfs. The following discussion describes how the implementation of new conveyance might affect the performance of a Sites Reservoir Project. California EcoRestore is designed to implement a comprehensive suite of habitat restoration actions to support the long-term health of the Delta's native fish and wildlife species.

- **Water Supply:** Construction of new conveyance would reduce the uncertainty associated with Delta diversions to export water from the Delta. Diversions for export with new conveyance are expected to be more sustainable from a regulatory standpoint because the conveyance would not interfere with the recovery of aquatic species in the Delta. This type

of diversion facility would tend to maintain the benefits associated with the Sites Reservoir Project into the future. The extent to which this would occur is largely dependent on the permit conditions for Delta conveyance.

- **Coldwater for Anadromous Fish:** Delta conveyance and EcoRestore are expected to improve conditions in the Delta for anadromous fish. These actions should improve survival throughout the entire life cycle of anadromous fish (including migration through the Delta). This would improve the survival of juvenile fish produced upstream as a result of coldwater pool and flow augmentation benefits stemming from Sites Reservoir.

- **Shasta Dam and Reservoir Enlargement Project:** Preconstruction activities are under way for the potential raise of Shasta Dam. The proposed raise of 18.5 feet would provide additional storage for water supply and cold water benefits for anadromous fish. Preliminary studies (DWR 2007) suggest that the benefits of raising Shasta and Sites Reservoir may be additive. Additional study is under way to determine the effects of implementing both projects as they are currently formulated. The modeling results described within this document do not include the enlargement of Shasta Lake in the No Action Alternative. However, it is anticipated that there will still be incremental benefits because NODOS captures the accretions below Shasta Dam.

- **Other Potential Storage Projects:** Water operations modeling was based on existing system facilities and operational considerations. Other storage projects under consideration include the Shasta Dam raise, construction of Temperance Flat Reservoir on the upper San Joaquin River, and an expansion of Los Vaqueros Reservoir. These projects were not accounted for in the model. Additional modeling of operations with the inclusion of these facilities is needed to further evaluate the potential for competition for water and to determine how the benefits would be affected (i.e., benefits could be additive, negatively impacted, or synergistically enhanced). Implementation of the other storage projects may change the benefits during some year types. For example, raising Los Vaqueros may provide sufficient water to south-of-the-Delta refuges in some year types to reduce the demand for Sites Reservoir Project water to these same refuges.

Effects of Climate Variability and Sea Level Rise on Sites Reservoir Project Operations

Future climate variability could result in hydrologic conditions and sea levels that differ from the existing conditions used to evaluate the alternatives. This uncertainty could result in benefits that differ from the benefits estimated for the alternatives. The potential for, and magnitude of, this variability is widely debated. The State is conducting ongoing studies of how climate variability could affect the way California receives and stores its water. According to the *California Water Plan Update 2013* (DWR 2013), California could experience variability in temperature, precipitation, and snow levels. The results to date indicate that variable climate could affect the hydrology, water temperature, and future operations for both flood management and water supply deliveries. The *California Water Plan Update 2018* indicates that it is necessary to expand climate science and monitoring efforts to reduce the risk and uncertainty in future California water management.

The *Sacramento and San Joaquin Basins Study* (Reclamation 2016b) has findings similar to this Report. This Study indicated that Delta salinity, reservoir surface area, pelagic species, and the coldwater pool would all be negatively impacted by more than 10 percent compared to current conditions.

End-of-September and end-of-May storage would decrease, but the change would be less than 10 percent. Improved climate data would likely increase confidence in the accuracy of these percentages.

Sites Reservoir Project investigators requested a sensitivity analysis of the effects and benefits of the Sites Reservoir Project alternatives under scenarios associated with climate. The resulting Sites Reservoir Project climate and sea level rise sensitivity analysis has been prepared as a tool for planners, resources specialists, stakeholders, and the public to consider the influence of climate and sea level rise on the Sites Reservoir Project and to verify that the findings in the Feasibility Report are adequate. An independent evaluation of climate on the operations of Sites Reservoir was developed as part of the WSIP application (Authority 2017).

In the sensitivity analysis, the No Project Alternative and Sites Reservoir Project Alternatives A, B, C, and D were simulated for four additional climate and sea level scenarios. The climate and sea level scenarios used in this sensitivity analysis were previously developed for the *Bay Delta Conservation Plan (BDCP) Effects Analysis and ADEIR/S* (DWR 2012). The following four climate and sea level scenarios, in addition to the current climate and sea level scenario (Current) were selected for sensitivity analyses:

- The Early Long-Term (ELT) scenario, which assumes the median (Q5) of an ensemble of general circulation model (GCM) projections at a point in time 8 years into the future (approximately 2025) and a sea level rise of 15 centimeters (6 inches)
- The Late Long-Term (LLT) scenario, which assumes the median (Q5) of an ensemble of GCM projections at a point in time 40 years into the future (approximately 2060) and a sea level rise of 45 centimeters (18 inches)
- The Late Long-Term (LLT Q2) scenario, which assumes the "drier, more warming" lower bound (Q2) of an ensemble of GCM projections at a point in time 40 years into the future (approximately 2060) and a sea level rise of 45 centimeters (18 inches)
- The Late Long-Term (LLT Q4) scenario, which assumes the "wetter, less warming: upper bound (Q4) of an ensemble of GCM projections at a point in time 40 years in the future (approximately 2060) and a sea level rise of 45 centimeters (18 inches)

The ELT Q5, LLT Q5, LLT Q2, and LLT Q4 projections described above were based on 112 future climate projections under the World Climate Research Program's Coupled Model Intercomparison Project Phase 3 (CMIP3). Appendix 25A of the Sites Reservoir Draft EIR/EIS includes a detailed description of the sensitivity analysis using the CMIP3-based projections. Appendix 25B of the Sites Reservoir Draft EIR/EIS summarizes a climate variability sensitivity analysis using the CMIP5-based projections.

Based on the comparison of the Sites Reservoir Project alternatives with the No Project Alternative evaluated across Current, ELT, and all LLT climate and sea level scenarios, the following expectations have been confirmed based on the results of CALSIM II simulations of these scenarios:

- The ability to divert water into Sites Reservoir Project storage is the same or slightly increased due to changes in the timing of snowmelt runoff and the continued opportunity to use the intakes under a wide range of climate scenarios.
- The Sites Reservoir Project alternatives can provide a similar array of potential benefits under a wide range of climate and sea level scenarios.

The potential effects of climate variability on the primary objectives are summarized as follows:

- **Water Supply:** Between the Current, ELT, and LLT climate and sea level scenarios, for all Sites Reservoir Project alternatives, long-term average annual total exports at Banks Pumping Plant and Jones Pumping Plant increase from the No Project Alternative consistently. Across all climate and sea level scenarios below median and Dry year (lower quartile) averages show strong exports throughout, due to the Sites Reservoir Project alternatives, with the absolute and relative magnitude of improvement increasing as the effect of varying climate and sea level rise. The sensitivity analysis results indicate that the increment of water provided by the Sites Reservoir Project alternatives could increase even as overall system supply decreases. The relative economic value of all four Sites Reservoir Project alternatives is likely to increase relative to the No Project Alternative condition, given that the performance of water supply reliability for agricultural, urban, and environmental uses under the No Project Alternative is more likely to decrease as a result of changing conditions, changes to the availability of water resulting from climate variability, and sea level rise.
- **Improving the Survivability of Anadromous Fish:** For the primary objective of increasing survival of anadromous fish populations, the highest priority is to maintain improved storage conditions through the Dry years (lower quartile) and summer months (July through September season). The most substantial relative improvement in storage is at Shasta Lake. The increase in coldwater pool would improve the benefits in Dry years, which may occur more frequently in the future. Anadromous fish benefits would likely increase in this instance.

Reclamation evaluated a series of water management action portfolios in *Central Valley Project Integrated Resource Plan Final Report* (Reclamation 2014b) using three socioeconomic and six climate futures. Sites Reservoir was included in two of the portfolios, but not modeled as a standalone project. With both Sites Reservoir and Delta conveyance, this evaluation showed reductions in unmet demands averaging 795 TAF/year, decreases in Sacramento River water temperatures at Jelly's Ferry averaging 0.5°F, and net economic benefits of $341 million in 2085.

More recently, the Authority evaluated the potential effects of climate variability for the WSIP application. A detailed description of the WSIP evaluation is provided in Appendix A to the *WSIP Technical Reference* (CWC 2016). The climate projections for 2030 and 2070 were derived from an ensemble of 20 global climate projections selected by DWR's Climate Change Technical Advisory Group. These climate assumptions were incorporated into the CALSIM II model. For Sites Reservoir, the evaluation of the 2030 and 2070 conditions showed a considerable increase in the benefits to anadromous fish, as is shown on Figure 10-1 (Authority 2017).

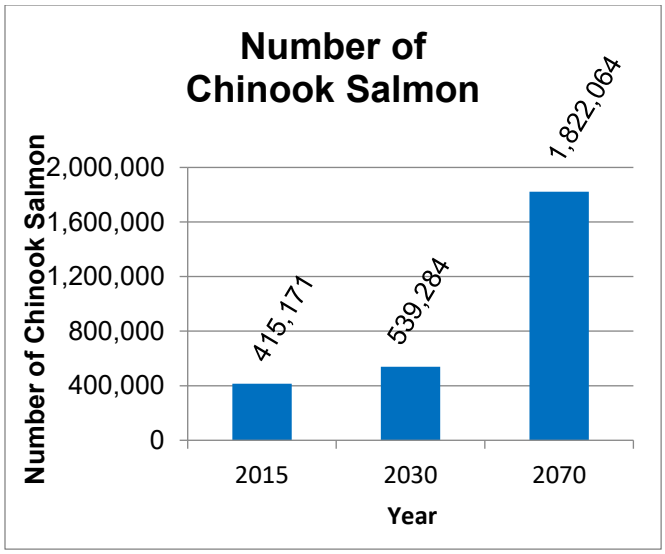


Figure 10-1. Increased Salmon Population with Sites Reservoir (Authority 2017)

In summary, the climate scenarios considered in the sensitivity analysis would likely increase water supply and anadromous fish benefits for all alternatives.

CVP Power and Hydropower Operations

In exercising the operational flexibility purpose, Reclamation may choose to release its Sites Project Water from Sites Reservoir to meet a CVP purpose, in lieu of releasing a like amount of CVP water from a CVP reservoir. Such in-lieu release may impact power generation and associated revenue, depending on when the action is taken. If water is released from Sites Reservoir in the summer months to conserve more cold water in Shasta (or Folsom) for later release in the fall months, then CVP power is impacted as follows:

- The water that would normally have been released from Shasta (or Folsom) during the summer months would have generated power that would be worth more than the power generated in the fall months.
- The water conserved in Shasta (or Folsom) through the summer months would result in a higher storage level during the fall, and therefore could generate more power during the fall months.
- Water conserved in Shasta (or Folsom) too far into the fall or winter would be subject to spilling for flood control operations. In this instance, no power would be generated from the spilled water.

Table 10-1 and 10-2 provide results from LT-Gen modeling from the refined alternative evaluation (i.e., including the amended COA and 2019 BiOps) for the effects of Sites Reservoir on power generation and power usage at Reclamation facilities. Even if the power generated is relatively constant, a change in the timing of releases from Shasta Dam could impact CVP power revenues. Further modeling is needed to better evaluate the effects on revenue using a shorter time-step to

account for daily fluctuations in energy prices. It may also be possible to modify the timing of operations to minimize or avoid these impacts without negatively affecting the benefits of the project.

Table 10-1. Alternative A1 Less No Action Alternative: Effect on Long-Term Federal Facility Power Generation (annual generation results from LTGEN model)

Generation (GWh)												
Shasta (includes Keswick)												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Long-term Average	2.5	4.2	1.4	-0.1	-1.4	-17.8	-21.0	-3.7	11.4	8.6	7.0	15.6
Wet	0.9	0.2	0.0	0.0	-2.8	-6.7	-17.1	0.9	10.3	3.8	2.6	0.6
Above Normal	0.1	1.9	0.3	3.0	5.0	-30.2	-42.2	-8.8	28.0	13.1	-8.3	24.2
Below Normal	0.6	18.0	0.2	-2.5	0.3	-32.3	-21.6	-14.3	8.8	24.9	18.4	12.5
Dry	5.3	1.8	2.8	-3.5	2.2	-25.9	-26.5	-7.2	9.5	-2.2	14.3	40.6
Critical	6.3	2.7	5.0	4.8	-11.5	-1.7	-1.4	8.6	4.0	12.5	6.1	6.3
Folsom (includes Nimbus)												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Long-term Average	0.6	0.2	-0.2	-0.2	-0.3	-1.3	-0.1	0.7	-0.5	-1.9	1.8	1.1
Wet	1.1	-0.1	0.0	0.0	0.0	-0.4	-2.1	0.2	-0.1	0.2	1.2	-0.4
Above Normal	-1.9	0.0	0.0	0.0	-0.2	-4.9	-2.6	1.2	-4.8	-1.1	6.4	2.2
Below Normal	2.3	1.0	-0.5	-0.2	-0.2	-1.5	0.4	1.1	0.5	-5.5	1.9	2.1
Dry	1.0	0.0	0.5	-0.5	-1.1	-2.1	2.3	1.2	0.2	-2.3	0.7	2.1
Critical	-0.6	0.1	-1.2	-0.6	-0.1	1.8	2.5	0.0	0.1	-2.1	0.2	0.5
Pumping (GWh)												
Red Bluff												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Long-term Average	0.9	0.8	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.2
Wet	1.1	0.7	0.2	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.4	0.1
Above Normal	1.3	1.1	0.6	0.0	0.0	0.0	0.0	0.0	-0.1	0.1	0.2	0.1
Below Normal	0.9	0.8	0.8	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.3
Dry	0.6	0.9	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4
Critical	0.4	0.6	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
South of Delta												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Long-term Average	3.0	6.2	2.4	0.3	1.3	2.4	4.2	3.1	4.1	0.1	1.1	1.2
Wet	0.3	4.7	2.4	1.1	0.5	0.3	2.2	0.2	3.7	3.3	-2.0	1.7
Above Normal	4.3	8.6	-2.8	-4.9	-0.4	0.2	3.8	1.0	12.5	3.2	-5.6	-0.7
Below Normal	2.7	5.9	3.7	1.7	3.9	6.7	15.6	3.6	0.9	1.4	12.5	2.8
Dry	3.2	3.7	-0.3	-0.3	2.5	1.7	-2.4	6.3	4.8	-8.8	0.6	6.0
Critical	8.0	11.5	9.6	2.5	-0.2	5.0	5.7	6.1	0.2	2.3	1.7	-7.0

Table 10-2. Alternative D1 Less No Action Alternative: Effect on Long-Term Federal Facility Power Generation (annual generation results from LTGEN model)

Generation (GWh)												
Shasta (includes Keswick)												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Long-term Average	2.4	3.7	2.9	0.3	-1.2	-17.3	-21.1	-9.5	13.0	9.7	8.9	19.1
Wet	1.8	0.3	0.0	0.0	-2.9	-6.7	-17.1	-1.8	10.4	3.2	2.9	2.6
Above Normal	0.0	5.3	0.1	3.0	4.9	-27.6	-42.4	-24.8	26.3	14.1	-7.0	32.3
Below Normal	0.5	15.0	0.2	-0.1	-0.6	-32.8	-23.5	-23.6	11.4	30.2	22.5	10.4
Dry	2.6	1.5	10.2	-2.8	4.1	-24.2	-28.1	-15.4	13.3	-6.4	15.4	50.4
Critical	7.7	-0.5	4.2	3.3	-11.9	-2.5	3.2	13.3	7.9	20.0	10.8	5.9
Folsom (includes Nimbus)												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Long-term Average	0.6	0.5	0.0	-0.2	-0.3	-1.3	-0.3	0.8	-1.0	-1.3	1.1	1.2
Wet	1.2	0.3	0.0	0.0	0.0	-0.4	-2.1	0.1	-0.1	0.2	0.7	0.1
Above Normal	-1.9	-0.1	0.0	0.0	-0.2	-4.4	-3.1	0.8	-4.8	-1.1	5.5	2.5
Below Normal	2.9	1.0	-0.5	0.0	-0.2	-2.1	0.2	1.2	-0.6	-3.5	2.2	1.2
Dry	0.6	0.6	0.9	-0.4	-1.2	-2.1	2.1	1.9	-0.7	-1.3	-0.8	1.7
Critical	-0.8	0.3	-0.8	-0.4	-0.1	1.9	2.1	-0.1	-0.3	-2.1	-0.7	1.5
Pumping (GWh)												
Red Bluff												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Long-term Average	0.9	0.8	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.2
Wet	1.1	0.8	0.3	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.4	0.1
Above Normal	1.3	1.1	0.8	0.0	0.0	0.0	0.0	0.0	-0.1	0.1	0.3	0.1
Below Normal	1.0	0.8	0.9	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.5
Dry	0.6	1.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4
Critical	0.4	0.6	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
South of Delta												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Long-term Average	3.4	6.4	3.4	-0.5	1.2	2.3	3.7	3.2	4.5	-0.4	-1.2	1.7
Wet	0.4	4.9	2.6	-1.8	0.5	0.3	2.2	0.2	4.1	3.1	-1.7	2.3
Above Normal	3.8	6.3	-2.3	-5.5	-0.4	0.1	3.6	0.9	12.7	5.0	-6.1	0.2
Below Normal	3.7	7.2	3.2	2.3	2.9	4.9	12.8	1.8	-1.2	2.3	4.5	0.1
Dry	2.8	4.7	1.9	-0.3	3.0	2.4	-3.1	8.3	7.6	-11.6	-2.3	9.7
Critical	10.2	11.5	13.2	3.0	-0.2	5.7	7.0	6.2	0.0	0.4	-0.7	-8.5

Preliminary economic modeling with the LTGEN results shows an overall long-term average annual increase in revenue from generation at Shasta and Keswick of $502,000 for Alternative A1 and an increase of $683,000 with Alternative D1.

Other impacts (shown in Tables 10-1 and 10-2) may result from the use of the Red Bluff Pumping Plant for diversions to fill Sites Reservoir. Following optimization, any residual impact at Red Bluff Pumping Plant would need to be mitigated by the Authority. Preliminary economic modeling with the LTGEN results shows a long-term average increase in annual pumping cost of $145,000 for Alternative A1 and an increase of $152,000 for Alternative D1.

Pumpback Operations

Pumpback operations were not included in Alternatives A1 and D1. The cost for these facilities appears to be higher than the return on investments warrants. However, energy markets in California fluctuate and the benefits associated with pumpback operations are dependent on the individual utility that would integrate the energy produced into its facilities portfolio. The potential for ownership and operation of pumpback hydropower generation facilities continues to be reviewed by the Authority. As a result, the potential for the future addition of pumpback capability is likely outside of the scope of this project. There is no Federal cost share for pumpback benefits. If an energy utility were identified to develop pumpback capabilities in the future, this would necessitate a reevaluation of the cost allocation and cost assignment.

The future electricity market is not static, and continues to change in response to increasing use of renewable energy; primarily, solar and wind. Renewable energy production peaks occur in summer, which is driving down the market price, especially mid-day. The high variability of the market continues to shape the development of hydropower facilities for the project. Emerging technologies, such as lithium-ion batteries, are demonstrating the ability to provide ancillary services that traditional hydropower projects used to provide (e.g., Tesla's 100 MW South Australian project). Reevaluation of the single purpose alternative for hydropower may be warranted in the future and the cost assignment will be adjusted if appropriate.

CAISO is currently exploring an expansion of its grid operations into other western states to enhance energy flow to meet the West's demand for reliable, affordable, and sustainable power. The shift to a regional ISO would also expand resource flexibility, improve transmission planning and grid reliability, and promote clean energy. Such a change is expected to increase price competition in California and greater dependence on out-of-state renewable energy sources.

Cost Estimates

The cost estimates developed for the comprehensive plans included in this Feasibility Report are based on a 2020 estimate. Varying uncertainties are associated with the material and unit costs used to develop the estimates. Trends from the past few years were used to try to estimate the cost of materials, but outside factors could further influence price changes.

DEC Special Assessment Findings

A DEC team evaluated the engineering and costs basis for this report in April 2020. The review found that the risks and uncertainties associated with the project have been mitigated to reflect a feasibility level for designs and cost estimates.

Operations Cost

Operations costs will vary depending on hydrologic year type. Average OM&R costs are provided in the analysis.

Environmental Effects of Project Actions

Anadromous fish are very sensitive to changes in their surroundings, especially elevated temperatures and depth of flows. Predicting fish survival is difficult because of the many factors that influence fish and their environment. As a result, there is uncertainty in how fish populations would respond to the temperature and flow changes that would be accomplished by the alternatives. There is also uncertainty in the estimated benefits that have been monetized for anadromous fish.

Anadromous Fish in the Sacramento River

To reduce the uncertainty associated with the evaluation of anadromous fish populations, the Feasibility Report considered two independent lines of analysis:

- A qualitative evaluation of the effects of the increases in coldwater pool (with the greatest benefits at Shasta Lake and Oroville Reservoir) on fish populations.
- Use of the SALMOD model to evaluate juvenile fish production, movement, and survival between Keswick Dam and Red Bluff (SALMOD is the best-available model for estimating survival and mortality for all four runs of Chinook salmon. SALMOD accounts for changes in both water temperature and flow, and has been previously applied on the Sacramento River between Keswick Dam and Red Bluff [Bartholow 2003; Kent 1999; Reclamation 2008a].)

Findings indicated overall beneficial trends from the implementation of the Sites Reservoir Project. Uncertainty regarding the survival of anadromous fish is also related to seasonal and long-term water conditions throughout the Sacramento River, in the Delta, and in the Pacific Ocean. Climate also has the potential to influence anadromous fish survival.

Comments on the EIR/EIS (Reclamation and Authority 2017) included questions on the temperature effects of releases from the Delevan Pipeline to the Sacramento River. Appendix 7F of the EIR/EIS included a preliminary analysis of these effects and impacts to river temperature were not identified as being significant. The change in temperature in the Sacramento River based on preliminary analysis ranges from -1.4 percent to +1.1 percent at the Delevan pipeline discharge facility. Further work is anticipated to resolve this question in the final EIR/EIS.

In summary, there are uncertainties in estimating how the population of fish will change with implementation of the project. There are also uncertainties on how natural changes like climate variability or other environmental factors will contribute to the decline in the abundance, distribution, or health of anadromous fish, regardless of project implementation.

Aquatic Species in the Delta

A major concern in the Delta is the declining population of several species, including Delta smelt, threadfin shad, longfin smelt, and striped bass. In fall 2004, Delta fish surveys registered sharp declines in these four species. Subsequent surveys have confirmed the trend, raising concerns that Delta smelt risk extinction, and longfin smelt risk extirpation. There are uncertainties in estimating how the populations of Delta and longfin smelt will change with implementation of the project. There are also uncertainties on how natural changes like climate variability or other environmental factors will contribute to the decline in the abundance, distribution, or health of fish, regardless of project implementation.

Adaptive Management

Adaptive management of Sites Reservoir Project operations reduces the risk and uncertainty of achieving the project objectives of increasing the survival of anadromous fish and Delta ecosystem enhancement. It is possible to shift operations of the Sites Reservoir Project public benefit components to selectively focus on either anadromous fish in the Sacramento River between Keswick Dam and Red Bluff, or to focus on species like Delta smelt much farther downstream. This possibility is illustrated by the differences in benefits from Alternatives C and D that are achieved with different operating strategies, despite having essentially the same facilities. As described in Chapter 6, Alternative Development, the alternatives incorporate modification of releases (e.g., shifting releases from the Delevan Intake/Release structure to the CBD to further enhance the potential benefits for smelt species). Flexible operations based on best-available science and new information as it becomes available can make use of adaptive management to focus on the highest-priority use in the purposes described in this Report for public benefit water supplies from the Sites Reservoir Project. Such operations would minimize the risk that the project would perform at a level that is below the forecasted level of benefits. Additional analysis of adaptive management is provided in *WSIP Application for Sites Reservoir* (Authority 2017).

Economic Benefit Estimation

Economic benefits are based on modeled results that may differ from real-time operations. To address the risk and uncertainty related to valuation of benefits, the results from alternative valuation methods are presented in Appendix C for each benefit category to serve as a sensitivity analysis.

Water Supply Reliability and Demands

Future water supplies and demands are uncertain. This uncertainty affects the projected water supply benefits. Many variables are considered in forecasting future water supply requirements for California. The *California Water Plan Update 2013* (DWR 2013) estimates demand for several growth scenarios, ranging from "lower than current trends," which assumes that population growth would be slower than currently projected; to "higher than current trends," which assumes that population growth would be faster than currently projected, with nearly 70 million people living in California in 2050. The analysis in this Report is consistent with current trends, but future growth could be higher or lower than forecasted. In summary, there is uncertainty in estimating the future benefits of water supply.

Energy Costs Associated with Conveyance

To generate the energy price forecast for the Study, three sources were used:

- Forward energy "broker" quotations provided by Tullet Liberty (Tullet)[1]
- Natural gas futures and natural gas futures basis as reported by the New York Mercantile Exchange
- Forecasted spot electricity and natural gas prices as provided by Ventyx semiannual structural forecast (formerly Global Energy Decisions)[2]

Nevertheless, there is high volatility in wholesale energy markets, especially price risk and uncertainty in the underlying fuel markets. Changes in future energy costs may result in the following uncertainties:

- Operating costs (specifically, the energy costs required for pumping) could be higher or lower than estimated. The recent trend is a decrease in energy costs for pumping during the hours when solar energy and wind energy are readily available.
- The estimated hydropower benefits are dependent on the market for renewable energy and the ancillary benefits from integration with these resources. Widespread implementation of renewable energy has been the primary driver of volatility in the energy market over the last decade. These benefits are likely to stay the same or increase.

Modeled Benefits for CVP Operational Flexibility

Further work is needed to refine the potential operational scenarios that could result from improved operational flexibility and confirm the level of benefits presented in this report.

Modeled Benefits for Anadromous Fish

The benefits for anadromous fish as described in this Report are contingent on conserving water for operational flexibility in CVP reservoirs for late summer/fall release. This Report uses benefits in average years to calculate the BCR. Sites Reservoir would provide the greatest benefits in below normal, dry, and critical years when less water is available in CVP reservoirs. This improves drought resiliency for the coldwater pool and protects anadromous fish in the years where they suffer the greatest temperature-related impacts.

This Report does not estimate the negative effects of potential mortality associated with diversions. Instead, it assumes full mitigation for diversion through the cost associated with the mitigation for fish habitat.

Modeled Deliveries for Incremental Level 4 Refuge Water Supply

Benefits were estimated using CALSIM II modeling results. Although the model showed no impacts to CVP or SWP contractors, there is a possibility that the quantity of modeled deliveries could displace deliveries to contractors (including water transfers initiated by the contractors). There is a history of challenges associated with the delivery of 9,300 AF or less of Incremental Level 4 water

[1] Tullet, among other things, is an energy brokerage company that matches buyers and sellers.

[2] Ventyx is forecasting the actual day-ahead cash price that will occur in the spot markets in the future, not the price at which futures or forward contracts should be priced.

acquired north-of-Delta through Jones PP to south-of-Delta refuges during the transfer window due to its relative priority.

This Study assumed Incremental Level 4 refuge water supply will be conveyed during the fall. The Banks Pumping Plant was prioritized for conveying water south of the Delta with additional pumping from the Jones Pumping Plant when capacity allowed. Real-time operations may vary from the modeled performance due to priority and availability. Figure 10-2 shows the available capacity as modeled at Jones and Banks Pumping Plants that could potentially be used to convey water to south-of-the-Delta refuges.

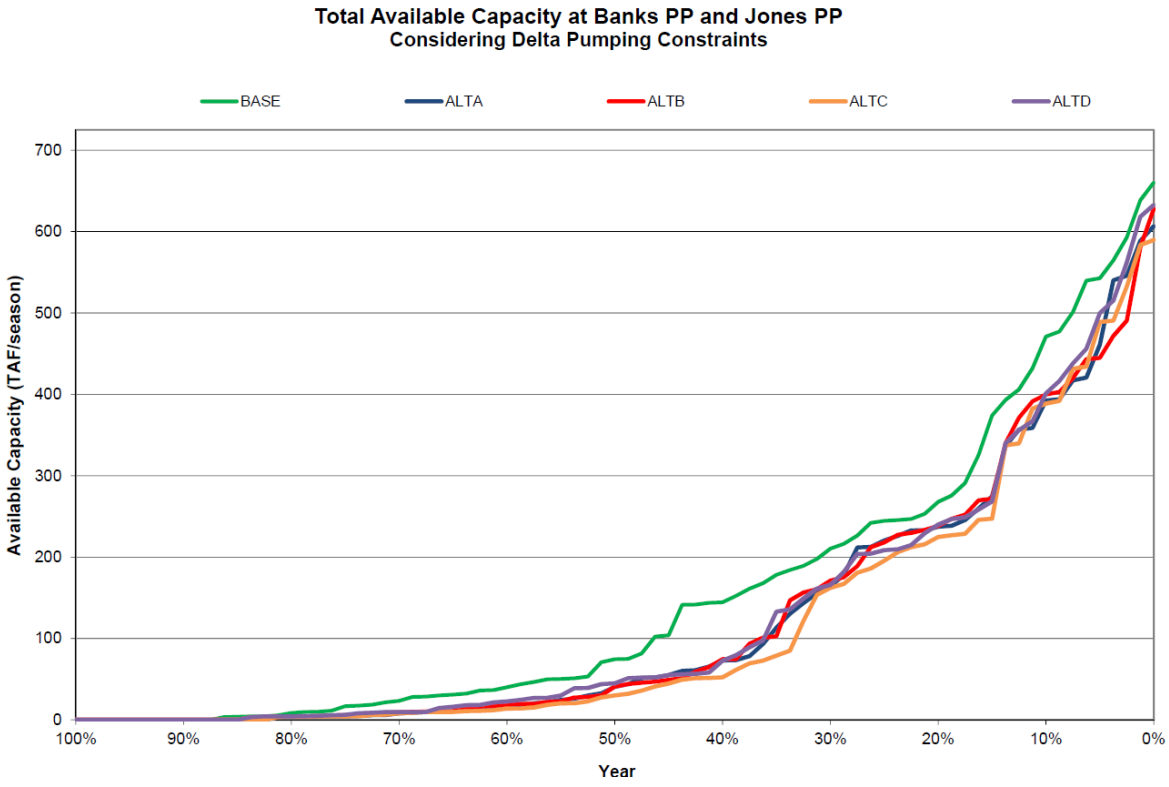


Figure 10-2. Capacity at Banks and Jones Pumping Plants under modeled Delta Pumping Constraints (CH2M HILL 2018)

Furthermore, the model includes all CVPIA refuges, including four refuges that are not currently able to receive full Level 4 water based on incomplete water conveyance infrastructure (Gray Lodge Wildlife Area, Mendota Wildlife Area, Pixley National Wildlife Refuge, and Sutter National Wildlife Refuge). Conveyance systems for these refuges could be constructed prior to 2030 (the model assumes future conditions). Failure to construct the new conveyance could result in an overestimation of benefits to Incremental Level 4 refuge water supply. This Study assumes that these conveyance issues can be overcome if water is made available to support the mission of each refuge.

DWR has periodically assigned a Delta barrier fee when temporary barriers are installed as an emergency action due to Delta salinity. This fee is charged for pumping water across the Delta. This periodic fee is not well defined and has not been included in the OM&R estimate.

Hydropower Benefit Estimation

Operation of the CAISO grid has changed dramatically with the introduction of solar and wind energy generation facilities throughout California. In the past, there were clearly defined on-peak and off-peak hours associated with the use of power by consumers. The change in the timing of power generation has redefined grid operations over the last 5 years. There is also uncertainty and a lack of standardization in the methods that are used to monetize the ancillary benefits (especially those for pumpback generation) that could result in an underestimation of benefits.

Cost Share

There is a risk to the project should the Authority not meet the funding requirement consistent with WIIN. The Authority is currently working with investors to secure future funding, including funding from the State. WIIN requires upfront funding from the non-Federal sponsor.

Post-Authorization Report

Reclamation will prepare a post-authorization report that will update information from work performed during pre-construction. The post-authorization report will document any changes in project formulation, costs, benefits, and cost allocation. Changes in project costs or benefits in the post-authorization report could affect project feasibility.

Chapter 11 Findings and Conclusions

This Feasibility Report documents the development, evaluation, and comparison of the Project alternatives in a way that is consistent with the Federal P&Gs. A Draft EIR/EIS has been prepared consistent with NEPA and CEQA (Reclamation and Authority 2017) and the public review period has been completed. This chapter summarizes the major findings and conclusions of this Feasibility Report.

Need for the Project

The primary planning objectives address important statewide and local water supply and ecosystem improvement needs. The primary planning objectives for the refined alternatives are as follows:

- Water Supply
- CVP Operational Flexibility
- IL4 Water Supply for CVPIA Refuges
- Anadromous Fish
- Delta Ecosystem Enhancement

To the extent possible, while meeting the above primary planning objectives, the Feasibility Report also recognizes opportunities to accomplish the following:

- Recreation
- Flood Damage Reduction

Multiple Cost-Effective Plans

An iterative process was used to develop alternatives. Four initial alternatives were evaluated, and then two refined alternatives (Alternatives A1 and D1) were developed and evaluated with refined objectives and modeled for updated regulatory conditions.

- **Alternative A1:** A 1.3-MAF reservoir at Sites with a new intake/release structure on the Sacramento River. Operations would emphasize south-of-the-Delta export to SWP contractors.
- **Alternative D1:** A 1.8-MAF reservoir at Sites with a new intake/release structure on the Sacramento River. Operations would emphasize a blend of north-of-the-Delta agricultural supply (primarily CVP contractors) with south-of-the-Delta exports to SWP and CVP contractors.

Alternative A1 is the lowest cost alternative and Alternative D1 has the highest cost. The lower and higher cost alternatives were considered to evaluate the full range of Project costs and benefits. This

is a State-led project under the WIIN Act and the Authority is the lead agency. This Feasibility Report evaluates the range of potential Federal interest. The Authority is in the process of right-sizing the Project. A post-authorization change report will be necessary to confirm the level of Federal interest and reconcile the cost assignment when the Authority has finalized their Project description.

As shown in Table 11-1, Alternatives A1 and D1 have nearly equivalent estimated net NED benefits (Alternative A1 has very slightly higher net NED benefits).

Table 11-1. Summary of Costs and Benefits for Sites Reservoir Project Refined Alternatives
($ millions, 2019)

Cost/Benefit	Alternative A1	Alternative D1
Total Capital Cost ($M)[a]	$6,510	$7,365
Annual Costs ($M/yr)[b]	$228	$255
Annual Benefits ($M/yr)	$250	$278
Annual Net Benefits ($M/yr)	$22	$23

Notes:
Interest and amortization based on a 2.75 percent Federal discount rate over a 100-year period analysis. Totals may not sum exactly due to rounding.
[a] Capital cost shown for 2019 price levels (including IDC).
[b] Includes OM&R expenditures.
OM&R = operation, maintenance, and replacement
$M = millions of dollars
$M/yr = millions of dollars per year

National Economic Development Account

The evaluation of the accomplishments, benefits, and costs indicates that Alternative A1 would provide the highest net NED benefits. Alternative A1 is also considered to be protective of the environment. Consistent with the P&Gs, Alternative A1 is identified as the NED Plan; however, the net NED benefits are nearly equivalent for the two alternatives and are within the range of error associated with the modeling that was used to evaluate the alternatives. Alternative A1, a smaller reservoir, frames the lower range of potential reservoir facilities. The Authority is currently evaluating how to best size the facilities to correspond to the needs of the investing participants (see Appendix K).

Other Principles and Guidelines Accounts

Alternative D1 provides the highest RED benefits. Alternative D1 would provide more water supply for local agriculture.

Alternative D1 also provides the greatest value under the EQ account. The operations under Alternative D1 would provide greater benefits to anadromous fish (including endangered winter-run Chinook salmon) in the Sacramento River. The operations for any alternative could be adaptively managed to selectively increase benefits for either smelt or salmon.

Long-term drought preparedness, sustainable groundwater management, and emergency water supply and emergency response were considered under the OSE account. Alternative D1 provides the highest value for the OSE account.

Alternative Costs

The estimated costs for Alternatives A1 and D1 are shown in Table 11-2.

Table 11-2. Estimated Costs for Alternatives A1 and D1

Item	Alternative A1 (NED Plan)	Alternative D1
Construction Cost to Midpoint of Construction ($ millions)	$5,792	$6,552
Pre-construction Cost ($ millions)	$371	$420
Interest During Construction ($ millions)[a]	$718	$813
Estimated Total Capital Cost ($ millions)	$6,510	$7,365
Annual Costs ($ millions/year)[b]	$228	$255

Notes:
Costs are based on 2019 price levels and shown in 2019 dollar terms. Interest and amortization based on a 2.75 percent Federal discount rate over a 100-year period analysis.

[a] For Interest During Construction (IDC), construction is expected to begin in 2022 and require 8 years for completion. IDC is shown at 2019 price levels.

[b] Annual costs include operation, maintenance, and replacement (OM&R) expenditures (including energy use conveyance costs) and are presented in 2019 dollars at 2019 price levels.

NED = National Economic Development

The Federal construction cost (i.e., without IDC) assigned for the NED Plan is $1,446 million (Alternative A1) and $1,641 million (Alternative D1).

Benefits of the NED Plan

The NED Plan would provide benefits associated with each of the primary and secondary objectives (Table 11-3). Although there are uncertainties (see Chapter 9), the NED Plan can be adaptively managed to maintain a high level of benefits under a wide range of potential future conditions. It should be noted that the deliveries of IL4 Water Supply to CVPIA Refuges could be reduced to zero if the non-Federal partners do not meet their assigned costs for OM&R.

Feasibility of the NED Plan

The findings in this Feasibility Report indicate that all alternatives, including the NED Plan, appear to be feasible.

Technical Feasibility

Technical feasibility considers both the feasibility of constructing the facilities and the feasibility of the operations for the Project.

Facilities: The facilities for Alternatives A1 and D1 are considered to be constructible and could be operated and maintained. The engineering design has been developed to support a Class 3 level (feasibility). Class 3 estimates are based on limited information and intended for project screening and determination of feasibility.

Table 11-3. Summary of Estimated Average Benefits for the NED Plan

Item	Alternative A1 (NED Plan)	Alternative D1
Water Supply (Primary Objective)		
Total increased annual water supplies (Average Annual – Authority and CVP)	185 TAF	204 TAF
Total increased annual water supplies (Dry and Critical years – Authority and CVP)	335 TAF	403 TAF
Increased emergency water supply response capability	Yes	Yes
CVP Operational Flexibility (Primary Objective)		
Increased annual deliveries Operational Flexibility (Average Annual)	69 TAF	73 TAF
Increased annual deliveries Operational Flexibility (Dry and Critical years)	87 TAF	114 TAF
Additional average annual storage in CVP reservoirs (TAF, end of September)	148 TAF	175 TAF
Anadromous Fish (Primary Objective)		
Average end-of-September increase in Shasta Lake coldwater pool	138 TAF	164 TAF
Winter-run Chinook fish habitat unit increase (thousand fish – SALMOD)	214	268
IL4 Water Supply for CVPIA Refuges		
Modeled average annual supplemental water supply	32 TAF	34 TAF
Delta Ecosystem Enhancement (Primary Objective)		
Release to the Yolo Bypass (TAF/yr)	57 TAF	51 TAF
Recreation (Secondary Objective)		
Recreation user-days	187,000	187,000
Flood Damage Reduction (Secondary Objective)		
Total area with increased flood protection (100-year flood event)	9,570 acres	9,570 acres

Authority = Sites Project Authority
CVP = Central Valley Project
Delta = Sacramento–San Joaquin River Delta
NED = National Economic Development
SALMOD = Salmonid Population Model
TAF = thousand acre-feet
TAF/yr = thousand acre-feet per year

A summary of the estimates is provided in the section titled "Design Considerations" in Appendix B, Engineering. Reclamation performed DEC reviews in July 2007 and May 2014, and a special assessment in March 2017. Reclamation closed out the DEC process in April 2020.

A detailed risk assessment was performed on the Project in 2018 to assess the potential for cost increase. The risk assessment is included in Appendix I of this Feasibility Report.

Operations: The ability of an alternative to achieve the level of benefits identified in this Feasibility Report depends on cooperative operation of Sites Reservoir with the CVP and SWP and permitting conditions to be determined in coordination with regulatory agencies. A Water Rights Strategy and Operations Plan between Reclamation, the Authority, and DWR (see Chapter 6, Alternative

Development) is needed. The Authority is coordinating with Reclamation and DWR to develop the Water Rights Strategy and Operations Plan. This is necessary to achieve the benefits presented in this Feasibility Report for Alternatives A1 and D1. One key principle is that Sites Reservoir operations would not deprive anyone who has a higher priority right of the use of water under that right, including the CVP, SWP, or their contractors, or any other water rights holders.

As necessary, Reclamation will negotiate the terms of the amendatory CVP contracts to recognize Sites Reservoir as a source of water so that Sites Reservoir water can service CVP lands and do so under COA periods.

Environmental Feasibility

Confirmation of environmental feasibility will occur on the signing of a ROD and once all Project permits and approvals have been secured for construction. The Project will not receive Federal funding for construction prior to completion of the Final EIR/EIS and ROD. The environmental effects are evaluated in the Draft EIR/EIS (Reclamation and Authority 2017). Producing the Final Feasibility Report without the Final EIR/EIS requires a waiver from CMP 09-02. The Authority is leading the development of the Final EIR/EIS.

An environmentally preferred alternative that is consistent with NEPA requirements will be identified in the Final EIR/EIS and confirmed in the ROD. Should the conclusions of the Final EIR/EIS vary significantly from the conclusions of the Draft EIR/EIS, it will be necessary to reevaluate environmental feasibility. Constructing Sites Reservoir would affect environmental resources in the Primary, Secondary, and Extended Study Areas. Beneficial effects correspond to the following resource areas: water management, agricultural resources, fisheries and aquatic resources, socioeconomics, power and energy, and recreation. Temporary construction-related effects would be reduced to less-than-significant levels through mitigation. Significant and unavoidable effects include effects on seven resource areas (terrestrial biological resources, aquatic biological resources, paleontological resources, historical and tribal resources, land use, air quality, and climate change/greenhouse gas emissions).

The Draft EIR/EIS is incorporated by reference into this document. The Draft EIR/EIS evaluates the representative environmental effects (a summary of the Draft EIR/EIS is provided in Appendix M). The proposed mitigation measures are presented in Appendix 1A of the Draft EIR/EIS and are included in the alternative cost estimates. Reclamation and the Authority will incorporate environmental commitments and BMPs to avoid or minimize potential Project impacts. Public comments on the Draft EIR/EIS will be addressed and incorporated into the Final EIR/EIS. Comments received on the Draft EIR/EIS are characterized in Chapter 1 of this Feasibility Report. An approach to responding to comments has been developed and is outlined in Appendix M.

Economic Feasibility

Based on evaluations to date, Alternatives A1 and D1 are economically feasible and would generate positive NED average annual benefits of $243.5 million and $270.4 million, respectively. Alternative A1 provides the greatest net annual NED benefits ($15.5 million). The BCR is 1.07, and the total net present worth for the benefits over the 100-year planning horizon is approximately $539 million. Alternative D1 provides net annual NED benefits of $15.0 million. The BCR is 1.06, and the total net present worth for the benefits over the 100-year planning horizon is approximately $524 million. Table 11-4. Cost Assignment for Federal and Non-Federal Partners for Construction and OM&R Costs: Alternative A1 and D1 shows the cost assignment for Alternative A1 and Alternative D1.

Table 11-4. Cost Assignment for Federal and Non-Federal Partners for Construction and OM&R Costs: Alternative A1 and D1

Purpose/Action	Construction Costs – Nominal						OM&R Cost Assignment - Annualized					
	Federal		Non-Federal Partners[a]		Total Construction Cost		Federal		Non-Federal Partners		Total Annual OM&R Cost	
	Percent	Cost ($M)	Percent	Cost ($M)	Percent	Cost ($M)	Percent	Cost ($M/Yr)	Percent	Cost ($M/Yr)	Percent	Cost[c] ($M/Yr)
Alternative A1 (2019 Costs)												
Anadromous Fish	80%	$290	20%	$73	6.3%	$363			100%	$1.9	4.5%	$1.9
CVP Operational Flexibility[b]	100%	$1,156			19.9%	$1,156	100%	$7.1			17.3%	$7.1
Water Supply			100%	$3,238	55.9%	$3,238			100%	$26.6	64.3%	$26.6
M&I Water Supply			*100%*	*$2,878*	*88.9%*	*$2,878*			*100%*	*$24.5*	*92.2%*	*$24.5*
Ag Water Supply			*100%*	*$360*	*11.1%*	*$360*			*100%*	*$2.1*	*7.8%*	*$2.1*
Delta Ecosystem Enhancement			100%	$421	7.3%	$421			100%	$2.2	5.2%	$2.2
IL4 Water Supply for CVPIA Refuges[c]			100%	$483	8.3%	$483	9.9%	$0.3	90.1%	$2.6	6.9%	$2.9
Recreation			100%	$64	1.1%	$64			100%	$0.4	0.9%	$0.4
Flood Damage Reduction			100%	$71	1.2%	$71			100%	$0.4	0.9%	$0.4
TOTAL	**25%**	**$1,446**	**75%**	**$4,348**	**100%**	**$5,794**	**18.0%**	**$7.4**	**80.5%**	**$33.9**	**100%**	**$41.4**
Alternative D1 (2019 Costs)												
Anadromous Fish	80%	$383	20%	$96	7.3%	$479			100%	$2.2	5.1%	$2.2
CVP Operational Flexibility[b]	100%	$1,258			19.2%	$1,258	100%	$6.9			15.6%	$6.9
Water Supply			100%	$3,752	57.2%	$3,752			100%	$29.7	65.8%	$29.7
M&I Water Supply			*100%*	*$3,375*	*90.0%*	*$3,375*			*100%*	*$27.7*	*93.2%*	*$27.7*
Ag Water Supply			*100%*	*$376*	*10.0%*	*$376*			*100%*	*$2.0*	*6.8%*	*$2.0*
Delta Ecosystem Enhancement			100%	$385	5.9%	$385			100%	$1.8	4.1%	$1.8
IL4 Water Supply for CVPIA Refuges[c, d]			100%	$538	8.2%	$538	10.3%	$0.3	89.7%	$2.6	7.0%	$2.9
Recreation			100%	$68	1.0%	$68			100%	$0.4	0.9%	$0.4
Flood Damage Reduction			100%	$75	1.1%	$75			100%	$0.3	0.8%	$0.3
TOTAL	**25.0%**	**$1,641**	**75.0%**	**$4,913**	**100%**	**$6,554**	**16.2%**	**$7.2**	**83.8%**	**$37.1**	**100%**	**$44.3**

Notes:

[a] Includes State and Authority members paid funding.

[b] Capital cost assignment for CVP Operational Flexibility is based on the WIIN Act (Public Law 114-322). All OM&R for CVP Operational Flexibility is assigned to the Federal government (costs are paid by the beneficiaries).

[c] Capital cost assignment for IL4 Water Supply for CVPIA Refuges is to the non-Federal partners (State funded through WSIP component of Proposition 1). Reclamation has determined there is no CVPIA cost sharing for construction costs associated with this purpose. In exchange for Federal construction funding for other benefits, Reclamation will receive refuge water supplies at no cost (donation). Reclamation has determined that investigation construction costs associated with IL4 Water Supply for CVPIA Refuges benefits are ineligible for credit under the CVPIA cost-sharing agreement between the State and Reclamation.

[d] OM&R costs associated with IL4 refuge water supplies can be broken down into two categories: (1) the cost of filling the reservoir, which is a joint cost that will be paid for by the Non-Federal partners, and (2) the cost of delivering water from the Delevan Pipeline Discharge to the Refuge, which a separable cost that is subject to the cost-share requirements of CVPIA. The annual OM&R cost for IL4 refuge water supply has two distinct components:

[1]. The cost to divert water to fill the reservoir and other reservoir O&M costs ($2.5 million for Alternatives A1 and D1)

[2]. The cost to deliver water from the reservoir (end of the Delevan Pipeline) to the refuge boundary ($0.4 million for Alternatives A1 and D1)

The first component is treated as a joint cost and allocated 100% to the JPA. The second component is a separable conveyance cost and subject to the 75/25 cost share requirement under CVPIA. Therefore, $0.3 million is allocated to the Federal government and $0.1 million is allocated to the non-Federal partners. The Federal government is allocated approximately 10% ($0.3 million) of the $2.9 million in total annual OM&R costs allocated to IL4 refuge water supply.

Sub-allocations for M&I and agricultural are based on relative benefits and deliveries.

Totals may not sum exactly due to rounding.

$M = millions of dollars
$M/yr = millions of dollars per year
Ag = agriculture
CVP = Central Valley Project
IDC = interest during construction
IL4 = Incremental Level 4
M&I = municipal and industrial
OM&R = operation, maintenance, and replacement
SWP = State Water Project

The Federal government is assigned the full construction cost for CVP Operational Flexibility and approximately half the costs for Anadromous Fish purpose. No aid-to-irrigation is allowed for construction costs of CVP Operational Flexibility, and where ability to pay analysis determines the payment capacity is insufficient, the water will not go to that purpose. All other construction costs would be paid by the non-Federal partners.

All OM&R costs under the CVP Operational Flexibility Project purpose are assigned to the Federal government and will be assigned using the existing Ratesetting Policies and cost pools and recovered through the existing Ratesetting process.

In exchange for Federal construction funding, Reclamation will receive IL4 Water Supplies for CVPIA Refuges at no cost. The Project's non-Federal partners will pay 100 percent of the IL4 Water Supply for CVPIA Refuges purpose's OM&R expenses that are not attributable to conveyance (i.e., diversions and filling). Under the planned assignment of costs, the cost to convey IL4 Water Supply for CVPIA Refuges from the Delevan pipeline discharge to the refuges would be consistent with CVPIA cost share requirements (75 percent Federal and 25 percent State). These costs would vary by year, depending on hydrology and the amount of water delivered from the Project.

All other future OM&R costs will be paid by the non-Federal partners. The cost assignment will be reevaluated in the post-authorization report, including the funding for OM&R.

This Project is determined to be financially feasible, contingent on securing an agreement for the funding of the non-Federal cost share for both pre-construction and construction activities. The CWC has allocated $816 million in funding to the Sites Reservoir Project through the WSIP process. The Authority will be pursuing its share of the funding through the commercial lending market.

Section 4007(c) of the WIIN Act requires the Authority to enter into an agreement with Reclamation to provide sufficient funding as necessary to pay the non-Federal cost share prior to commencement of construction. The Federal allocation may be adjusted in the future, based on State investment levels, through the WSIP process.

Federal Interest

For an action to be implementable, a Federal interest in the action is required and the action must be feasible. Federal actions must contribute to the NED Plan in accordance with the requirements of the P&Gs. The alternatives provide positive net benefits while protecting the environment.

Reclamation's Interest: Reclamation's interest in the action is based on 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 Alternatives A1 or D1 in an environmentally and economically sound manner would accomplish the following:

- Provide the CVP system with operational flexibility to maximize available CVP water supplies for agricultural, urban, and environmental uses.
- Improve deliveries of Incremental Level 4 supply for optimum habitat management in the Central Valley refuges

- Improve Sacramento and American River water temperatures and flow conditions for salmon and other native fish
- Enhance habitat conditions for endangered Delta smelt

Consistency with CALFED and CVPIA: Alternatives A1 and D1 would contribute to CALFED objectives, including a water storage objective of 1.9 MAF north of the Delta, ecosystem enhancement, and water supply reliability. Both plans would support the CVPIA objective of improving the survival of anadromous fish. The CVPIA identifies actions and programs to mitigate the impacts of the existing CVP. The possible implementation of Sites Reservoir would not be a substitute for any CVPIA activities. These activities are expected to be completed as required, independent of any enhancement associated with the project alternatives.

Cooperative Operations

The Authority will operate Sites Reservoir. Power would be acquired from the commercial utility market for diversions to fill Sites Reservoir. Operations to use water from Sites Reservoir to conserve water in CVP reservoirs to benefit anadromous fish would be at the discretion of CVO.

Coordinated Operations Agreement

With the addition of a new storage facility, Reclamation will request that Reclamation and the State review *The Agreement between the United States of America and the Department of Water Resources (DWR) of the State of California for Coordinated Operation of the Central Valley Project (CVP) and the State Water Project (SWP), also known as Coordinated Operations Agreement (COA)*, per Article XIV and Article XVI. Although neither Reclamation nor DWR will own, operate, or have a controlling interest in the Sites Reservoir Project, the United States may partially fund and participate in the project through cost-sharing and contracting for a portion of the water. This water would be integrated into the operations of the CVP. In addition, the development, diversion, conveyance, use, and application of water under the control of the Sites Reservoir Project is inherently tied to other water management activities in California through the coordinated operations of the CVP and SWP because the Sites water will be used for in-basin uses and applied to CVP and SWP service area lands. The COA will be reviewed per Articles 14 and 16.

Operations Framework

The Authority, or any successor in interest, will develop an Operations Framework for the Sites Reservoir Project, in coordination with Reclamation, prior to filing for a water right permit. Any such Operations Framework must be approved by Reclamation. The Operations Framework will describe the range of Sites Reservoir Project water management activities, and how those activities would cooperatively integrate with the operations of the CVP and SWP without impairing the operation of the CVP. Reclamation expects that similar requirements will be established for the SWP at or during the State process. A review of the Operations Framework will occur when new requirements are placed on the operations of the CVP and SWP. Reclamation has the discretion to determine how cooperative operations with Sites Reservoir would achieve the benefit of operational flexibility for the CVP, and to ensure that Sites Reservoir operations do not impair the continued operations of the CVP. The Authority will take direction from Reclamation on how to avoid such impairment. In lieu deliveries will be addressed in the water rights and Operations Framework.

Reclamation has begun meeting with the Authority and DWR to develop the required agreements and Operations Framework.

Sites-Reclamation Coordinated Operations Principles

The principles of an operation agreement between Reclamation, the Sites Project Authority (Authority), or other parties are currently under development by both agencies/parties. The coordinated operations principles will further guide the operations framework and the negotiations for a coordinated operation agreement between the Authority, Reclamation, and DWR for the integrated operation of Sites Reservoir with the CVP and the SWP along with a mutually agreeable water right permit approach and contractual agreement terms and conditions. A principle foundational requirement for coordinated operations exists from in the WIIN Act, Section 4007 paragraph (e) which states:

> (e) RIGHTS TO USE CAPACITY.-Subject to compliance with State water rights laws, the right to use the capacity of a federally owned storage project or State-led storage project for which the Secretary of the Interior has entered into an agreement under this subsection shall be allocated in such manner as may be mutually agreed to by the Secretary of the Interior and each other party to the agreement.

The assumption is that the following considerations will be addressed as the Project moves forward:

- Facilities constructed as part of the Sites Reservoir Project (Project) will be owned and operated by the Authority.
- Reclamation, as an investor in the Sites Project, will manage its share of storage in Sites Reservoir, for the purposes for which the investment is made.
- The Sites Project will seek water right(s) to divert to storage under Excess water conditions, as that term is defined in the 1986 COA, as amended, and which may be further amended or superseded.
- Water released by the Authority from the Project will be scheduled and coordinated with the CVP and SWP operators.
- Water supplies delivered by the Project to Project partners and beneficiaries would not negatively affect, in any way, CVP and SWP operations or the yield of either project.
- Exchange of water between the Sites Project and the CVP to meet obligations of the other may occur provided there is a sufficient water available to effectuate the exchange; and sufficient demand exists for the water to be exchanged.
- To the extent there could be benefits to the CVP in using Sites water in lieu of CVP water (e.g. increased Shasta Reservoir cold water) the parties will negotiate the use of CVP power for conveyance of this "in lieu" CVP delivery when using CVP facilities.
- Operation of the Project and use of capacity in CVP and SWP facilities would not negatively impact Reclamation's or the State's respective abilities to meet existing legal obligations and/or power generation of the CVP or SWP. The right to use capacity in CVP facilities will have to be illustrated in water rights and contractual foundations and will need permission from Reclamation and meet criteria (such as water rights and approvals from the fishery agencies) for the use of excess capacity at federal facilities.

- Operation of the Project would not injure prior water rights or cause unreasonable harm to fish and wildlife resources.

In addition to those issues covered above, coordination to be addressed during operations would include the following:

- Annual protocol for identifying the availability of and scheduling for exchanges and use of Sites storage space by Reclamation.
- Protocol for annual start-of-year scheduling and end-of-year reporting of Project deliveries to the Central Valley Operations Office as needed for the CVPIA work plan or for other purposes.
- Protocol for coordination on WIIN Act reporting requirements and WIIN Act opportunities.
- Protocol for daily accounting.
- Protocol for accounting under Coordinated Operations Agreement
- Protocol for (daily, weekly, monthly, quarterly, semi-annually, annual) consultations.
- Protocol for resolution of disputes.

Reclamation will coordinate with the Authority to develop a final integrated operations agreement. Reclamation will develop CVP operations policy, develop annual operating plans, coordinate with the SWP and other system operators, and make real-time operating decisions.

Water Rights

Water Right Applications and Changes

The Project will rely upon existing water rights held by Reclamation and the State of California. The Authority intends to petition the State Water Resources Control Board (SWRCB) for an assignment of a prior State Filing for the collection to storage of water at Sites Reservoir and subsequent beneficial use of that water, and augment that as needed with a new water right application for Project components that might constitute a new appropriation that extends beyond the prior State Filing. Some modifications to the place of use and/or point of diversion/ rediversion of the prior State Filing would be sought through a water right change petition. Depending on operational components and operational flexibility desired by Reclamation and the Authority, some modification to the place of use and/or point of rediversion to the existing water rights held by Reclamation may be required to realize full Project benefits and provide operational flexibility for the Project (e.g. adding places of use and points of rediversion as necessary for the rediversion to storage of CVP water in Sites Reservoir).

Reclamation, the State and the Authority will work in partnership to file change petitions with the SWRCB. No consolidation of water rights is anticipated, and water rights (modified) will continue to be held individually by Reclamation and the Authority. Reclamation and the Authority will partner on water rights hearings before the SWRCB as appropriate, while recognizing the need for Reclamation to ensure, through the application and hearing process, that the SWRCB include terms and conditions in the Sites water right permit(s) that are necessary for implementation of the

coordinated operations principals. The Authority will work closely with Reclamation to ensure that the overall strategy and timing for water rights actions meets the needs of all parties and the Project's implementation schedule.

Water Rights Approach

The Authority will seek to secure the assignment of an amended State-filed application or will apply for a new water right for the Sites Reservoir Project. A separate water right for the generation of power is not required for the generation of power that is incidental to the movement of water to meet the requirements for other purposes. This includes, but is not limited to, the following:

- The development of a Water Rights Strategy (including a final determination regarding whether pump storage needs to be addressed).
- Requirements that are placed by the SWRCB on operations of the Sites Reservoir Project shall be included in the water right.
- Reclamation anticipates cooperating with the Authority on any required changes to Reclamation's water rights.
- The Authority will not have a point of diversion or rediversion in any Federal storage facility. Reclamation retains full discretion over any CVP water in a Federal reservoir through cooperative operations with the Sites Reservoir Project. The Authority and Reclamation will address water benefits in the Operations Framework, including beneficiary pays.
- The Authority will protect senior water rights, including those of the CVP and SWP, when operating Sites Reservoir. The Operating Plan will likely include restrictions, in addition to the determination of excess conditions, on water diversions to fill Sites Reservoir. The Operating Plan will also address compliance with temperature requirements for Decision 90-5 and applicable requirements under the ESA.
- Reclamation will retain the ability to divert and store water pursuant to its water right. Reclamation will use its storage space and associated conveyance capacity in the Sites Reservoir Project to improve its operational flexibility on a real-time basis.
- The Authority's water right application will provide sufficient information to demonstrate a reasonable likelihood that unappropriated water is available for the proposed appropriation for Sites Reservoir.

The United States is expected to enter into an agreement with the Authority for Sites Reservoir Project water, which will provide for the storage and delivery of Sites Reservoir Project water. Reclamation will use this water, at its discretion, for CVP Operational Flexibility. Reclamation may reschedule this water from one year to the next, subject to Authority rescheduling requirements. This may also be referred to as "carryover."

Reclamation may also direct any of its Sites Reservoir Project water that is undeliverable or unusable to another storage facility for use at a later time.

Water Contracts

Warren Act Contracts for Authority Use of Federal Facilities (storage and conveyance)

- The Authority and/or its participating members shall enter into Warren Act Contracts with Reclamation for use of Excess Capacity (i.e., diversion, storage, conveyance, or pumping capacity in Federal project facilities which is in excess to that needed to achieve a Reclamation project's authorized purposes).
- The Authority's and/or its participating members' use of Federal non-storage and appurtenant facilities will be subject to available capacity and shall not impede the delivery of CVP water. The determination of available capacity and impediment of delivery of CVP water is at Reclamation's sole discretion.
- The Authority and/or its participating members will be responsible for NEPA and ESA requirements when obtaining a Warren Act Contract.
- All costs associated with the use of Excess Capacity in Federal facilities by the Non-Federal Sponsors will be an Authority and/or its participating members' requirement pursuant to Reclamation Law and Policy.
- If electrical power is required to convey or pump the Non-Project water into, through or from the Project facilities, the Authority shall be responsible for the acquisition and payment of all electrical power and associated transmission service charges.

Sites Reservoir Project Contracts with Existing CVP Contractors

The Authority will enter into agreements (consistent with the Operations Framework) with their Project Agreement Members, some of whom are existing CVP contractors, for a supplemental water source delivered from Sites Reservoir and purchased through the upfront capital Project cost. The Authority shall not provide Sites Reservoir Project water in a manner that negatively impacts the CVP financially or violates CVPIA, including any water transferred out by a CVP contractor. Reclamation will make its yearly CVP allocation to support the maximized delivery of CVP supplies and allocated reimbursement of the Federal investment. Sites Reservoir Project water will not be included during the CVP allocation process. However, when Reclamation is in a Condition of Shortage, Reclamation will take into consideration Sites Reservoir Project water in accordance with the then-existing CVP Municipal & Industrial Water Shortage Policy.

Users of Sites Reservoir water shall hold the United States harmless for any change in water quality caused by the movement of water through Sites Reservoir.

Water Operations Management Team

A management team could be formed to facilitate decision making under the operations agreement. The team could be comprised of representatives from Reclamation's Central Valley Operations Office and DWR, USFWS, CDFW, and the Authority. If formed, the team could meet to address water system conditions (including hydrologic and regulatory conditions) and seasonal demands and to make real-time operations decisions. The water operations management team for the Project may coordinate with, or become part of, existing operations forums for the CVP and SWP.

Other Operational Agreements and Plans

The Authority, in collaboration with Project partners or beneficiaries, would coordinate to develop other plans and agreements required for Project implementation, operations, and maintenance, including agreements with the State of California. These would include agreements between the Authority and DWR for the coordinated operations, exchanges, and use of facilities. The Authority will also enter into an agreement with DWR for administration of public benefits funded under Proposition 1, including flood damage reduction, recreation, and Incremental Level 4 Refuge Water Supply. The Authority will enter into agreements with CDFW for Proposition 1 fisheries-related benefits.

The Authority will seek permission from Reclamation for use of excess capacity in federal facilities in order to effectuate the Project. The Authority will also seek permission from DWR for use of excess capacity in State facilities in order to effectuate the Project. Reclamation's California-Great Basin – Interior Region 10 will need to seek approval from the Commissioner in order to execute a contract with the Authority for use of excess capacity in the CVP for the carriage of non-Project water.

The Authority will also execute agreements with the Local Agency Partners for costs associated with M&I and agricultural water supplies received from the Project.

Power Resources

The Authority will furnish their own power when pumping and/or conveying non--CVP water through Federal facilities associated with implementing the Sites Reservoir Project. No CVP power will be available to pump and/or convey non-CVP water through Federal facilities.

Although power is a benefit of the Sites Reservoir Project, it is not expected to provide benefits to the CVP. As proposed, there may be lost generation value to the CVP directly caused by the Sites Reservoir Project through water released from Sites Reservoir in lieu of water released from a Federal facility, resulting in reduced flows from the Federal facilities. A potential foregone energy value could be the result of changing the timing of the power generation from peak-season months to off-peak cost months or could be the result of changing the release to periods when water will be spilled to satisfy flood control requirements.

The Authority will enter into an agreement with Reclamation to provide for reimbursement to recover the costs of CVP power used to pump and convey Sites Project water through Federal facilities. Reclamation and the Authority are studying the potential impacts of operations on CVP power and will mitigate if there are negative impacts.

Operations Implementation and Review

The Authority shall implement the Operating Plan and operate the Sites Reservoir Project in compliance with all applicable Federal and State requirements and in coordination with the CVP.

- The Authority will be responsible for implementing the BiOp and all permits associated with construction and operation of the Sites Reservoir Project.
- Any requirements that are placed on operations of the Sites Reservoir Project by the SWRCB shall be included in the Sites water right and will be addressed in the contractual agreement with Reclamation.

- A review of the Operating Plan will occur periodically, and should new requirements be placed on the operations of the CVP and SWP, those new requirements will be included in a revised Operating Plan with the Authority.

Recommended Plan

This Feasibility Report evaluates Alternatives A1 and D1 to frame the reservoir sizes under consideration by the Authority. The Authority will make a decision on reservoir size prior to proceeding to construction.

By July 31, 2021, the following would be completed by Reclamation in partnership with the Authority or successor entity:

- Development of a preferred plan to be presented in a Final EIS.
- An Integrated Operations Framework.
- Updated Project benefits and costs. It is intended the operations would maintain a Federal BCR greater than 1.
- The relationship between Project yield and investment is not linear. Through the feasibility study, we show that the yield to repayment functionality is a reasonable cost. This will be further developed in post authorization through an Operations Framework (similar to COA), and include negotiations from a water rights and contractual basis, and analysis that captures operations, yield, and bonding mechanisms to illustrate yield enhancement and show decision-makers that the Project is moving towards reasonable projected outcomes as depicted in the feasibility report.

Due to the complexity of this Project and the high Federal investment, Reclamation finds validation of the feasibility results is necessary during the pre-construction phase. Reclamation shall confirm the feasibility results and document changes in a post-authorization report prior to providing funding for construction, other than pre-construction funding for design and permitting.

This page intentionally left blank

Chapter 12 Recommendations

Alternatives A1 and D1 frame the range of reservoir sizes under consideration by the Authority. This is a State-led project and the diversity of potential participants includes local, state, and federal interests as a collective of investors. This means right-sizing and optimizing the Project for current conditions and affordability of all participants, while maintaining flexibility to adapt the Project to changing conditions. The Authority is evaluating participants needs and regulatory requirements to determine the optimum size of the reservoir, and Reclamation will validate the feasibility results and document changes to the conclusions of this report in a post-authorization report prior to physical construction. The post-authorization report will validate the Federal interests based on the Authority's determination for participation, size, and operating requirements.

Results of analysis conducted to date indicate that Alternatives A1 (NED Plan) and D1 are technically, financially, and economically feasible. A Draft EIR/EIS has been prepared and environmental feasibility will be confirmed in the Final EIR/EIS. Key findings and the cost assignment are shown in Table 12-1.

Table 12-1. Key Findings and Cost Assignment

Parameter	Alternative A1 (1.3 MAF)	Alternative D1 (1.8 MAF)
Average Water Supply Increase (TAF)	116	131
Average Deliveries for CVP Operational Flexibility (TAF)	69	73
Average Increase in End-of-September Storage for Shasta (TAF)	138	164
Average Deliveries for Delta Ecosystem Enhancement (TAF)	57	51
BCR	1.07	1.06
NED Average Annual Benefit ($ millions)	$244	$270
Total Project Construction Cost ($ millions)	$5,792	$6,552
Total Federal Construction Cost Assignment	$1,446	$1,641
Combined Authority and State Construction Cost Assignment	$4,346	$4,991
Federal Construction Phase Cost	$1,353	$1,537
Pre-Construction Phase Cost	$93	$104

Facilities – Alternative A1 includes a 1.3-MAF reservoir, three pumping/generating plants, a new regulating reservoir on the GCID Canal, approximately 13 miles of conveyance pipelines (Delevan and TRR pipelines), a new intake on the Sacramento River, modified roads (including a bridge across Sites Reservoir), and two new recreation areas. Alternative D1 has a larger, 1.8 MAF reservoir and an extra substation to power the Delevan pumping/generating plant from Colusa (this avoids landowner impacts and new transmission lines on the border of Delevan National Wildlife Refuge).

Benefits – Both alternatives would provide benefits associated with each of the primary and secondary objectives. Both alternatives are economically feasible and would generate a positive

NED average annual benefits (see Table 12-1). Although there are uncertainties, the alternatives can be adaptively managed to maintain a high level of benefits under a wide range of potential future conditions.

Cost Allocation and Assignment – The WIIN Act (P.L. 114-322) Section 4007 allows the Secretary to participate in a State-led storage project in an amount equal to 25 percent or less of the total cost of the Project. The Federal construction cost (i.e., without IDC) for the alternatives is shown in Table 12-1, including the breakdown for construction and pre-construction activities. The non-Federal Project partner would be responsible for the balance of construction costs.

The non-Federal partner would be responsible for all costs that are not allocated to the Federal government. The CWC has determined that the Project is eligible for up to $816 million in funding, including $40.8 million for pre-construction funding, from California through the WSIP process under Proposition 1 (applies to both alternatives because both alternatives deliver State benefits). The State's investment would fund the Authority for the capital costs allocated by the State to Project benefits that are considered public, including IL4 Water Supply for CVPIA Refuges, Delta Ecosystem Enhancement, Recreation, and Flood Damage Reduction.

The Federal cost-share is representative of feasibility, and the Federal government may change cost sharing percentages within the Project purposes as the Project continues to be developed by Reclamation and the Authority. Changes to cost sharing would be documented in a post-authorization report, and could be reflected in the capital costs and/or OM&R.

The Federal government is assigned the full construction cost for CVP Operational Flexibility and approximately half the costs for Anadromous Fish purpose. All other construction costs would be paid by the non-Federal partners.

All OM&R costs under the CVP Operational Flexibility Project purpose are assigned to the Federal government and will be assigned using the existing Ratesetting Policies and cost pools and recovered through the existing Ratesetting process.

In exchange for Federal construction funding, Reclamation will receive IL4 Water Supplies for CVPIA Refuges at no cost. The Project's non-Federal partners will pay 100 percent of the IL4 Water Supply for CVPIA Refuges purpose's OM&R expenses that are not attributable to conveyance (i.e., diversions and filling). Under the planned assignment of costs, the cost to convey IL4 Water Supply for CVPIA Refuges from the Delevan pipeline discharge to the refuges would be consistent with CVPIA cost share requirements (75 percent Federal and 25 percent State). These costs would vary by year, depending on hydrology and the amount of water delivered from the Project.

Upfront cost sharing of costs assigned to non-Federal participants will be provided. The Department of the Interior would negotiate and enter into an agreement with non-Federal partners on behalf of the United States for planning, permitting, design, and construction costs up to 25 percent of the total Project cost.

The cost assignment will be re-evaluated in the post-authorization report, including funding for OM&R.

Recommendations

As the NED Plan is being reviewed for approval, the NODOS Investigation recommends the following actions.

Recommendations for the Secretary of the Interior:

- Determine the Project is feasible. There are Federal benefits, as framed by Alternatives A1 and D1 in this Report, and submit the following determinations to Congress, in accordance with Section 4007(c)(2)(D) of WIIN:
  - The Project is technically and financially feasible;
  - Sufficient non-Federal funding is available to complete the Project;
  - The Project sponsors are financially solvent; and
  - A proportional share of the Project's benefits are Federal benefits.
- Request that Congress funds the Federal share of construction.
  - Request that Congress authorize Reclamation to increase the construction cost to allow for escalation from stated price levels (2019) to the notice to proceed for each contract or work package, based upon Reclamation's Construction Cost Trends publication or similar source.
- Request that Congress annually appropriate funds so Project construction can occur in the most efficient and expeditious manner to avoid cost overruns and ensure timely completion.
- Request that Congress authorize and annually appropriate funds for OM&R to improve CVP Operational Flexibility.

Reclamation will study the use of excess storage capacity, when available, in Sites Reservoir for storage of CVP water to improve the operational flexibility of the CVP.

Due to the complexity of this project and high Federal investment, Reclamation recommends validating the feasibility results in pre-construction and documenting any changes in a post-authorization report.

	1	2			3	4							
Phase	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
NEPA/ CEQA			Draft EIR/S		Final EIR/S ROD								
Permitting		Permitting				Mitigation and Monitoring							
Water Rights				Obtain Rights									
Engineering		Preliminary and Final Design											
Real Estate		Right–of-Entry			Real Estate								
Construction					Construction								
Operations													Start - Up

CEQA = California Environmental Quality Act
CWC = California Water Commission
EIR = Environmental Impact Report
EIS = Environmental Impact Statement
NEPA = National Environmental Policy Act
NOD = Notice of Determination
ROD = Record of Decision
WSIP = Water Storage Investment Program

Figure 12-1. Authority Timeline for Sites Reservoir Project

Next Steps

The following sections summarize next steps.

Approval

As determined by the Secretary, in accordance with the WIIN Act, and funded by Congress, the Authority and Reclamation can begin pre-construction activities. An Agreement in Principal and Project Partnership Agreement between Reclamation and the Authority will be developed to define various roles, responsibilities, and obligations for the construction of the Project for both parties as further defined in this chapter.

Prior to physical construction the Authority and Reclamation will develop a post-authorization report consistent with the final design, Final EIR/EIS, permits, operations requirements, and other Project agreements. The post-authorization report will define the final Federal participation, benefits, operations plan, and use of Federal facilities.

According to the WIIN Act, approvals are needed from the Secretary and Congress to proceed with construction (to include pre-construction activities). Funding appropriated in Fiscal Year 2021 would enable the Project to meet the anticipated construction schedule that has been developed by the Authority.

Pre-Construction Activities

The Federal cost share of preconstruction activities is shown in Table 12-1 for each alternative. Pre-construction activities consist of:

- A Post-Authorization Change Report
- Engineering Design
- Site Investigations and Mapping
- Operations Plan
- Hydropower
- Project Partnership Agreement
- Reclamation Facilities
- Environmental Compliance and Regulatory Requirements
- Permits and Approvals
- Coordination and Outreach
- Mitigation
- Lands

After review by the Office of Management and Budget, the most likely remaining requirement is transmittal of the following documents by the Secretary to Congress for approvals: Final Feasibility Report, Draft EIR/EIS, report of financial capability, and a letter from the Governor.

The Authority is expected to enter into an agreement with the United States for Sites Reservoir Project Water, based on a negotiated water rights foundation, which would provide for the storage and delivery of Sites Reservoir Project Water. Reclamation would use this water, at its discretion, for CVP Operational Flexibility and Anadromous Fish purposes.

Operations

Operations will be reviewed using the requirements of COA for adding a locally owned, State, or Federal facility to the CVP and SWP system, per Article XIV and Article XVI of COA. In accordance with the COA review findings, an Operations Plan would be developed to address the long-term planning and integration processes, and how the additional water supply provided by Sites Reservoir and associated infrastructure would be managed, in coordination with existing water supplies and system features. All contractual goals, including those that are not currently CVP/SWP land-based, would need an amended or new contract for delivery of water to service areas. The recognition of water rights will be accomplished through integration into a new Operations Framework (similar to COA), because the very nature of the CVP/SWP system changes with the addition of new facilities. The Operations Framework connects the new operational facility and the agreements needed to function efficiently. The Operations Plan may include restrictions on diversions, requirements to meeting temperature requirements, and other benefits claimed.

Additional operations analysis is being performed to evaluate how the Sites Reservoir Project can be most effectively integrated with Delta conveyance and future water storage projects.

Hydropower

Additional evaluation of hydropower is being undertaken to understand what, if any, impacts or benefits to CVP power may occur.

Project Partnership Agreement

Upon Project authorization, Reclamation would enter into a Project Partnership Agreement for construction of the Project. As of the effective date of this Feasibility Report, the total construction costs (escalated to midpoint of construction) are projected to be $5,792 million for Alternative A1. These amounts are estimates that are subject to adjustment and are not to be construed as the total financial responsibilities of the Federal Government or non-Federal sponsor.

Reclamation Facilities

This Feasibility Report and/or Congressional authorization would allow the modification of various Federally owned facilities as described in the post-authorization report.

Environmental Compliance and Regulatory Requirements

The environmental effects are evaluated in the Sites Reservoir Draft EIR/EIS (Reclamation and Authority 2017). Producing the Final Feasibility Report without the Final EIR/EIS requires a waiver from CMP 09-02. The Authority is leading the development of the Final EIR/EIS. The post-authorization report will include review of the findings from the ongoing activities to complete the Final EIR/EIS.

The Final EIR/EIS for the NODOS/Sites Reservoir Project would satisfy NEPA by providing a meaningful analysis of all issues relevant to the human environment. However, implementation of the Project would be subject to additional Federal, State, and local laws, policies, and environmental regulations. All 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 EIR/EIS to make decisions and/or issue permits if a project is authorized. The ROD would not be completed until the pre-construction permits and approvals have been acquired.

Permits and Approvals

The lead agencies would need to obtain various permits and regulatory authorizations before beginning Project construction (physical construction, not pre-construction activities). The lead agencies would also have to comply with a number of environmental regulatory requirements as part of the NEPA/CEQA process. Water rights at Funks Reservoir would be addressed in the Authority's Water Rights Strategy. Modifications within existing BOR water rights may be necessary and BOR would participate in making such requests to the SWRCB. Appendix K identifies the potential permits and approvals for Project implementation.

Coordination and Outreach

Efforts to engage the public, Federally recognized Indian tribes, Native American groups, NGOs, public agencies, impacted landowners, and other stakeholders in decisions affecting the implementation of the Sites Reservoir Project would continue as an important aspect in the investigation.

Future public outreach activities to support the Sites Reservoir Project would include additional formal public meetings, focused stakeholder workshops, and increased outreach activities to landowners in the Project footprint and local public agencies.

The outreach activities would continue to support the goals of expanding awareness of the Project, obtaining community support for the Project, maintaining transparency and accountability to the public, reducing legal risk, and providing opportunities for public input at appropriate investigation milestones.

Indian Tribe Consultation and Coordination

Since the initiation of the NODOS Investigation, agency representatives have provided Indian tribes with status updates and opportunities to comment on issues or resources of concern. Communication regarding the proposed Sites Reservoir area in particular has been ongoing with the Colusa Indian Community Council, the Cortina Rancheria, the Grindstone Indian Rancheria, and the Paskenta Band of Nomlaki Indians. The Colusa Indian Community Council and the Cortina Rancheria are NEPA cooperating agencies. The Federally recognized tribes in the primary study area are the Cachil Dehe Band of Wintun Indians of the Colusa Indian Community of the Colusa Rancheria, the Cortina Indian Rancheria of Wintun Indians of California, and the Grindstone Indian Rancheria of Wintun-Wailaki Indians of California.

The Draft EIR/EIS describes supporting analyses, studies, coordination, impacts, and mitigation, as necessary, of resources and topics of concern to Indian tribes. Numerous cultural resources would be affected by the implementation of any of the action alternatives. Tribal participation will continue through the NHPA Section 106 and NEPA processes, in accordance with Executive Orders 13175 and 12898, and through other Federal requirements.

Agency Coordination

Agency consultation and involvement has occurred throughout the NODOS Investigation to date—both informally and formally. The NODOS Investigation Study management structure encompasses the active participation of numerous cooperating and responsible agencies pursuant to NEPA and CEQA, respectively representatives from resources agencies, and other stakeholders.

Key elements of forthcoming agency coordination activities are described in the Draft EIR/EIS, the Planning Aid Memorandum and Coordination Act Report, and documents to be issued by USACE under CWA Section 404. Reclamation has been coordinating with USFWS under the FWCA; however, USFWS was unable to provide the draft FWCA report at the time of the publication of this final Federal Feasibility Report. Upcoming coordination will also include working with the SWRCB and CVRWQCB on the CWA 401 permit.

USACE: USACE has responsibilities relative to issuing permits for wetland impacts, construction of facilities in navigable waters, and flood management. Early coordination with USACE would support obtaining permits for the Project, should it move forward to implementation.

Tehama-Colusa Canal Authority: The TCCA performs OM&R of the Corning and T-C Canals and the associated pumping facilities at Red Bluff.

Glenn-Colusa Irrigation District: The GCID Canal is under consideration for diversion and conveyance of the Sacramento River supplies to Sites Reservoir in all of the alternatives. The Authority would need to contract with GCID for pump and conveyance services to divert Sites Project Water at GCID's Hamilton City Pumping Plant and convey it through GCID's main canal to the TRR.

Local Property Owners' Land and Water Rights: Lands in the proposed area of the Sites Reservoir would be inundated. Consequently, assessments have been made to determine the extent of impacts to lands and structures, and potential mitigations. The Authority provides opportunities for regular landowner involvement, including weekday access to staff at the Maxwell Project office.

Mitigation

After the approval of all required permits, the implementation of mitigation measures may proceed before—or concurrent with—other Project facilities, in compliance with NEPA/CEQA and standard practices.

Lands

The Authority would coordinate all land acquisition activities, including acquiring lands for Project facilities and for mitigation purposes.

Construction

The Project would be constructed in phases. Early construction activities (primarily associated with providing access to the major facilities for construction) would begin in 2021.The Authority plans to complete design in early 2022. Construction of the dams, pumping plants, and pipelines is expected to approximately 7 to 8 years for completion. A timeline of major actions to complete the Sites Reservoir Project, and future milestones leading to Project implementation, are shown on Figure 12-1.

Federal Role

Under the NED Plan, the Federal role would be to provide funding for the benefits identified in this Report.

- Reclamation would support the design investigations, engineering, and coordinate Project management and all aspects of the Project with the Authority and the State.
- Reclamation would coordinate with the Authority in the analysis for the hydropower facilities.
- Reclamation would support the Authority to secure Federal regulatory compliance and permitting for the Project (including ecosystem and water quality benefits identified by the Authority and the State and water rights modifications), as authorized, through a sequenced process.
- Reclamation, the Authority, and the State would implement the Operating Plan.
- Reclamation would validate the feasibility results during the pre-construction phase, and document any changes in a post-authorization report, as needed.
- Reclamation would pursue a cost-share agreement and secure a signed MOU for preconstruction and construction.

If Federal approvals and authorization are not granted, Reclamation would continue to participate in a limited capacity. Because the Project would affect the CVP's operating environment, Reclamation would participate in and review operational aspects of the Project. It is the responsibility of the Authority to ensure operation of the Sites Reservoir Project would cause no net negative impacts to the CVP, SWP, or their contractors. Avoiding these impacts includes, but is not limited to, no net negative operational, financial, or environmental compliance impacts to the CVP.

Non-Federal Role

The Authority would be the owner and operator, and would maintain the Sites Reservoir Project.

- The Authority would lead Project implementation and develop the Final EIR/EIS.
- The Authority would lead the construction effort, including the environmental commitments and mitigation measures identified in the Final EIR/EIS. Reclamation could have a role in reviews during the construction phase.
- The Authority would enter into agreements with all investors for the construction, operation, and maintenance of the Sites Reservoir Project.

This page intentionally left blank

Chapter 13 Glossary

The definitions in this glossary refer to the areas covered under the primary and secondary planning objectives for the Draft Feasibility Report for the NODOS/Sites Reservoir Project and the regulatory terms used in the process.

Term	Definition
acre-foot	The volume of water that would cover 1 acre to a depth of 1 foot, or 325,851 gallons of water. A flow of 1 cfs for 1 day is approximately 2 acre-feet. An average California household uses between 0.5 and 1 acre-foot of water per year.
active capacity	The reservoir capacity normally usable for storage and regulation of reservoir inflows to meet established reservoir operating requirements. It is also the total capacity less the sum of the inactive and dead capacities.
active conservation capacity (active storage)	The reservoir capacity available for seasonal or cyclic water storage that is assigned to regulate reservoir inflow for irrigation, power, municipal and industrial use, fish and wildlife, navigation, recreation, water quality, and other purposes. It does not include exclusive flood control capacity. It extends from the top of the active conservation capacity to the top of the inactive capacity (or dead capacity, where there is no inactive capacity).
alluvial/alluvium	A general term for clay, silt, sand, gravel, or similar unconsolidated soil strata deposited by flowing water in the bed of the stream or on its floodplain or delta. A general term referring to the clay, silt, and gravel that are deposited by a stream, creek, or water body. Alluvium is found around rivers and deltas, frequently making soils fertile.
anadromous fish	Freshwater fish species that migrate to the ocean then return to spawn in freshwater. They include Coho salmon, Chinook salmon, and steelhead. <u>Alternative Definitions:</u> Fish that live in ocean water and move inland to spawn, such as salmon. Fish species, such as salmon, that migrate from freshwater streams to the ocean and back to complete their life cycles.
Anadromous Fish Restoration Program	A program required to be developed under Section 3406(b)(1) of the CVPIA (see *Central Valley Project Improvement Act*, below) that identifies instream and Delta flows and other actions needed for the recovery of anadromous fish species.
aquifer	An underground layer of permeable rock or soil that stores water and yields significant quantities of water to wells or springs.
average annual runoff	Average total annual runoff volume calculated for a selected period of record at a specified location, such as a dam or stream gauge.
average year water demand	Demand for water under average hydrologic conditions for a defined level of development.

Term	Definition
bedload	Sediment in a stream that is moved on or immediately above the streambed, usually consisting of boulders, pebbles, and gravel.
beneficial use	Actual or reasonable potential use that may be made of waters of the State, including, but not limited to, domestic, municipal, agricultural, and industrial uses.
benefit-cost ratio (BCR)	The ratio of the present value of project benefits to the present value of the project costs; used in economic analysis.
berm	A sloped wall or embankment (typically constructed of earth, hay bales, or timber framing) used to prevent inflow or outflow of material.
Biological Opinion (BiOp)	Under Section 7 of the Federal ESA, a document that states the opinion of the appropriate Federal regulatory agency—NMFS or USFWS—as to whether a Federal action is likely to jeopardize the continued existence of a threatened or endangered species or result in the destruction or adverse modification of critical habitat. Often, a Biological Assessment is prepared by the consulting or action agency as source material for the regulatory agency.
biota	All living organisms of a region.
brackish water	Water with a salinity level that exceeds normally acceptable standards for municipal, domestic, or irrigation uses, but that is less than that of seawater.
CALFED Bay-Delta Program (CALFED)	A collaboration among 25 State and Federal agencies that came together with a mission to develop and implement a long-term comprehensive plan that will restore ecological health and improve water management for beneficial uses of the San Francisco Bay/Sacramento–San Joaquin River Delta system. CALFED focused on the following areas and programs: ecosystem health, water supply reliability, water quality, levee system integrity, watershed management, storage, conveyance, environmental water account, water use efficiency, water transfers, and science.
CALFED Bay-Delta Program Final Programmatic Environmental Impact Statement / Environmental Impact Report (CALFED PEIS/EIR)	The NEPA and CEQA compliance document that provides the environmental consequences of alternative actions relating to CALFED.
CALFED Bay-Delta Programmatic Environmental Impact Statement / Report Record of Decision (CALFED ROD)	The ROD issued by the Federal lead agencies for adopting the CALFED program as described in the CALFED PEIS/EIR and associated actions. The CALFED ROD is a general framework for addressing CALFED. It includes program goals, objectives, and projects intended primarily to benefit the Delta system, its tributaries, and areas that receive water supplies exported from the Delta.
California Aqueduct	The primary conveyance facility of the SWP; it conveys water from the Delta through the San Joaquin Valley and along the eastern slope of the Coastal Range to Southern California.
California Endangered Species Act (CESA)	CESA is implemented by CDFW. CESA prohibits the "take" of listed threatened or endangered species.

Term	Definition
California Environmental Quality Act (CEQA)	A California statute passed in 1970 (California Public Resources Code Section 21000 et seq.) shortly after the passage of the Federal NEPA. It requires lead agencies(public and private) to prepare and submit for public review environmental impact assessments on projects under their purview. There are four levels of analysis under CEQA: Initial Study, Negative Declaration; Mitigated Negative Declaration; and Environmental Impact Report.
California Species of Special Concern	Species designated by the CDFW as having declining population levels, limited ranges, and/or continuing threats that make them vulnerable to extinction. The purpose of this designation is to halt or reverse the decline of such species by calling attention to their plight and addressing issues of concern early enough to secure their long-term viability.
California Water Action Plan	A plan issued in January 2014 and updated in 2016, primarily as a response to the state's deficiencies in drought preparedness. The plan is intended to be a 5-year roadmap toward achieving sustainable water management in California.
California Water Commission	Advises the California Department of Water Resources on matters within the department's jurisdiction, approves rules and regulations, and monitors and reports on the construction and operation of the State Water Project. The commission is responsible for administering the Water Storage Investment Program (see *Water Storage Investment Program*, below).
California WaterFix	A proposal to update California's aging water delivery system, including how water is diverted from the Sacramento–San Joaquin River Delta. The proposal is part of the State's overall water management portfolio, along with water conservation, groundwater management, water recycling, and ecosystem protection.
California Water Plan (CWP) Update	The CWP provides a framework for water managers, legislators, and the public to consider options and make decisions regarding California's water future. The CWP is updated every 5 years, and it identifies and evaluates existing and proposed statewide demand management and water supply augmentation programs and projects to address the state's water needs.
CALSIM (California Statewide Integrated Model)	A planning model designed to simulate the systemwide monthly operations of the CVP and SWP under current and future conditions that was jointly developed by DWR and Reclamation. CALSIM predicts how reservoir storage and river flows would be affected based on incorporated changes in future system operations. CALSIM output is typically used to help assess impacts on water supply, water quality, aquatic resources, and recreation.
CALSIM II	The version of CALSIM used for this study.
carryover water	Table A water that is allocated to a SWP contractor in a given year, but is unused in that year and stored for that contractor in SWP supply reservoirs (when storage space is available) for use by that contractor in a following year. The water is temporarily stored or carried over primarily in San Luis Reservoir (see *Table A amount*, below)
Central Valley Project (CVP)	A Federally operated water management and conveyance system constructed for diversion, storage, carriage, distribution, and beneficial use, for flood control, irrigation, municipal, domestic, industrial, fish and wildlife mitigation, protection, and restoration, generation and distribution of electric energy, salinity control, navigation, and other beneficial uses, of waters of the Sacramento River, the American River, the Trinity River, and the San Joaquin River, and their tributaries.

Term	Definition
Central Valley Project Improvement Act (CVPIA)	P.L. 102-575, Title 34, which was signed into law on October 30, 1992, mandates major changes in the management of the Federal CVP. The CVPIA recognizes that fish and wildlife are equal in importance to agricultural, municipal, industrial, and hydropower uses.
Climate Variability	Considered the effects of variability in temperature and precipitation as well as sea-level rise.
CVP Operations Criteria and Plan (OCAP)	The OCAP describes the regulatory and physical constraints and conditions under which the CVP and SWP currently operate.
consumptive use	Diversions of water withdrawn upstream and not returned downstream as wastewater.
contaminants	Any undesirable physical, chemical, biological, or radiological substance present in water as a result of human activities.
conveyance	Provides for the movement of water. Conveyance infrastructure includes natural watercourses and constructed facilities like canals and pipelines.
cooperating agency	Under NEPA, any agency, other than the lead Federal agency, that has jurisdiction by law or special expertise related to an action requiring an EIS and has agreed to provide assistance in the preparation of an EIS. Alternative Definition: According to the Council on Environmental Quality (40 C.F.R. 1508.5), "cooperating agency" means any Federal agency, other than a lead agency, that has jurisdiction by law or special expertise with respect to any environmental impact involved in a proposed project or project alternative. A State or local agency of similar qualifications or, when the effects are on lands of tribal interest, a Native American tribe may, by agreement with the lead agencies, also become a cooperating agency.
Coordinated Operations Agreement (COA)	The agreement between the United States and the State of California for Coordinated Operations of the CVP and SWP, commonly known as the Coordinated Operations Agreement, or COA, was executed in November 1986 and amended December 2018 pursuant to P.L. 99-546, the California Central Valley Project Act (California Water Code Part 3, Division 6 [starting at Section 11100]) and the California Water Resources Development Bond Act (California Water Code Chapter 8, Part 6, Division 6 [starting at Section 12930]) to coordinate the operations of the CVP and SWP facilities to meet Sacramento Valley in-basin uses, maintain their respective annual water supplies, and establish how the two agencies share surplus flows.
critical habitat	An area designated as critical habitat listed in 50 C.F.R. Parts 17 or 226 (50 C.F.R. Part 402.02). Critical habitat areas are specific geographic areas, whether occupied by special-status species or not, that are determined to be essential for the conservation and management of special-status species, and that have been formally described in the *Federal Register*.
cubic feet per second (cfs)	A unit of discharge for measurement of a flowing liquid equal to a flow of 1 cubic foot per second (448.8 gallons per minute, 7.48 gallons per second, or 1.98 acre-feet per day). This measurement is a rate of streamflow (the volume, in cubic feet, of water passing a reference point in 1 second).

Term	Definition
dead pool conditions	Refers to the condition when water in a reservoir cannot be drained by gravity through a dam's outlet works. Water that is in the dead pool is not considered part of the conservation pool.
Decision 1641 (D-1641)	State Water Resources Control Board water rights decision (March 2000) that implemented the 1995 Bay-Delta Water Quality Control Plan, establishing terms and conditions regulating points of diversion for the CVP and SWP. D-1641 superseded earlier issued D-1485.
Delta	See *San Francisco Bay/Sacramento–San Joaquin River Delta, below*.
Delta Cross Channel (DCC)	An existing gated structure and channel connecting the Sacramento River at Walnut Grove to the North Fork of the Mokelumne River. The facility was constructed as a feature of the CVP to control movement of Sacramento River water into the central Delta and to the south-Delta export pumps.
Delta export	Water pumped from the Delta for use outside the Delta.
Delta-Mendota Canal (DMC)	The major conveyance facility of the CVP; it carries water from the Delta to the town of Mendota in the central San Joaquin Valley.
Delta outflows	Downstream freshwater flows from the Delta that protect the beneficial uses within the Delta from the intrusion of saline water.
Delta Risk Management Strategy (DRMS)	The DRMS program was undertaken to evaluate the risks and consequences of the failure of Delta levees and other assets to the State (e.g., water export disruption and economic impacts) and the Delta (e.g., levees, infrastructure, and the ecosystem). The program considered exposure to all hazards.
Delta Stewardship Council (DSC)	The DSC was created in legislation to achieve the State-mandated coequal goals for the Delta. "Coequal goals" means the two goals of providing more reliable water supply for California and protecting, restoring, and enhancing the Delta ecosystem. The primary responsibility of the DSC is to develop, adopt, and implement the Delta Plan. The DSC, through its adoption and implementation of the Delta Plan, is tasked with providing a more reliable water supply for California (California Water Code Section 85054).
Delta Vision	The Delta Vision process concluded at the end of 2008, a little more than 2 years after it began, with a suite of strategic recommendations for long-term, sustainable management of the Delta. The Delta Vision Committee submitted its final implementation plan to Governor Arnold Schwarzenegger on recommended actions on how the Sacramento–San Joaquin Delta should be managed to fulfill its coequal goals of water supply reliability and ecosystem restoration. The implementation plan sets priorities based on the Delta Vision Strategic Plan developed by the Governor's Delta Vision Blue Ribbon Task Force.
Directives and Standards	Reclamation's internal guidance for conducting business. The Directives and Standards provide a level of detail necessary to ensure consistent application of Reclamation-wide policy.
dissolved oxygen (DO)	The amount of oxygen dissolved in water, usually expressed in milligrams per liter, parts per million, or percent of saturation.
diversion	The act of taking water out of a river system or changing the flow of water in a system for use in another location.

Term	Definition
drainage area	The area of land from which water drains into a river, usually bounded peripherally by a natural divide of some kind such as a hill. For example, the land area of the Sacramento River Basin drains into the Sacramento River. Also called river basin or watershed.
drought condition	Drought (a period of abnormally low rainfall) is a gradual phenomenon. Defining when drought begins is a function of water shortage impacts to water users. Hydrologic conditions constituting a drought for water users in one location may not constitute a drought for water users in a different part of the state or with a different water supply. Individual water suppliers may use criteria such as rainfall/runoff, amount of water in storage, decline in groundwater levels, or expected supply from a water wholesaler to define their water supply conditions.
DSM2 (Delta Simulation Model II)	Delta Simulation Model II (DSM2) is a publicly available one-dimensional hydrodynamic, water quality, and particle-tracking model. DSM2 can calculate stages, flows, and velocities; and many mass transport processes, including salts, multiple non-conservative constituents, temperature, trihalomethane formation potential, and individual particles throughout the Delta. DSM2 uses output from CALSIM II.
ecosystem	An interactive system that includes the organisms of a natural community association together with their abiotic physical, chemical, and geochemical environment.
electrical conductivity (EC)	A measurement of how easily electricity flows through water. EC correlates with the TDS in water. The higher the TDS, the more easily electricity flows through the water and the higher the electrical conductivity. See also *salinity, below.*
emergency response	A reaction by a person, community, or agency to an incident or event that threatens public safety, health, and welfare such as fire or flooding. Another example of an emergency response would be the release of supplemental freshwater to move or help stabilize the intrusion of seawater into the Delta in response to Delta levee failures.
emergent vegetation	Flooded or ponded areas that support rooted herbaceous vegetation with parts of the shoot both below and above water.
endangered species	Those species listed as endangered under ESA and CESA; any species that is at high risk of extinction in the near future throughout all or a significant portion of its range.
Endangered Species Act (ESA)	The Federal Endangered Species Act of 1973 is administered by the U.S. Department of the Interior's USFWS and the U.S. Department of Commerce's National Oceanic and Atmospheric Administration's NMFS. ESA Section 9 and its implementing regulations prohibit "take" of listed threatened or endangered species.
endemic species	A species restricted to and known to occur naturally only within a specific geographic area.
enhancement	Actions that are expected to improve conditions beyond current levels.
entrainment	The incidental trapping of fish and other aquatic organisms in water diverted from streams, rivers, and reservoirs; the process of drawing fish into diversions along with water, resulting in the loss of such fish.

Term	Definition
environmental water	The water for wetlands, for the instream flow in a major river or in the Bay-Delta designated for environmental purposes, or for a designated wild and scenic river.
ephemeral	A stream, pool, or lake that occurs for only the "wet" portion of the year. These bodies of water are usually dry during the summer months.
erosion	The gradual degradation of land by water, wind, general weather conditions, and reservoir fluctuations; the diminishing of property by the elements. With regard to levees specifically: loss of levee material as a result of the effects of channel flows, tidal action, boat wakes, and wind-generated waves.
estuary	Regions of interaction between rivers and nearshore ocean waters, where river flow and tidal action mix saltwater and freshwater.
eutrophication	The degradation of water quality as a result of enrichment by nutrients, primarily nitrogen and phosphorus, which in turn results in excessive plant (principally algae) growth and decay.
Evolutionarily Significant Unit (ESU)	A population or group of populations that is considered distinct (and hence a "species") for purposes of conservation under the ESA. To qualify as an ESU, a population must (1) be reproductively isolated from other conspecific populations; and (2) represent an important component in the evolutionary legacy of the biological species.
exceedance plots	A probability plot of, for example, flows where *N* percent exceedance flow is the flow that is equaled or exceeded *N* percent of the time.
extinct (species)	No longer in existence because of failure to adapt to environmental change. (Compare to *extirpated (species), below*.)
extirpated (species)	No longer surviving in regions that were once part of the species' range. (Compare to *extinct (species), above*.)
Federal Energy Regulatory Commission (FERC)	The Federal agency that licenses hydroelectric facilities.
Federally recognized tribe	Native American tribes or groups recognized by the Federal government and eligible for funding and services from the Bureau of Indian Affairs.
flood frequency analysis	A procedure for identifying the magnitude of flow (i.e., the *N* year precipitation event) that would be the event equaled on an average of every *N* years. In the case of a 20-year event, there is a 5 percent chance that it will be equaled during any given year. Flood frequency is also referred to as recurrence interval and return period.
forebay	A storage reservoir that is upstream from a generating or pumping plant.
greenhouse gas (GHG) emissions	Also referred to as carbon intensity or carbon footprint. Various water use activities (and other activities) can involve the use of substantial amounts of carbon-based energy, which in turn results in GHG emissions that contribute to the accumulation of GHGs in the atmosphere and is related to climate change.
gross reservoir capacity	The total storage capacity available in a reservoir for all purposes, from the streambed to the normal maximum operating level. Includes inactive storage, but excludes surcharge (water temporarily stored above the elevation of the top of the spillway).
groundwater	Any water naturally stored underground in aquifers or that flows through and saturates soil and rock, supplying springs and wells.

Term	Definition
groundwater overdraft	The condition of a groundwater basin in which the amount of water withdrawn by pumping exceeds the amount of water that recharges the basin over a period of years during which water supply conditions approximate average conditions.
habitat	The specific places where the environmental conditions (i.e., physical and biological conditions) are present that are required to support occupancy by individuals or populations of a given species.
harm	An act that kills or injures wildlife. Such an act may include significant habitat modification or degradation that kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering (50 C.F.R. 17.3).
hydraulics	The study of the practical effects and control of moving water; it is used to refer to the relationship between channel geometry and flow, velocity, and the depth of water.
hydrodynamic	The study of the motion of water. A hydrodynamic model is a tool able to represent the movement of water within a study area. Such a model is typically a numerical computational model.
hydrograph	A chart or graph showing the change in flow over time for a particular stream or river.
hydrology	The science that studies natural runoff and its effects on streamflows.
hydrostatic pressure	The pressure of water at a given depth resulting from the weight of the water above it.
inactive capacity (inactive storage)	Reservoir capacity exclusive of and above the dead capacity, from which the stored water is normally not available because of operating agreements or physical restrictions. Under abnormal conditions, such as a shortage of water or a requirement for structural repairs, water may be evacuated from this space. The inactive capacity extends from the top of inactive capacity to the top of the dead capacity.
incidental take	Take that results from, but is not the purpose of, carrying out an otherwise lawful activity.
Incremental Level 4 refuge water supply	Represents the increment of water above Level 2 refuge water quantities required for optimum habitat management. The total Incremental Level 4 contract allocation is 133,264 acre-feet annually. Pursuant to CVPIA, Reclamation must acquire Incremental Level 4 water supplies through voluntary measures which do not require involuntary reallocations of CVP yield, including purchase of water supplies from willing sellers which is Reclamation's primary acquisition method. Reclamation must also acquire additional Incremental Level 4 water to provide for contract conveyance losses. All costs associated with the acquisition and delivery of Incremental Level 4 water are non-reimbursable, with a 75% Federal responsibility and 25% California State cost share responsibility.
instream uses	The beneficial uses of water within a river or stream, such as providing habitat for aquatic life, sport fishing, river rafting, or scenic beauty.
lead agency	The government agency that has the principal responsibility for carrying out or approving a project and, therefore, the principal responsibility for preparing CEQA/NEPA documents. For the NODOS Feasibility Report, DWR is the state lead agency under CEQA, and Reclamation is the federal lead agency under NEPA.

Term	Definition
Least-Cost Planning Simulation model (LCPSIM)	Urban economic model to determine the least-cost solution for supply/demand balance.
levee	A natural or artificial embankment that constrains the flow of water to a channel.
Level 2 refuge water supply	Represents the historical average amount of water received by those CVPIA refuges identified in the Report on Refuge Water Supply Investigations (3/1989) prior to CVPIA enactment in 1992; and represents two-thirds of the water supplies identified for full habitat development for those refuges identified in the San Joaquin Basin Action Plan/Kesterson Mitigation Report (12/1989). The total Level 2 contract allocation is 422,251 acre-feet annually, and is considered the baseline water required for wildlife habitat management. Level 2 water is provided primarily from CVP yield. All costs associated with the delivery of Level 2 water are 100% reimbursable by CVP contractors.
Level 4 refuge water supply	The total water supply required for optimum habitat management for 19 Central Valley refuges identified in CVPIA. Level 4 water is 555,515 acre-feet, and is the total of Level 2 and Incremental Level 4 water supplies.
Locally Preferred Plan	Project alternative that is preferred by the non-Federal sponsor or project proponent.
mean sea level (msl)	The average height of the sea's surface. MSL is used as a datum plane for the measurements of elevations and depths.
mitigation	Those actions that will minimize the impacts that are projected to occur through project development.
Monterey Agreement	DWR and certain representatives of the SWP contractors agreed in 1994 to a set of principles, known as the Monterey Agreement, to settle long-term water allocation disputes and to establish a new water management strategy for the SWP. The disputes focused on the allocation of shortages in water supply—particularly under what circumstances the initial reductions to agricultural use should be imposed before reducing allocations to urban contractors—and concerned both temporary shortages that occur due to droughts and other temporary causes and the possibility of specified types of permanent shortages of supply of project water.
municipal and industrial (M&I)	Freshwater for urban area and industrial consumptive uses; also known as "urban water."
National Economic Development (NED)	A plan that reasonably maximizes net national economic development benefits consistent with the Federal objective to contribute to national economic development while protecting the nation's environment.
National Environmental Policy Act (NEPA)	A Federal law passed in 1970 (40 C.F.R. Parts 1501.1–1501.8) requiring Federal lead agencies to prepare and submit for public review Environmental Impact Statements on major Federal projects under their purview with potentially significant environmental effects. NEPA has three levels of analysis: Categorical Exclusion, Environmental Assessment, and Environmental Impact Statement.
non-government organization (NGO)	An organization that is neither a part of a government nor a conventional for-profit business. NGOs may be funded by governments, foundations, businesses, or private persons.

Term	Definition
non-native species	Botanical, wildlife, and aquatic species brought into a new area that originate elsewhere. Non-native species may dominate the local species or in some way negatively affect the environment of the native species.
non-project water	Water that is not CVP or SWP water. Refers to other water supplies acquired by CVP and SWP contractors.
normal pool (or reservoir) elevation	The highest elevation at which reservoir water is normally stored. This elevation is usually the spillway crest elevation.
noxious weed	An alien, introduced, or exotic, undesirable plant species that is aggressive and overly competitive with more desirable native species.
offstream storage	A reservoir that is not constructed on a major stream and receives water through conveyance from a remote location. The water supply for the reservoir is diverted from a nearby stream via one or more conveyance facilities to the reservoir.
Operations Criteria and Plan (OCAP)	See *CVP Operations Criteria and Plan, above*.
participating agency	Under NEPA, any Federal, State, tribal, regional, or local government agency, other than a lead or cooperating agency, that may have an interest in the implementation of a project. Non-governmental organizations and private entities cannot serve as participating agencies. A cooperating agency is any Federal agency other than a lead agency.
partnering agency	The project proponents that cost-share in the planning, design, construction, and operation of a project.
pelagic fish	Fish that live near the water's surface rather than on the bottom. Pelagic fish include Delta smelt, longfin smelt, striped bass, and salmon. Also refers to fish that live their entire lives in open water (e.g., Delta smelt, longfin smelt, and striped bass).
Principles and Guidelines	Released in 1983 by the U.S. Water Resources Council, the *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies*, known as the Principles and Guidelines or P&Gs, established standards and procedures for use by Reclamation and other Federal agencies when formulating, evaluating, and selecting major water projects, including projects related to water supply, navigation, storm resilience, wetland restoration, and flood-damage reduction (WRC 1983). The Water Resources Development Act of 2007 (P.L. 110-114) called for revisions to the 1983 P&Gs. In 2013, *Principles, Requirements, and Guidelines for Investments in Water Resources* (PR&G) were issued with the intent to revise and replace the 1983 P&Gs.
project yield	Water supply that can be delivered on a long-term basis that is attributed to all features of a project, including integrated operation of units that could be operated individually.

Term	Definition
Proposition 1	Approved In November 2014 by California voters, Proposition 1 authorizes $7.545 billion in general obligation bonds to fund various water-related programs, including $2.7 billion for new water storage projects. The programs will support the California Water Action Plan (see *California Water Action Plan*, above)
pumped storage project	A hydroelectric power plant and reservoir system that uses an arrangement whereby water released for generating energy during peak load periods is stored and pumped back into the upper reservoir, usually during periods of reduced power demand.
pumping-generating plant	A plant that can either pump water or generate electricity, depending on the direction of water flow. Alternative Definition: A plant with reversible turbine units that may be used to pump water or generate electricity.
range	The geographic area a species is known or believed to occupy.
Reasonable and Prudent Alternative (RPA)	The BiOps prepared by USFWS and NMFS may include RPAs that provide alternative actions to a proposed project that impose certain restrictions on project operations to be protective of the species when a proposed project is found to have the potential to jeopardize endangered species.
Reasonable and Prudent Measure (RPM)	The BiOps prepared by USFWS and NMFS may include RPMs that impose certain restrictions on project operations to be protective of the species.
Reclamation Temperature and Mortality model (RECTEMPMORT)	This model provides monthly average temperature calculations and uses output from CALSIM II.
recycled water	Urban wastewater that becomes suitable, as a result of treatment, for a specific beneficial use. Also called reclaimed water.
responsible agency	Under CEQA, an agency other than the lead agency that has legal responsibility for carrying out or approving a project or elements of a project. This agency is required to rely on the lead agency's environmental document in acting on whatever aspect of the project requires its approval, but must prepare and issue its own findings regarding the project (CEQA Guidelines Section 15096 [California Natural Resources Agency 2014]). CDFW, the Office of Historic Preservation, the Central Valley Flood Protection Board, the Air Resources Board, and the Central Valley Regional Water Quality Control Board are responsible agencies for the NODOS Feasibility Report.
restoration	Actions that are viewed as providing recovery to a pre-existing ecological condition.
riparian	Vegetation or other resources associated with a river that are dependent on groundwater and floodwater controlled by the river, the land adjacent to a natural watercourse such as a river or stream, and riparian water rights. Often supports vegetation that provides important wildlife habitat and important fish habitat values when growing large enough to overhang the bank.
riprap	A protective blanket of large, loose stones placed in random fashion on the upstream and downstream faces of embankment dams, streambanks, a reservoir shore, the sides of a channel, or other land surfaces to protect them from erosion or scour caused by current, wind, and/or wave action.

Term	Definition
river basin	The area of land from which water drains into a river, usually bounded peripherally by a natural divide of some kind such as a hill. For example, the land area of the Sacramento River Basin drains into the Sacramento River. Also called a drainage area or watershed.
runoff	The volume of surface flow from an area.
saddle dam	A subsidiary dam of any type constructed across a saddle or low point on the perimeter of a reservoir.
salinity	The amount of dissolved salts in a given volume of water. Salinity may be expressed in terms of a concentration or as an EC. When describing salinity influenced by seawater, salinity often refers to the concentration of chlorides in the water. See *total dissolved solids, below*.
SALMOD	Salmonid population model that incorporates streamflow, water temperature, and habitat type.
salmonid	Fish species belonging to the salmon family, including salmon and trout.
San Francisco Bay/Sacramento–San Joaquin River Delta (Delta)	As described in California Water Code Section 12220, an area that generally extends from Sacramento to the north, Tracy to the south, Interstate 5 to the east, and Collinsville to the west. The Delta covers approximately 738,000 acres.
scour	Removal of soil or fill material by the flow of floodwaters. The term is frequently used to describe storm-induced, localized conical erosion around pilings and other foundation supports where the obstruction of flow increases turbulence.
sediment	Rock and mineral particles transported by water. Sediment relevant to wetlands tends to be relatively fine because the low gradients involved do not transport larger particles.
sedimentation	The deposition by settling of a suspended material.
seepage	The movement of water through a porous material in response to a hydraulic gradient.
seismicity	The frequency, intensity, and distribution of earthquake activity in an area.
settlement	A downward movement of a surface as a result of underlying soil compression or consolidation caused by an increased load or the loss of underlying soil (foundation) support.
signal spillway	A spillway above the operating high water elevation of the reservoir that is alarmed to alert operators if the level in the reservoir exceeds the high water elevation (most likely due to over pumping). It is not an emergency release structure.
Sites Project Authority (Authority)	The Authority consists of seven member agencies: Reclamation District 108, Tehama-Colusa Canal Authority, Yolo County Flood Control and Conservation District, Maxwell Irrigation District, Glenn-Colusa Irrigation District, the County of Colusa, and the County of Glenn. The Authority formed to pursue the development and construction of Sites Reservoir.
smolt	A young salmon that has assumed the silvery color of the adult and is ready to migrate to the sea.

Term	Definition
snags	Fallen branches, any dead or dying standing tree, washed-out shrubs, and small logs. Snags are important for the provision of food, shelter, and breeding places for animals in the water.
special-status species	Federal and State classifications for plant and animal species that are either listed as threatened or endangered, are formally recognized candidates for listing, or are declining to a point where they may be listed.
spillway	A structure that passes normal and/or flood flows in a manner that protects the structural integrity of the dam, an overflow channel of a dam or impoundment structure, or a structure over or through which flow is discharged from a reservoir.
stage	Water surface elevation above an established datum; typically measured in feet above msl.
stakeholder	Anyone who lives in a watershed or has land management, administrative, or other responsibilities or interests in it. Stakeholders may be individuals, businesses, government agencies, or interest groups.
State Water Project (SWP)	A major California State water storage and conveyance system that pumps water from the Delta for agricultural, urban domestic, and industrial purposes. The SWP was authorized by legislation in 1951.
State water system	All of the state's water systems collectively, including local, regional, state, and federal systems that provide water resources benefits within California, regardless of whether the benefits are public or private.
surface water	Water that remains on the earth's surface, in rivers, lakes, reservoirs, or oceans.
suspended load	Sediment that is transported by suspension in the water column of a stream or river.
Sustainable Groundwater Management Act (SGMA)	The California law (2015 Amendments [effective January 1, 2016]; related statutory provisions are SB 1168 [Pavley], AB 1739 [Dickinson], and SB 1319 [Pavley]) that aims for local and regional agencies to develop and implement sustainable groundwater management plans. When fully implemented, SGMA is expected to effectively administer groundwater pumping within the state.
Table A amount	The maximum amount of SWP water that the State has agreed to make available for delivery to a SWP contractor during the year. The State and the SWP contractors also use Table A amounts to serve as a basis for allocation of some SWP costs among the contractors. Alternative Definition: The amount of water a contractor is entitled to buy from DWR over a specified period, usually 1 year.
take	Take of species under the Federal ESA: To harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct. Take of species under the CESA: An action to or attempt to hunt, pursue, catch, capture, or kill.
terrestrial species	Types of species of animals and plants that live on or grow from the land.
threatened species	Any species that has the potential to become endangered in the near future.

Term	Definition
total dissolved solids (TDS)	A quantitative measure of the residual minerals dissolved in water that remain after evaporation of a solution. Usually expressed in milligrams per liter. See *salinity*.
trash rack	A metal or reinforced concrete structure placed at the intake of a conduit, pipe, or tunnel that prevents the entrance of debris over a certain size. A device or structure at an intake to prevent floating or submerged debris from entering the intake.
tributary	A stream flowing into a lake or larger stream.
turbidity	A decrease in the transparency of a solution due to the presence of suspended and dissolved substances. This decrease causes incident light to be scattered, reflected, and attenuated rather than transmitted in straight lines; the higher the intensity of the scattered or attenuated light, the higher the value of the turbidity. Generally reported as either Nephelometric Turbidity Units (newer usage) or Fiber Transceiver Units (older usage).
unimpaired flow	The flow past a specified point on a natural stream that is, or would be, unaffected by stream diversion, storage, import, export, return flow, or change in use caused by modifications in land use. Sometimes referred to as historic flow without development.
Upper Sacramento River Daily Operations Model (USRDOM)	A model developed to simulate daily reservoir operations and daily river flows for the Upper Sacramento River.
Upper Sacramento River Temperature/ Water Quality Model (USRWQM)	A model developed to simulate the temperature regime of the Upper Sacramento River and provide estimates of daily average riverine temperature conditions.
vernal pools	Ephemeral wetlands forming in shallow depressions underlain by a substrate near the surface that restricts the percolation of water.
water conveyance capacity	The flow capacity of a channel; used to describe the flow in channels.
water diversions	Withdrawal of water from a water body, some of which might be returned downstream after use.
water quality	Description of the chemical, physical, and biological characteristics of water, usually in regard to its suitability for a particular purpose or use.
Water Quality Control Plan (WQCP)	The WQCP (or Basin Plan) defines and designates beneficial uses of waters, establishes water quality objectives to protect those uses, identifies water quality threats, and outlines corrective measures to be implemented. The WQCP is used to develop discharge limits and guide Regional Water Quality Control Board decisions on specific cases.
water reliability	A measure of a system's ability to sustain the social, environmental, and economic systems that it serves during different types of years (e.g., dry, wet, average years).

Term	Definition
water rights	In water law, refers to the right of a user to use water from a water source (e.g., a river, stream, pond, or source of groundwater). Water rights in California are administered by the State Water Resources Control Board. Alternative Definition: A legally protected right to take possession of water occurring in a water supply and to divert it to beneficial uses. Appropriative Water Right – A water right based on physical control over surface water or based on a permit or license for its beneficial use. Appropriative water rights are divided into pre-1914 and post-1914 water rights. Post-1914 rights require a State-issued permit or license for beneficial use. Area of Origin – Water right statutes initiated in 1931 to protect local areas against export of water. These statues have seldom been invoked. Riparian Water Right – A water right based on the ownership of land bordering a river or waterway. A landowner whose property borders a river has a right to use water from that river on his land. This right cannot be transferred apart from the land, except for fish and wildlife purposes.
watershed	The area of land from which water drains into a river, usually bounded peripherally by a natural divide of some kind such as a hill. For example, the land area of the Sacramento River Basin drains into the Sacramento River. Also called drainage area or river basin.
waters of the United States	As defined in Section 404 of the Federal Clean Water Act waters of the United States refers to: Navigable waters of the United States, interstate waters, all other waters where the use or degradation or destruction of the waters could affect interstate or foreign commerce, tributaries to any of these waters, and wetlands that meet any of these criteria or are adjacent to any of the above.
Water Storage Investment Program (WSIP)	A program through which the California Water Commission evaluates applications and allocates $2.7 billion of bond funding to eligible projects. Funding is limited to eligible projects for benefits associated with: (1) Ecosystem improvements, (2) Water quality improvements in the Delta, or in other river systems, (3) Flood control, (4) Emergency response, and (5) Recreation (WC § 79753).
water transfers	Marketing arrangements that can include the permanent sale of a water right by the water right holder; a lease of the right to use water from the water right holder; and the sale or lease of a contractual right to water supply.
water-year	California's water-year begins on October 1, the beginning of the rainy season, and ends on September 30 of the following calendar year.
wetland	Areas that are inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support—and that under normal circumstances do support—a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.

Term	Definition
X2	The location (measured in kilometers from the Golden Gate Bridge) where TDS concentrations are 2 parts per thousand. The length of time X2 must be positioned at set locations in the estuary each month is determined by a formula that considers the previous month's inflow to the Delta and a "Level of Development" factor, denoted by a particular year. X2 is currently used as the primary indicator in managing Delta outflows. The X2 indicator is also used to reflect a variety of biological consequences related to the magnitude of freshwater flowing downstream through the estuary and the upstream flow of saltwater in the lower portion of the estuary. The outflow that determines the location of X2 also affects both the downstream transport of some organisms and the upstream movement of others and affects the overall water operations of the CVP and SWP.

Chapter 14 References

Anderson, James. (2018). Using river temperature to optimize fish incubation metabolism and survival: a case for mechanistic models. 10.1101/257154.

Authority (Sites Project Authority). 2014. *Sites Reservoir Alternatives Evaluation.* November.

Authority. 2016a. *Mitigation Measure Evaluation and Cost Estimate.*

Authority. 2016b. *Sacramento and San Joaquin Basins Study.* March.

Authority. 2017. *Sites Project Water Storage Investment Program Application.* August (est.).

Bartholow, J. M. 2003. *Modeling Chinook Salmon with SALMOD on the Sacramento River, California.*

CALFED (California Federal Bay-Delta Program). 2000a. *CALFED Bay-Delta Program Final Environmental Impact Statement/Environmental Impact Report.* July. [Referred to in text as CALFED PEIS/EIR.]

CALFED. 2000b. *CALFED Bay-Delta Programmatic Record of Decision.* August. [Referred to in text as CALFED ROD.]

CALFED. 2000c. *Initial Surface Water Storage Screening Report.* August.

California Department of Finance. 2016. *E-2 California County Population Estimates and Components of Change by Year.*

California Natural Resources Agency. 2014. CEQA Guidelines Section 15096. Accessed March 2017. http://resources.ca.gov/ceqa/guidelines/.

California Natural Resources Agency. 2015. Draft CalWater Fix Economic Analysis, November 2015. Available at: http://www.restorethedelta.org/wp-content/uploads/2016/09/CA-WaterFix-Economic-Analysis-Sunding.pdf.

California Natural Resources Agency. 2017. *Delta Smelt Resiliency Strategy Progress Report.* June.

CH2M Hill. 2016a. Sites Project Water Operations Overview. Presentation by CH2M Hill. October.

CH2M Hill. 2016b. *White Paper: Water Rights Considerations for Sites Reservoir.*

CWC (California Water Commission). 2016. *Water Storage Investment Program Draft Technical Reference.* November.

Davids Engineering and Orland-Artois Water District. 2002. *Groundwater Management Plan.*

Delta Stewardship Council. 2013. *The Delta Plan.* May.

Delta Vision Blue Ribbon Task Force. 2008. *Our Vision for the California Delta.*

DWR (California Department of Water Resources). 1975. *Major Surface Water Development Opportunities in the Sacramento Valley: A Progress Report.* DWR Northern District. February.

DWR. 2005. *California Water Plan Update 2005: A Framework for Action.*

DWR. 2006. *Technical Memorandum Report on Progress on Incorporating Climate Change into Management of California's Water Resource.*

DWR. 2007. *Surface Storage Investigation Highlights.*

DWR. 2008. *Flood Rapid Assessment Model (F-RAM) Development.* Developed by URS for DWR. November.

DWR. 2009. *Delta Risk Management Strategy, Phase 1.* February.

DWR. 2012. *Bay Delta Conservation Plan (BDCP) Effects Analysis and ADEIR/S.*

DWR. 2013. *California Water Plan Update 2013.*

DWR. 2014a. *Preliminary Design and Cost Estimating Report.* May.

DWR. 2014b. *North-of-the Delta Offstream Storage Preliminary Administrative Draft Environmental Impact Report.* May.

DWR. 2016. Appendix B, Table B-24. In: *Equivalent Unit Charge for Water Supply for Each Contractor.* Bulletin 132-16.

DWR. 2017. *Water Available for Replenishment Report.* January.

EPA (United States Environmental Protection Agency). 1980. *Information for States on Developing Affordability of Drinking Water.* Office of Drinking Water.

Executive Office of the President. 2013. *The President's Climate Action Plan.* Washington, DC: The White House, June.

Federal Register. 2016. "Department of the Interior, Bureau of Reclamation [RR83550000, 178R5065C6, RX.59389832.1009676], Change in Discount Rate for Water Resources Planning." Vol. 81, No. 227 (Friday, November 25, 2016). Accessed February 2017, http://docs.regulations.justia.com/entries/2016-11-25/2016-28339.pdf.

Groot, C., and L. Margolis. 1991. *Pacific Salmon Life Histories.* December.

Kent, J. J. 1999. *Application of SA of a Salmonid Population Model for the Sacramento River, California.* Master's Thesis, Colorado State University, Fort Collins, Colorado, 79 pp.

Loomis, John. 2005. *Updated Outdoor Recreation Use Values on National Forests and Other Public Lands.* General Technical Report PNW-GTR-658. Portland, Oregon: USDA Forest Service, Pacific Northwest Research Station. October. http://www.fs.fed.us/pnw/pubs/pnw_gtr658.pdf.

Martin, B. T., A. Pike, S. N. John, N. Hamda, J. Roberts, S. T. Lindley, and E. M. Danner. 2017. Phenomenological vs. Biophysical Models of Thermal Stress in Aquatic Eggs. *Ecology Letters* 20:50–59.

NMFS (National Marine Fisheries Service). 2009. *Biological Opinion and Conference Opinion of the Long-Term Operations of the Central Valley Project and State Water Project,* National Marines Fisheries Service, Southwest Region. June 4.

NMFS. 2014. *Recovery Plan for Sacramento River Winter-run Chinook Salmon, Central Valley Spring-run Chinook Salmon, and Central Valley Steelhead.* July.

NRA, CDFA, and CalEPA (California Natural Resources Agency, California Department of Food and Agriculture, and California Environmental Protection Agency). 2014. *California Water Action Plan.*

NRA, CDFA, and CalEPA. n.d. *California Water Action Plan 2016 Update.* No date. http://resources.ca.gov/docs/california_water_action_plan/Final_California_Water_Action_Plan.pdf.

Public Policy Institute of California. 2007. *Envisioning Futures for the Sacramento–San Joaquin Delta.*

Raftelis Financial Consultants Inc. and American Water Works Association. n.d. *2015 California-Nevada Water and Wastewater Rate Survey*. Rancho Cucamonga, California: California-Nevada Section, American Water Works Association, no date. Accessed July 2017. https://assets.documentcloud.org/documents/3731528/CANVRateSurvey2015.pdf.

Reclamation (Bureau of Reclamation). 1988. *Central Valley Project Irrigation Ratesetting Policy*.

Reclamation. 1989a. *Report on Refuge Water Supply Investigations: Central Valley Hydrologic Basin, California.* Sacramento, California.

Reclamation. 1989b. *San Joaquin Basin Action Plan/Kesterson Mitigation Report*. December.

Reclamation. 2008. *Water Supply and Yield Study.* Mid-Pacific Region. March.

Reclamation. 2011. Draft Shasta Lake Water Resources Investigation Feasibility Report. November.

Reclamation. 2012a. *Reclamation Manual: Directives and Standards.* CMP 09-02. Subject: Water and Related Resources Feasibility Studies. September 13.

Reclamation. 2012b. *Final Value Planning Study, North-of-the-Delta Offstream Storage Investigation.* November.

Reclamation. 2014a. *Design, Construction, and Estimating Review Report for North-of-the-Delta Offstream Storage*. May.

Reclamation. 2014b. *Central Valley Project Integrated Resource Plan Final Report.* November.

Reclamation. 2014c. *Sacramento and San Joaquin Basins Study Climate Impact Assessment*. September.

Reclamation. 2015. *Shasta Lake Water Resources Investigation: Feasibility Report*. Mid-Pacific Region. July.

Reclamation. 2016a. *NODOS Investigation Project Management Plan*.

Reclamation. 2016b. *Sacramento and San Joaquin Basins Study*. March.

Reclamation. 2017a. Central Valley Project (CVP). Mid-Pacific Region website. Last updated January 5, 2017. https://www.usbr.gov/mp/cvp/index.html.

Reclamation. 2017b. *Outbriefing: North-of-the-Delta Offstream Storage Investigation (NODOS) Special Assessment Review*. March.

Reclamation. 2017c. *Design, Estimating, and Constructability Special Assessment*.

Reclamation. 2019a. *Long-Term Coordinated Operation of the CVP and SWP: Biological Assessment*. Mid-Pacific Region. August.

Reclamation. 2019b. *Reclamation Manual Directives and Standards, TRMR 122*.

Reclamation 2019c. *Irrigation Ability-to-Pay Analyses* (PEC 11-01).

Reclamation and Authority (Bureau of Reclamation and Sites Project Authority). 2015. *Memorandum of Understanding*. July.

Reclamation and Authority. 2017. *Draft Sites Reservoir Environmental Impact Report/ Environmental Impact Statement*. July/August (est.).

Reclamation and Authority. 2018. Presentation. *Comments on Draft Sites Reservoir Environmental Impact Report/ Environmental Impact Statement*. July/August (est.).

Reclamation and DWR (Bureau of Reclamation and California Department of Water Resources). 2002. *North-of-the-Delta Offstream Storage Investigation Scoping Report*. [Referred to in text as Scoping Report.]

Reclamation and DWR. 2006a. *North-of-the-Delta Offstream Storage Investigation: Initial Alternatives Information Report*. May.

Reclamation and DWR. 2006b. *North-of-the-Delta Offstream Storage Investigation Final Initial Alternatives Information Report*. [Referred to in text as IAIR.]

Reclamation and DWR. 2008. *North-of-the-Delta Offstream Storage Investigation Plan Formulation Report*. [Referred to in text as the PFR.]

Reclamation and DWR. 2013. *North-of-the-Delta Offstream Storage Investigation, 2013 Progress Report*. December.

Reclamation and DWR. 2016. *Central Valley Project and State Water Project 2016 Drought Contingency Plan for Water Project Operations*. February–November.

Reclamation and USFWS (Bureau of Reclamation and United States Fish and Wildlife Service). 2003. Decision of Implementation of Section 3406(b)(2) of the Central Valley Project Improvement Act. May.

RWQCB (Central Valley Regional Water Quality Control Board). 2016. *Water Quality Control Plan for the Sacramento and San Joaquin River Basins*. July.

SWRCB (State Water Resources Control Board). 1978. Water Rights Decision 1485.

SWRCB. 1991. *Delta Water Quality Control Plan for Salinity, Temperature, and Dissolved Oxygen*.

SWRCB. 1995. *Bay-Delta Water Quality Control Plan*. May.

SWRCB. 2000. Water Rights Decision 1641 Revised. March.

SWRCB. 2010. *Development of Flow Criteria for the Sacramento-San Joaquin Delta Ecosystem*. Final. California Environmental Protection Agency. August 3.

SWRCB. 2016. Water Rights: Frequently Asked Questions. Accessed February 2017. http://www.waterboards.ca.gov/waterrights/board_info/faqs.shtml.

SWRCB. 2018. *SWRCB July 2018 Framework for the Sacramento/Delta Update to the Bay-Delta Plan*.

Toolson, Eric, and Nan Zhang. 2013. *NODOS Hydropower Benefits*. November.

U.S. Census Bureau. 2013. *Families and Living Arrangements*. https://www.census.gov/hhes/families/data/cps2013.html.

U.S. Department of Agriculture. 2018. *2018 California Almond Acreage Report*.

USFWS (United States Fish and Wildlife Service). 2008. *Biological Opinion on the Effects of Long Term Coordinated Operations of the Central Valley (CVP) and State Water Project (SWP) on Delta Smelt and its Designated Critical Habitat*. December 13.

WRC (U.S. Water Resources Council). 1983. *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies*. Washington, DC, March 10. [Referred to in text as P&Gs.]

WRC. 2013. *Principles, Requirements and Guidelines for Federal Investments in Water Resources*. March.

WRC. 2015. *Principles, Requirements and Guidelines for Federal Investments in Water Resources*. May.

This page intentionally left blank

Acronyms and Abbreviations

°F	Fahrenheit
AB	Assembly Bill
AF	Acre-feet
ATP	ability to pay
Authority	Sites Project Authority
BA	Biological Assessment
Bay-Delta	San Francisco Bay–Sacramento River and San Joaquin River Delta
BCR	Benefit-cost ratio
BDCP	Bay Delta Conservation Plan
BiOp	USFWS Biological Opinion
BMP	Best Management Practice
C.F.R.	Code of Federal Regulations
CAISO	California Independent System Operator
CALFED PEIS/EIR	CALFED Bay-Delta Program Final Environmental Impact Statement / Environmental Impact Report
CALFED ROD	CALFED Bay-Delta Programmatic Record of Decision
Caltrans	California Department of Transportation
CBD	Colusa Basin Drain
CCR	California Code of Regulations
CDFW	California Department of Fish and Wildlife
CEQA	California Environmental Quality Act
CESA	California Endangered Species Act

cfs	cubic feet per second
CMIP3	Coupled Model Intercomparison Project Phase 3
CMP 09-02	Reclamation Manual: Directives and Standards–Water and Related Resources Feasibility Studies
COA	Coordinated Operations Agreement
CVO	Central Valley Operations
CVP	Central Valley Project
CVPIA	Central Valley Project Improvement Act
CWA	Clean Water Act
CWC	California Water Commission
CY	cubic yard(s)
D-1485	Delta and Suisun Marsh and Water Right Decision 1485
D-1641	State Water Resources Control Board Decision 1641
DEC	Design, Estimating, and Construction
Delta	Sacramento–San Joaquin River Delta
DOI	United States Department of the Interior
DPS	Southern Distinct Population Segment
DWR	California Department of Water Resources
EC_w	electrical conductivity
EIR	Environmental Impact Report
EIS	Environmental Impact Statement
ELT	Early Long-Term
EPA	United States Environmental Protection Agency
EQ	Environmental Quality
ERP	Ecosystem Restoration Program

ESA	Federal Endangered Species Act
ESU	evolutionarily significant unit
FAC	Reclamation Manual Series – Project Planning and Facility Operations, Maintenance, and Rehabilitation
Feasibility Report	North-of-the-Delta Offstream Storage Investigation Feasibility Report
FTE	full-time equivalent
FWCA	Fish and Wildlife Coordination Act
GCID	Glenn-Colusa Irrigation District
GCM	general circulation model
GHG	greenhouse gas
GWh	gigawatt-hours
I-	Interstate
IAIR	North-of-the-Delta Offstream Storage Investigation Final Initial Alternatives Information Report
IDC	Interest During Construction
IL4	Incremental Level 4
Investigation	North-of-the-Delta Offstream Storage Investigation
IOS	Interactive Object-oriented Salmon Simulation
km	Kilometer(s)
kV	Kilovolt(s)
LCPSIM	Least-Cost Planning Simulation Model
LLT	Late Long-Term
LOPP	Lease of Power Privilege
LPP	Locally Preferred Plan
LTGen	LongTermGen
M&I	municipal and industrial

MAF	million acre-feet
MCL	Maximum Contaminant Level
mg/L	milligram(s) per liter
MOU	Memorandum of Understanding
msl	mean sea level
MW	megawatt(s)
NED	National Economic Development
NEPA	National Environmental Policy Act
NGO	non-governmental organization
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NOD	North-of-the-Delta
NODOS	North-of-the-Delta Offstream Storage
NOI	Notice of Intent
NOP	Notice of Preparation
NOx	Nitrous oxides
NPV	Net Present Value
NWR	National Wildlife Refuge
OCAP	Operations Criteria and Plan
OM&R	operation, maintenance, and replacement
OSE	Other Social Effects
P&Gs	Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies
P.L.	Public Law
PARO	Power and Risk Office

PFR	North-of-the-Delta Offstream Storage Investigation Plan Formulation Report
PG&E	Pacific Gas and Electric Company
P.L.	Public Law
ppt	part(s) per thousand
QRA	Quantitative Risk Assessment
RBPP	Red Bluff Pumping Plant
Reclamation	Bureau of Reclamation
RED	Regional Economic Development
ROD	Record of Decision
ROG	reactive organic gases
RPA	Reasonable and Prudent Alternative
RWSP	Refuge Water Supply Program
SALMOD model	Sacramento River Chinook Salmon Juvenile Production
SB	Senate Bill
Scoping Report	North-of-the-Delta Offstream Storage Investigation Scoping Report
SGMA	Sustainable Groundwater Management Act
SHPO	State Historic Preservation Officer
SR	State Route
State	State of California
SWAP	Statewide Agricultural Production
SWP	State Water Project
SWRCB	State Water Resources Control Board
TAF	thousand acre-feet
TAF/year	thousand acre-feet per year
T-C	Tehama-Colusa

TCCA	Tehama-Colusa Canal Authority
TDS	total dissolved solids
TRR	Terminal Regulating Reservoir
Tullet	Tullet Liberty
U.S.C.	United States Code
USACE	United States Army Corps of Engineers
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
WAPA	Western Area Power Association
WC	California Water Code
WIFIA	Water Infrastructure Finance and Innovation Act
WIIN	Water Infrastructure Improvements for the Nation
WQCP	Water Quality Control Plan
WRC	Water Resources Council
WSE	water surface elevation
WSIP	Water Storage Investment Program
X2	the distance in kilometers from the Golden Gate Bridge to the location where salinity in the Delta is 2 parts per thousand